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Constellation Energy
Nuclear Generation Group

January 22, 2009

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Amendment to Application to Revise Technical Specification Limiting Conditions of Operation (LCOs) 3.3.2, 3.3.4, and 3.8.1

REFERENCES: a) Letter from John Carlin (Ginna LLC) to Document Control Desk (NRC) dated December 19, 2008, Application to Revise Technical Specification Limiting Conditions of Operation (LCOs) 3.3.2, 3.3.4, and 3.8.1

By letter dated December 19, 2008 (Ref (a)), R.E. Ginna Nuclear Power Plant (Ginna LLC) requested an amendment to Ginna Renewed Operating License DPR-18.

The attachments included with the original letter require replacement. Ginna LLC requests that the original Attachments 3, 4, and 5 of Reference (a) that were provided to the NRC be superseded with the attached files included as an enclosure to this letter.

Should you have questions regarding the information in this submittal, please contact Mr. David Wilson at (585) 771-5219 or at David.F.Wilson@Constellation.com.

Very truly yours,

John Carlin

A001
NRR

1002081

STATE OF NEW YORK :
: **TO WIT:**
COUNTY OF WAYNE :

I, John Carlin, being duly sworn, state that I am Vice President, R.E. Ginna Nuclear Power Plant, LLC (Ginna LLC), and that I am duly authorized to execute and file this request on behalf of Ginna LLC. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Ginna LLC employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and for the State of New York and County of Monroe, this 22 day of January, 2009.

WITNESS my Hand and Notarial Seal:

Notary Public

SHARON L. MILLER
Notary Public, State of New York
Registration No. 01MI6017755
Monroe County
Commission Expires December 21, 2010

My Commission Expires: 12-21-10
Date

Enclosure: Revised Attachments 3 Through 5

cc: S. J. Collins, NRC
D. V. Pickett, NRC
Resident Inspector, NRC (Ginna)
P. D. Eddy, NYSDPS
J. P. Spath, NYSERDA

ENCLOSURE

Revised Attachments 3 Through 5

ATTACHMENT 3

DA-EE-96-068-03
"Offsite Power Load Flow Study"

CALCULATION COVER SHEET

A. INITIATION

Site ☐ CCNPP ☐ NMP ☒ REG

Calculation No.: DA-EE-96-068-03 Revision No.: 5

Vendor Calculation (Check one): ☐ Yes ☒ No

Responsible Group: NEE

Responsible Engineer: Bill Roettger

B. CALCULATION

ENGINEERING DISCIPLINE: ☐ Civil ☐ Instr & Controls ☐ Nuclear ☒ Electrical ☐ Mechanical ☐ Other ____

Title: OFFSITE POWER LOAD FLOW STUDY

Unit ☒ 1 ☐ 2 ☐ COMMON

Proprietary or Safeguards Calculation ☐ YES ☒ NO

Comments: PERIODIC REVISION

Vendor Calc No.: ____ REVISION NO.: ____

Vendor Name: ____

Safety Class (Check one): ☒ SR ☐ AUGMENTED QUALITY ☐ NSR

There are assumptions that require Verification during walkdown: TRACKING ID: N/A

This calculation **SUPERSEDES**: DA-EE-96-068-03, REVISION 4

C. REVIEW AND APPROVAL:

Responsible Engineer: Bill Roettger W C Roettger — Printed Name and Signature — August 23, 2007 Date

Is Design Verification Required? ☑ Yes ~~☒ No~~ PS

If yes, Design Verification Form is ☑ Attached ☐ Filed with: ____

Independent Reviewer: Paul Swift Paul W Swift — Printed Name and Signature — 8/23/07 Date

Approval: [signature] — Printed Name and Signature — 8/24/07 Date

Revision Status Sheet

Revision Number	**Affected Sections**	**Description of Revision**
0	all	Original document
1	all	See Revision 1
2	all	See Revision 2
3	all	See Revision 3
4	all	See Section 1.2
5	all	See Section 1.3

1.0 OBJECTIVE and REVISION HISTORY

1.1 The primary purpose of this analysis is to demonstrate that the Ginna Station offsite power sources will be capable of maintaining adequate voltage regulation for all required operating conditions. The expected electrical system voltages will be evaluated for both normal and emergency operating conditions. In addition the continuous current duty imposed on the power distribution equipment (transformers, cables, circuit breakers, bus work, etc) will be reported for informational purposes. While evaluation of the continuous rating of equipment is outside the scope of this analysis, this information is reported in order to facilitate other analysis.

1.1.1 This analysis will also demonstrate the ability of the offsite power system to maintain adequate voltages during plant start up conditions and other motor starting events.

1.2 Specific changes that were associated with the previous revision (4) to this calculation included the following:

- Modify the maximum dropout voltage associated with the loss of voltage relays on the safety related 480 Volt buses. This value was decreased from 382.4 to 378.8 volts (Ref 4.34).
- Modify the technique for evaluating the degraded undervoltage relays response to an initial voltage dip followed by stepped voltage increases secondary to LTC action (Attachment XII).
- Modify the ETAP model to reflect motor field measurement data collected during plant start up subsequent to the 2006 outage
    - CATS 12982 (RCP motor start data and evaluate the need for pre-RCP start criteria). For the RCP motor start simulations, the RCP Locked Rotor Current Value (at 4000 Volts) was reduced to 4583 amps (from 4800 amps) based on field testing (See attachment VII). Also the starting power factor was increased from 2.2% to 10.% in order to reflect a more typical, yet conservative value. Also the RHR pumps were re-configured to be on during the RCP start and the pressurizer heaters were re-configured to be off.
    - Update LTC (767 and 7T) timing based on RCP motor start data (Attachment VII).
    - Update the BHP loading information associated with the MFWP motors.
- Modify the ETAP model to reflect any updated manufacturer information associated with new equipment installed during the 2006 outage (MFWP, Transformer 7T final test reports, etc)
    - The two 5300 HP, 4kV MFWP motors were renameplated as 5500 HP, 4kV motors. Test data was collected during the outage so that the motor loading during normal conditions could be refined. The complete motor details are contained in Attachment VII.
    - The 7T tap changing field tests (after installation of new pulley) indicated that the time between tap changes would be 3.0 seconds. Also the final test report

indicated a slight change in impedance (Final Z = 3.89%, Final X/R = 15.62; Previous values = 3.83% and 13.39).

- Updated the Containment Fan ETAP model to better match the power factor and efficiencies listed in the January 14, 1993 manufacture report (NOTE: Slightly better power factor and efficiency values were contained in a July 5, 1993 report however the more conservative values in the January 14, 1993 report were used). Also updated the locked rotor current value based on curve KN011492 (Locked rotor current reduced to 1689.6 amps from 1772 Amps)
- Based upon a review of the anticipated flow rates and the associated pump curves, the following BHP loading modifications were made (See Attachment 7 for details)

Motor	HP (Rated)	Old BHP (%)	Revised BHP (%)	Revised BHP Applicable for the following situations
Containment Spray	200	111	100	Accident
RHR	200	87	75	Accident and RCP Start
CCW	150	99	66	All cases
SI	350	106	100	Accident

- Turned control room heaters off (MCCN and MCCP) for Accident Cases (See Attachment 7)
- Expand the scope to include offsite power alarm setpoint (108.9 kV) simulations for LOCA conditions (verify that neither the loss of voltage relay and/or the degraded voltage relays will operate).
- Upgraded the model to be compatible with ETAP Power Station Version 5.5.0N
- Upgraded the presentation of results to include a one page summary sheet for each case.

1.3 Specific changes that are associated with this revision (5) to this calculation include the following:

- Modify the bus voltage criteria associated with the loss of voltage relays on the safety related 480 Volt buses. The bus voltage is now required not to drop below the maximum Analytical Limit associated with the loss of voltage relay which has been established as 95.3 volts in DA-EE-93-006-08. The voltage of 95.3 corresponds to 381.2 volts or 79.42% of 480. The previous version of this calculation used a criterion of 378.8 volts or 78.92%.
- Modify the bus voltage criteria associated with the degraded voltage relays on the safety related 480 Volt buses. The bus voltage is now required to recover above 100.5% of the maximum Analytical Limit associated with the degraded voltage relay prior to the degraded voltage relay timing out. The 100.5% factor translates the relays maximum dropout value to a maximum reset value. The maximum analytical limit, which has been established as 108.0 volts in DA-EE-93-006-08, results in a bus voltage criterion of 108.54 volts. The voltage of 108.54 corresponds to 434.16 volts

or 90.45% of 480. The previous version of this calculation used a criteria of 433.2 volts or 90.25%

- Modified the MCC loading (slightly) to be consistent with the most recent version of DA-EE-92-011-07. The loading on MCC C increased by about 2 kW (see Attachment 7 for details).
- Based upon a review of the anticipated flow rates and the associated pump curves, the following BHP loading modifications were made (See Attachment 7 for details)

Motor	HP (Rated)	BHP (%) - LF Rev 4	BHP (%) - LF Rev 5	Revised BHP Applicable for the following situations
Containment Spray	200	100	111	Accident (Injection)
RHR	200	75	75	Accident (Injection)
RHR	200	75	87	RCP Start
CCW	150	66	66	Normal and Injection
CCW	150	66	100	RCP Start
SI	350	100	106	Accident (Injection)
Containment Fan	300	86	80	Accident (Injection)
Containment Fan	300	32	32	Normal, RCP Start

The above BHP changes resulted in no motor MW loading change for the normal operating condition simulations, increased the accident loading simulations by approximately 0.04 MW and increased the loading for the RCP start simulation by approximately 0.112 MW. The above BHP changes also resulted in no motor MW loading change for the "Plant Trip, No Accident" simulations.

2.0 CONCLUSIONS

2.1 The Ginna offsite and onsite power distribution system is shown to provide adequate voltage levels for the safety related buses as well as the 4kV buses; the voltages for the non safety related 480 volt buses were quantified in this analysis but not specifically evaluated for adequacy. Numerous plant operating modes and all offsite power alignments were evaluated. The detailed results of all of the simulations are presented in Attachment XI. A summary of the non-motor starting load flow simulations and key results are shown in the following table:

Ginna Nuclear Station - Summary of Load Flow Simulations, 2007 As Built (Ref DA-EE-96-068-03, Rev 5)

Case	Lowest (or highest) 480 V "Safety Related Bus" Voltage			480 V Bus Voltage Criteria	Lowest (or highest) 4kV Bus Voltage			4160 V Bus Voltage Criteria	Total In-house Motor Load		Total In-house Static Load		Total In-house (Total Load)		Maximum Branch Overload (non cable)	Branch Overload ID
	Bus Name	Voltage (% 480)	Voltage /Criteria	Volts (%)	Bus Name	Voltage (% 4160)	Voltage /Criteria	Volts (%)	MW	MVAR	MW	MVAR	MW	MVAR	(% Rating)	
101_2007_AB	Bus 17	95.60	1.06	90.45	RCP1A	98.36	1.14	86.54	29.61	14.93	1.28	-2.06	30.88	12.87	100.0	Main Generator
101b_2007_AB	Bus 17	96.51	1.07	90.45	RCP1A	98.43	1.14	86.54	29.61	14.93	1.30	-2.06	30.91	12.87	100.0	Main Generator
101c_2007_ab	Bus 17	100.30	1.11	90.45	XFMR18P	103.39	1.19	86.54	29.61	14.93	1.40	-2.41	31.01	12.52	100.0	Main Generator
102G_2007_AB	Bus 16	103.54	0.98	105.42	Xfmr11_Xwndg_Secondary	107.03	1.01	105.77	28.31	14.23	0.06	-2.41	28.37	11.82	100.0	Main Generator
102_2007_AB	Bus 16	103.54	0.98	105.42	Xfmr12BSecX	104.25	0.99	105.77	28.31	14.23	0.06	-2.28	28.37	11.95	100.0	Main Generator
103_2007_AB	Bus 16	103.55	0.98	105.42	Xfmr12ASecX	104.27	0.99	105.77	28.31	14.23	0.06	-2.28	28.37	11.95	100.0	Main Generator
104_2007_AB	Bus 16	103.38	0.98	105.42	Xfmr11_Xwndg_Secondary	104.14	0.98	105.77	28.31	14.23	0.06	-2.28	28.37	11.95	100.0	Main Generator
105_2007_AB	Bus 16	103.44	0.98	105.42	Xfmr12ASecX	104.16	0.98	105.77	28.31	14.23	0.06	-2.28	28.37	11.95	100.0	Main Generator
106_2007_AB	Bus 16	87.10	1.10	79.42	RCPB_SW	90.15	1.12	80.77	24.92	12.57	0.65	-1.74	25.57	10.83	0.0	0
107_2007_AB	Bus 14	86.30	1.09	79.42	RCP1A	89.47	1.11	80.77	24.92	12.57	0.64	-1.72	25.57	10.85	0.0	0
108_2007_AB	Bus 14	83.03	1.05	79.42	RCP1A	86.30	1.07	80.77	24.92	12.57	0.59	-1.59	25.51	10.98	109.3	767Regulator
109_2007_AB	Bus 16	85.34	1.07	79.42	RCPB_SW	88.43	1.09	80.77	24.92	12.57	0.62	-1.67	25.54	10.90	0.0	0
110_2007_AB	Bus 14	95.03	1.06	90.45	RCP1A	97.99	1.13	86.54	24.92	12.57	0.77	-2.04	25.69	10.53	0.0	0
111_2007_AB	Bus 16	95.02	1.05	90.45	RCPB_SW	97.89	1.13	86.54	24.92	12.57	0.77	-2.04	25.69	10.53	0.0	0
112_2007_AB	Bus 14	94.27	1.04	90.45	RCP1A	97.26	1.12	86.54	24.92	12.57	0.76	-2.02	25.68	10.55	108.0	767Regulator
112B_2007_AB	Bus 14	94.62	1.05	90.45	RCP1A	97.59	1.13	86.54	23.90	12.06	0.77	-2.04	24.67	10.02	103.5	767Regulator
113_2007_AB	Bus 16	95.33	1.05	90.45	RCPB_SW	98.19	1.13	86.54	24.92	12.57	0.77	-2.08	25.70	10.52	0.0	0
114_2007_AB	Bus 16	85.54	1.08	79.42	Xfmr 16P	91.76	1.14	80.77	16.41	9.08	0.04	-1.80	16.46	7.28	102.3	SST14
115_2007_AB	Bus 14	84.76	1.07	79.42	Xfmr14P	91.17	1.13	80.77	16.41	9.08	0.04	-1.79	16.46	7.30	102.3	SST14
116_2007_AB	Bus 14	82.68	1.04	79.42	Xfmr14P	89.27	1.11	80.77	16.41	9.08	0.04	-1.70	16.45	7.38	102.3	SST14
116L_2007_AB	Bus 14	79.66	1.00	79.42	Xfmr14P	86.52	1.07	80.77	16.41	9.08	0.04	-1.60	16.45	7.48	103.0	Bus 14
117_2007_AB	Bus 14	84.28	1.06	79.42	Xfmr 16P	90.66	1.12	80.77	16.41	9.08	0.04	-1.75	16.46	7.33	102.3	SST14
117L_2007_AB	Bus 14	81.37	1.02	79.42	Xfmr 16P	87.99	1.09	80.77	16.41	9.08	0.04	-1.65	16.45	7.43	102.3	SST14
118_2007_AB	Bus 14	92.83	1.03	90.45	Xfmr14P	98.64	1.14	86.54	16.41	9.08	0.05	-2.08	16.46	7.00	102.3	SST14
119_2007_AB	Bus 14	92.57	1.02	90.45	Xfmr14P	98.40	1.14	86.54	16.41	9.08	0.05	-2.07	16.46	7.01	102.3	SST14
119B_2007_AB	Bus 14	92.55	1.02	90.45	Xfmr14P	98.39	1.14	86.54	16.41	9.10	0.05	-2.07	16.46	7.03	102.3	SST14
120_2007_AB	Bus 14	91.27	1.01	90.45	Xfmr14P	97.19	1.12	86.54	16.41	9.08	0.05	-2.02	16.46	7.06	102.3	SST14
121_2007_AB	Bus 14	92.93	1.03	90.45	Xfmr 16P	98.68	1.14	86.54	16.41	9.08	0.05	-2.07	16.46	7.01	102.3	SST14
124_2007_AB	Bus 14	94.72	1.05	90.45	Xfmr14P	100.42	1.16	86.54	16.41	9.08	0.05	-2.15	16.47	6.93	102.4	SST14

Case	Case Description	Case Note
101_2007_AB	Case 101 - Normal Ginna on line - offsite 0/100 (ckt 7T) - Min voltages (4118) on Bus 12A and 12B, V13A = 102.18%	Checking adequacy of voltages on safety related buses assuming offsite regulators are working
101b_2007_AB	Case 101b - Normal Ginna on line - offsite 100/0 - V13A = 118 kV, checking 34.5 kV voltage	
101c_2007_ab	Case 101c - Normal Ginna on line - offsite 100/0 - V13A = 123 kV, checking 34.5 kV voltage	
102G_2007_AB	Case 102G - Norm Ops, MaxOffsiteVoltage, Max Gen Voltage, Min Load on Safety Buses, 50/50N	
102_2007_AB	Case 102 - Norm Ops, MaxOffsiteVoltage, Norm Gen Voltage, Min Load on Safety Buses, 50/50N	Checking for high voltages, regulators are working but they have limited buck capability (by design)
103_2007_AB	Case 103 - Norm Ops, MaxOffsiteVoltage, Norm Gen Voltage, Min Load on Safety Buses, 50/50A	
104_2007_AB	Case 104 - Norm Ops, MaxOffsiteVoltage, Norm Gen Voltage, Min Load on Safety Buses, 100/0	
105_2007_AB	Case 105 - Norm Ops, MaxOffsiteVoltage, Norm Gen Voltage, Min Load on Safety Buses, 0/100	
106_2007_AB	Case 106 - PlantTripNoAcc, MinOffsiteVoltage, BeforeRegAction, 50/50N, Taps in worst position	
107_2007_AB	Case 107 - PlantTripNoAcc, MinOffsiteVoltage, BeforeRegAction, 50/50A, Taps in worst postion	
108_2007_AB	Case 108 - PlantTripNoAcc, MinOffsiteVoltage, BeforeRegAction, 100/0, Taps in worst postion	
109_2007_AB	109_2007_AB- PlantTripNoAcc, MinOffsiVolt, BeforeRegAct, 0/100 -, Taps in worst position	
110_2007_AB	110_2007_AB - PlantTripNoAcc, MinOffsiteVoltage, AfterRegAction, 50/50N	
111_2007_AB	Case 111 - PlantTripNoAcc, MinOffsiteVoltage, AfterRegAction, 50/50A	
112_2007_AB	Case 112 - PlantTripNoAcc, MinOffsiteVoltage, AfterRegAction, 100/0	
112B_2007_AB	Case 112B - PlantTripNoAcc, MinOffsiteVoltage, AfterRegAction, 100/0, CPB is off, One ABEF(1B) is also off	CPB and ABEF are off
113_2007_AB	Case 113 - PlantTripNoAcc, MinOffsiteVoltage, AfterRegAction, 0/100	
114_2007_AB	114_2007_AB - PlantTripAcc, MinOffsiteVoltage, BeforeRegAction, 50/50N	
115_2007_AB	Case 115 - PlantTripAcc, MinOffsiteVoltage, BeforeRegAction, 50/50A	
116_2007_AB	116_2007_AB - PlantTripAcc, MinOffsiteVoltage, BeforeRegAction, 100/0	
116L_2007_AB	116L_2007_AB - PlantTripAcc, OffsiteAlarmVoltage, BeforeRegAction, 100/0, CREATS heater off	
117_2007_AB	Case 117 - PlantTripAcc (Large Break), MinOffsiteVoltage, BeforeRegAction, 0/100	
117L_2007_AB	Case 117 L - PlantTripAcc (Large Break), Offsite Alarm Voltage (108.9kV), 7T Tap(sec) = 8L, 0/100, CREATS heaters off	
118_2007_AB	118_2007_AB - PlantTripAcc, MinOffsiteVoltage, AfterRegAction, 50/50N	
119_2007_AB	119_2007_AB - PlantTripAcc, MinOffsiteVoltage, AfterRegAction, 50/50A	
119B_2007_AB	119B_2007_AB - PlantTripAcc, MinOffsiteVoltage, AfterRegAction, 50/50A, Spare SWP on Bus 18 (SWPA)	
120_2007_AB	120_2007_AB - PlantTripAcc, Offsite Alarm Voltage, AfterRegAction, 100/0	
121_2007_AB	121_2007_AB - PlantTripAcc, Offsite Alarm Voltage, After RegAction, 0/100	
124_2007_AB	124_2007_AB - PlantTripAcc, 118kV at Station 13A, Backfeed through GSU	

2.1.1 Comparing the results in the above table with those associated with the previous simulations (Revision 4 of this analysis) results in the following observations:

- The normal and non accident simulations (Cases 101 – 113) in the Revision 5 analysis are nearly identical to those in the Revision 4 analysis. The 480 V bus criteria did go up slightly for Revision 5 which caused case 109 and 113 to have a 1% reduction in the 480 volt criteria margin. The actual voltages as well as any overloads for these cases remained unchanged because the loading was essentially unchanged.
- The total in house loading did increase slightly for the accident simulations (Cases 114 – 124) and this coupled with the increase in the 480 V bus criteria resulted in a reduction in the 480 V margins of approximately 1% for many of these cases. The load increase for Revision 5 occurred on the safety related buses so the overloads shown also increased by about 1%.

2.1.2 The basis for the various 4160 Bus Voltage Criteria and 480 Bus Voltage Criteria shown in the above table is summarized below (detailed explanation in section 7.6):

Bus Voltage Criteria	Volts	% (4160 or 480)	Basis for Criteria
480 V Minimum Continuous	434.16	90.45	Degraded UV relay Max Analytical Limit reset voltage (safety related bus)
480 V Minimum Momentary	381.2	79.42	Loss of Voltage Relay - Max Analytical Limit (safety related bus)
480 V Maximum	506	105.42	110% of 460 V (Motor terminal voltage criteria)
4160 V Minimum Continuous	3600	86.54	90% of 4000 V (Motor terminal voltage criteria)
4160 V Minimum Momentary	3360	80.77	Bus Undervoltage Relay Setting (with 5% margin)
4160 V Maximum	4400	105.77	110% of 4000 V (Motor terminal voltage criteria)

2.1.3 Case 102G_2007_AB indicates that the voltage on Bus 11B slightly exceeds the 105.77% of 4160 Volt limit (110% of 4kV = motor limit). It should be noted that there is no significant voltage drop from the bus to the motor terminals (Bus 11B = 106.69% and voltage at the terminals of CBPB is 106.68%). The slight overvoltage on the bus and motor terminals does not exist in Case 102_2007_AB because in Case 102 the Ginna generator voltage is regulated to a more typical value (104.2% of 19kV) rather than the maximum value (107.4% of 19kV). During normal plant operating conditions, Buses 11A and 11B will be about 0.5% lower than the generator terminal voltage. Therefore as long as the generator voltage is regulated to a value less than 106.3% of 19kV (20.2kV) then the Bus 11A and Bus 11B voltages will be within the acceptance criteria of 105.8% of 4160V. A review of historical operating points (Attachment IX) indicates that it is very unusual for the Ginna generator voltage to be above 20.2 kV. It is also worth noting that the generator has a nominal maximum V/Hz limit of 105% so it is expected that any operation of the Ginna generator at or above 20.2 kV would be both rare and of a short duration. Because of these considerations, no meaningful loss of life to the 4 kV motors is expected to occur and the slight overvoltage identified in Case 102G is considered acceptable.

2.1.4 Case 116L and 117L demonstrate that the loss of voltage relays will not operate if the Station 13A voltage drops to 108.9 kV (offsite power operability limit) following a plant trip. This means that the voltages on the safety related buses will still be acceptable even if the Station 13A voltage drops to 108.9 kV following a plant trip. These two cases were run assuming "plant trip – accident" conditions however the conclusion is also valid for the "plant trip – non accident" since the non-accident cases result in less severe voltage drops on the safety related buses. These two cases also demonstrate that the conclusion is valid for any offsite power alignment configuration (0/100, 100/0, 50/50N and 50/50A). The 0/100 (117L) and 100/0 (116L) cases were run but the voltage drop associated with the 50/50 cases will never be worse than the 100/0 case.

2.1.5 Cases 120 and 121 reflect the scenario associated with cases 116L and 117L, after the regulators have had a chance to respond. For both Case 120 and 121, the regulator returns the 480 volt bus voltage above the maximum reset level of the degraded undervoltage relays (90.45%). Attachment XII contains an evaluation of the speed at which these regulators return the voltage above this reset level and concludes that the degraded undervoltage relays will not trip before the voltage gets restored.

2.1.6 Even though Case 120 demonstrates that the 767 regulator is able to return the voltage to a level above the reset level, the regulator is fully tapped out (Tap position = 16R). The #7 voltage regulating transformer (7T) by contrast is on tap position 10R (Case 121). The difference is due mostly to the fact that the 767 regulator has to overcome a 2.5% buck in Transformer 6 while the 7T transformer does not. While it would be possible to eliminate the buck in Transformer 6 and therefore effectively give the 767 regulator more taps, it would also prevent the opportunity to eliminate the "neutral time penalty". Transitioning through the neutral point on a load tap changer is a two step process (each with a time delay) and because the 767 regulator is currently blocked at the neutral point, there is currently an opportunity to eliminate one of these delays.

2.1.7 Even though both regulators (767 and 7T) bring the bus voltage above the degraded under-voltage reset value, prior to the relay timing out, the margin for the 767 regulator is small (See Attachment XII). In order to increase the margin for the 767 regulator, the following corrective actions should be investigated further.

- Move the LTC stop plug to the NA position (prevents two neutral tap positions and adds 3.6 seconds of margin)
- Change the Load tap changing motor to a higher RPM version (One possibility is to change the 1150 RPM motor to a 1575 RPM motor, however it would be necessary to verify that any higher speed would not cause the controls to "double tap")

2.1.8 The spare SW pump motor (currently installed as SWP1D) has slightly different characteristics than the other three SW motors. The key differences that affect the load flow results are tabulated below:

Motor	P (kW)	Q (kVAR)
Spare SWP	256.1	121.9
SWP	257	102.4

The slightly worse power factor associated with the spare SWP motor will result in a little more voltage drop to that particular safety related bus (#17 or #18 depending upon spare motor location). Of the four safety related buses, Buses 17 and 18 are almost never the limiting case from a voltage drop point of view (See results table, section 2.1, Buses #14 or #16 are limiting due to their higher loading). In order to quantify the additional voltage drop caused by the spare SWP motor, Case 119_2007_AB was repeated (Case 119B_2007_AB) and for case 119B, the spare SWP was placed at SWPA (Bus 18). Comparing case 119 with 119B shows the voltage on bus 18 was reduced to 96.16% (Case 119B) from 96.28% (Case 119). From a load flow point of view, the spare SWP motor can be placed on either Bus 17 or Bus 18. The performance of the spare SWP will also be evaluated in the short circuit analysis and in the dynamic analysis.

2.1.9 As can also be seen from the results table in section 2.1, there are several cases where branch (equipment) overloads occurred. It should be noted that only the single most severe "non-cable" overloads are listed for each case in the table (more details are contained in the one page summaries and detailed printouts in Attachment XI). Cable ampacity is outside the scope of this analysis and is addressed under DA-EE-99-096. While equipment overloads are not specifically within the scope of this analysis, these issues are addressed in section 7.7 of this calculation.

2.2 Motor starting simulations were performed in order to quantify the capability of the offsite power system to start the large auxiliary motors (RCP, MFWP, etc). These simulations generally consist of three voltage/ load flow snapshots; The first is a load flow snapshot just prior to starting the motor, the next, a snapshot just after the motor breaker has been closed, and a final snapshot after the motor has successfully accelerated. These simulations are not full dynamic simulations however they are sufficient to quantify the minimum voltage level during a motor start. This minimum voltage can then be compared against any applicable undervoltage relay setting and the minimum voltage starting requirements for the motor. The RCP motor as well as the MFWP motor were both designed to start with 80% of nameplate voltage at the motor terminals (80% of 4,000 V = 3200 Volt). Since this voltage is below the 3360 volt limit mentioned above, the bus undervoltage relay criteria (3360V) will be limiting. The detailed results of all of the motor starting simulations are presented in Attachment XI. A summary of the motor starting simulations and key results are shown in the following table.

Ginna Nuclear Station - Summary of Load Flow Simulations, 2007 As Built (Ref DA-EE-96-068-03, Rev 5)																
Case	Lowest (or highest) 480 V "Safety Related Bus" Voltage			480 V Bus Voltage Criteria	Lowest (or highest) 4kV Bus Voltage			4160 V Bus Voltage Criteria	Total In-house Motor Load		Total In-house Static Load		Total In-house (Total Load)		Maximum Branch Overload (non cable)	Branch Overload ID
	Bus Name	Voltage (% 480)	Voltage /Criteria	Volts (%)	Bus Name	Voltage (% 4160)	Voltage /Criteria	Volts (%)	MW	MVAR	MW	MVAR	MW	MVAR	(% Rating)	
128_2007_AB	Bus 18	96.06	1.06	90.45	RCP1A	98.56	1.14	86.54	13.16	7.25	0.05	-2.09	13.22	5.17	0.0	0
129_2007_AB	Bus 17	77.60	0.98	79.42	RCPB_SW	79.96	0.99	80.77	13.16	7.25	2.23	20.34	15.40	27.60	317.6	RCP1B_24
129B_2007_AB	Bus 17	79.42	1.00	79.42	RCPB_SW	81.66	1.01	80.77	13.16	7.25	2.33	21.22	15.49	28.47	324.4	RCP1B_24
129C_2007AB	Bus 16	80.01	1.01	79.42	RCPB_SW	81.78	1.01	80.77	12.91	7.13	2.34	21.28	15.24	28.41	324.8	RCP1B_24
130_2007_AB	Bus 18	96.38	1.07	90.45	RCP1A	98.86	1.14	86.54	18.80	9.27	0.05	-2.08	18.86	7.18	0.0	0
131_2007_AB	Bus 18	97.67	1.08	90.45	RCP1A	100.13	1.16	86.54	13.16	7.25	0.06	-2.15	13.22	5.11	0.0	0
132_2007_AB	Bus 17	79.79	1.00	79.42	RCPB_SW	82.01	1.02	80.77	13.16	7.25	2.35	21.36	15.51	28.61	325.7	RCP1B_24
133_2007_AB	Bus 17	97.30	1.08	90.45	RCP1B	99.82	1.15	86.54	18.80	9.27	0.06	-2.13	18.86	7.14	0.0	0
137_2007_AB	Bus 18	98.08	1.08	90.45	RCP1A	100.52	1.16	86.54	13.12	7.21	0.06	-2.18	13.17	5.04	0.0	0
138_2007_AB	Bus 17	79.93	1.01	79.42	RCPB_SW	82.15	1.02	80.77	13.12	7.21	2.36	21.28	15.48	28.49	326.3	RCP1B_24
139_2007_AB	Bus 17	96.92	1.07	90.45	RCP1B	99.46	1.15	86.54	18.76	9.23	0.05	-2.12	18.81	7.11	0.0	0

Case	Case Description	Case Note
128_2007_AB	Plant Startup_RCPA running (Cold BHP), RegulatorsWorking, 100/0, Normal Offsite Voltage	
129_2007_AB	Plant Startup_ Starting RCPB Snapshot, RCPA running (Cold BHP), 100/0, Normal Offsite Voltage	
129B_2007_AB	Plant Startup_ Starting RCPB Snapshot, RCPA running (Cold BHP), 100/0, Max Offsite Voltage	
129C_2007AB	Plant Startup_ Starting RCPB Snapshot, RCPA running (Cold BHP), 100/0, Max Offsite Voltage SW1D off	
130_2007_AB	Plant Startup_Both RCPs running (Cold BHP), RegulatorsWorking, 100/0, Normal Offsite Voltage	
131_2007_AB	Plant Startup_RCPA running (Cold BHP), RegulatorsWorking, 0/100, Normal Offsite Voltage	
132_2007_AB	Plant Startup_ Starting RCPB Snapshot, RCPA running (Cold BHP), 0/100, Normal Offsite Voltage	
133_2007_AB	Plant Startup_Both RCPs running (Cold BHP), RegulatorsWorking, 0/100, Normal Offsite Voltage	
137_2007_AB	Plant Startup_RCPA running (Cold BHP), RegulatorsWorking, 50/50, 13A = 121.4kV	
138_2007_AB	Plant Startup_ Starting RCPB Snapshot, RCPA running (Cold BHP), 50/50, Stn 13A = 121.4 kV	
139_2007_AB	Plant Startup_Both RCPs running (Cold BHP), RegulatorsWorking, 50/50, Normal Offsite Voltage	

2.2.1 The overloads shown in the above table are not a concern since they simply represent the motor starting current flowing through the RCP breaker. The breaker's current-time characteristics are set in a manner to allow this starting current to flow.

2.2.2 Case 129 in the above table suggests that the 480 V bus voltage could be violated during an RCP start case. This means that the loss of voltage relays could possibly operate and transfer the safety related buses to the emergency diesel generator. Case 129 assumes that the power system is aligned in the 100/0 mode with normal (120.75 kV) offsite voltage at Station 13A. It should be noted that the RCP start scenarios are for plant startup only and have no impact on any accident mitigation scenarios.

2.2.3 The loss of voltage relays have a nominal 2.4 second time delay associated with them but the RCP motor can take about 25 seconds to start (Ref Attachment 7). In general there is negligible voltage improvement during the first 2.4 seconds of an RCP start.

2.2.4 The improvement resulting from assuming that the Station 13A is at its maximum (123 kV) value, prior to starting the RCP, is shown in Case 129B. Additional improvement associated with further assuming that SWPD is off is demonstrated by Case 129C.

2.2.5 ETAP cases 137 and 138 were performed in order to compare the calculated ETAP results with actual field measurements that were obtained during the startup of RCPB during the 2006 RFO. Case 137 is a snapshot of voltages just before the RCP is started while Case 138 is a snapshot of voltages right after the breaker has closed. The following two tables compare the ETAP and field results:

ETAP vs Measured - Prestart			
	Measured (% 4160V or % 480)	ETAP Case 137 (% 4160 V or % 480)	Measured - ETAP (%)
Bus 11B	101.1	101.9	-0.79
Bus 16	99.8	99.7	0.04
Bus 17	99.3	99.2	0.17

ETAP vs Measured - RCP Start			
	Measured (% 4160V or % 480)	ETAP Case 138 (% 4160 V or % 480)	Measured - ETAP (%)
Bus 11B	84.2	83.4	0.81
Bus 16	82.9	80.7	2.26
Bus 17	82.2	79.9	2.24

2.2.6 The above comparison tables demonstrate that the ETAP results are slightly conservative and that the amount of conservatism is comparable to the magnitude of the criteria violation documented in Case 129. It is therefore recommended that additional ETAP simulations be performed in order to more firmly establish any "pre-start" requirements that may be applicable for either the RCP or MFW motors. Once these requirements are established, the appropriate plant start up procedures can be modified.

2.2.7 The current flowing through the 767 regulator during case 129 is 658 amps and this current is expected to last for about 25 seconds (RCP starting time at 80% voltage). The voltage on the secondary of the regulator is such that the regulator will start responding and try to boost the voltage (after an initial 5 second delay). The tap changer is only rated for 447 amps and therefore the current flowing through the tap changer will be about 150% of its rating. The power factor of this excessive current is approximately 0.45. It should be noted that IEEE Standard C57.91-1995 (Section B.2.2, Reference 4.18) suggests regulators have the capability of 40 breaking operations at twice rated current. The standard also cautions against operating the LTC in this fashion because the factory acceptance tests are done under ideal conditions (new oil, new contacts, recently adjusted, etc.) and that such currents can cause excessive contact wear and extra contamination, requiring more frequent maintenance. The regulator manufacturer verified that the 767 regulator had the capability to meet these conditions, (Reference 4.36). It should be noted that the minimum voltage on a safety related bus during the RCP start was 77.60% of 480V. This voltage corresponds to a degraded relay voltage of 93.12 volts which would result in the degraded undervoltage relay operating no faster than 38 seconds Attachment XII). The bus voltage should improve without the regulator operating because the RCP will successfully start after about 25 seconds.

2.3 The following calculations will need to be reviewed in order to determine if they need to be revised as a result of changes to this calculation:

- DA-EE-93-006-08 (Safeguards 480V UV Relays and VM)
- DA-EE-99-096 (Power Cable Ampacity)
- DA-EE-93-104-07 (480 Volt Coordination)
- DA-EE-93-107-07 (4160 Volt Coordination)
- DA-EE-2000-016 (Instrument Performance Evaluation and Setpoint Verification, Undervoltage Relay Setpoints, 4160 Volt Buses 11A and 11B
- DA-EE-92-131-06 (AC Motor Operated Valve Degraded Voltages)
- DA-EE-92-011-07 (Class 1E Motor Control Center Loading)

2.4 Based on a limited comparison, the ETAP computer model used in this analysis calculates conservative yet reasonable results. Calculated values were compared with measured results for the RCP start simulation and the calculated voltages were about 2% lower than the measured results. The calculated system loading for a plant trip scenario was compared to the measured loading (January 27, 2007 trip) and the calculated value was approximately 2.0 MVA greater than the measured value.

3.0 DESIGN INPUTS

3.1 Not Applicable.

4.0 REFERENCED DOCUMENTS

4.1 Drawings:

Drawing
33013-2539 (Plant One Line Diagram)
10904-164 (MCC C Schedule)
10904-0174 (MCC G Schedule)
11253-1 Sh. 3
11253-1 Sh. 4
11253-1 Sh. 6
11253-1 Sh. 11
11253-1 Sh. 17
11253-1 Sh. 18

4.2. R. E. Ginna Updated Final Safety Analysis Report (UFSAR).

4.2.1 Table 6.3-3 (SI and RHR Flow Rates)

4.2.2 Table 6.2-27 (Containment Spray Pump Design Parameters)

4.2.3 Figure 6.2-4 "Containment Atmosphere Pressure, Double-Ended Pump Suction Break – Minimum Safeguards"

4.3 Design Analysis EEA-03001, Loadflow and Voltage Profile Analysis (superseded by Rev 0 of this analysis).

4.4 Design Analysis DA-EE-92-011-07, Class 1E Motor Control Center Loading.

4.5 Design Analysis DA-EE-93-006-08, 480 Volt Undervoltage Relay Settings and Test Acceptance Criteria.

4.6 Design Analysis , "Adequacy of Station Electric Distribution System Voltages", Docket No. 50-244, December 6, 1979.

4.7 National Fire Protection Association, National Electrical Code .

4.8 Lindeburg, Michael R., Engineer-In-Training Reference Manual, Seventh edition.

4.9 EPRI Power Plant Electrical Reference Series, Volume 2, "Power Transformers", EL-5036.

4.10 EPRI Power Plant Electrical Reference Series, Volume 4, "Wire and Cable", EL-5036.

4.11 Design Analysis DA-EE-99-096, “Power Cable Ampacity” EWR 5298

4.12 Correspondence, R. Mecredy to A. Johnson, USNRC, “Offsite Power Systems”, September 20, 1990.

4.13 Specification ANSI C50.41-1982, “Standard for Polyphase Induction Motors for Power Generating Stations”.

4.14 IEEE Standard 242, Buff Book, “Protection and Coordination”, 1986.

4.15 IEEE/ANSI C57.96-1999, “Guide for Loading Dry Type Distribution and Power Transformers”.

4.16 Instruction Manual, Beckwith Electric Co., Inc., Tap Changer Control M-2001.

4.17 Westinghouse Transmission and Distribution Reference Book, 1964.

4.18 IEEE Std C57.91-1995, “IEEE Guide for Loading Mineral-Oil Immersed Transformers”

4.19 Transformer and reactor test reports and manufacturer information, applicable reports attached to analysis (see Attachment VI).

4.20 Westinghouse Correspondence, From Ronald C. Johnson to George S. Link, “Overvoltage Capability Study on LAC Motors-Ginna Station”, Dated 1/21/80.

4.21 Westinghouse Correspondence, From D. J. O’Shea to George S. Link, “Overvoltage Capability Study on LAC Motors-Ginna Station”, Dated 11/14/79.

4.22 Design Analysis DA-EE-93-104-07, “480 Volt DB Breaker Amptector Retrofit Coordination and Circuit Protection Study”.

4.23 Design Analysis DA-EE-93-107-07, “4160 Volt Overcurrent Relays Coordination and Circuit Protection Study”.

4.24 BOP Engineering Report – AC Distribution System Section 8.5.1, Stone and Webster, Revision 0, 5/5/05

4.25 Stone and Webster Calculation E-002, “Electrical Factors, Main Feedwater Pumps Motor Upsize” 12/13/05, Rev 1.

4.26 Ginna Station Software Change Request 2007-0020, Upgrade ETAP from 5.0.3N to 5.5.0N.

4.27 Email from John Sargent to Bill Roettger, May 1, 2006, “MFWP updated info”

4.28 Email from John Sargent to Bill Roettger, May 2, 2006, “Accepted: Spare Service Water

Motor Testing"

4.29 General Maintenance Procedure, GME-50-02-DB75, Westinghouse 480V Air Circuit Breaker, Type DB-75 Maintenance for Type DB-75 Breakers.

4.30 Work Order 20100699, Page 112, Attachment 4, Amptector (52/14) Data Sheet, 3/27/02

4.31 Ginna Station Technical Procedure 0-1.1, "Plant heat up from cold shutdown to hot shutdown"

4.32 Email from Mark Finley to John Sargent and Bill Roettger, August 24, 2006 , Ginna 2nd pump test (MFWP).

4.33 Email from Jim Dunne to Bill Roettger and John Sargent, August 28, 2006, Ginna 2nd pump test (MFWP)

4.34 Email stream; Joe Pacher to Bill Roettger, John Sargent, Ted Miller and Paul Swift on Oct 2, 2006 (ETAP Simulations – Maximum dropout voltage for the loss of voltage relays)

4.35 Email stream – Ted Miller to Bill Roettger, Feb 15, 2007, "RCP Start – Why is RHR on?"

4.36 Email stream – Ted Miller to Bill Roettger, Feb 21, 2007, "UZE High Current Capability"

4.37 "Evaluation of Operating Data for the Summer of 2006 from the Four 115 kV Generator Leads at the Ginna Nuclear Power Plant", USI Report by John S. Engelhardt, December 14, 2006

4.38 Design Analysis DA-ME-2006-016 (Table A give 1688 GPM for RHR pump)

4.39 SPCR 2006-0001 (Set point change request to throttle RHR valve)

5.0 ASSUMPTIONS

5.1 Most of the input data used in this analysis to model the electrical system is based on actual data taken from nameplates, manufacturer specifications, or test reports. Where verifiable data was unavailable, data was assumed based on conservative assumptions, typical values found in various engineering documents, or from actual field test results. See attachments for details.

5.2 Assumptions were made as to predict loading for each case. Conservative assumptions were utilized to ensure that "worst case" scenarios were reviewed. Generally, if a load could be ON, it was assumed ON unless otherwise noted. Specific examples include assuming that all three condensate pumps were on (only two are normally on) and assuming both auxiliary building exhaust fans were on (interlocks in motor start circuit prevents both from being on). Similarly it was assumed that all four SWP motors were generally running even though under normal conditions, only two or three would be running (All four run during an SI condition). By making conservative assumptions as described above, the maximum loading on each safety train was assured, thereby reducing the number of computer simulations required. Load decisions for each case were also made based on plant configuration, operating procedures, test data, and discussions with control room operators. The loads assumed ON and their corresponding magnitudes and power factors are summarized in Attachment VII for each of the scenarios studied.

5.3 The following voltage ranges (steady state) will be assumed. The minimum and maximum system voltages were obtained from alarm setpoints (Energy Control Center takes corrective action within 15 minutes) while the minimum and maximum generator voltages were obtained from 2003 - 2004 operating data.

Condition	Station 13A Voltage (PU on 115 kV)	Ginna Generator (PU on 19 kV)
Normal Voltage	1.05 pu (120.75 kV)	1.042 pu (19.8 kV)
Minimum Voltage	1.026 pu (118 kV)	0.995 pu (18.9 kV)
Maximum Voltage	1.070 pu (123 kV)	1.074 pu (20.4 kV)

The voltage at Station 13A following a Ginna trip will momentarily dip (or rise) depending largely upon the MVAR output of the generator prior to the trip. Based upon actual plant experience (Attachment IX), the most severe voltage dip occurred during a plant trip on 3/7/96 at which time the Station 13A voltage momentarily dipped to 111.8 kV (97.22% of 115kV). All plant trip simulations, unless otherwise noted, assumed a Station 13A voltage of 111.8 kV which seems conservative since the subsequent installation of capacitors at Station's 13A and 122 result in it being highly unlikely that the 115 KV system voltages would dip to 111.8 KV in the future.

5.3.5 The transmission operator's (Rochester Gas and Electric) State Estimator program, which is run every 15 minutes and is based on real time data, simulates a Ginna unit trip and calculates the resulting Station 13A voltage. If the Station 13A voltage is calculated to be 108.9 kV or lower, an alarm is generated. Four plant trip / accident simulations (116L, 117L, 120 and 121) were performed assuming that the Station 13A voltage was 108.9 kV. The purpose of these simulations was to verify that neither the loss of voltage relays nor the degraded under voltage relays (on the safety related buses) would operate and thereby cause an unnecessary transfer of safety loads to the emergency diesel generators.

5.4 Any error associated with the 7T and 767 regulators and/or load compensation scheme will be less than or equal to 1%. The 7T load tap changer is set up to maintain the primary of 12A at 102.0 % (with a 0.8 % bandwidth) while the 767 regulator is configured to regulate the 4160 V buses on the secondary of transformer 12B to 1.0 per unit. The settings of these two regulators are expected to give similar performance since the drop through the #12A and B transformers is about 2% (plant trip, no accident conditions). The ETAP model does not have a "load drop compensation" scheme for the regulators so it was assumed that both regulators attempt to maintain the primary of their respective # 12 transformers to 1.01 per unit (corresponds to 0.99 pu at the 4 kV bus under "plant trip, no accident" conditions). For the simulations that quantify the voltage levels prior to "regulation action", it will be assumed that the associated taps are initially in the position that results in minimum voltage levels (767 regulator tap = nominal, 7T tap = 2.5% reduction).

5.5 Cable types were assumed to be 3/c for the purposes of determining cable impedances even though most cable types are actually 3-1/c triplex (ETAP cable library did not have a triplex option). This assumption underestimates the cable reactance which is conservative for the short circuit calculation but is non conservative for the voltage drop calculations. The effect of this non-conservative assumption will in general be limited to the calculated results underestimating the voltage drop to the actual motor terminals as opposed to having any significant effect on the bus voltages (because the transformer impedance will dominate). In general the limiting voltage criteria is at the bus because of the undervoltage relay settings and therefore this non-conservative assumption is not expected to alter the final conclusions of this calculation. The results of the voltage drop studies will be reviewed with this non conservative assumption in mind.

5.6 The power factor correction filters associated with the two 2000 HP circulation water pumps are always assumed to be in service if the corresponding circulation water pump is in service.

6.0 COMPUTER CODES

6.1 Electrical Transient Analysis Program (ETAP) Power Station, Version 5.5.0N, Operations Technology Incorporated.

The ETAP Power Station program allows computer modeling of the Ginna electrical distribution system. It then calculates power flows on lines and voltages at all modeled points. This version of the software is compliant with 10 CFR Appendix B (Quality Assurance Criteria) and 10 CFR 21.

7.0 ANALYSIS

7.1 Offsite Power System Configuration

7.1.1 Attachment I is a single line diagram of the offsite power system. The offsite power system for Ginna has two offsite power sources (Circuits 767 and 7T). Circuit 767 includes or refers to both Transformer 6 and the 767 voltage regulator while Circuit 7T includes or refers to the #7 voltage regulating transformer. Both 34.5 KV circuits originate from Station 13A which is located south of Lake Road directly across from Ginna. Both circuits are routed to Ginna's switchyard via underground cable (approximately 3300 feet).

7.1.2 Circuit 7T supplies auxiliary (startup) transformer 12A and Circuit 767 supplies auxiliary (startup) transformer 12B. The station auxiliary (startup) transformers are used to supply the normal auxiliary power during plant startup and shutdown. During normal operations, the station auxiliary transformers remain energized, essentially unloaded (except for supplying mostly safeguard buses), and plant auxiliary power is supplied from the main generator via the unit auxiliary transformer (#11). When the plant is not operating, and offsite power is not available, the principle source of power is the emergency diesel generators. For long-term outages of offsite power, a backup source of power is from the outgoing power feeder. Power can be brought in over this feeder to the unit auxiliary transformer (#11) by removing flexible generator bus disconnects to disconnect the main generator (See UFSAR section 8.1.1).

7.1.3 Upon a plant trip, the main generator remains connected to the transmission system for 60 seconds. During this time the MWatt output of Ginna decreases rapidly; however, the generator is still capable of supplying or absorbing VAR's. Therefore, upon a trip, the voltage on the 115 KV transmission system does not change significantly until the generator has separated and the VAR support from Ginna is gone (see section 7.4).

7.1.4 The offsite power system can be configured to allow the following four offsite power source configurations:

Offsite Power Alignment	Power Supply to A Train Loads	Power Supply to B Train Loads
50/50 Normal	Circuit 7T	Circuit 767
50/50 Alternate	Circuit 767	Circuit 7T
100/0	Circuit 767	Circuit 767
0/100	Circuit 7T	Circuit 7T

7.1.5 An additional configuration is the potential to back feed through the main transformer. As described in Section 8 of the UFSAR, during a loss of offsite power a back feed path from the 115 KV distribution system through the GSU transformer can be utilized to provide an additional source of power if both Circuit 7T and 767 are not available. The flexible generator bus disconnects can be removed and power supplied from the unit auxiliary transformer.

7.2 Offsite Power Historical Configuration

7.2.1 The offsite power system was designed prior to the implementation of GDC-17. The following information provides a time line perspective (dates are approximate) of the modifications that have been performed to improve the overall reliability of the offsite power system:

(1968): The electrical power system was initially designed with a single station auxiliary (startup) transformer (12A) and a single source of offsite power (Circuit 767).

(1970): A spare transformer (12B) was added after the beginning of commercial operation.

(1977): The spare transformer was permanently connected to the 34.5 KV bus.

(1989): To increase the availability margin in the event of a single system failure, the 34.5 KV bus was split. Station auxiliary transformer 12B was connected to offsite power Circuit 767 and station auxiliary transformer 12A was connected to offsite power Circuit 751.

(1990): A voltage regulator was installed on Circuit 751 to increase its ability to provide acceptable voltage levels.

(1996): 75 MVAR's of capacitors were installed at Station 122. This reduced the voltage support required by Ginna on the 115 KV transmission system.

(1996): A voltage regulator was installed on Circuit 767 to increase its ability to provide acceptable voltage levels.

(1999): 50 MVAR's of capacitors were installed at Station 13A. This reduced the voltage support required by Ginna on the 115 KV transmission system.

(2002) Upgraded existing 50 MVAR's of capacitors at Station 13A to 75 MVAR's

(2006) Replaced circuit 751 with Transformer 7T

7.2.2 The above modifications indicate that significant changes have been performed since Ginna was originally licensed to improve its overall reliability and voltage capability.

7.3 Analysis Method

7.3.1 The Ginna Station Offsite Power sources and onsite power distribution systems, including all electrical loads, have been modeled using ETAP (Electrical Transient Analysis Program). The program and models are utilized to simulate the operating conditions of the system. For variations in load, supply voltage, and switching configurations, the program calculates bus voltages and power flows throughout the electrical system. This study will utilize the Ginna models and this program to determine bus voltages and current flows for expected normal and worst case system conditions. These results will be analyzed to ensure that adequate voltage regulation and thermal capability will be maintained for expected operating conditions at Ginna Station.

7.3.2 Model Development

7.3.2.1 **Offsite Source Impedances**

To more accurately utilize the ETAP program for modeling the offsite sources, the power source is modeled back to Station 13A (115 KV). The offsite source impedances at Station 13A were provided by the RG&E Electrical Systems Planning Group. Attachment II details the source strengths at Stations 13A for both Ginna on-line and off-line.

7.2.2.2 **Ginna Main Generator**

Data regarding the main generator at Ginna is required to accurately model the generators performance during steady state load flow and/or short circuit conditions. Attachment III contains critical data including generator MVA rating, speed, voltage and sub-transient and transient impedances. The generator dynamic parameters are not required in this analysis; however, the data has been incorporated in the model and added as an attachment for completeness. Main generator dynamic performance is not within the scope of this analysis.

7.3.2.3 Transmission Lines/Underground Cable Feeds

Circuit 767 is routed to the Ginna switchyard via 3300 feet of two parallel 250 KCM underground cables. Circuit 7T is routed to the Ginna switchyard via 2411 feet of two parallel 500 KCM and 1254 feet of two parallel 250 KCM underground cables. Attachment IV provides details on the circuit impedances utilized in the ETAP model.

The pipe cable from the GSU to Station 13A is modeled as an impedance and therefore does not have a continuous rating built into the ETAP model. The continuous rating of the pipe cable (up to 4000 amps with oil pumps working – Reference 4.37) will be compared against the anticipated duty manually. Note: Case 101 shows this current to be 2899.3 amps which is well within the capability of the pipe cable.

7.3.2.4 Bus Work Impedances and Continuous Current Ratings

The equivalent bus work impedances from Transformers 12A and 12B to Buses 12A and 12B has been included in the ETAP model. The impedance of the bus work will have minimal effect on the simulation results; however, it has been added for completeness. Short bus work structures on the offsite circuit supplies have been neglected and are modeled in ETAP as breakers. The bus impedance is negligible in comparison to the transmission line impedances and will not impact the simulation results. Attachment V provides details on the bus work lengths and the impedances utilized in the model.

The ampacity for the 19 kV bus work is shown in the following table

	kV	Amps (Self Cooled)	Amps (Forced Cooled)
Main Bus	19	12,000	20,000
Tap Bus (impedance and rating not currently modeled in ETAP)	19	1,500	1,500

7.3.2.4 Transformer Impedances

Included in the ETAP model are the various large distribution system transformers. The impedances and X/R ratios utilized in the computer model are based on transformer manufacturer test results and calculations. Attachment VI details the transformer impedances utilized and includes copies of the manufacturer test reports on the transformers. Also included is information about the transformer voltage ratings, KVA rating, winding configurations, tap connections and grounding type. This information is required for input into ETAP.

7.3.2.5 **Bus Loading Information**

The electrical system loading includes 4 KV bus loads, 480 volt bus loads and motor control center loads. The buses supply various size motors and miscellaneous electrical loads. A listing of all the loads included in the ETAP model is provided in Attachment VII. Included is information regarding the motor horsepower rating, RPM, nameplate current, nameplate voltage, KVA code, locked rotor current, service factor, efficiency, and power factor. The specific reference for all equipment data is included along with any assumptions. Also included is information regarding the expected loading of the applicable equipment during various loading scenarios. The basis for the specified loadings is also provided along with any assumptions. The intent was to provide a conservative approximation of the expected bus loadings. Loading conditions were defined for normal operations, plant trip (non-accident conditions), plant trip (LOCA conditions) and the expected loading during Reactor Coolant Pump (RCP) starts.

Attachment VII also includes specific information for the ETAP dynamic machine data field. This information is not required for the scope of this analysis; however, it has been included for completeness and to assist in future model development.

7.3.2.6 **Cable Impedances**

The cables feeding the various loads fed from the 4 KV and 480 volt buses was modeled based on information obtained from individual circuit schedules or from a review of cable tray and conduit drawings. Attachment VIII contains a complete listing of the cables modeled including their length and conductor size. Cable impedances utilized in the model are from the ETAP library. A comparison was made of these impedances to other standards and the ETAP model impedances are reasonable. For load flow studies ETAP automatically adjusts the impedances to reflect a 90°C conductor temperature. This is the rated temperature of the cables and provides a conservatively high impedance for performing loadflow simulations.

7.4 Grid Voltages

7.4.1 "Normal" offsite power voltage levels at Station 13A are controlled by the Energy Control Center (ECC). The alarm setpoints for the 115 KV transmission system is 123 KV (High Alarm) and 118 KV (Low Alarm).

7.4.2 Typically, only during transients (worst case is a trip of Ginna) does the 115 KV system drop below the low alarm setting (118 KV). If the voltage drops below the low alarm setting ECC makes corrections to bring back the system voltage. A review of previous plant trip data indicates the potential for a 10 to 15 minute voltage restoration period.

7.4.3 The magnitude of the voltage dip on the 115 KV transmission system following a plant trip is a function of the voltage support that Ginna Station is providing prior to the trip. The voltage support that Ginna provides is a function of its "NET MVAR" output. The amount of MVARs supplied to Station 13A is referred to as the "NET MVAR" output of Ginna.

The "GROSS MVAR" output includes the MVAR losses in the Generator Step Up Transformer as well as the MVARS supplied to Transformer 11. When Ginna is at full power, there are about 35 MVARs of losses in the GSU (Case 101, 102, etc).

Attachment IX contains a plot of the 1995 % occurrence plot of the Ginna "NET MVAR" output as well a PPCS plot of the Ginna "Net MVAR output" as a function of Ginna terminal voltage (4/1/03-4/1/04). A similar MVAR-voltage plot for the 1995 time period (prior to GSU replacement) is also included. Also included in Attachment IX are voltage profiles of the 115 KV system voltage at Station 13A following recent Ginna Trips. Included on the plots is the amount of VAR support Ginna was providing prior to the trip. The results are summarized as follows:

Date of Plant Trip	NET MVAR's at Time of Trip	Minimum 115 KV System Voltage
5/10/90	-86 MVARs (Ginna absorbing VARs)	118.8 KV
12/11/90	+3 MVARs (Ginna Providing VARs)	116.6 KV
9/26/90	+46 MVARs (Ginna Providing VARs)	114.0 KV
3/7/96	+112 MVARs (Ginna Providing VARs)	111.8 KV
2/5/02	-6.85 MVARS (Ginna absorbing VARS)	116.95 kV
1/27/07	-24 MVARS (Ginna absorbing VARS)	118.1 kV

7.4.4 A review of the above table and the voltage profile curves in Attachment IX indicates the relationship between Ginna's NET MVAR output and expected voltages on the 115 KV system following a Ginna trip. The more MVAR support that Ginna is providing to the system prior to the trip, the greater the reduction in Station 13A voltage after the generator separates from the system.

7.4.5 The trip on 3/7/96 occurred when Ginna was operating at its maximum expected NET MVAR output. A review of the Ginna % occurrence NET MVAR output plot in Attachment IX indicates that Ginna's NET MVAR did not exceed approximately 110 NET MVAR's in 1995. The % occurrence plot indicates that Ginna only operated at 110 NET MVAR's about 1% of the time in 1995.

7.4.6 The installation of 75 MVAR's of capacitors at Station 122 and 75 MVAR's of capacitors at Station 13A are intended to reduce the voltage support requirements of Ginna. The capacitor at Station 13A is typically switched in when Ginna approaches 50 MVAR's of output to the 115 KV system. Therefore, the installation of capacitors has reduced the requirement for Ginna to operate at high MVAR outputs. In this analysis a minimum 115 KV system voltage of 111.8 KV will be assumed for worst case simulations, unless noted otherwise. The installation of capacitors at Station's 13A and 122 result in it being highly unlikely that the 115 KV system voltages would dip to 111.8 KV in the future. Therefore, this voltage should provide a very conservative minimum voltage for performing simulations. As previously noted, several simulations were performed assuming that the Station 13A voltage drops to 108.9 kV following a Ginna trip since that is currently the offsite power operability alarm level.

7.5 Effect of Voltage Regulators

7.5.1 The 767 regulator is an auto transformer while #7 transformer (7T) has an automatic load tap changer. They both have 16 steps (5/8% per step) in both the raise and lower direction however the ability to buck the 34.5 kV voltage lower is blocked for both devices. The 767 regulator is blocked from giving any buck (Transformer 6 has a built in 2.5 % buck) while the 7T transformer is allowed to give up to a 2.5% buck.

7.5.2 The voltage regulators have time delays associated with their operation. There is a time delay before they start to step the voltage and another time delay between steps. Both regulators are setup with a 5 second time delay (Beckwith controller) before they will start to step up the voltage. The intent of the delay is to minimize the amount of stepping the regulator performs during normal operations (motor starts). This reduces the overall stress and wear on the tap changer contacts. After the 5 second time-delay, the regulator can performs 5/8% steps. The time delay between steps is a function of how long it takes the regulator's tap changer's springs to charge and perform the next step (there is no time delay intentionally programmed into the LTC). The 7T regulator has a 3.0 second time delay between steps and the Circuit 767 regulator has a 3.6 second time delay between steps. The difference in the time delays between steps for the two regulators is due to differences in the regulator tap changer design (motor speeds and/or pulley sizes).

7.5.3 The Circuit 767 regulator has been configured to block the lower taps. This was performed to ensure that when the grid was in an elevated voltage condition, the regulators would not be acting as a step down transformer. If the transformer was configured to allow the use of the step down taps it could contribute to potentially lower initial voltages (voltage prior to regulator stepping) because it could be acting as a step down transformer during voltage transients. Transformer #6 is already configured to be on a 2.5% lower tap. Therefore, elevated bus voltages during high grid conditions have not been a significant concern on the Ginna buses. With the regulator configured in a "block lower" configuration it will not regulate the bus voltages during elevated grid conditions. An assessment of both the advantages of reducing the bus voltages during normal operations and the potential negative consequences of being in a "worse" initial voltage condition following a plant trip was performed. The decision was made to not degrade the offsite power's ability when it is most needed (following plant trip during LOCA conditions). Therefore, the Circuit 767's lower tap positions are blocked. Similarly the 7T regulator was blocked from giving more than a 2.5% buck.

7.6 Acceptable Voltage Limits for Simulations

7.6.1 In this section, the allowable voltage range on various buses in the Ginna electrical distribution system will be developed. These limits will be used in loadflow simulations to ensure that acceptable voltages will be maintained during both normal and emergency conditions.

7.6.2 Since both offsite circuits have voltage regulators, an acceptance criteria will be defined for both the transient voltage conditions that can occur prior to the regulator responding and during steady state conditions that would occur after the regulator responds. An assessment will be made later in this analysis to evaluate the times it takes the regulators to respond. The acceptance criteria will act as a first pass /fail for simulations being performed in this analysis. Any failures will be further addressed in this analysis for impact on the adequacy of the Ginna Electric Distribution System.

7.6.3 4KV Bus Acceptance Criteria

7.6.3.1 **Minimum Continuous Voltage Limit (4 KV Buses):**

On the Ginna 4160 volt system, all motors are rated at 4000 volts (See Attachment VII). In accordance with reference 4.13 these motors are rated for continuous operation at voltages of $\pm$10%. Therefore, the minimum acceptable voltage at the motors' terminals after the voltage regulators respond is 3600 volts (0.865 p.u. on a 4160 volt base).

7.6.3.2 **Minimum Momentary Voltage Limit (4 KV Buses):**

Since the voltage regulators have a time delay before responding to transient voltage conditions, a minimum voltage limit during transient conditions must be defined. In this analysis the minimum transient voltage limit will be based on the undervoltage relay setting on the 4 KV buses. This will ensure the buses are not shed before the voltage regulators have a chance to raise the voltages. The Bus 12A and 12B undervoltage relays are set at 75% of 4200 volts (see drawings 11253-1 sheets 6 and 17). Buses 11A and 11B have two sets of undervoltage relays with the 27-1 and 27-2 relays set at 68.33% of 4200 volts and the 27-3 and 27-4 relays set at 75% of 4200 volts (See drawing 11253-1 sheet 11). The 27-3 and 27-4 relays are utilized for a reactor trip signal only. For conservatism and to account for potential relay drift and setpoint error a 5% tolerance will be added to the relay setpoints (actual setpoint tolerance and drift should be significantly less). Therefore, a minimum voltage limit of 80% of 4200 volts will be used in this analysis (0.8077 p.u. on a 4160 volt base). None of the 4 KV motors are expected to stall if the voltage momentarily dips to 80.77% of 4160 volts. The breakdown torques for the motors are around 2 per-unit. Therefore, even if the motors were operating at full load it would take a motor terminal voltage of approximately 70% of 4 KV for the motors to stall. The 27-1 and 27-2 relays on Buses 11A and 11B are utilized to shed the motor loads and their setpoints (68.33% of 4200 volts) is in the region where motor stalling would be a concern.

7.6.3.3 **Maximum Voltage Limit (4 KV Buses):**

Elevated voltages on the 4160 volt buses can result in long term aging concerns with 4 KV motor loads. On the Ginna 4160 volt system, all motors are rated at 4000 volts (See Attachment VII). These motors are rated for continuous operation at voltages of $\pm$10%. Therefore, a maximum continuous acceptable voltage at the motors' terminals is 4400 volts (1.0577 p.u. on a 4160 volt base). Operation at voltages above this limit are a long term insulation degradation concern.

Therefore the acceptance criteria for the 4 KV buses in the computer simulations is as follows:

4 KV Voltage Limits

Operating Condition	Voltage Limit
Minimum Continuous Voltage at Motor Terminals (voltage after regulators respond)	3600 Volts (0.865 p.u. on a 4160 volt base)
Minimum Transient Voltage on 4 KV Buses (voltage before regulators respond)	3360 Volts (0.808 p.u. on a 4160 volt base)
Maximum Motor Terminal Voltage	4400 Volts (1.058 p.u. on a 4160 volt base)

7.6.4 480V Bus Acceptance Criteria

7.6.4.1 The 480 volt buses contain a mixture of 480, 460 and 440 volt rated equipment. The safety related 480 volt buses (14, 16, 17 and 18) have both loss of voltage and degraded voltage relays that are utilized to ensure acceptable equipment protection. The "loss of voltage" relays have a setting of 372.8 volts with a 2.4 second time delay. The degraded voltage relays have an inverse time tripping characteristic. These degraded voltage relays have a dropout voltage setting of 420.8 volts and a time lever setting of 6 (Reference 11253-1 Sheet 3). The time delay characteristics for the degraded voltage relays are shown in Attachment X. It should be noted that the first curve shown in Attachment X is for a drop out setting of 412 volts rather than 420.8 volts. The 420.8 volt curve would be slightly to the right of the shown curve. A testpoint at 92 volts for the 420.8 volt curve would be at 40 seconds as opposed to 42.5 seconds for the 412 volt curve. The undervoltage relay settings will provide the basis for the acceptance criteria in the load flow simulations for the 480 volt buses. The ultimate limit on non safety busses (13 and 15) is their loss of voltage relay setpoint of 328 volts (see drawing 11253-1 sh. 18).

7.6.4.2 The settings of the safety related 480 volt bus undervoltage relays was evaluated in Design Analysis DA-EE-93-006-08 (Reference 4.5). In this analysis both the specified settings and the minimum and maximum tolerances for the voltage setting of the relays was determined (including effects of drift and setting accuracy). The maximum undervoltage relay dropout and reset voltages will be utilized in this analysis for the acceptance criteria to conservatively ensure that the worst case voltage dips do not result in undervoltage relay actuation. Based on the information in Design Analysis DA-EE-93-006-08 and Reference 4.34, the relays have the following maximum voltage limits:

<u>Degraded Voltage Relays</u>	
Maximum Analytical Limit Reset Voltage	434.16 Volts
<u>Loss of Voltage Relays</u>	
Maximum Analytical Limit Dropout Voltage	381.2 Volts
Maximum Reset Voltage**	

**In this analysis it must be demonstrated that voltage dips are not below loss of voltage relay dropout voltage. Therefore, the loss of voltage relay reset voltage is not utilized in this analysis.

7.6.4.3 **Minimum Continuous Voltage Limit (480 Volt Buses):**

The minimum continuous voltage limit is defined as the voltage on the 480 volt buses after the voltage regulators respond to transient voltage dips on the offsite power transmission system (i.e., after Ginna trip). The minimum voltage limit utilized in this analysis is based on the 480 volt bus voltage being above the degraded voltage relay's reset voltage of 434.16 volts (0.9045 p.u. on a 480 volt base). The acceptance criteria developed in this section will be utilized to assess load flow results. In section 7.8 of this analysis an assessment will be made of the worst case simulation results in this analysis to demonstrate that the regulators respond fast enough to ensure the degraded voltage relays reset prior to timing out.

7.6.4.4 **Minimum Transient Voltage Limit (480 Volt Buses):**

Since the voltage regulators have a time delay before responding to transient voltage conditions, a minimum voltage limit during transient conditions must be defined. In this analysis the minimum transient voltage limit on the 480 volt buses will be based on the loss of voltage relay maximum credible dropout voltage of 381.2 volts (0.7942 of 480 volt base).

7.6.4.5 **Maximum Voltage Limit (480 Volt Buses):**

Elevated voltages on the 480 volt buses can result in long term aging concerns with 480 volt loads. The 480 volt system contains a mixture of 480, 460 and 440 volt rated equipment. Equipment is typically rated for continuous operation at voltages of $\pm$10%. In this analysis a maximum acceptable continuous bus voltage of 506 volts will be utilized (110% of 460 volts). This should result in no equipment loss of life for 460 and 480 volt loads. In references 4.20 and 4.21 the operation of the safety related 440 volt motors on the 480 volt buses at elevated voltages as high as 515 volts was evaluated. The results demonstrate no motor loss of life on any of the 440 volt motors with the exception of the Motor Driven Auxiliary Feedwater Motors (MDAFWP's) and these motors have subsequently been replaced with 460 volt motors. In addition, when the motors are operating there would be a voltage drop between the 480 volt buses and the motors. Therefore, the operation of the 480 volt buses at 506 volts (1.0542 p.u. on a 480 volt base) during high grid voltage conditions is acceptable.

7.6.4.6 The acceptance criteria for the 480 buses in the computer simulations is as follows:

480 Volt Bus Voltage Limits

Operating Condition	Voltage Limit
Minimum Continuous Voltage 480 Volt Buses (voltage after regulators respond)	434.16 Volts (0.9045 p.u. on a 480 volt base)
Minimum Transient Voltage on 480 Volt Buses (voltage before regulators respond)	381.2 Volts (0.7942 p.u. on a 480 volt base)
Maximum Continuous Voltage on 480 Volt Buses	506 Volts (1.054 p.u. on a 480 volt base)

7.7 Computer Simulations

7.7.1 Loadflow simulations will be run to ensure that acceptable voltages are maintained during both normal and emergency operating conditions. Each offsite power source configuration will be analyzed to determine its adequacy for the following operating conditions:

Normal Operations
Plant Trip (Non-Accident Conditions)
Plant Trip (Accident Conditions)

7.7.2 The following is a description of all the specific simulations that were run and analyzed for this study. They are grouped based on the plant mode of operation and subsequent loading and operating configurations. General results will be described in each section. The simulation results for each case are included in Attachment XI of this analysis.

7.7.3 Normal Operations – Ginna On-Line

7.7.3.1 Cases were run from normal power operations, with Ginna on-line. Offsite power is aligned to feed buses 12A and 12B which feed the safety related 480 volt buses. Buses 11A and 11B are supplied via the unit auxiliary transformer (Transformer #11) while Ginna is on-line.

7.7.3.2 The purpose of performing these simulations is to determine the minimum and maximum expected voltages on the buses during normal operations.

7.7.3.3 **Normal Operations - Minimum Voltage Conditions**

While both regulators are configured in a manner that would result in at least 4160 Volts on the 4160 volt buses (during normal operations), it was assumed that the 4160 volt buses would only be at approximately 4118 (0.99 per unit on a 4160 V basis) for the Case 101 simulation. The intent of this simulation was to demonstrate that the voltage levels on the safety related buses would be adequate under normal conditions.

For this simulation a high bus loading will result in a conservative calculation of the minimum 480 volt bus voltage. A review of the "Daily Electrical Logs" indicates that the normal safety related 480 volt bus loading is between 300 and 700 KVA on Buses 14 and 16 and between 300 and 600 KVA on Buses 17 and 18. The following loading was utilized in this simulation:

Bus	S (KVA)	power factor (%)
14	988	94.2
16	979	94.4
17	868	95.0
18	864	95.6

The power factors in the above table are relatively high because the pressurizer heaters and intake heaters are assumed on.

Since the 4 KV bus voltage is being fixed for this simulation, individual simulations for each offsite power alignment is not required. The results of this simulation are displayed in Attachment XI (Case #101). A review of the simulation results indicates that the 4 KV and 480 volt buses were maintained well above the acceptance criteria specified in section 7.6 of this analysis.

7.7.3.4 Normal Operations - Maximum Voltage Conditions

Since the regulators will be configured to have limited buck capability, they will not always be able to maintain their pre-set base voltage during elevated transmission system voltages. The purpose of these simulations is to demonstrate that the buses will not rise above the acceptance criteria limits specified in section 7.6 of this analysis. To determine a maximum expected bus voltage, a conservatively high transmission system voltage will be assumed and a minimum loading on the 480 volt buses will also be assumed. The maximum voltage at Station 13A will be based on the Energy Control Center Alarm setting which is 123 KV. For these simulations the following bus loadings were assumed:

Bus	S (KVA)	power factor (%)
14	282	87
16	254	86.6
17	277	92.9
18	277	92.9

Simulations were performed for all four possible offsite power alignments. The results of these simulations are included in Attachment XI (Cases 102-105). A review of these results indicates that the high bus voltage limits specified in section 7.6 of this analysis were never exceeded with the exception of case 102G. The justification associated with case 102G was previously presented in the conclusion section of this analysis.

7.7.4 Plant Trip - Non-Accident Loading

7.7.4.1 The following cases simulate the minimum expected voltages on the 480 volt and 4 KV buses following a plant trip. Upon a plant trip, buses 11A and 11B remain fed via Transformer 11 for 60 seconds. The buses then transfer to the offsite power supplies (52/BTA-A and 52/BTB-B close). In these simulations, the worst case offsite transmission system voltages will be assumed (111.8 KV at Station 13A), unless otherwise noted. The maximum expected bus loadings will be utilized as determined in Attachment VII of this analysis. Simulations will be performed to determine the minimum initial voltage dip that would occur prior to the voltage regulators responding and then additional simulations will be performed to show the effect of the voltage regulators.

The results for each of the following simulations are included in Attachment XI.

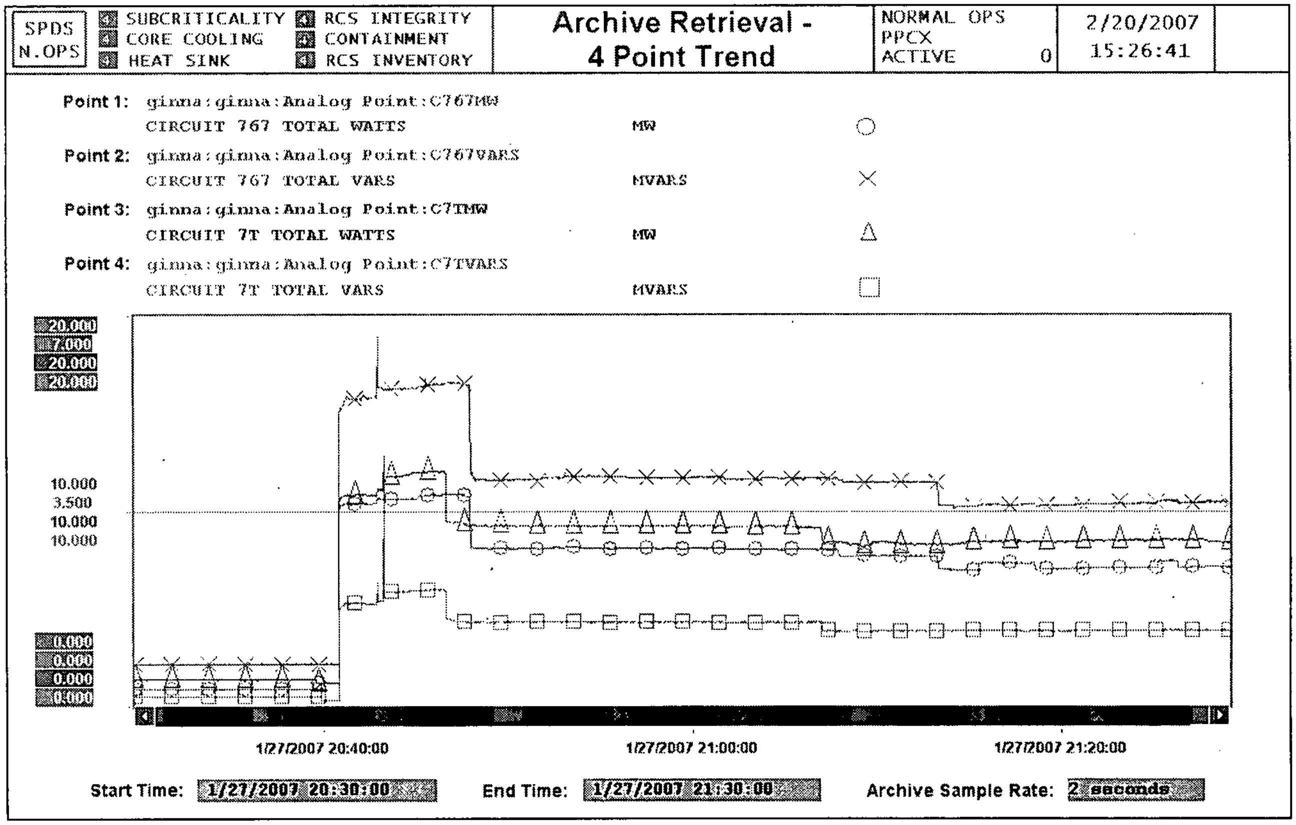
Offsite Alignment	Time Frame	Case #
50/50 Normal	(Before Regulator Responds)	106
50/50 Alternate	(Before Regulator Responds)	107
100/0	(Before Regulator Responds)	108
0/100	(Before Regulator Responds)	109
50/50 Normal	(After Regulator Responds)	110
50/50 Alternate	(After Regulator Responds)	111
100/0	(After Regulator Responds)	112
100/0	(After Regulator Responds)	112B
0/100	(After Regulator Responds)	113

A review of the above simulation results indicates that acceptable voltages were maintained for all the above simulations. Some overloading of the 767 regulator did occur during some of these simulations (Cases 108, 112 and 112B).

The consequences of branch overloads are often a function of the overload duration and the duration for the overloads highlighted in the above results table are expected to be relatively short. The overload on the 767 regulator (Cases 108 and 112) is expected to be eliminated within 30 minutes because of operator actions (possibly by tripping the main feed water pumps). The 767 regulator has a rating of 26.67 MVA and was built in accordance with the ANSI C57.91 – 1995 standard (Reference 4.18). A preliminary review of that standard suggests that a 10% overload for 30 minutes would not be expected to result in any significant loss of life. It can also be noted that LTCs built to this standard are capable of 40 breaking operations at twice the rated current. A preliminary review of the overload protection for the 767 circuit (Drawings 3309-1, 3309-31, 3309-35 and 11253 series) does not reveal any protective devices that would remove the 767 regulator for a 10% overload condition and therefore the circuit would not be inadvertently tripped.

The above mentioned overload of the 767 regulator was further investigated in Case 112B. This case is the same as case 112 except some of the "built in conservatism" was removed. Case 112B turned off ABEF1B since interlocks prevent both ABEF1A and ABEF1B being on simultaneously (Both fans were assumed on in case 112). Case 112B also turned off CPB. Case 112 had assumed all three Condensate pumps were on while case 112B assumes only two are on; for normal operations only two condensate pumps are on. The effect of removing these two loads result in the overload on the 767 regulator being reduced from 108% to 103.5%.

A plant trip occurred on January 27, 2007 and the following auxiliary loading information was obtained from the PPCX system.



The loading information from the above PPCX plot is compared against the corresponding ETAP values from case 112B in the following table:

Load	**PPCX (50/50N mode)**	**ETAP Case 112B (100/0 mode)**
Power flowing into 767	10.89 MW + J 5.79 MVAR	24.968 MW + J 11.945 MVAR = 27.68 MVA
Power Flowing out of 7T	12.06 MW + J 5.98 MVAR	
Total	22.95 +11.77 MVAR = 25.79 MVA	24.968 MW + J 11.945 MVAR = 27.68 MVA

The above table suggests that there is still about 2 MVA of conservatisms in Case 112B and that in actual loading conditions, the 767 regulator is not expected to experience any overload for a plant trip, no accident scenario. It should be noted that the 25.79 MVA value from the PPCX shown in the above table includes the load associated with the third condensate pump (Case 112B only assumes two condensate pumps on). The third condensate pump motor draws about 1.1 MVA of load. While not true for the 1/27/07 trip, it is generally expected that the third condensate pump would not auto-start for a plant trip condition.

7.7.5 Plant Trip- LOCA Conditions

7.7.5.1 Simulations were performed to simulate the loading on the buses during worst case accident conditions following the completion of ESFAS sequencing. Since Buses 11A and 11B do not transfer for 60 seconds following a plant trip the ESFAS sequencing will have been completed prior to the transfer of Buses 11A and 11B to offsite power. Therefore, the worst case voltages will occur after all the loads have started and 4 KV Buses 11A and 11B have transferred their loads to the offsite power circuits.

7.7.5.2 System voltages will be assumed to go to the lowest credible values as determined in section 7.4 of this analysis and/or go to offsite power operability alarm setpoint (116L, 117L, 120 and 121). The bus loadings will be assumed to be at their maximum loading as determined in Attachment VII of this analysis. Simulations will be performed to determine the minimum initial voltage dip that would occur prior to the voltage regulators responding and then additional simulations will be performed to show the effect of the voltage regulators.

7.7.5.3 The results for each of the following simulations are included in Attachment XI.

Offsite Alignment	Time Frame	Case #
50/50 Normal	(Before Regulator Responds)	114
50/50 Alternate	(Before Regulator Responds)	115
100/0	(Before Regulator Responds)	116
100/0 - Alarm	(Before Regulator Responds)	116L
0/100	(Before Regulator Responds)	117
0/100 - Alarm	(Before Regulator Responds)	117L
50/50 Normal	(After Regulator Responds)	118
50/50 Alternate	(After Regulator Responds)	119
50/50 Alternate	(After Regulator Responds – Spare SW on Bus 18)	119B
100/0 -Alarm	(After Regulator Responds)	120
0/100 -Alarm	(After Regulator Responds)	121

7.7.5.4 A review of the above simulation results (Attachment XI) indicates that acceptable voltages were maintained for all the above listed cases. Case 116L shows the least amount of margin at the 480 volt bus. The margin is less than 1% but that is not surprising since the offsite alarm limit (108.9 kV) was selected such that the minimum voltage on the 480 safety bus would "just" be acceptable for this worst case scenario. The following is a list of some of the conservatisms associated with Case 116L:

- The offsite power system is assumed to be aligned 100/0 at the time of the LOCA. This is not a not the normal system configuration.
- The maximum analytical limit (381.2 volts, 79.42% of 480) for the LOV relay was used as the criteria. The actual relay calibration procedure that is currently in use would result in a slightly lower criterion.
- The voltage is assumed to go down to 108.9 kV following a Ginna Trip however the worst case voltage dip ever recorded during a unit trip at Ginna was 111.8 kV

7.7.5.4.1 The overloads shown for the LOCA conditions (Cases 114 – 124) are also expected to be relatively short due to the nature of accident loads. In particular, the containment fans, whose brake horsepower is proportional to air density, will experience changes in load current during the accident transient. Attachment VII indicates that the Containment Fan BHP loading during the initial injection phase of the accident is 239.2 HP (54 psig) but that the BHP drops down to 172 HP as the containment pressure drops down to 30 psig (Recirculation phase).

7.7.5.4.2 **SST14 Overloads**

Table 6 in IEEE C57.96-1999 (Reference 4.15) indicates that a 150 degree C rise transformer, operating in a 40 degree C environment, can be overloaded by 9% for two hours with no significant loss of life assuming that it's loading before and after the overload is 90% of the transformers rating. The SST14 loading prior to an accident would be significantly below 90%, therefore the 2.3 – 3.0% overload shown on SST14 for the LOCA conditions will not result in any significant loss of life for the transformer because the load is expected to be significantly less within two hours.

7.7.5.4.3 **Bus 14/16 Feeder Breaker Overloads**

The Bus 14 and Bus 16 supply breakers are rated for 3000 amps continuous current and are set at the 3000 amp limit. The breaker curves (10910-0018B, 10910-0011B) are plotted assuming ±10% accuracy. The breakers at Ginna may actually have a smaller tolerance band (±2%) around the pick up setting, however the general maintenance procedure (GME-50-02-DB75) has a +/- 10% acceptance criteria for the "as found" pick up setting. It should be noted that the most recent "as found" pick up for 52/14 was 4.9 amps (3000-5CT) which is within the 2% tolerance band. Similarly the most recent (6/20/05) "as found" pick up for 52/16 was also 4.9 amps. It should be noted that the current flowing through the Bus 14 supply breaker could be as high as 3089 amps prior to the regulators responding (Case 116L). The operating time of the supply breaker is about 270 seconds for this current magnitude and the regulator (767) takes about 66.2 seconds to fully improve the voltage. Once the regulators have responded, the current would be reduced below 2700 amps (2697 amps,Case 120). Therefore no inadvertent trip of the Bus 14 and/or Bus 16 supply breakers will occur. It should be noted that PCR 2007-0030 has been issued in order to change the LTPU setting from 1 to 1.1 for the Bus 14 and 16 feeder breakers. This action will provide additional margin against an inadvertent trip of these breakers.

7.7.6 Plant Trip- Back Feed to Main Transformer During Post LOCA Conditions

7.7.6.1 An additional configuration being addressed is the potential to back feed through the main transformer. As described in Section 8.3.1.2.6.1 of the UFSAR, during a loss of offsite power a back feed path from the 115 KV distribution system through the GSU transformer can be utilized to provide an additional source of power if both Circuits 7T and 767 are not available. The flexible generator bus disconnects can be removed and power supplied from the unit auxiliary transformer.

7.7.6.2 A simulation was performed to simulate the loading on the buses during worst case accident conditions following the completion of ESFAS sequencing. As discussed in the UFSAR it is assumed that it will take approximately 8 hours to perform the alignment to back feed through the GSU transformer. Therefore, this simulation will be modeled with all ESFAS loads already started and the 4 KV buses at their worst case expected loadings.

Offsite Alignment	**Case #**
Back feed Through GSU	124

7.7.6.3 A review of the above simulation results indicates that acceptable voltages were maintained for all the above simulations.

7.8 Response Time of Voltage Regulators

7.8.1 In this analysis simulations were performed to demonstrate that during the initial voltage transient following a Ginna trip the voltages did not go below the loss of voltage relay settings on the 480 volt buses. Additional simulations were also performed to demonstrate that after the Circuit 767 and 7T voltage regulators responded the bus voltages were raised above the degraded voltage relay reset values. A review of the simulation results indicates for some plant conditions there is a time frame while the voltage regulators are responding that the 480 volt bus voltages are below the degraded voltage relays' dropout voltage setting. In this section an evaluation of the response time of the voltage regulators will be performed to ensure the degraded voltage relays will not time out prior to the voltage regulators raising the 480 volt bus voltage above the degraded voltage relays' reset voltage.

7.8.2 The voltage regulators on Circuits 767 and 7T are both configured with a 5 second time delay before they will start to raise (or lower) the bus voltages. Once they start to step there is a 3.6 second time delay between tap changes on the Circuit 767 regulator and a 3.0 second time delay between tap changes on the 7T regulator. The time difference is due to physical differences in the voltage regulators tap changer design and the tap changer motor speeds. Each regulator performs a 5/8% change in voltage for each tap change. It should be noted that there are really two neutral positions in each of the LTCs, so transitioning through the neutral position takes twice as long as transitioning through any of the other tap positions. The details of the timing associated with changing the tap positions is contained in Attachment VI. Actual operating times for the 767 regulator are apparent from the RCP start tests shown in Attachment VII.

7.8.3 The time delays associated with the degraded voltage relays is shown in Attachment X and XII. A review of previous test results obtained per Procedure PR-1.1 verifies the 368 volt (relay voltage = 92 V) point (40 seconds nominal). Note that the first curve in Attachment X is for a slightly different dropout setting (103 V rather than 105.2 volts) so the actual curve will be slightly to the right of the one shown. The simulation results in section 7.7 demonstrated that the bus voltage never went below the loss of voltage relaying maximum dropout voltage of 381.2 volts.

7.8.4 To ensure the voltage regulators respond fast enough, calculations were performed to determine the time frame required for the regulators to raise the 480 volt bus voltages above the degraded voltage relay reset voltage setpoints (434.16 volts or 90.45% of 480V). These calculations were performed by using the worst case scenarios performed in section 7.7 for each voltage regulator. The worst case voltage dips on the 480 volt buses occurred for the Circuit 767 regulator when it was aligned in 100/0 during LOCA conditions with the Station 13A voltage maintained at its offsite operability alarm setpoint of 108.9 kV (Case 116L). Similarly, the worst case 480 volt bus voltages for the 7T regulator occurred when it was aligned in 0/100 during LOCA conditions (Case 117L). Therefore calculations will be performed to determine the time required for the regulators to respond during these conditions and raise the 480 volt bus voltages above the degraded voltage relaying maximum reset voltages.

7.8.5 Circuit 7T Load Tap Changer Response

Case 117L represents the minimum voltage case (prior to voltage regulator action, 0/100, large break LOCA) for the 7T Load Tap Changer. The minimum voltage at any safety related bus was 81.37 % of 480V (390.58 volts). This corresponds to a relay voltage of 97.64 volts which corresponds to an estimated operating time of about 42.5 seconds (Assuming the voltage stayed at 97.64 volts for the entire 42.5 seconds and also assuming the maximum relay reset value of 434.16 bus volts).

The 7T Load Tap Changer is in the 2.5% buck position (8L) for Case 117L. In Case 121 (after regulator response) the regulator is in the 10R position and the voltage on bus 14 is 92.93% of 480 (446.06 volts) which is well above the 434.16 reset point. A total of 18 tap position changes were made but we traversed through the neutral so the tap transition time is 19 * 3.0 = 57.0 seconds; adding in the 5 second initial delay we get a total time 62 seconds.

Since the estimated relay operating time (42.5 seconds) is less than the regulator response time (62 seconds), it is necessary to do a detailed analysis evaluating how the degraded relay responds to an improving voltage profile. This detailed analysis is contained in Attachment XII. The conclusion from Attachment XII is that the degraded undervoltage relay will not operate during this condition.

7.8.6 Circuit 767 Voltage Regulator Response

Case 116L represents the minimum voltage, maximum duty case (prior to voltage regulator action, 100/0, large break LOCA) for the 767 voltage regulator. The minimum voltage at any safety related bus was 79.66 % of 480V (382.37 volts). This corresponds to a relay voltage of 95.59 volts which corresponds to an estimated operating time of about 40.4 seconds (Assuming the voltage stayed at 95.59 volts for the entire 40.4 seconds and also assuming the maximum relay reset value of 434.16 bus volt).

The 767 regulator is in the neutral position for Case 116L. In Case 120 (after regulator response) the regulator is in the 10% boost position (16R) and the voltage on bus 14 is 91.27% of 480 (438.10volts) which is above the 434.16 reset point. A total of 16 tap position changes were made but we traversed through the neutral so the tap transition time is 17 * 3.6 = 61.2 seconds; adding in the 5 second initial delay we get a total time of 66.2 seconds.

Since the estimated relay operating time (40.4 seconds) is less than the regulator response time (66.2 seconds), it is necessary to do a detailed analysis evaluating how the degraded relay responds to an improving voltage profile. This detailed analysis is contained in Attachment XII. The conclusion from Attachment XII is that the degraded undervoltage relay will not operate during this condition.

8.0 Results

8.1 The Ginna offsite and onsite power distribution system is shown to provide adequate voltage levels for the required loads for all operating modes and offsite power alignments. This analysis demonstrates that the voltage regulators on Transformer 7T and Circuit 767 respond in an acceptable manner to ensure adequate voltages.

THIS CALCULATION HAS BEEN ABRIDGED FOR SUBMITTAL IN THAT ITS SUPPORTING DOCUMENTATION, WHICH CONTAINS PROPRIETARY INFORMATION, HAS BEEN REMOVED. THIS SUPPORTING DOCUMENTATION WILL BE MADE AVAILABLE TO THE NRC UPON REQUEST.

ATTACHMENT 4

DA-EE-92-098-01
"Diesel Generator A Steady State Loading Analysis"

Design Analysis

Diesel Generator A Steady State Loading Analysis

Ginna Station
CONSTELLATION ENERGY

DA-EE-92-098-01

Revision 5

8/7/07
Effective Date

Prepared By: [signature] Design Engineer — 8/6/07 Date

Reviewed By: [signature] Reviewer — 8/7/07 Date

Revision Status Sheet

Revision Number	Affected Sections	Description of Revision
1	Multi-Sections	SW Motor Replacement (PCR's 95-046 and 95-075) and MCC Loading Analysis Revision (DA-EE-92-011-07). Also included additional recirculation phase case.
2	Indicated by Redline	Revised to reflect SI pumps not drawing suction from BAST during injection phase and reference D/G Room Temperature analysis ME-91-0010.
3	Indicated by Redline	Revised to reflect changes in the Service Water Pump loading requirements due to the pumps being replaced under TE 94-0586.
4	4.4.5	Revised to change date in reference in 4.4.5 as in CATS item #10588.
	4.4.12.4	Revised Service Water Pump Curve; No analysis changes required.
5	all	Updated to reflect 2007 As Built conditions – See section 1.5

1.0 OBJECTIVE AND REVISION HISTORY

1.1 The objective of this analysis is to quantify the maximum steady state loading on Emergency Diesel Generator A (EDGA) during worst case accident loading conditions. This analysis will demonstrate the diesel generator rating is adequate for steady state emergency load requirements. The EDGA loading associated with Injection, High Head Recirculation and Low Head Recirculation modes will be individually evaluated.

1.2 The steady state loading is defined as the generator loading following the safeguard sequencing period in which the various motors are started and motor operated valves are aligning. The ability of the generator to handle these transients will be evaluated in a separate dynamic loading analysis (DA-EE-92-111-01).

1.3 In this analysis, the loading for each motor fed from Emergency Generator A will be evaluated. The impact of any data uncertainties and/or conservative assumptions will be addressed in the Results section of this analysis.

1.4 The corresponding Diesel Generator B steady state loading analysis will be contained in DA-EE-92-120-01.

1.5 The purpose of this revision (5) was to document the maximum steady state loading on Emergency Diesel Generator A (EDGA) for the 2007 As Built Conditions. Specific changes that are associated with this revision include:

- Increased the kVAR rating of the diesel generator set to 1500 kVAR from 1462.5 kVAR (See section 7.3.4)
- Corrected the 440 V motor driven fire pump rated current to 231 amps (from 281 amps) per Westinghouse memo to Ted Miller dated 6/28/2002 (DBCOR 2002-0025) and PCR2001-0038. This had no effect on the results because the motor is assumed off.
- Replaced the two 440V, 250 horsepower motor driven auxiliary feedwater pump motors with 460V, 300 horsepower motors per TE 2004-0007.
- A new 460 V, 350 HP SWP motor (spare) was installed (April 28, 2006) and the existing 460 V, 350 HP SWP motor D was removed. Since the spare motor has slightly different running characteristics than the other SWP motors, the model was expanded to allow the "Spare" SWP motor to be installed on either the A or B train.
- Incorporated CREATS and MCC changes per PCR 2003-0037. Specifically the following MCC loading, which is based largely on Table 5 of DA-EE-2003-062, was assumed:

Table 1 - MCC Loading - Accident with LOOP

MCC Loading - Accident with LOOP				
	Injection Phase		Recirc Phase	
	P (KW)	Q (KVAR)	P (KW)	Q (KVAR)
MCC C (1)	85.37	46.58	85.37	46.58
MCC D (2)	97.34	57.68	97.34	57.68
MCC H	13.84	11.47	13.84	11.47
MCC J	12.99	10.94	12.99	10.94
MCC K	18.50	11.50	18.50	11.50
MCC L	2.49	2.34	2.49	2.34
MCC M	2.49	2.34	2.49	2.34
MCC N	18.00	10.00	46.00	10.00
MCC P	18.00	10.00	46.00	10.00
Note 1: MCC C Loading does not include MCC's H, K and L				
Note 2: MCC D Loading does not include MCC's J and M				

- Turned control room heaters off (MCCN and MCCP) for Injection Phase and turned them on for Recirculation Phase (Consistent with Emergency Operating Procedures).
- Updated the Containment Fan ETAP model to better match the power factor and efficiencies listed in the June 1993 manufacture report. Also updated the locked rotor current value based on curve KN011492 (Locked rotor current reduced to 1689.6 amps from 1772 Amps)
- Refined cable data (EDG cables are not in magnetic duct, etc.).
- Based upon DA-ME-2006-016 (Ref 4.3.10) and SPCR 2006-0001 (Ref 4.4.8.4) the BHP for the RHR was reduced for the Injection phase due to the effect of valve throttling (See Table below and Attachment I for details)

Table 2 - RHR Flow Rate and BHP

RHR Flow Rate and BHP		
Accident Mode	GPM	BHP
Injection	<= 1688	150
Recirculation	Any (Max BHP assumed)	173

- Modified the "recirculation phase" BHP associated with the Containment Fan based on the revised containment pressure – time profile (UFSAR Figure 6.2-4, Reference 4.4.9.4). In particular the containment fan BHP was increased from 128 HP to 172 HP for the recirculation phase.

- Modified the "injection phase" BHP associated with the Containment Fan based on the revised containment pressure – time profile (UFSAR Figure 6.2-4, Reference 4.4.9.4). In particular the containment fan BHP was decreased from 256 HP to 239.2 HP for the injection phase (Max containment pressure = 54 psig rather than 60 psig).
- Expanded the scope of the analysis to include an evaluation and document the effect of "off nominal" frequency operation (i.e. monthly test acceptance criteria range is 59.5 Hz to 60.5 Hz).
- Expand the scope of the analysis to include an evaluation and document the effect of "off nominal" voltage operation (i.e. monthly test acceptance criteria range is 470 – 504 volts).
- Expanded the scope of the analysis to include a comparison of the maximum kW demand on the EDG with the test requirements in the "Tech Spec" This comparison was made in order to verify that the maximum EDG demand is less than or equal to the minimum requirements set forth in the "Tech Spec" (i.e. "Verify each DG is synchronized and loaded and operates for > =60 minutes and < 120 minutes at a load >= 1950 kW and < 2250 kW.")
- Modified the ETAP computer model such that it runs on ETAP 5.5.0N. Also expanded the computer model to include the calculation of the continuous current duties imposed on the equipment for informational purposes only.

2.0 CONCLUSIONS

2.1 A Summary of the loadings as well as the percent safety margins is shown in the following table for each of the three accident scenarios:

Table 3 - EDGA Steady State Loading Summary

EDGA Steady State Loading Summary (Off Nominal Frequency and Voltage Considerations Included)				
	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
EDG Load - Injection	1977	947	2192	2720
EDG Rating (2 hour)	2250	1500	2868	3450
Percent Margin Injection Phase	12.1%	36.9%	23.6%	21.2%
EDG Load - HHR	1807	839	1993	2472
EDG Rating - Continous	1950	1500	2500	3000
Percent Margin HHR	7.3%	44.1%	20.3%	17.6%
EDG Load _LHR	1505	695	1658	2057
EDG Rating - Continous	1950	1500	2500	3000
Percent Margin LHR	22.8%	53.7%	33.7%	31.4%

Percent Margin=(Rating - Duty) / Rating *100

2.2 As demonstrated in the table above, the most limiting case for the steady state loading on Emergency Diesel Generator A would be the injection phase. The injection phase loading is limiting from an absolute magnitude (kW and kVAR) point of view however from a "kW percent margin" point of view, the high head recirculation phase has less margin between the anticipated duty and the capability of the emergency diesel generator. The percent margin shown for the high head recirculation phase is associated with the time period two hours into a LOCA. As time progresses, the containment pressure will continue to decrease and the corresponding loading on the containment fans will decrease and therefore the percent margin will increase. The percent margin shown in the above table is well within the Regulatory Guide 1.9 requirement of "not less than 5 percent (margin)".

2.3 As demonstrated in Section 7.5.12, the maximum generator loading, during the injection phase with the generator at rated voltage and frequency, would be 1939 KW and 928 KVAR (0.90 pf). This loading is within the continuous rating of the diesel generator set (1950 KW and 1500 kVAR). It is also well within the emergency rating (2250 KW for 2 hour and 2300 KW for ½ hour). The injection phase duration, while variable, will be completed within two hours for a large break LOCA.

2.4 The impact of "off nominal" voltage and/or frequency operation has been evaluated in section 7.6 of this analysis. Operating the EDG at a frequency of 60.4 Hz would increase the BHP loading by 2.0%. Operating at a reduced frequency would reduce the BHP loading. Voltage variations in the range anticipated have been shown to have a very small impact on the kW or kVAR operating margins although the current (amps) margin was reduced a few percentage points. Section 7.6 demonstrates that by combining the worst case frequency (60.4 Hz) and worst case voltage (465.3 volts) scenarios, the EDG loading increases to 1977 kW (Injection Phase). The additional loading due to off-nominal voltage and frequency is already included in Table 3 above.

2.4.1 The "Tech Spec – SR 3.8.1.3" states: "Verify each DG is synchronized and loaded and operates for >= 60 minutes and < 120 minutes at a load >= 1950 kW and < 2250 kW." It is important that the minimum Tech Spec test limit (1950 kW) be greater than the maximum duty imposed on the EDG. After including the effect of "off nominal" voltage and frequency, this criteria is no longer met and a "Tech Spec Change" will be required (Reference CR-2006-004136).

2.4.2 The Main Control Board kW meters that are used during the "Tech Spec" test have a nominal accuracy of +/- 1% however the most recent calibration of these meters (Reference 4.1.7) shows an accuracy better than 0.1 kW in the 1950 kW – 2000 kW region of the meter. Therefore the negative margin between the maximum loading on the EDG and the minimum "Tech Spec" test limit is 27.1kW. A "Tech Spec Change" will be required because the total worst case loading (1977 kW) exceeds the minimum Tech Spec test limit (1950 kW). It is important to recognize that the two hour rating of the EDG is not exceeded, only the testing limit in the Tech Spec.

2.5 This analysis demonstrates that Emergency Diesel Generator A is adequately sized for the worst case steady state accident loading requirements. The following table summarizes the resulting safety related bus voltages and currents for informational purposes (other analyses may reference this table). It should be noted that the following table assumes that the EDG is operating at rated voltage and frequency. The impact associated with off-nominal voltage and frequency operation is documented in section 7.6 of this calculation.

Table 4 - Safety Related Bus Voltages and Currents (when EDG is at rated voltage and frequency)

Bus Voltages and Current Flow From EDG to Bus			
	Bus	V (% 480)	I (amps)
Injection	14	98.12	2224.87
	18	99.81	342.52
High Head Recirc	14	98.60	1654.56
	18	99.63	677.39
Low Head Recirc	14	98.93	1260.09
	18	99.63	677.39

3.0 DESIGN INPUTS

3.1 ANSI / IEEE Standards

3.1.1 IEEE Standard 387-1984 "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations"

3.2 Nuclear Regulatory Commission Documents

3.2.1 Regulatory Guide 1.9 Revision 2, December 1979 "Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants".

4.0 REFERENCED DOCUMENTS

4.1 Procedures

4.1.1 Procedure E-0, "Reactor Trip or Safety Injection".

4.1.2 Procedure E-1, "Loss of Reactor or Secondary Coolant".

4.1.3 Procedure ES-1.3, "Transfer to Cold Leg Recirculation".

4.1.4 Procedure PT-12.1, "Emergency Diesel Generator 1A (Monthly Test)".

4.1.5 Procedure CP-513, "Diesel Generator Main Control Board Meter Calibration for Diesel Generator A or B

4.1.6 Procedure RSSP-2.2, "Diesel Generator Load and Safeguard Sequence Test" (with recorded data – Dated 10/11/06)

4.1.7 Procedure CP-502.1, "Calibration of A Emergency Diesel Kilowatt Meters" and Work Order 20400829-03 (10/18/05)

4.1.8 Technical Specification Section SR 3.8.1.3 "kW test requirement for EDG"

4.2 Drawings

4.2.1 33013-2539, "AC System Plant Load Distribution One Line Wiring Diagram"

4.2.2 33013-1736 Sheets 3, 4 and 5 "Diesel Generator A Exciter Cabinet Interconnection Diagram"

4.3 Design Analysis

4.3.1 Design Analysis DA-EE-92-011-07, "Class 1E Motor Control Center Loading".

4.3.2 Design Analysis DA-EE-92-010-06, "Containment Fan Break horsepower Requirements".

4.3.3 Design Analysis ME-91-0010, "D/G Building HVAC Analysis".

4.3.4 Intentionally left blank

4.3.5 Design Analysis DA-EE-92-111-01, "Diesel Generator A Dynamic Analysis".

4.3.6 Design Analysis DA-EE-92-112-01, "Diesel Generator B Dynamic Analysis".

4.3.7 Design Analysis DA-EE-96-068-03, "Offsite Power Load Flow Study"

4.3.8 Design Analysis DA-EE-97-040, "Test Results of 350 HP Service Water Pump Motors".

4.3.9 Design Analysis DA-EE-2003-062, "PCR 2003-0037 Electrical Factors Analysis"

4.3.10 Design Analysis DA-ME-2006-016 (Table A give 1688 GPM for RHR pump)

4.4 Miscellaneous Documents

4.4.1 Bill of Materials, Gilbert Associates, Inc. W.O. 4155, Emergency Diesel Engine Generator Sets

4.4.2 Letter, Westinghouse Electric Corporation Power Systems to Rochester Gas & Electric Corp., November 9, 1976, "Ginna Station Diesel Driven Generator SO 75P0503.

4.4.3 Engine Data Sheet MI-17136, G-202. Model 251F

4.4.4 Letter General Electric Locomotives to William Roettger (RG&E), Dated May 14, 1992, "Diesel Generator Data".

4.4.5 Letter General Electric Locomotives to Rochester Gas and Electric, Dated December 18, 1991, "Response to Questions on ALCO Diesel Engine Generators".

4.4.6 Letter Westinghouse Electric Corporation from R. Curtis Funston to Mr. C. J. Williams (ALCO Products, Inc.), Dated January 10, 1968.

4.4.7 Basler Electric Drawing 90-43800-910 Rev D "Schematic and Interconnection Diagram for Series Boost Exciter Voltage Regulator"

4.4.8 Ginna Station Motor Data Sheet

4.4.8.1 Ginna Station Software Change Request 2007-0020, Upgrade ETAP from 5.0.3N to 5.5.0N.

4.4.8.2 May 3, 2007 Email from Ted Miller to Bill Roettger, "EDG Loading" (Voltage and Frequency deviations).

4.4.8.3 May 24, 2007 Email from Ted Miller to Bill Roettger, "Need to drop 4kW" (Tech Spec, Exciter Load and meter location).

4.4.8.4 SPCR 2006-0001 (Set point change request to throttle RHR valve)

4.4.9 Ginna UFSAR

4.4.9.1 Table 6.3-3 (SI and RHR Flow Rates)

4.4.9.2 Table 6.2-27 (Containment Spray Pump Design Parameters)

4.4.9.3 Table 8.3-2a "Diesel Generator Loading - Train A"

4.4.9.4 Figure 6.2-4 "Containment Atmosphere Pressure, Double-Ended Pump Suction Break – Minimum Safeguards"

4.4.10 Field Walkdown data base "MTRDATA.RPT" 11/1/91

4.4.11 Westinghouse letter to R. DiBaudo , May 26, 1988

4.4.12 Motor Data Sheets & Curves

4.4.12.1 Worthington SI Pump Curve #s, E-207328, E-207348, E-207340

4.4.12.2 Bechtel SI pump Data Sheets S/Ns -1613234,1613235, 1613236
4.4.12.3 Pacific Pump Test Performance Curve 33250B

4.4.12.4 Johnston Pump Service Water Pump Performance Curve, Job#98JC1413S-SJC66628, TC-8518, Rev #1.

4.4.12.5 Ingersoll-Rand Curve 46125 2/21/69 and Curve 46126 2/21/69, Containment Spray

4.4.12.6 Ingersoll-Rand Curve N625 Rev 0 1/10/75

4.4.12.7 IR Pump Curve 44236 , 2/15/83, Component Cooling

4.4.12.8 Bechtel Centrifugal Pump Data Sheet - Service Water

4.4.12.9 Reliance Electric Induction Motor Test - Service Water

4.4.13 Standard Handbook for Electrical Engineers, By Donald Fink, 1978, McGraw Hill.

4.4.14 EWR 5295, "Ginna Electric Distribution System study", Motor Testing Data

4.4.15 RHR Pump Motor Rewind Test Data Sheet, P.O. NQ-11583-C-RD, Dated 5/10/89.

4.4.16 Telex, R.M. Harper to P.M. Cameton, Dated September 22, 1969.

5.0 ASSUMPTIONS

5.1 The diesel generator has its regulator set to maintain 1.0 per unit voltage (480 volts). (Step 6.3.10 of Reference 4.1.4 requires operators to verify that voltage is controlled to 480 volts). The impact of "off nominal" voltage and frequency is addressed in Section 7.6 of this calculation.

5.2 The power factor for the load associated with the diesel generator excitation system was assumed to be 1.0. (Assuming a different power factor would increase only the MVAR load on the generator. The results of this analysis will demonstrate that the MVAR loading is not a limiting factor).

5.3 The Aux Feedwater pumps were assumed to be operating rather than the Standby Aux Feedwater Pumps (SAFWP). The SAFWPs are only used if the Aux Feedwater system fails. The only identified common mode failure for the MDAFW pumps is a steam or feed line break in the Intermediate Building. Due to the fact that an accident of this type would not affect containment fan loading or require containment spray, it is not the limiting case for diesel generator loading and therefore will not be evaluated as part of this analysis.

5.4 All MOV loads are assumed off. (MOVs are a transient type load that will be addressed in the dynamic simulation).

5.5 All "optional" loading on the EDG is assumed off. The operator will not put on "optional" loading unless the EDG has sufficient capacity. Operator loading beyond the diesel generator capabilities is assumed to be bounded by the single failure of one diesel generator (ie. this would constitute a second failure).

6.0 COMPUTER CODES

6.1 Electrical Transient Analysis Program (ETAP) Power Station, Version 5.5.0N, Operations Technology Incorporated.

The ETAP Power Station program allows computer modeling of the Ginna electrical distribution system. It then calculates power flows on lines and voltages at all modeled points. This version of the software is compliant with 10 CFR Appendix B (Quality Assurance Criteria) and 10 CFR 21 (See Reference 4.4.8.1).

7.0 ANALYSIS

7.1 General Description

7.1.1 The maximum diesel generator loading will occur during a loss of offsite power coincident with an accident in which the various Engineered Safety Feature (ESF) pumps and fans used for accident mitigation are operating at their maximum horsepower requirements. The worst possible credible single failure from a diesel loading standpoint occurs when there is a failure of one safety train (Loss of one diesel generator) during safety injection. This results in the maximum horsepower loading for the fans and pumps and increases the injection phase time duration. In this event the 480 volt bus loads would be shed with the exception of the MCC's and containment spray, the ESF pumps and fans would then be sequenced on. The following loads would be fed from diesel generator A:

- Safety Injection Pump A
- Safety Injection Pump C
- Residual Heat Removal Pump A
- Service Water Pump A or C*
- Containment Fan A
- Containment Fan D
- Auxiliary Feedwater Pump A
- Containment Spray Pump A (Starts on Hi-Hi CNMT Pressure)
- MCC's C, H, K, L and N

*Which Service Water Pump would auto start depends on the position of the Service Water Selector Switch.

7.1.2 Worst Case Accident Scenario

7.1.2.1 The maximum diesel loading will occur during a design basis large break loss of coolant accident. This is based on the fact the RCS will de-pressurize and containment pressure and temperature will be close to maximum design conditions. This will result in maximum SI and RHR pump flow, containment spray will actuate and the containment fans will be operating near their maximum horsepower requirements. The large break LOCA is more limiting then other major accidents such as a smaller break LOCA or steam line break in containment due to the following:

7.1.3 Steam Line Break (In Containment):

7.1.3.1 The RCS pressure does not decrease during a steam line break as much as it would during a large break LOCA. Therefore the RHR pumps would be operating at a reduced horsepower. In addition, the injection phase is much shorter due to makeup to the reactor only being required to compensate for the reduced RCS temperature. In an accident of this type the RHR pumps would be shut off relatively soon. Therefore, the maximum diesel generator loading would be less for this accident and the injection phase would be shorter. Since the RCS is intact, sump recirculation will not be required and RHR will be used for long term cooldown.

7.1.4 **Smaller Break LOCA's:**

7.1.4.1 The RCS pressure does not decrease as much during a large break LOCA. Depending upon the break size it is possible for the containment pressure not to rise enough to initiate containment spray (28 psig). For break sizes smaller then a large break there would be a reduced containment pressure and temperature. Therefore the containment fans would operate at a significantly reduced brake-horsepower as compared to the large break LOCA case (Attachment I). As a result, the overall loading on the diesel generators would be significantly less for break sizes smaller then a large break LOCA.

7.1.5 **Other Accidents:**

7.1.5.1 For other credible accidents such as a steam line break outside containment or S/G tube rupture, there would not be any significant increase in containment pressure, therefore containment spray would not be operating and the containment fans would be operating at a significantly reduced brake-horsepower. In addition the RCS pressure would not drop enough to cause RHR flow into the RCS. Therefore the diesel generators would be operating at a significantly reduced loading than during a large break LOCA.

7.2 Large Break LOCA Evaluation

7.2.1 The three possible different Engineered Safety Feature (ESF) modes during a large break LOCA are as follows:

- Injection Phase
- Recirc Phase – High Head
- Recirc Phase - Low Head

The injection phase will be followed by either a High Head or Low Head recirculation phase. During the recirculation phase, coolant spilled from the break and water from the containment spray collect in containment sump B. The RHR pumps are aligned to take suction from this sump and either provide suction to the SI pumps for high head recirculation or pump directly into the core through deluge valves for low head recirculation. The type of recirculation (either high head or low head) depends on the status of the core.

7.2.2 The loading for each mode will be compared against the appropriate EDG ratings (Continuous or 2 hour (Injection Phase)).

7.2.3 **Large Break LOCA Injection Phase Duration**

7.2.3.1 The following evaluation provides a basis for determining the time frame for the injection phase of a large break loss of coolant accident (LOCA). This value will provide a basis for determining the acceptability of the emergency diesel generator loading during a large break LOCA.

7.2.3.2 The maximum length of the injection phase during a large break LOCA is based on the RWST level. The operators are guided by Emergency Operating Procedure E-1 during the injection phase of a LOCA. This procedure instructs the operators to end the injection phase when the RWST level is less than 28%. It is possible for the system to stabilize and the operators to terminate the injection phase prior to the RWST reaching 28% level, however the maximum injection phase length would occur if it is required to pump the tank down to this level.

7.2.3.3 If a large break LOCA occurred coincident with the loss of offsite power and the failure of Diesel Generator B, SI pumps A and C, RHR pump A and Containment Spray Pump A are aligned to take suction from the RWST during the injection phase. The flow rates from these pumps determines the length of the injection phase. The following flow rates are the design flow rates for these pumps in accordance with the UFSAR.

Motor	Flow Rate	UFSAR Section
SI Pump A	300 GPM (Design)	Table 6.3-3
SI Pump C	300 GPM (Design)	Table 6.3-3
RHR Pump A	1560 GPM (Design)	Table 6.3-3
Containment Spray Pump A	1200 GPM (Design)	Table 6.2-27

7.2.3.4 The RWST contains approximately 338,000 gallons of borated water. Assuming the pumps are operating at their design flow rates and two SI pumps, one RHR and the containment spray pump are taking suction from the RWST, the flow from the RWST would be 3,360 GPM. Based on these flow rates it would take approximately 72.4 minutes to drain the RWST from 100% filled (338,000 gallons) to 28% filled (94,640 gallons). This value is very conservative because during a large break LOCA the RCS is de-pressurized and the pumps would be expected to operate at significantly higher flow rates.

7.2.3.5 When the RWST is lowered to 28% filled, procedure E-1 transfers the operators to procedure ES-1.3 to make the transition into the recirculation phase. The transition from injection to recirculation phase will not happen instantaneously but “ending” the injection phase will very quickly result in a reduction of the EDG loading as various motors are “pull stopped” and the associated valves re-aligned prior to restarting the motor.

7.3 **Diesel Generator Ratings**

7.3.1 The diesel generator rating is based on the rating of the engine/generator combination.

7.3.2 **Generator**

7.3.2.1 Per the nameplate on the diesel generators the continuous ratings for the generator portion is as follows:

2500 KVA, 80% power factor, 3000 amps, 480 volts.

7.3.2.2 This corresponds to a continuous rating of: 2000 kW + j 1500 KVAR which satisfies the continuous rating specified in the Bill of Material (Reference 4.4.1, Attachment II) for the complete EDG set (1950 KW). Per a Westinghouse correspondence dated November 9, 1976 (Reference 4.4.2, Attachment II) the generator has a service factor rating of 1.15 which corresponds to 2868 KVA (3450 amps at 80% power factor and 480 volts).

7.3.3 **Engine**

7.3.3.1 Reference 4.4.3 (Attachment II) indicates that the engine portion of the EDG has a continuous rating of 2750 HP or 2051 KW. The engine continuous rating needs to be greater than the continuous rating of the "diesel generator unit" in order to account for generator efficiency as well as friction and windage. The Bill of Material indicates that the continuous rating (of the diesel generator unit) should be 1950 kW so the 1950 kW value will be used.

7.3.4 **Diesel Generator Set Rating**

7.3.4.1 **Real Power Rating (Watts)**

7.3.4.1.1 The Bill of Material (Ref 4.4.1) indicates that the diesel generator units should have a two hour rating of 2250 KW and a ½ hour rating of 2300 KW . These ratings were further clarified in General Electric correspondence dated May 14, 1992 (Reference 4.4.4) which specified that the ratings are cumulative. It stated the generators are rated to operate at 2300 KW for a ½ hour and then at 2250 for two additional hours and then at 1950 KW continuously. The temperature of the diesel generator rooms for the various operating scenarios and the acceptability for these temperatures is addressed in Design Analysis ME-91-0010.

7.3.4.2 **Reactive Power Rating (VAR's)**

7.3.4.2.1 In accordance with a Westinghouse correspondence dated January 10, 1968 (Reference 4.4.6) the field voltage for these generators would be 99.2 volts with a field current of 126 amps when the diesel generator is loaded to 2000 KW with a 0.8 pf. This would correspond to 12.5 KVA. In accordance with Basler drawing D-90-43800-910 (Reference

4.4.7) the exciter/ voltage regulator has a rating of 14.5 KW. Therefore it is reasonable to assume the exciter could provide the field current to generate enough VAR's to operate at 0.8 pf for a generator loading of 2300 KW. However in this analysis it will be demonstrated that the VAR loading will not be a limiting condition. Therefore it will be conservative to assume that the VAR output rating of 1500 KVAR's corresponding to 0.8 pf for 2500 kVA and 2000 kW does not increase for the two hour rating conditions.

7.3.4.3 The capability of the diesel generator sets can therefore be conservatively stated as:

EDG Steady State Rating Summary				
	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
EDG Rating - Continous	1950	1500	2500	3000
EDG Rating (2 hour)	2250	1500	2868	3450

7.4 Motor Data

7.4.1 The following motor parameters must be determined for each motor during each phase (both injection and recirculation) of an accident:

1. Brake Horse-Power Requirements
2. Motor Power Factor
3. Motor Efficiency

7.4.1.1 Utilizing the above parameters the real and reactive power requirements of the motors will be determined by the ETAP program.

7.4.2 Power Factor and Efficiency

7.4.2.1 The power factor and efficiency is required to calculate the real and reactive power requirements of the various motors. Manufacturer power factor and efficiency data was generally available for most of the motors because the motors are relatively new and/or have been rewound. Where specific data was not available (SI and RHR) reasonable assumptions were made (Attachment I).

7.4.3 Motor Efficiency and Power Factor Adjustments

7.4.3.1 Motor power factor and efficiency is slightly affected by variations in motor loading and terminal voltage. As indicated on Page 20-46 of Reference 4.4.13 the efficiency and power factor increase with the percent loading of a motor. The following plot depicts how power factor and efficiency vary as a function of load for the auxiliary feedwater motor.

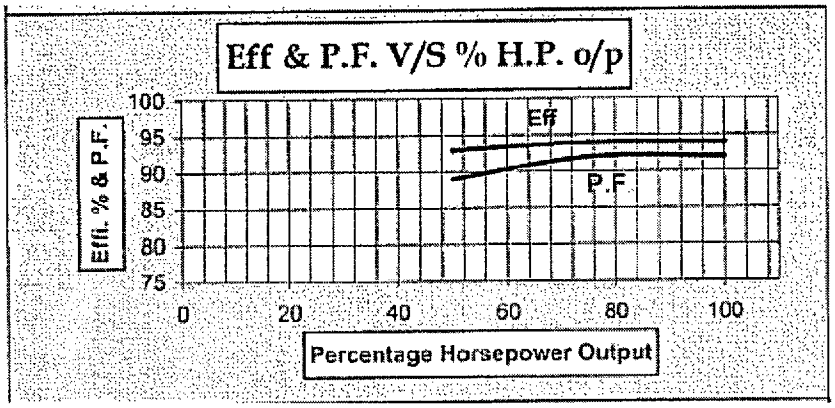


Figure 1 - Efficiency and Power Factor vs. BHP load (AFW Pump)

The above figure suggests that power factor and efficiency variations, as a function of motor load, are probably not very significant, particularly when the loading is between 80 and 100%. Many motors being evaluated in this analysis operate near or even slightly above their horsepower rating. For some of the newer and/or rewound motors, the manufacturer provided this variation information and consequently this data was input into the ETAP computer program. For the older motors (SI, RHR) this information was not available and reasonable assumptions were made (Attachment I).

7.4.3.2 In general, motor efficiency slightly increases and power factor slightly decrease as the terminal voltage rises above the motor rating. In this case, the diesels are feeding the loads, and hence the voltages would be very close to and sometimes even above the motor voltage rating (Attachment III). The final power factor and efficiency values used for each of the motors during the injection phase are tabulated in the following two tables along with their corresponding nominal values.

Table 5 - Motor Efficiency Values - Injection Phase Loading

Motor Efficiency - Injection Phase						
Load	Motor Rating (HP)	ETAP Motor Input (kW)	BHP (HP)	ETAP Efficiency	Mfgr Efficiency (Nominal)	Ref. for Nominal Efficiency
Safety Injection Pump A	350.0	290.32	371.0	**95.3%**	94.5%	Ref 4.4.8
Safety Injection Pump C	350.0	290.32	371.0	**95.3%**	94.5%	Ref 4.4.8
Residual Heat Removal Pump A	200.0	120.53	150.0	**92.8%**	92.7%	Ref 4.4.8
Containment Fan A	300.0	192.90	240.0	**92.8%**	92.3%	1/14/93 test report
Containment Fan D	300.0	192.90	240.0	**92.8%**	92.3%	1/14/93 test report
Service Water Pump A (Spare)	350.0	256.09	325.5	**94.8%**	94.5%	6/2/2003 Data Sheet
Service Water Pump C	350.0	0.00	0.0	**0.0%**	0.0%	NA
Auxiliary Feedwater Pump A	300.0	221.33	279.0	**94.0%**	94.0%	7/27/04 Data Sheet
Containment Spray Pump A	200.0	184.00	222.0	**90.0%**	92.1%	Attachment I
Component Cooling Water Pump A	150.0	0.00	0.0	**0.0%**	0.0%	NA

Table 6 - Motor Power Factor Values - Injection Phase Loading

Motor Power Factor - Injection Phase						
Load	ETAP Motor Input (kVA)	ETAP Motor Input (kW)	BHP (HP)	ETAP Power Factor	Mfgr Power Factor (Nominal)	Ref. for Nominal Power Factor
Safety Injection Pump A	319.0	290.32	371.0	**91.0%**	90.9%	Ref 4.4.8
Safety Injection Pump C	319.0	290.32	371.0	**91.0%**	90.9%	Ref 4.4.8
Residual Heat Removal Pump A	132.6	120.53	150.0	**90.9%**	91.0%	Ref 4.4.8
Containment Fan A	212.0	192.90	240.0	**91.0%**	90.5%	1/14/93 test report
Containment Fan D	212.0	192.90	240.0	**91.0%**	90.5%	1/14/93 test report
Service Water Pump A (Spare)	283.6	256.09	325.5	**90.3%**	90.4%	6/2/2003 Data Sheet
Service Water Pump C	0.0	0.00	0.0	**0.0%**	0.0%	NA
Auxiliary Feedwater Pump A	240.6	221.33	279.0	**92.0%**	92.0%	7/27/04 Data Sheet
Containment Spray Pump A	203.8	184.00	222.0	**90.3%**	88.4%	Attachment I
Component Cooling Water Pump A	0.0	0.00	0.0	**0.0%**	0.0%	NA

The above two tables demonstrate that the efficiency and power factors values used by the ETAP program for the injection phase are both typical and reasonably consistent with the manufacturer provided "nominal loading, nominal voltage" values. Slight variations in the ETAP values can be expected for the recirculation modes (high head, low head) if the motor BHP value changes. A "high" efficiency value would be considered non-conservative in this case since it would reduce the overall kW loading on the EDG and similarly a "high" power factor would also be considered non-conservative since it would reduce the kVAR loading on the EDG. The impact of data uncertainties will be addressed in the Results section of this calculation.

7.4.4 Brake-Horsepower Requirements

7.4.4.1 The horsepower requirements of the various pumps were determined by using the vendor supplied pump curves (Attachment I). The horsepower requirement of the containment fans was developed based on Reference 4.3.2. The table below summarizes the BHP used for each of the three modes associated with a large break LOCA event. Additional details concerning the basis for the BHP loading is provided in the following sections.

Table 7 - Brake Horsepower Loading (at 60.0 Hz)

		Pump or Fan Curve		Large Break LOCA - ETAP Value		
Load	Motor Rating (HP)	Design Point BHP (HP)	Max BHP (HP)	Injection (HP)	High Head Recirc (HP)	Low Head Recirc (HP)
Safety Injection Pump A	350.0	355.0	368.0	371.0	0.0	0.0
Safety Injection Pump C	350.0	355.0	368.0	371.0	371.0	0.0
Residual Heat Removal Pump A	200.0	150.0	173.0	150.0	174.0	174.0
Containment Fan A	300.0	256.0	256.0	240.0	174.0	174.0
Containment Fan D	300.0	256.0	256.0	240.0	174.0	174.0
Service Water Pump A (Spare)	350.0	311.0	312.0	325.5	325.5	325.5
Service Water Pump C	350.0	311.0	312.0	0.0	322.0	322.0
Auxiliary Feedwater Pump A	300.0	262.0	280.0	279.0	279.0	279.0
Containment Spray Pump A	200.0	188.0	220.0	222.0	0.0	0.0
Component Cooling Water Pump A	150.0	140.0	150.0	0.0	150.0	150.0
Total BHP (HP)	2850.0	2584.0	2695.0	2198.5	1969.5	1598.5
Total BHP (kW)	2125.3	1926.9	2009.7	1639.4	1468.7	1192.0

It should be noted that the ETAP program has a slight limitation on assigning BHP values, namely the BHP value has to be an integer percent of the motor rating. This explains why the ETAP Safety Injection loading was 371 HP (106% of 350 HP) for the injection phase rather than 368 HP (105.14% of 350 HP).

7.5 Basis for BHP Loading Values

7.5.1 The following discussion provides the basis for the horsepower requirements of the various loads fed from Diesel Generator A during each of the three modes for of a large break LOCA event.

7.5.2 Safety Injection Pumps A and C

7.5.2.1 Safety Injection Pumps A and C would sequence onto Diesel Generator A during an accident condition. They are the first major loads sequenced onto the diesel. During a large break LOCA, the RCS would de-pressurize and flow from the SI pumps would be approaching a maximum value. SI pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve (368 HP – See attachment 1). One SI pump is turned off in the High Head phase and both are turned off in the Low Head phase.

7.5.3 Residual Heat Removal Pump A

7.5.3.1 Residual Heat Removal Pump A would sequence onto Diesel Generator A after the SI motors. During the injection phase, flow from the RHR pump goes directly into the RCS. The flow rate for the RHR pumps was assumed to be less than or equal to 1688 GPM during the injection phase of a large break LOCA. The design flow rate is 1560 GPM and the maximum flow rate is 2500 GPM (UFSAR Table 6.3-3). During a large break LOCA, the RCS would de-pressurize and flow from the RHR pump would be approaching a maximum value, however valve throttling will limit the flow rate to approximately 1688 GPM. This flow rate assumption results in the BHP being no more than 150 HP during the injection phase (Attachment I). The RHR pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve (173 HP) during the recirculation phase.

7.5.4 Containment Fans A and D

7.5.4.1 The containment fans, sequenced on after the RHR and Service Water motors, are constant flow fans. Therefore the horsepower requirements of the fan motors are directly proportional to the density of the air/steam mixture in containment. The density is directly related to containment pressure. As demonstrated in Reference 4.3.2, the maximum containment fan brake-horsepower requirements would occur when the containment pressure is at its design pressure, 60 psig. The fan motor horsepower requirements under these conditions would be 256 HP. In actuality the maximum accident containment pressure occurs during a steam line break in containment and is less than the containment design pressure. During a large break LOCA the containment pressure would reach a maximum value of 54 psig (UFSAR Figure 6.2-4) and therefore the maximum containment fan loading would be 239.2 HP during the injection phase.

7.5.4.2 Two hours into a LOCA, the containment pressure would drop below 30 psig (Reference 4.4.9.4). At that pressure, the BHP on the Containment Fans would be 172 HP (Attachment 1). Therefore, when comparing the total accident load to the EDG continuous rating, it will be assumed that the containment fans would be operating at 172 HP. Technically, the recirculation phase could start sooner than 2 hours into a LOCA and therefore the Containment Fan BHP would be greater than 172 HP, but in no case would it be greater than what was assumed for the injection phase (239.2 HP). The transition from the injection phase to the recirculation phase will always result in a load decrease for the EDG even if the Containment Fan loading stayed at 239.2 HP (Table 7). When we are comparing the recirculation phase loading to the EDG continuous rating, we are inherently referring to the recirculation phase loading as it exists, at least two hours into a LOCA event. Therefore the Containment Fan loading during the recirculation phase will be assumed to be 172 HP.

7.5.5 Service Water Pump A or C

7.5.5.1 Service Water Pump A or C would sequence onto Diesel Generator A at approximately 15 seconds depending upon which pump is selected. During the injection phase the service water pump would provide cooling to the containment fan coolers, the diesel generators and a few miscellaneous loads.

7.5.5.2 A review of the pump curve (Attachment I) indicates that the peak pump load requirement should be 312 HP; however, this testing was done on a test stand and may not accurately reflect the efficiency of the installed configuration at Ginna. Based on some field measurements contained in Attachment I, a conservative value of 326 HP will be utilized. The BHP loading for the Service water pumps is not expected to change during the recirculation phase however the second service water pump would be turned on.

7.5.5.3 The spare motor for service water pumps (currently installed on pump D) has slightly different characteristics from the other three service water pump motors. In particular, its power factor is slightly worse resulting in the motor drawing about 20 kVAR more from the EDG than the other motors (Attachment III, recirculation phase). The kW draw is the same for all four of the motors. In order to be conservative, if only one service water pump was assumed to be on (injection phase), then it was assumed that the spare service water pump was the one on.

7.5.6 Auxiliary Feedwater Pump A

7.5.6.1 Auxiliary Feedwater Pump A would sequence onto Diesel Generator A at approximately 30 seconds. During a large break LOCA the RCS would de-pressurize and there would not be any flow through the steam generators from the RCS. Therefore feedwater flow would not be required and the operators would shut the pump off after the level returned to a nominal value. However to be conservative it will be assumed that this pump remains running for the entire injection and recirculation phase (during smaller breaker LOCA's it is credible for the pumps to remain operating during both the low head and high head recirculation phases).

7.5.6.2 This pump takes suction from the condensate storage tank and pumps directly into steam generator A. Flow into steam generator A is automatically controlled to 200 GPM by MOV 4007. However the system configuration is such that a line exists for this pump to also provide flow back to the condensate storage tank. A normally closed air operated valve prevents flow to the tank. On a loss of offsite power the instrument air compressors would be lost and this valve would eventually fail open. This would result in flow from this pump going to both the steam generators and the condensate tank. Therefore, the flow could actually exceed the 200 GPM. In accordance with the pump curve (Attachment I), the maximum BHP loading would be limited to 280HP and this value was assumed for both the injection and recirculation phase.

7.5.7 Containment Spray Pump A

7.5.7.1 Containment Spray Pump A automatically starts when the containment pressure reaches 28 psig. This would occur very early during a large break LOCA. During the injection phase the containment spray pumps draw flow from the RWST and sprays directly into containment. The Containment Spray pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve that is associated with an assumed maximum flow rate of 1625 GPM (220 HP – See attachment 1).

7.5.7.2 In the process of transferring to the recirculation phase containment spray would be pull stopped. This pump would not be restarted unless the containment pressure was above 37 psig. Based on Section 6.2 of the UFSAR the containment pressure would be reduced to less then 30 psig within the time frame required to enter the recirculation phase. Therefore containment spray will be assumed off during the recirculation phase.

7.5.8 Component Cooling Water Pump A

7.5.8.1 The component cooling water pump is not utilized during the injection phase. During the recirculation phase, component cooling water is required to provide cooling for the RHR heat exchanger. The CCW pump would be aligned such that its flow would be approaching a maximum value. According to the pump curve (Attachment I), the maximum BHP loading would be 150 HP and this is the loading that was assumed for both the High Head and Low Head recirculation modes.

7.5.9 Motor Control Center Loading

7.5.9.1 The MCC loading, shown in Section 1.5, was derived from Table 5 of DA-EE-2003-062. The loading was assumed the same for both injection and recirculation phases with the exception.that the control room heaters were turned on for the recirculation phase. Only MCCs C, H, K, L and N are associated with EDGA. The other MCCs listed in Section 1.5 are associated with EDGB and are not part of this analysis.

7.5.10 Excitation and Voltage Regulator Requirements

7.5.10.1 In accordance with Basler drawing D-90-43800-910 (Reference 4.4.7) the exciter and voltage regulator power requirements are 14.5 KW for a generator rated for 2000 KW at a 0.8 power factor. The drawing does not indicate what the VAR requirements are for this system. Westinghouse provided data specific for the excitation requirements of the emergency generators at Ginna per Reference 4.4.6. This information indicates that the field voltage would be 99.2 volts with a field current of 126 amps at full load with a 0.8 pf. This would correspond to 12.5 KVA. At unity power factor and full load the excitation power requirements reduced to 6.4 KVA (70.7 volts and 90 amps). It will be demonstrated in this analysis that the power factor during the injection phase is significantly greater then 0.8. Therefore it is reasonable to assume that the actual power requirements of the excitation and voltage regulator system will be less then the value indicated on Basler drawing D-90-43800-910. However to be conservative 14.5 KW will be assumed.

7.5.11 Other Loads

7.5.11.1 The only other load automatically fed from Diesel Generator B is a crankcase exhaust motor that is powered by a 480-120 VAC transformer fed from the generator output terminals. There are two motors both with a nameplate rating of 115 VAC/4.6 amps. Therefore assuming a 0.85 power factor the load due to these two motors combined is 899 Watts and 557 VARS (Note – this is two single phase loads being treated as a balanced 3 phase load which is OK since it is such a small load and the kW loading is correct).

7.5.11.2 Cable losses were calculated using the computer program ETAP. A complete printout of the ETAP results is contained in Attachment III.

7.5.12 Injection Phase Load Summary

Table 8 - Load Summary - Injection Phase (when EDG is at rated voltage and frequency)

Load	Electrical Input to Load (ETAP Calculated) P (kW)	Q (kVAR)	S (kVA)
Safety Injection Pump A	290.32	132.26	319.03
Safety Injection Pump C	290.32	132.26	319.03
Residual Heat Removal Pump A	120.53	55.27	132.60
Containment Fan A	192.90	88.00	212.02
Containment Fan D	192.90	88.00	212.02
Service Water Pump A (Spare)	256.09	121.94	283.64
Service Water Pump C	0.00	0.00	0.00
Auxiliary Feedwater Pump A	221.33	94.29	240.58
Containment Spray Pump A	184.00	87.66	203.81
Component Cooling Water Pump A	0.00	0.00	0.00
MCC Loading (total)	141.02	82.94	163.60
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	33.25	44.46	55.52
Total Load Supplied by EDG (Sum)	1938.62	928.08	2149.32
Total Generation (EDG)	**1938.62**	**928.08**	**2149.32**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (2 hour)	**2250.00**	**1500.00**	**2868.00**
Percent Margin=(Rating - Duty) / Rating *100	**13.84%**	**38.13%**	**25.06%**

Table 9 - MCC Detail - Injection Phase (when EDG is at rated voltage and frequency)

MCC	Motor Load P(kW)	Motor Load Q (kVAR)	Static Load P(kW)	Static Load Q (kVAR)	Total Load P(kW)	Total Load Q (kVAR)
MCCC	74.80	40.37	12.50	6.75	87.30	47.12
MCCH	13.86	11.48	0.00	0.00	13.86	11.48
MCC1K	18.45	12.88	0.00	0.00	18.45	12.88
MCCN_Xfmr	1.80	0.00	0.42	0.00	2.22	0.00
MCCN_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCN_Heat	0.00	0.00	0.00	0.00	0.00	0.00
MCCN_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC1L	2.73	2.57	0.00	0.00	2.73	2.57
MCC Total	**128.10**	**76.19**	**12.92**	**6.75**	**141.02**	**82.94**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.5.13 High-Head Recirculation Phase Load Summary

Table 10 - Load Summary - High Head Recirculation Phase (when EDG is at rated voltage and frequency)

Load	Electrical Input to Load (ETAP Calculated) P (kW)	Q (kVAR)	S (kVA)
Safety Injection Pump A	0.00	0.00	0.00
Safety Injection Pump C	290.32	132.26	319.03
Residual Heat Removal Pump A	139.82	64.11	153.82
Containment Fan A	139.98	68.28	155.74
Containment Fan D	139.98	68.28	155.74
Service Water Pump A (Spare)	256.09	121.94	283.64
Service Water Pump C	256.97	102.37	276.60
Auxiliary Feedwater Pump A	221.33	94.29	240.58
Containment Spray Pump A	0.00	0.00	0.00
Component Cooling Water Pump A	121.86	57.28	134.65
MCC Loading (total)	167.09	83.00	186.57
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	22.63	29.27	37.00
Total Load Supplied by EDG (Sum)	1772.03	822.09	1953.43
Total Generation (EDG)	**1772.03**	**822.09**	**1953.43**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (Cont.)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**9.13%**	**45.19%**	**21.86%**

Table 11 - MCC Detail - High Head Recirculation Phase (when EDG is at rated voltage and frequency)

MCC	Motor Load P(kW)	Motor Load Q (kVAR)	Static Load P(kW)	Static Load Q (kVAR)	Total Load P(kW)	Total Load Q (kVAR)
MCCC	74.80	40.37	12.62	6.81	87.42	47.18
MCCH	13.86	11.48	0.00	0.00	13.86	11.48
MCC1K	18.45	12.88	0.00	0.00	18.45	12.88
MCCN_Xfmr	1.80	0.00	0.42	0.00	2.22	0.00
MCCN_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCN_Heat	0.00	0.00	25.95	0.00	25.95	0.00
MCCN_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC1L	2.73	2.57	0.00	0.00	2.73	2.57
MCC Total	**128.10**	**76.19**	**38.99**	**6.81**	**167.09**	**83.00**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.5.14 Low-Head Recirculation Phase Load Summary

Table 12 - Load Summary - Low Head Recirculation Phase (when EDG is at rated voltage and frequency)

Load	Electrical Input to Load (ETAP Calculated)		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump A	0.00	0.00	0.00
Safety Injection Pump C	0.00	0.00	0.00
Residual Heat Removal Pump A	139.82	64.11	153.82
Containment Fan A	139.98	68.28	155.74
Containment Fan D	139.98	68.28	155.74
Service Water Pump A (Spare)	256.09	121.94	283.64
Service Water Pump C	256.97	102.37	276.60
Auxiliary Feedwater Pump A	221.33	94.29	240.58
Containment Spray Pump A	0.00	0.00	0.00
Component Cooling Water Pump A	121.86	57.28	134.65
MCC Loading (total)	167.36	83.05	186.83
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	16.41	20.84	26.52
Total Load Supplied by EDG (Sum)	1475.75	681.44	1625.49
Total Generation (EDG)	**1475.75**	**681.44**	**1625.49**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (Cont.)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**24.32%**	**54.57%**	**34.98%**

Table 13 - MCC Detail - Low Head Recirculation Phase (when EDG is at rated voltage and frequency)

	Motor Load		Static Load		Total Load	
MCC	**P(kW)**	**Q (kVAR)**	**P(kW)**	**Q (kVAR)**	**P(kW)**	**Q (kVAR)**
MCCC	74.80	40.37	12.70	6.86	87.50	47.23
MCCH	13.86	11.48	0.00	0.00	13.86	11.48
MCC1K	18.45	12.88	0.00	0.00	18.45	12.88
MCCN_Xfmr	1.80	0.00	0.43	0.00	2.23	0.00
MCCN_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCN_Heat	0.00	0.00	26.13	0.00	26.13	0.00
MCCN_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC1L	2.73	2.57	0.00	0.00	2.73	2.57
MCC Total	**128.10**	**76.19**	**39.26**	**6.86**	**167.36**	**83.05**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.6 Evaluation of "Off Nominal" Voltage and Frequency operation.

7.6.1 Off Nominal Voltage Evaluation

PT-12.1 (Reference 4.1.4) indicates that the EDG voltage, after startup, has to be within the range of 470 volts (97.92%) to 504 volts (105%). It should be noted that this stated voltage range is for the case of the EDG unloaded and does not necessarily reflect the voltage range management capability of the EDG when it is supporting the accident mitigation loads. A more accurate measure of this capability can be obtained by reviewing the final "voltage setting" acceptance criteria (480 V to 490 V) in PT-12.1 and combine this with the actual steady state voltages obtained from the annual "Diesel Generator Load and Safeguard Sequence Test" (RSSP-2.2). A plot of the 1996 field results is shown below:

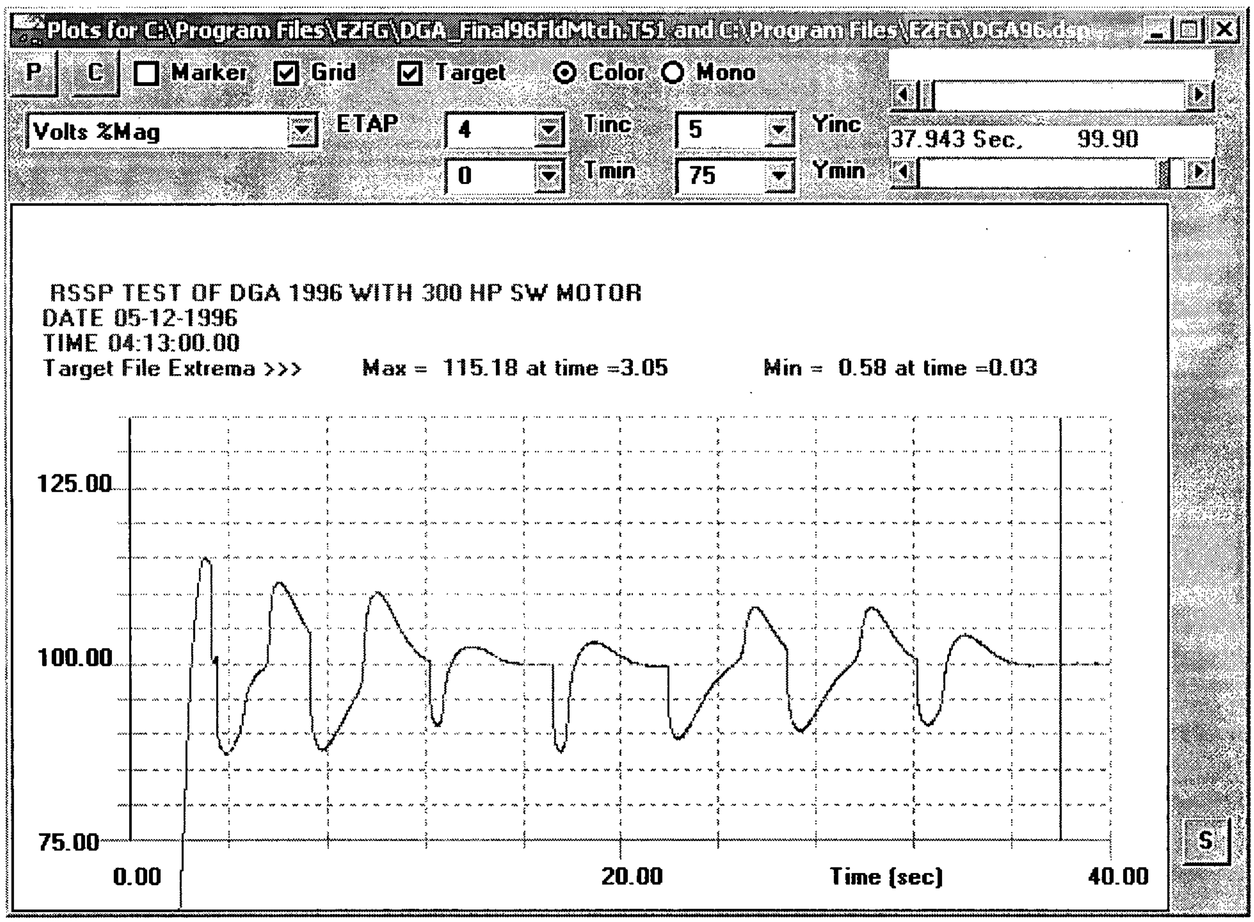


Figure 2 - EDGA Voltage (%480V) during 1996 RSSP2.2

The above figure demonstrates that the final voltage at the EDG terminals was 99.9% of 480 volts or 479.52 volts which is the minimum value (when rounded up) indicated for the final voltage setting acceptance criteria identified in PT-12.1. The final kW load on the EDG during the above test was 1230 kW. While this loading is below the anticipated injection phase loading of 1939 kW, the above test does give a good indication of the

EDGs voltage management capability during loaded conditions. The above curve also demonstrates that this capability is not diminished as more load is added during the sequence. The most recent RSSP test (10/11/06) recorded a steady state voltage of 480 volts after the loads had been sequenced on. Based on the above results and discussions, it is concluded that a conservative estimate of the EDGs voltage management capability during accident conditions, according to the MCB meter, would be a voltage range between 470 volts and 504 volts. The accuracy of the meters on the main control board are +/- 1% so the actual steady state EDG voltage, during accident conditions, is expected to be within the following range: Vmax = 509.04 volts (106%), V min = 465.3 volts (96.94%).

The majority of the loads on the EDG are induction motors and those types of loads are routinely considered constant MVA loads for the voltage range under consideration. This implies that the kW and kVAR load associated with the induction motors will not be affected by the voltage variations. Higher voltages will cause the current flow to these motors to go down and hence there will be a reduction in the cable kW and kVAR losses. Conversely, a reduction in voltage will cause a slight increase in the cable losses. The loading associated with the small amount of static load will respond exactly opposite to the cable losses (i.e. an increase in voltage will cause the static kW loading to go up while a decrease in voltage will cause the static loading to go down). The kW and kVAR loading on the EDG is dominated by induction motors so it is reasonable to expect that for the voltage range of interest, the kW and kVAR loading on the EDG will not be impacted by the above mention voltage variations. In order to verify this conclusion the injection phase simulations were repeated for the voltage range of interest and the results are tabulated below:

Table 14 - Impact of Off Nominal Voltage on EDG Loading

EDGA Loading - Injection Phase				
EDG Voltage (Volts)	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
480.00	1939	928	2149	2585
509.04	1937	924	2146	2434
465.30	1940	931	2152	2670

7.6.2 Off Nominal Frequency Evaluation

PT-12.1 (Reference 4.1.4) indicates that the EDG frequency, after startup, has to be within the range of 59.5 Hz to 60.5 Hz. It should be noted that this stated frequency range is for the case of the EDG unloaded and does not necessarily reflect the frequency range management capability of the EDG when it is supporting the accident mitigation loads. A more accurate measure of this capability can be obtained by reviewing the final "frequency setting" acceptance criteria (60 to 60.1 Hz.) in PT-12.1 and combine this with the actual steady state frequency obtained from the annual "Diesel Generator Load and Safeguard Sequence Test" (RSSP-2.2). A plot of the 1996 field results is shown below:

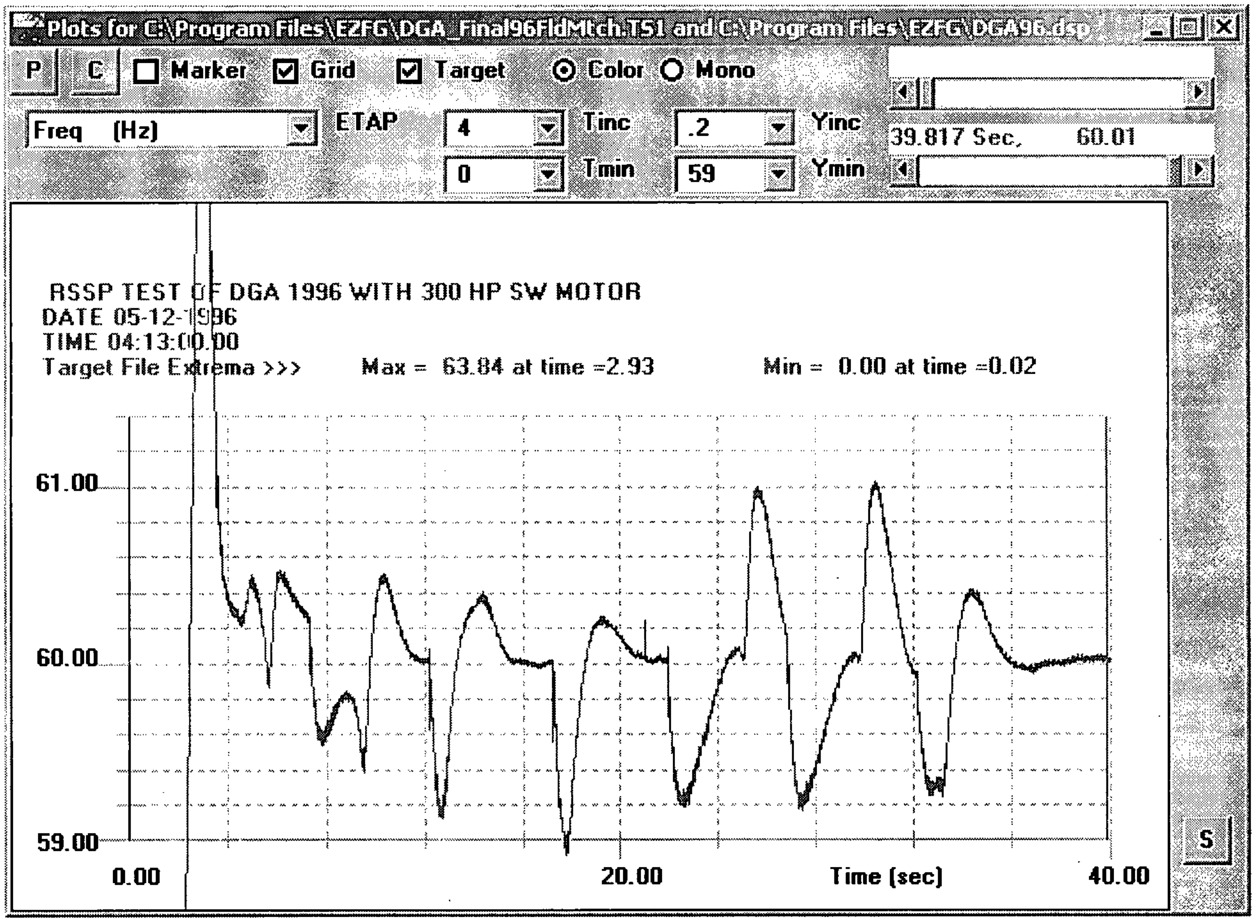


Figure 3 - EDGA Frequency (Hz) during 1996 RSSP2.2

The above figure demonstrates that the final frequency was 60.01 Hz which is within the setting acceptance criteria identified in PT-12.1 (60.0 to 60.1 Hz). As previously mentioned, the final kW load on the EDG during the above test was 1230 kW. While this loading is below the anticipated injection phase loading of 1939 kW, the above test does give a good indication of the EDGs frequency management capability during loaded conditions. The above curve also demonstrates that this capability is not diminished as more load is added during the sequence. The most recent RSSP2.2 test (10/11/06) recorded a steady state frequency of 60.1 Hz after the loads had been sequenced on. Based on the above results and discussions, it is concluded that a reasonable estimate of the EDGs frequency management capability during accident conditions, according to the MCB meter, would be a frequency range between 59.5 Hz and 60.1 Hz (Note that the upper frequency limit was reduced from the 60.5 Hz value noted in PT12.1 based on the 1996 field measurements).The accuracy of the meters on the main control board are +/- 0.3 Hz.so the actual steady state EDG frequency during accident conditions can be expected to be within the following range: Fmax = 60.4 Hz. , F min = 59.2 Hz.

The mechanical BHP loading of fans and pumps tend to go up as the cube of the speed and since the majority of the load on the EDG is this type of load, it is reasonable to assume that the kW load on the EDG would be 1.02 times greater at 60.4 Hz, as compared to the 60Hz kW loading value.

7.6.3 Determining maximum loading for off Nominal Voltage and Frequency

The effect of the stated voltage variations has been shown to be negligible and could therefore reasonably be ignored. Applying the 1.02 multiplying factor to all of the loads (small static loads as well as the motor loads) will tend to compensate for ignoring the small effect associated with voltage variations. Therefore the effect of both voltage variation and frequency variation can be incorporated into the results by simply multiplying each of the loads kW and kVAR values by 1.02. The power factor can be assumed to be unaffected by the small variations in voltage and/or frequency. The following tables summarize the individual loads that are expected if the diesel generator is operating at its worst case voltage and frequency (465.3 volts and 60.4 Hz)

Table 15 - Load Summary - Injection Phase (when EDG is operating at 465.3 volts and 60.4 Hz)

Injection Phase Loading - Off Nominal Frequency and Voltage Considerations Included			
	Electrical Input to Load (ETAP Calculated)		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump A	296.12	134.91	325.41
Safety Injection Pump C	296.12	134.91	325.41
Residual Heat Removal Pump A	122.94	56.37	135.25
Containment Fan A	196.75	89.76	216.26
Containment Fan D	196.75	89.76	216.26
Service Water Pump A (Spare)	261.22	124.37	289.31
Service Water Pump C	0.00	0.00	0.00
Auxiliary Feedwater Pump A	225.76	96.17	245.39
Containment Spray Pump A	187.68	89.41	207.89
Component Cooling Water Pump A	0.00	0.00	0.00
MCC Loading (total)	143.84	84.59	166.87
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	33.91	45.35	56.63
Total Load Supplied by EDG (Sum)	1977.39	946.64	2192.31
EDG Rating (2 hour)	**2250.00**	**1500.00**	**2868.00**
Percent Margin=(Rating - Duty) / Rating *100	**12.12%**	**36.89%**	**23.56%**

Table 16 - Load Summary - High Head Recirculation Phase (when EDG is operating at 465.3 volts and 60.4 Hz.)

High Head Recirculation Loading - Off Nominal Frequency and Voltage Considerations Included			
	Electrical Input to Load		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump A	0.00	0.00	0.00
Safety Injection Pump C	296.12	134.91	325.41
Residual Heat Removal Pump A	142.62	65.39	156.89
Containment Fan A	142.78	69.65	158.86
Containment Fan D	142.78	69.65	158.86
Service Water Pump A (Spare)	261.22	124.37	289.31
Service Water Pump C	262.10	104.41	282.14
Auxiliary Feedwater Pump A	225.76	96.17	245.39
Containment Spray Pump A	0.00	0.00	0.00
Component Cooling Water Pump A	124.30	58.43	137.34
MCC Loading (total)	170.43	84.66	190.30
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	23.08	29.85	37.74
Total Load Supplied by EDG (Sum)	1807.47	838.53	1992.50
EDG Rating (2 hour)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**7.31%**	**44.10%**	**20.30%**

Table 17 - Load Summary - Low Head Recirculation Phase (when EDG is operating at 465.3 volts and 60.4 Hz)

Low Head Recirculation Loading - Off Nominal Frequency and Voltage Considerations Included			
	Electrical Input to Load		
Load	P (kW)	Q (kVAR)	S (kVA)
Safety Injection Pump A	0.00	0.00	0.00
Safety Injection Pump C	0.00	0.00	0.00
Residual Heat Removal Pump A	142.62	65.39	156.89
Containment Fan A	142.78	69.65	158.86
Containment Fan D	142.78	69.65	158.86
Service Water Pump A (Spare)	261.22	124.37	289.31
Service Water Pump C	262.10	104.41	282.14
Auxiliary Feedwater Pump A	225.76	96.17	245.39
Containment Spray Pump A	0.00	0.00	0.00
Component Cooling Water Pump A	124.30	58.43	137.34
MCC Loading (total)	170.70	84.71	190.57
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	16.74	21.26	27.05
Total Load Supplied by EDG (Sum)	1505.27	695.07	1658.00
EDG Rating (2 hour)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**22.81%**	**53.66%**	**33.68%**

8.0 Results

8.1 The most limiting case for the steady state kW loading on Emergency Diesel Generator A would be the injection phase during a large break LOCA event. Frequency and voltage deviations, from nominal, can increase the EDG loading with the worst case being high frequency and low voltage. The following table demonstrates that under worst case conditions, the injection phase loading on the EDGA will slightly exceed the continuous rating of the EDG. The table also compares the injection phase loading duty with the 2 hour capability of the EDG since the injection phase will be complete within 2 hours.

Table 18 - EDGA Loading and % Margin - Worst Case

Worst Case EDGA Loading - Injection Phase, Off nominal Voltage and Freq						
	Freq (Hz)	EDG Voltage (Volts)	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
EDG Load	60.4	465.30	1977	947	2192	2720
EDG Rating - Continous			1950	1500	2500	3000
% Margin (Continuous Rating)			-1.4%	36.9%	12.3%	9.3%
EDG Rating - 2 Hour			2250	1500	2868	3450
% Margin (2 hour Rating)			12.1%	36.9%	23.6%	21.2%

Percent Margin=(Rating - Duty) / Rating *100

8.1.1 Even though the worst case kW loading (1977 kW) slightly exceeds the continuous rating of the EDG (1950 kW), this is not a violation of the actual EDG capability or rating since it does not exceed the two hour rating (2250 kW) and the injection phase will be completed within two hours.

8.1.2 The worst case loading (1977 kW) does however slightly exceeds the minimum "Tech Spec" test limit (1950 kW) and therefore a "Tech Spec" change will be required.

8.2 The results of this analysis (see Table 3) indicate that there is significant margin between the loading duty that will be imposed on EDGA during accident conditions and the inherent capability of the diesel generator set. It is felt that the overall effect of any data uncertainties (motor characteristics, actual flows, pump characteristics, etc.) would be relatively small; recognizing that some of data uncertainties would increase EDG loading while others would decrease the loading.

8.3 The following is a list of conservatisms, inherent in this calculation, that provide additional margin from what has been tabulated above:

1. The service water pump was assumed to be operating at 326 BHP even though the maximum value on the pump curve was 312 BHP.
2. The worst case injection phase loading (1977 kW) was determined by assuming that both the voltage and frequency deviations from nominal were in the direction to maximize the kW loading. In addition, the associated meters (V and Hz) were also assumed to have errors in a direction that maximized the kW loading. It is unlikely that these four independent issues would simultaneously hit their worst case positions.

8.4 This analysis demonstrates Diesel Generator A is adequately sized for the worst case steady state accident loading requirements.

THIS CALCULATION HAS BEEN ABRIDGED FOR SUBMITTAL IN THAT ITS SUPPORTING DOCUMENTATION, WHICH CONTAINS PROPRIETARY INFORMATION, HAS BEEN REMOVED. THIS SUPPORTING DOCUMENTATION WILL BE MADE AVAILABLE TO THE NRC UPON REQUEST.

ATTACHMENT 5

DA-EE-92-120-01
"Diesel Generator B Steady State Loading Analysis"

Design Analysis

Diesel Generator B Steady State Loading Analysis

Ginna Station
CONSTELLATION ENERGY

DA-EE-92-120-01

Revision 5

8/8/07
Effective Date

Prepared By:	N C Kurtz Design Engineer	8/7/07 Date
Reviewed By:	[signature] Reviewer	8/8/07 Date

Revision Status Sheet

Revision Number	Affected Sections	Description of Revision
1	Multi-Sections	SW Motor Replacement (PCR's 95-046 and 95-075) and MCC Loading Analysis Revision (DA-EE-92-011-07). Also included additional recirculation phase case.
2	Indicated by Redline	Revised to reflect SI pumps not drawing suction from BAST during injection phase and reference D/G Room Temperature analysis ME-91-0010.
3	Indicated by Redline	Revised to reflect changes in the Service Water Pump loading requirements due to the pumps being replaced under TE 94-0586.
4	4.4.5	Revised to change date in reference in 4.4.5 as in CATS item #10588.
	4.4.12.4	Revised Service Water Pump Curve; No analysis changes required.
5	all	Updated to reflect 2007 As Built conditions – See section 1.5

1.0 OBJECTIVE AND REVISION HISTORY

1.1 The objective of this analysis is to quantify the maximum steady state loading on Emergency Diesel Generator B (EDGB) during worst case accident loading conditions. This analysis will demonstrate the diesel generator rating is adequate for steady state emergency load requirements. The EDGB loading associated with Injection, High Head Recirculation and Low Head Recirculation modes will be individually evaluated.

1.2 The steady state loading is defined as the generator loading following the safeguard sequencing period in which the various motors are started and motor operated valves are aligning. The ability of the generator to handle these transients will be evaluated in a separate dynamic loading analysis (DA-EE-92-112-01).

1.3 In this analysis the loading for each motor fed from Emergency Generator B will be evaluated. The impact of any data uncertainties and/or conservative assumptions will be addressed in the Results section of this analysis.

1.4 The corresponding Diesel Generator A steady state loading analysis will be contained in DA-EE-92-098-01.

1.5 The purpose of this revision (5) was to document the maximum steady state loading on Emergency Diesel Generator B (EDGB) for the 2007 As Built Conditions. Specific changes that are associated with this revision include:

- Increased the kVAR rating of the diesel generator set to 1500 kVAR from 1462.5 kVAR (See section 7.3.4)
- Corrected the 440 V motor driven fire pump rated current to 231 amps (from 281 amps) per Westinghouse memo to Ted Miller dated 6/28/2002 (DBCOR 2002-0025) and PCR2001-0038. This had no effect on the results because the motor is assumed off.
- Replaced the two 440V, 250 horsepower motor driven auxiliary feedwater pump motors with 460V, 300 horsepower motors per TE 2004-0007.
- A new 460 V, 350 HP SWP motor (spare) was installed (April 28, 2006) and the existing 460 V, 350 HP SWP motor D was removed. Since the spare motor has slightly different running characteristics than the other SWP motors, the model was expanded to allow the "Spare" SWP motor to be installed on either the A or B train.
- Incorporated CREATS and MCC changes per PCR 2003-0037. Specifically the following MCC loading, which is based largely on Table 5 of DA-EE-2003-062, was assumed:

Table 1 - MCC Loading - Accident with LOOP

MCC Loading - Accident with LOOP				
	Injection Phase		Recirc Phase	
	P (KW)	Q (KVAR)	P (KW)	Q (KVAR)
MCC C (1)	85.37	46.58	85.37	46.58
MCC D (2)	97.34	57.68	97.34	57.68
MCC H	13.84	11.47	13.84	11.47
MCC J	12.99	10.94	12.99	10.94
MCC K	18.50	11.50	18.50	11.50
MCC L	2.49	2.34	2.49	2.34
MCC M	2.49	2.34	2.49	2.34
MCC N	18.00	10.00	46.00	10.00
MCC P	18.00	10.00	46.00	10.00
Note 1: MCC C Loading does not include MCC's H, K and L				
Note 2: MCC D Loading does not include MCC's J and M				

- Turned control room heaters off (MCCN and MCCP) for Injection Phase and turned them on for Recirculation Phase (Consistent with Emergency Operating Procedures).
- Updated the Containment Fan ETAP model to better match the power factor and efficiencies listed in the June 1993 manufacture report. Also updated the locked rotor current value based on curve KN011492 (Locked rotor current reduced to 1689.6 amps from 1772 Amps)
- Refined cable data (EDG cables are not in magnetic duct, etc.).
- Based upon DA-ME-2006-016 (Ref 4.3.10) and SPCR 2006-0001 (Ref 4.4.8.4) the BHP for the RHR was reduced for the Injection phase due to the effect of valve throttling (See Table below and Attachment I for details)

Table 2 - RHR Flow Rate and BHP

RHR Flow Rate and BHP		
Accident Mode	GPM	BHP
Injection	<= 1688	150
Recirculation	Any (Max BHP assumed)	173

- Modified the "recirculation phase" BHP associated with the Containment Fan based on the revised containment pressure – time profile (UFSAR Figure 6.2-4, Reference 4.4.9.4). In particular the containment fan BHP was increased from 128 HP to 172 HP for the recirculation phase.

- Modified the "injection phase" BHP associated with the Containment Fan based on the revised containment pressure – time profile (UFSAR Figure 6.2-4, Reference 4.4.9.4). In particular the containment fan BHP was decreased from 256 HP to 239.2 HP for the injection phase (Max containment pressure = 54 psig rather than 60 psig).
- Expanded the scope of the analysis to include an evaluation and document the effect of "off nominal" frequency operation (i.e. monthly test acceptance criteria range is 59.5 Hz to 60.5 Hz).
- Expand the scope of the analysis to include an evaluation and document the effect of "off nominal" voltage operation (i.e. monthly test acceptance criteria range is 470 – 504 volts).
- Expanded the scope of the analysis to include a comparison of the maximum kW demand on the EDG with the test requirements in the "Tech Spec" This comparison was made in order to verify that the maximum EDG demand is less than or equal to the minimum requirements set forth in the "Tech Spec" (i.e. "Verify each DG is synchronized and loaded and operates for > =60 minutes and < 120 minutes at a load >= 1950 kW and < 2250 kW.")
- Modified the ETAP computer model such that it runs on ETAP 5.5.0N. Also expanded the computer model to include the calculation of the continuous current duties imposed on the equipment for informational purposes only.

2.0 CONCLUSIONS

2.1 A Summary of the loadings as well as the percent safety margins is shown in the following table for each of the three accident scenarios:

Table 3 - EDGB Steady State Loading Summary

EDGB Steady State Loading Summary (Off Nominal Frequency and Voltage Considerations Included)				
	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
EDG Load - Injection	1968	941	2182	2707
EDG Rating (2 hour)	2250	1500	2868	3450
Percent Margin Injection Phase	12.5%	37.2%	23.9%	21.5%
EDG Load - HHR	1800	835	1984	2462
EDG Rating - Continous	1950	1500	2500	3000
Percent Margin HHR	7.7%	44.3%	20.6%	17.9%
EDG Load _LHR	1498	692	1650	2048
EDG Rating - Continous	1950	1500	2500	3000
Percent Margin LHR	23.2%	53.9%	34.0%	31.7%

Percent Margin=(Rating - Duty) / Rating *100

2.2 As demonstrated in the table above, the most limiting case for the steady state loading on Emergency Diesel Generator B would be the injection phase. The injection phase loading is limiting from an absolute magnitude (kW and kVAR) point of view however from a "kW percent margin" point of view, the high head recirculation phase has less margin between the anticipated duty and the capability of the emergency diesel generator. The percent margin shown for the high head recirculation phase is associated with the time period two hours into a LOCA. As time progresses, the containment pressure will continue to decrease and the corresponding loading on the containment fans will decrease and therefore the percent margin will increase. The percent margin shown in the above table is well within the Regulatory Guide 1.9 requirement of "not less than 5 percent (margin)".

2.3 As demonstrated in Section 7.5.12, the maximum generator loading, during the injection phase with the generator at rated voltage and frequency, would be 1930 KW and 923 KVAR (0.90 pf). This loading is within the continuous rating of the diesel generator set (1950 KW and 1500 kVAR). It is also well within the emergency rating (2250 KW for 2 hour and 2300 KW for ½ hour). The injection phase duration, while variable, will be completed within two hours for a large break LOCA.

2.4 The impact of "off nominal" voltage and/or frequency operation has been evaluated in section 7.6 of this analysis. Operating the EDG at a frequency of 60.4 Hz would increase the BHP loading by 2.0%. Operating at a reduced frequency would reduce the BHP loading. Voltage variations in the range anticipated have been shown to have a very small impact on the kW or kVAR operating margins although the current (amps) margin was reduced a few percentage points. Section 7.6 demonstrates that by combining the worst case frequency (60.4 Hz) and worst case voltage (465.3 volt) scenarios results in a maximum loading of 1968 kW (Injection Phase). The additional loading due to off-nominal voltage and frequency is already included in Table 3 above.

2.4.1 The "Tech Spec – SR 3.8.1.3" states: "Verify each DG is synchronized and loaded and operates for >= 60 minutes and < 120 minutes at a load >= 1950 kW and < 2250 kW." It is important that the minimum Tech Spec test limit (1950 kW) be greater than the maximum duty imposed on the EDG. After including the effect of "off nominal" voltage and frequency, this criteria is no longer met and a "Tech Spec Change" will be required (Reference CR-2006-004136).

2.4.2 The Main Control Board kW meters that are used during the "Tech Spec" test have a nominal accuracy of +/- 1% however the most recent calibration of these meters (Reference 4.1.7) shows an accuracy better than 0.1 kW in the 1950 kW – 2000 kW region of the meter. Therefore the negative margin between the maximum loading on the EDG and the minimum "Tech Spec" test limit is 18.1kW. A "Tech Spec Change" will be required because the total worst case loading (1968 kW) exceeds the minimum Tech Spec test limit (1950 kW). It is important to recognize that the two hour rating of the EDG is not exceeded, only the testing limit in the Tech Spec.

2.5 This analysis demonstrates that Emergency Diesel Generator B is adequately sized for the worst case steady state accident loading requirements. The following table summarizes the resulting safety related bus voltages and currents for informational purposes (other analyses may reference this table). It should be noted that the following table assumes that the EDG is operating at rated voltage and frequency. The impact associated with off-nominal voltage and frequency operation is documented in section 7.6 of this calculation.

Table 4 - Safety Related Bus Voltages and Currents (when EDG is at rated voltage and frequency)

Bus Voltages and Current Flow From EDG to Bus			
	Bus	V (% 480)	I (amps)
Injection	16	98.15	2212.05
	17	99.71	343.08
High Head Recirc	16	98.63	1643.45
	17	99.43	678.98
Low Head Recirc	16	98.96	1249.63
	17	99.43	678.98

3.0 DESIGN INPUTS

3.1 ANSI / IEEE Standards

3.1.1 IEEE Standard 387-1984 "IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations"

3.2 Nuclear Regulatory Commission Documents

3.2.1 Regulatory Guide 1.9 Revision 2, December 1979 "Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants".

4.0 REFERENCED DOCUMENTS

4.1 Procedures

4.1.1 Procedure E-0, "Reactor Trip or Safety Injection".

4.1.2 Procedure E-1, "Loss of Reactor or Secondary Coolant".

4.1.3 Procedure ES-1.3, "Transfer to Cold Leg Recirculation".

4.1.4 Procedure PT-12.2, "Emergency Diesel Generator 1B (Monthly Test)".

4.1.5 Procedure CP-513, "Diesel Generator Main Control Board Meter Calibration for Diesel Generator A or B

4.1.6 Procedure RSSP-2.2, "Diesel Generator Load and Safeguard Sequence Test" (with recorded data – Dated 10/11/06)

4.1.7 Procedure CP-502.2, "Calibration of B Emergency Diesel Kilowatt Meters" and Work Order 20400830-04 (11/08/05)

4.1.8 Technical Specification Section SR 3.8.1.3 "kW test requirement for EDG"

4.2 Drawings

4.2.1 33013-2539, "AC System Plant Load Distribution One Line Wiring Diagram"

4.2.2 33013-1737 Sheets 2 and 3 "Diesel Generator B Exciter Cabinet Interconnection Diagram"

4.3 Design Analysis

4.3.1 Design Analysis DA-EE-92-011-07, "Class 1E Motor Control Center Loading".

4.3.2 Design Analysis DA-EE-92-010-06, "Containment Fan Break horsepower Requirements".

4.3.3 Design Analysis ME-91-0010, "D/G Building HVAC Analysis".

4.3.4 Intentionally left blank

4.3.5 Design Analysis DA-EE-92-111-01, "Diesel Generator A Dynamic Analysis".

4.3.6 Design Analysis DA-EE-92-112-01, "Diesel Generator B Dynamic Analysis".

4.3.7 Design Analysis DA-EE-96-068-03, "Offsite Power Load Flow Study"

4.3.8 Design Analysis DA-EE-97-040, "Test Results of 350 HP Service Water Pump Motors".

4.3.9 Design Analysis DA-EE-2003-062, "PCR 2003-0037 Electrical Factors Analysis"

4.3.10 Design Analysis DA-ME-2006-016 (Table A give 1688 GPM for RHR pump)

4.4 Miscellaneous Documents

4.4.1 Bill of Materials, Gilbert Associates, Inc. W.O. 4155, Emergency Diesel Engine Generator Sets

4.4.2 Letter, Westinghouse Electric Corporation Power Systems to Rochester Gas & Electric Corp., November 9, 1976, "Ginna Station Diesel Driven Generator SO 75P0503.

4.4.3 Engine Data Sheet MI-17136, G-202. Model 251F

4.4.4 Letter General Electric Locomotives to William Roettger (RG&E), Dated May 14, 1992, "Diesel Generator Data".

4.4.5 Letter General Electric Locomotives to Rochester Gas and Electric, Dated December 18, 1991, "Response to Questions on ALCO Diesel Engine Generators".

4.4.6 Letter Westinghouse Electric Corporation from R. Curtis Funston to Mr. C. J. Williams (ALCO Products, Inc.), Dated January 10, 1968.

4.4.7 Basler Electric Drawing 90-43800-910 Rev D "Schematic and Interconnection Diagram for Series Boost Exciter Voltage Regulator"

4.4.8 Ginna Station Motor Data Sheet

4.4.8.1 Ginna Station Software Change Request 2007-0020, Upgrade ETAP from 5.0.3N to 5.5.0N.

4.4.8.2 May 3, 2007 Email from Ted Miller to Bill Roettger, “EDG Loading” (Voltage and Frequency deviations).

4.4.8.3 May 24, 2007 Email from Ted Miller to Bill Roettger, “Need to drop 4kW” (Tech Spec, Exciter Load and meter location).

4.4.8.4 SPCR 2006-0001 (Set point change request to throttle RHR valve)

4.4.9 **Ginna UFSAR**

4.4.9.1 Table 6.3-3 (SI and RHR Flow Rates)

4.4.9.2 Table 6.2-27 (Containment Spray Pump Design Parameters)

4.4.9.3 Table 8.3-2b "Diesel Generator Loading - Train B"

4.4.9.4 Figure 6.2-4 “Containment Atmosphere Pressure, Double-Ended Pump Suction Break – Minimum Safeguards”

4.4.10 Field Walkdown data base "MTRDATA.RPT" 11/1/91

4.4.11 Westinghouse letter to R. DiBaudo , May 26, 1988

4.4.12 Motor Data Sheets & Curves

4.4.12.1 Worthington SI Pump Curve #s, E-207328, E-207348, E-207340

4.4.12.2 Bechtel SI pump Data Sheets S/Ns -1613234,1613235, 1613236

4.4.12.3 Pacific Pump Test Performance Curve 33250B

4.4.12.4 Johnston Pump Service Water Pump Performance Curve, Job#98JC1413S-SJC66628, TC-8518, Rev #1.

4.4.12.5 Ingersoll-Rand Curve 46125 2/21/69 and Curve 46126 2/21/69, Containment Spray

4.4.12.6 Ingersoll-Rand Curve N625 Rev 0 1/10/75

4.4.12.7 IR Pump Curve 44236 , 2/15/83, Component Cooling

4.4.12.8 Bechtel Centrifugal Pump Data Sheet - Service Water

4.4.12.9 Reliance Electric Induction Motor Test - Service Water

4.4.13 Standard Handbook for Electrical Engineers, By Donald Fink, 1978, McGraw Hill.

4.4.14 EWR 5295, "Ginna Electric Distribution System study", Motor Testing Data

4.4.15 RHR Pump Motor Rewind Test Data Sheet, P.O. NQ-11583-C-RD, Dated 5/10/89.

4.4.16 Telex, R.M. Harper to P.M. Cameton, Dated September 22, 1969.

5.0 ASSUMPTIONS

5.1 The diesel generator has its regulator set to maintain 1.0 per unit voltage (480 volts). (Step 6.3.10 of Reference 4.1.4 requires operators to verify that voltage is controlled to 480 volts). The impact of "off nominal" voltage and frequency is addressed in Section 7.6 of this calculation.

5.2 The power factor for the load associated with the diesel generator excitation system was assumed to be 1.0. (Assuming a different power factor would increase only the MVAR load on the generator. The results of this analysis will demonstrate that the MVAR loading is not a limiting factor).

5.3 The Aux Feedwater pumps were assumed to be operating rather than the Standby Aux Feedwater Pumps (SAFWP). The SAFWPs are only used if the Aux Feedwater system fails. The only identified common mode failure for the MDAFW pumps is a steam or feed line break in the Intermediate Building. Due to the fact that an accident of this type would not affect containment fan loading or require containment spray, it is not the limiting case for diesel generator loading and therefore will not be evaluated as part of this analysis.

5.4 All MOV loads are assumed off. (MOVs are a transient type load that will be addressed in the dynamic simulation).

5.5 All "optional" loading on the EDG is assumed off. The operator will not put on "optional" loading unless the EDG has sufficient capacity. Operator loading beyond the diesel generator capabilities is assumed to be bounded by the single failure of one diesel generator (ie. this would constitute a second failure).

6.0 COMPUTER CODES

6.1 Electrical Transient Analysis Program (ETAP) Power Station, Version 5.5.0N, Operations Technology Incorporated.

The ETAP Power Station program allows computer modeling of the Ginna electrical distribution system. It then calculates power flows on lines and voltages at all modeled points. This version of the software is compliant with 10 CFR Appendix B (Quality Assurance Criteria) and 10 CFR 21 (See Reference 4.4.8.1).

7.0 ANALYSIS

7.1 General Description

7.1.1 The maximum diesel generator loading will occur during a loss of offsite power coincident with an accident in which the various Engineered Safety Feature (ESF) pumps and fans used for accident mitigation are operating at their maximum horsepower requirements. The worst possible credible single failure from a diesel loading standpoint occurs when there is a failure of one safety train (Loss of one diesel generator) during safety injection. This results in the maximum horsepower loading for the fans and pumps and increases the injection phase time duration. In this event the 480 volt bus loads would be shed with the exception of the MCC's and containment spray, the ESF pumps and fans would then be sequenced on. The following loads would be fed from diesel generator B:

- Safety Injection Pump B
- Safety Injection Pump C
- Residual Heat Removal Pump B
- Containment Fan B
- Containment Fan C
- Service Water Pump B or D*
- Auxiliary Feedwater Pump B
- Containment Spray Pump B (Starts on Hi-Hi CNMT Pressure)
- MCC's D, J, M and P

*Which Service Water Pump would auto start depends on the position of the Service Water Selector Switch.

7.1.2 Worst Case Accident Scenario

7.1.2.1 The maximum diesel loading will occur during a design basis large break loss of coolant accident. This is based on the fact the RCS will de-pressurize and containment pressure and temperature will be close to maximum design conditions. This will result in maximum SI and RHR pump flow, containment spray will actuate and the containment fans will be operating near their maximum horsepower requirements. The large break LOCA is more limiting then other major accidents such as a smaller break LOCA or steam line break in containment due to the following:

7.1.3 Steam Line Break (In Containment):

7.1.3.1 The RCS pressure does not decrease during a steam line break as much as it would during a large break LOCA. Therefore the RHR pumps would be operating at a reduced horsepower. In addition, the injection phase is much shorter due to makeup to the reactor only being required to compensate for the reduced RCS temperature. In an accident of this type the RHR pumps would be shut off relatively soon. Therefore, the maximum diesel generator loading would be less for this accident and the injection phase would be shorter. Since the RCS is intact, sump recirculation will not be required and RHR will be used for long term cooldown.

7.1.4 **Smaller Break LOCA's:**

7.1.4.1 The RCS pressure does not decrease as much during a large break LOCA. Depending upon the break size it is possible for the containment pressure not to rise enough to initiate containment spray (28 psig). For break sizes smaller then a large break there would be a reduced containment pressure and temperature. Therefore the containment fans would operate at a significantly reduced brake-horsepower as compared to the large break LOCA case (Attachment I). As a result, the overall loading on the diesel generators would be significantly less for break sizes smaller then a large break LOCA.

7.1.5 **Other Accidents:**

7.1.5.1 For other credible accidents such as a steam line break outside containment or S/G tube rupture, there would not be any significant increase in containment pressure, therefore containment spray would not be operating and the containment fans would be operating at a significantly reduced brake-horsepower. In addition the RCS pressure would not drop enough to cause RHR flow into the RCS. Therefore the diesel generators would be operating at a significantly reduced loading than during a large break LOCA.

7.2 Large Break LOCA Evaluation

7.2.1 The three possible different Engineered Safety Feature (ESF) modes during a large break LOCA are as follows:

- Injection Phase
- Recirc Phase – High Head
- Recirc Phase - Low Head

The injection phase will be followed by either a High Head or Low Head recirculation phase. During the recirculation phase, coolant spilled from the break and water from the containment spray collect in containment sump B. The RHR pumps are aligned to take suction from this sump and either provide suction to the SI pumps for high head recirculation or pump directly into the core through deluge valves for low head recirculation. The type of recirculation (either high head or low head) depends on the status of the core.

7.2.2 The loading for each mode will be compared against the appropriate EDG ratings (Continuous or 2 hour (Injection Phase)).

7.2.3 **Large Break LOCA Injection Phase Duration**

7.2.3.1 The following evaluation provides a basis for determining the time frame for the injection phase of a large break loss of coolant accident (LOCA). This value will provide a basis for determining the acceptability of the emergency diesel generator loading during a large break LOCA.

7.2.3.2 The maximum length of the injection phase during a large break LOCA is based on the RWST level. The operators are guided by Emergency Operating Procedure E-1 during the injection phase of a LOCA. This procedure instructs the operators to end the injection phase when the RWST level is less than 28%. It is possible for the system to stabilize and the operators to terminate the injection phase prior to the RWST reaching 28% level, however the maximum injection phase length would occur if it is required to pump the tank down to this level.

7.2.3.3 If a large break LOCA occurred coincident with the loss of offsite power and the failure of Diesel Generator A, SI pumps B and C, RHR pump B and Containment Spray Pump B are aligned to take suction from the RWST during the injection phase. The flow rates from these pumps determine the length of the injection phase. The following flow rates are the design flow rates for these pumps in accordance with the UFSAR.

Motor	Flow Rate	UFSAR Section
SI Pump B	300 GPM (Design)	Table 6.3-3
SI Pump C	300 GPM (Design)	Table 6.3-3
RHR Pump B	1560 GPM (Design)	Table 6.3-3
Containment Spray Pump B	1200 GPM (Design)	Table 6.2-27

7.2.3.4 The RWST contains approximately 338,000 gallons of borated water. Assuming the pumps are operating at their design flow rates and two SI pumps, one RHR and the containment spray pump are taking suction from the RWST, the flow from the RWST would be 3,360 GPM. Based on these flow rates it would take approximately 72.4 minutes to drain the RWST from 100% filled (338,000 gallons) to 28% filled (94,640 gallons). This value is very conservative because during a large break LOCA the RCS is de-pressurized and the pumps would be expected to operate at significantly higher flow rates.

7.2.3.5 When the RWST is lowered to 28% filled, procedure E-1 transfers the operators to procedure ES-1.3 to make the transition into the recirculation phase. The transition from injection to recirculation phase will not happen instantaneously but "ending" the injection phase will very quickly result in a reduction of the EDG loading as various motors are "pull stopped" and the associated valves re-aligned prior to restarting the motor.

7.3 Diesel Generator Ratings

7.3.1 The diesel generator rating is based on the rating of the engine/generator combination.

7.3.2 Generator

7.3.2.1 Per the nameplate on the diesel generators the continuous ratings for the generator portion is as follows:

2500 KVA, 80% power factor, 3000 amps, 480 volts.

7.3.2.2 This corresponds to a continuous rating of: 2000 kW + j 1500 KVAR which satisfies the continuous rating specified in the Bill of Material (Reference 4.4.1, Attachment II) for the complete EDG set (1950 KW). Per a Westinghouse correspondence dated November 9, 1976 (Reference 4.4.2, Attachment II) the generator has a service factor rating of 1.15 which corresponds to 2868 KVA (3450 amps at 80% power factor and 480 volts).

7.3.3 Engine

7.3.3.1 Reference 4.4.3 (Attachment II) indicates that the engine portion of the EDG has a continuous rating of 2750 HP or 2051 KW. The engine continuous rating needs to be greater than the continuous rating of the "diesel generator unit" in order to account for generator efficiency as well as friction and windage. The Bill of Material indicates that the continuous rating (of the diesel generator unit) should be 1950 kW so the 1950 kW value will be used.

7.3.4 <u>Diesel Generator Set Rating</u>

7.3.4.1 Real Power Rating (Watts)

7.3.4.1.1 The Bill of Material (Ref 4.4.1) indicates that the diesel generator units should have a two hour rating of 2250 KW and a ½ hour rating of 2300 KW . These ratings were further clarified in General Electric correspondence dated May 14, 1992 (Reference 4.4.4) which specified that the ratings are cumulative. It stated the generators are rated to operate at 2300 KW for a ½ hour and then at 2250 for two additional hours and then at 1950 KW continuously. The temperature of the diesel generator rooms for the various operating scenarios and the acceptability for these temperatures is addressed in Design Analysis ME-91-0010.

7.3.4.2 Reactive Power Rating (VAR's)

7.3.4.2.1 In accordance with a Westinghouse correspondence dated January 10, 1968 (Reference 4.4.6) the field voltage for these generators would be 99.2 volts with a field current of 126 amps when the diesel generator is loaded to 2000 KW with a 0.8 pf. This would correspond to 12.5 KVA. In accordance with Basler drawing D-90-43800-910 (Reference 4.4.7) the exciter/ voltage regulator has a rating of 14.5 KW. Therefore it is reasonable to assume the exciter could provide the field current to generate enough VAR's to operate at 0.8 pf for a generator loading of 2300 KW. However in this analysis it will be demonstrated that the VAR loading will not be a limiting condition. Therefore it will be conservative to assume that the VAR output rating of 1500 KVAR's corresponding to 0.8 pf for 2500 kVA and 2000 kW does not increase for the two hour rating conditions.

7.3.4.3 The capability of the diesel generator sets can therefore be conservatively stated as:

EDGB Steady State Rating Summary				
	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
EDG Rating - Continous	1950	1500	2500	3000
EDG Rating (2 hour)	2250	1500	2868	3450

7.4 Motor Data

7.4.1 The following motor parameters must be determined for each motor during each phase (both injection and recirculation) of an accident:

1. Brake Horse-Power Requirements
2. Motor Power Factor
3. Motor Efficiency

7.4.1.1 Utilizing the above parameters the real and reactive power requirements of the motors will be determined by the ETAP program.

7.4.2 Power Factor and Efficiency

7.4.2.1 The power factor and efficiency is required to calculate the real and reactive power requirements of the various motors. Manufacturer power factor and efficiency data was generally available for most of the motors because the motors are relatively new and/or have been rewound. Where specific data was not available (SI and RHR) reasonable assumptions were made (Attachment I).

7.4.3 Motor Efficiency and Power Factor Adjustments

7.4.3.1 Motor power factor and efficiency is slightly affected by variations in motor loading and terminal voltage. As indicated on Page 20-46 of Reference 4.4.13 the efficiency and power factor increase with the percent loading of a motor. The following plot depicts how power factor and efficiency vary as a function of load for the auxiliary feedwater motor.

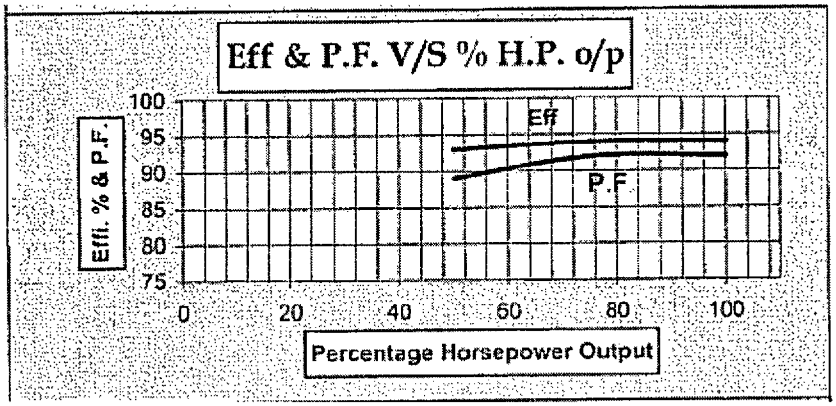


Figure 1 - Efficiency and Power Factor vs. BHP load (AFW Pump)

The above figure suggests that power factor and efficiency variations, as a function of motor load, are probably not very significant, particularly when the loading is between 80 and 100%. Many motors being evaluated in this analysis operate near or even slightly above their horsepower rating. For some of the newer and/or rewound motors, the manufacturer provided this variation information and consequently this data was input into the ETAP computer program. For the older motors (SI, RHR) this information was not available and reasonable assumptions were made (Attachment I).

7.4.3.2 In general, motor efficiency slightly increases and power factor slightly decrease as the terminal voltage rises above the motor rating. In this case, the diesels are feeding the loads, and hence the voltages would be very close to and sometimes even above the motor voltage rating (Attachment III). The final power factor and efficiency values used for each of the motors during the injection phase are tabulated in the following two tables along with their corresponding nominal values.

Table 5 - Motor Efficiency Values - Injection Phase Loading

Motor Efficiency - Injection Phase						
Load	Motor Rating (HP)	ETAP Motor Input (kW)	BHP (HP)	ETAP Efficiency	Mfgr Efficiency (Nominal)	Ref. for Nominal Efficiency
Safety Injection Pump B	350.0	290.32	371.0	**95.3%**	94.5%	Ref 4.4.8
Safety Injection Pump C	350.0	290.32	371.0	**95.3%**	94.5%	Ref 4.4.8
Residual Heat Removal Pump B	200.0	120.53	150.0	**92.8%**	92.7%	Ref 4.4.8
Containment Fan B	300.0	192.90	240.0	**92.8%**	92.3%	1/14/93 test report
Containment Fan C	300.0	192.90	240.0	**92.8%**	92.3%	1/14/93 test report
Service Water Pump B	350.0	0.00	0.0	**0.0%**	0.0%	NA
Service Water Pump D (spare)	350.0	256.09	325.5	**94.8%**	94.5%	6/2/2003 Data Sheet
Auxiliary Feedwater Pump B	300.0	221.33	279.0	**94.0%**	94.0%	7/27/04 Data Sheet
Containment Spray Pump B	200.0	184.00	222.0	**90.0%**	92.1%	Attachment I
Component Cooling Water Pump B	150.0	0.00	0.0	**0.0%**	0.0%	NA

Table 6 - Motor Power Factor Values - Injection Phase Loading

Motor Power Factor - Injection Phase						
Load	ETAP Motor Input (kVA)	ETAP Motor Input (kW)	BHP (HP)	ETAP Power Factor	Mfgr Power Factor (Nominal)	Ref. for Nominal Power Factor
Safety Injection Pump B	319.0	290.32	371.0	**91.0%**	90.9%	Ref 4.4.8
Safety Injection Pump C	319.0	290.32	371.0	**91.0%**	90.9%	Ref 4.4.8
Residual Heat Removal Pump B	132.6	120.53	150.0	**90.9%**	91.0%	Ref 4.4.8
Containment Fan B	212.0	192.90	240.0	**91.0%**	90.5%	1/14/93 test report
Containment Fan C	212.0	192.90	240.0	**91.0%**	90.5%	1/14/93 test report
Service Water Pump B	0.0	0.00	0.0	**0.0%**	0.0%	NA
Service Water Pump D (spare)	283.6	256.09	325.5	**90.3%**	90.4%	6/2/2003 Data Sheet
Auxiliary Feedwater Pump B	240.6	221.33	279.0	**92.0%**	92.0%	7/27/04 Data Sheet
Containment Spray Pump B	203.8	184.00	222.0	**90.3%**	88.4%	Attachment I
Component Cooling Water Pump B	0.0	0.00	0.0	**0.0%**	0.0%	NA

The above two tables demonstrate that the efficiency and power factors values used by the ETAP program for the injection phase are both typical and reasonably consistent with the manufacturer provided "nominal loading, nominal voltage" values. Slight variations in the ETAP values can be expected for the recirculation modes (high head, low head) if the motor BHP value changes. A "high" efficiency value would be considered non-conservative in this case since it would reduce the overall kW loading on the EDG and similarly a "high" power factor would also be considered non-conservative since it would reduce the kVAR loading on the EDG. The impact of data uncertainties will be addressed in the Results section of this calculation.

7.4.4 Brake-Horsepower Requirements

7.4.4.1 The horsepower requirements of the various pumps were determined by using the vendor supplied pump curves (Attachment I). The horsepower requirement of the containment fans was developed based on Reference 4.3.2. The table below summarizes the BHP used for each of the three modes associated with a large break LOCA event. Additional details concerning the basis for the BHP loading is provided in the following sections.

Table 7 - Brake Horsepower Loading (at 60.0 Hz)

		Pump or Fan Curve		Large Break LOCA - ETAP Value		
Load	Motor Rating (HP)	Design Point BHP (HP)	Max BHP (HP)	Injection (HP)	High Head Recirc (HP)	Low Head Recirc (HP)
Safety Injection Pump B	350.0	355.0	368.0	371.0	0.0	0.0
Safety Injection Pump C	350.0	355.0	368.0	371.0	371.0	0.0
Residual Heat Removal Pump B	200.0	150.0	173.0	150.0	174.0	174.0
Containment Fan B	300.0	256.0	256.0	240.0	174.0	174.0
Containment Fan C	300.0	256.0	256.0	240.0	174.0	174.0
Service Water Pump B	350.0	311.0	312.0	0.0	322.0	322.0
Service Water Pump D (spare)	350.0	311.0	312.0	325.5	325.5	325.5
Auxiliary Feedwater Pump B	300.0	262.0	280.0	279.0	279.0	279.0
Containment Spray Pump B	200.0	188.0	220.0	222.0	0.0	0.0
Component Cooling Water Pump B	150.0	140.0	150.0	0.0	150.0	150.0
Total BHP (HP)	2850.0	2584.0	2695.0	2198.5	1969.5	1598.5
Total BHP (kW)	2125.3	1926.9	2009.7	1639.4	1468.7	1192.0

It should be noted that the ETAP program has a slight limitation on assigning BHP values, namely the BHP value has to be an integer percent of the motor rating. This explains why the ETAP Safety Injection loading was 371 HP (106% of 350 HP) for the injection phase rather than 368 HP (105.14% of 350 HP).

7.5 <u>Basis for BHP Loading Values</u>

7.5.1 The following discussion provides the basis for the horsepower requirements of the various loads fed from Diesel Generator B during each of the three modes for of a large break LOCA event.

7.5.2 Safety Injection Pumps B and C

7.5.2.1 Safety Injection Pumps B and C would sequence onto Diesel Generator B during an accident condition. They are the first major loads sequenced onto the diesel. During a large break LOCA, the RCS would de-pressurize and flow from the SI pumps would be approaching a maximum value. SI pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve (368 HP – See attachment 1). One SI pump is turned off in the High Head phase and both are turned off in the Low Head phase.

7.5.3 Residual Heat Removal Pump B

7.5.3.1 Residual Heat Removal Pump B would sequence onto Diesel Generator B after the SI motors. During the injection phase, flow from the RHR pump goes directly into the RCS. The flow rate for the RHR pumps was assumed to be less than or equal to 1688 GPM during the injection phase of a large break LOCA. The design flow rate is 1560 GPM and the maximum flow rate is 2500 GPM (UFSAR Table 6.3-3). During a large break LOCA, the RCS would de-pressurize and flow from the RHR pump would be approaching a maximum value, however valve throttling will limit the flow rate to approximately 1688 GPM. This flow rate assumption results in the BHP being no more than 150 HP during the injection phase (Attachment I). The RHR pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve (173 HP) during the recirculation phase.

7.5.4. Containment Fans B and C

7.5.4.1 The containment fans, sequenced on after the RHR and Service Water motors, are constant flow fans. Therefore the horsepower requirements of the fan motors are directly proportional to the density of the air/steam mixture in containment. The density is directly related to containment pressure. As demonstrated in Reference 4.3.2, the maximum containment fan brake-horsepower requirements would occur when the containment pressure is at its design pressure, 60 psig. The fan motor horsepower requirements under these conditions would be 256 HP. In actuality the maximum accident containment pressure occurs during a steam line break in containment and is less than the containment design pressure. During a large break LOCA the containment pressure would reach a maximum value of 54 psig (UFSAR Figure 6.2-4) and therefore the maximum containment fan loading would be 239.2 HP during the injection phase..

7.5.4.2 Two hours into a LOCA, the containment pressure would drop below 30 psig (Reference 4.4.9.4). At that pressure, the BHP on the Containment Fans would be 172 HP (Attachment 1). Therefore, when comparing the total accident load to the EDG continuous rating, it will be assumed that the containment fans would be operating at 172 HP. Technically, the recirculation phase could start sooner than 2 hours into a LOCA and therefore the Containment Fan BHP would be greater than 172 HP, but in no case would it be greater than what was assumed for the injection phase (239.2 HP). The transition from the injection phase to the recirculation phase will always result in a load decrease for the EDG even if the Containment Fan loading stayed at 239.2 HP (Table 7). When we are comparing the recirculation phase loading to the EDG continuous rating, we are inherently referring to the recirculation phase loading as it exists, at least two hours into a LOCA event. Therefore the Containment Fan loading during the recirculation phase will be assumed to be 172 HP.

7.5.5 Service Water Pump B or D

7.5.5.1 Service Water Pump B or D would sequence onto Diesel Generator B depending upon which pump is selected. This motor is sequenced on after the RHR motor. During the injection phase the service water pump would provide cooling to the containment fan coolers, the diesel generators and a few miscellaneous loads.

7.5.5.2 A review of the pump curve (Attachment I) indicates that the peak pump load requirement should be 312 HP; however, this testing was done on a test stand and may not accurately reflect the efficiency of the installed configuration at Ginna. Based on some field measurements contained in Attachment I, a conservative value of 326 HP will be utilized. The BHP loading for the Service water pumps is not expected to change during the recirculation phase however the second service water pump would be turned on.

7.5.5.3 The spare motor for service water pumps (currently installed on pump D) has slightly different characteristics from the other three service water pump motors. In particular, its power factor is slightly worse resulting in the motor drawing about 20 kVAR more from the EDG than the other motors (Attachment III, recirculation phase). The kW draw is the same for all four of the motors. In order to be conservative, if only one service water pump was assumed to be on (injection phase), then it was assumed that the spare service water pump was the one on.

7.5.6 Auxiliary Feedwater Pump B

7.5.6.1 Auxiliary Feedwater Pump B would sequence onto Diesel Generator B after the containment fans have sequenced on. During a large break LOCA the RCS would de-pressurize and there would not be any flow through the steam generators from the RCS. Therefore feedwater flow would not be required and the operators would shut the pump off after the level returned to a nominal value. However to be conservative it will be assumed that this pump remains running for the entire injection and recirculation phase (during smaller breaker LOCA's it is credible for the pumps to remain operating during both the low head and high head recirculation phases).

7.5.6.2 This pump takes suction from the condensate storage tank and pumps directly into steam generator B. Flow into steam generator B is automatically controlled to 200 GPM by MOV 4008. However the system configuration is such that a line exists for this pump to also provide flow back to the condensate storage tank. A normally closed air operated valve prevents flow to the tank. On a loss of offsite power the instrument air compressors would be lost and this valve would eventually fail open. This would result in flow from this pump going to both the steam generators and the condensate tank. Therefore, the flow could actually exceed the 200 GPM. In accordance with the pump curve (Attachment I), the maximum BHP loading would be limited to 280HP and this value was assumed for both the injection and recirculation phase.

7.5.7 Containment Spray Pump B

7.5.7.1 Containment Spray Pump B automatically starts when the containment pressure reaches 28 psig. This would occur very early during a large break LOCA. During the injection phase, the containment spray pumps draw flow from the RWST and sprays directly into containment. The Containment Spray pumps were conservatively assumed to be operating at a BHP equal to the maximum value on the pump curve that is associated with an assumed maximum flow rate of 1625 GPM (220 HP – See attachment 1).

7.5.7.2 In the process of transferring to the recirculation phase, containment spray would be pull stopped. This pump would not be restarted unless the containment pressure was above 37 psig. Based on Section 6.2 of the UFSAR, the containment pressure would be reduced to less then 30 psig within the time frame required to enter the recirculation phase. Therefore containment spray will be assumed off during the recirculation phase.

7.5.8 Component Cooling Water Pump B

7.5.8.1 The component cooling water pump is not utilized during the injection phase. During the recirculation phase, component cooling water is required to provide cooling for the RHR heat exchanger. The CCW pump would be aligned such that its flow would be approaching a maximum value. According to the pump curve (Attachment I), the maximum BHP loading would be 150 HP and this is the loading that was assumed for both the High Head and Low Head recirculation modes.

7.5.9 Motor Control Center Loading

7.5.9.1 The MCC loading, shown in Section 1.5, was derived from Table 5 of DA-EE-2003-062. The loading was assumed the same for both injection and recirculation phases with the exception that the control room heaters were turned on for the recirculation phase. Only MCCs D, J, M and P are associated with EDGB. The other MCCs listed in Section 1.5 are associated with EDGA and are not part of this analysis.

7.5.10 Excitation and Voltage Regulator Requirements

7.5.10.1 In accordance with Basler drawing D-90-43800-910 (Reference 4.4.7) the exciter and voltage regulator power requirements are 14.5 KW for a generator rated for 2000 KW at a 0.8 power factor. The drawing does not indicate what the VAR requirements are for this system. Westinghouse provided data specific for the excitation requirements of the emergency generators at Ginna per Reference 4.4.6. This information indicates that the field voltage would be 99.2 volts with a field current of 126 amps at full load with a 0.8 pf. This would correspond to 12.5 KVA. At unity power factor and full load the excitation power requirements reduced to 6.4 KVA (70.7 volts and 90 amps). It will be demonstrated in this analysis that the power factor during the injection phase is significantly greater then 0.8. Therefore it is reasonable to assume that the actual power requirements of the excitation and voltage regulator system will be less then the value indicated on Basler drawing D-90-43800-910. However to be conservative 14.5 KW will be assumed.

7.5.11 Other Loads

7.5.11.1 The only other load automatically fed from Diesel Generator B is a crankcase exhaust motor that is powered by a 480-120 VAC transformer fed from the generator output terminals. There are two motors both with a nameplate rating of 115 VAC/4.6 amps. Therefore assuming a 0.85 power factor the load due to these two motors is 899 Watts and 557 VARS. (Note – this is two single phase loads being treated as a balanced 3 phase load which is OK since it is such a small load and the kW loading is correct).

7.5.11.2 Cable losses were calculated using the computer program ETAP. A complete printout of the ETAP results is contained in Attachment III.

7.5.12 Injection Phase Load Summary

Table 8 - Load Summary - Injection Phase (when EDG is at rated voltage and frequency)

	Electrical Input to Load (ETAP Calculated)		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump B	290.32	132.26	319.03
Safety Injection Pump C	290.32	132.26	319.03
Residual Heat Removal Pump B	120.53	55.27	132.60
Containment Fan B	192.90	88.00	212.02
Containment Fan C	192.90	88.00	212.02
Service Water Pump B	0.00	0.00	0.00
Service Water Pump D (spare)	256.09	121.94	283.64
Auxiliary Feedwater Pump B	221.33	94.29	240.58
Containment Spray Pump B	184.00	87.66	203.81
Component Cooling Water Pump B	0.00	0.00	0.00
MCC Loading (total)	133.90	79.58	155.77
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	31.57	42.58	53.01
Total Load Supplied by EDG (Sum)	1929.83	922.83	2139.12
Total Generation (EDG)	**1929.83**	**922.83**	**2139.12**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (2 hour)	**2250.00**	**1500.00**	**2868.00**
Percent Margin=(Rating - Duty) / Rating *100	**14.23%**	**38.48%**	**25.41%**

Table 9 - MCC Detail - Injection Phase (when EDG is at rated voltage and frequency)

	Motor Load		Static Load		Total Load	
MCC	**P(kW)**	**Q (kVAR)**	**P(kW)**	**Q (kVAR)**	**P(kW)**	**Q (kVAR)**
MCCD	86.78	49.79	12.32	7.07	99.11	56.85
MCCJ	13.39	11.27	0.00	0.00	13.39	11.27
MCCM	2.73	2.57	0.00	0.00	2.73	2.57
MCCP_Xfmr	1.80	0.00	0.42	0.00	2.22	0.00
MCCP_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCP_Heat	0.00	0.00	0.00	0.00	0.00	0.00
MCCP_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC Total	**121.16**	**72.51**	**12.75**	**7.07**	**133.90**	**79.58**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.5.13 High-Head Recirculation Phase Load Summary

Table 10 - Load Summary - High Head Recirculation Phase (when EDG is at rated voltage and frequency)

	Electrical Input to Load (ETAP Calculated)		
Load	P (kW)	Q (kVAR)	S (kVA)
Safety Injection Pump B	0.00	0.00	0.00
Safety Injection Pump C	290.32	132.26	319.03
Residual Heat Removal Pump B	139.82	64.11	153.82
Containment Fan B	139.98	68.28	155.74
Containment Fan C	139.98	68.28	155.74
Service Water Pump B	256.97	102.37	276.60
Service Water Pump D (spare)	256.09	121.94	283.64
Auxiliary Feedwater Pump B	221.33	94.29	240.58
Containment Spray Pump B	0.00	0.00	0.00
Component Cooling Water Pump B	121.86	57.28	134.65
MCC Loading (total)	160.06	79.64	178.78
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	22.56	29.17	36.87
Total Load Supplied by EDG (Sum)	1764.93	818.63	1945.54
Total Generation (EDG)	**1764.93**	**818.63**	**1945.54**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (Cont.)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**9.49%**	**45.42%**	**22.18%**

Table 11 - MCC Detail - High Head Recirculation Phase (when EDG is at rated voltage and frequency)

	Motor Load		Static Load		Total Load	
MCC	P(kW)	Q (kVAR)	P(kW)	Q (kVAR)	P(kW)	Q (kVAR)
MCCD	86.78	49.79	12.44	7.13	99.22	56.92
MCCJ	13.39	11.27	0.00	0.00	13.39	11.27
MCCM	2.73	2.57	0.00	0.00	2.73	2.57
MCCP_Xfmr	1.80	0.00	0.43	0.00	2.23	0.00
MCCP_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCP_Heat	0.00	0.00	26.04	0.00	26.04	0.00
MCCP_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC Total	**121.16**	**72.51**	**38.90**	**7.13**	**160.06**	**79.64**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.5.14 Low-Head Recirculation Phase Load Summary

Table 12 - Load Summary - Low Head Recirculation Phase (when EDG is at rated voltage and frequency)

Load	Electrical Input to Load (ETAP Calculated)		
	P (kW)	Q (kVAR)	S (kVA)
Safety Injection Pump B	0.00	0.00	0.00
Safety Injection Pump C	0.00	0.00	0.00
Residual Heat Removal Pump B	139.82	64.11	153.82
Containment Fan B	139.98	68.28	155.74
Containment Fan C	139.98	68.28	155.74
Service Water Pump B	256.97	102.37	276.60
Service Water Pump D (spare)	256.09	121.94	283.64
Auxiliary Feedwater Pump B	221.33	94.29	240.58
Containment Spray Pump B	0.00	0.00	0.00
Component Cooling Water Pump B	121.86	57.28	134.65
MCC Loading (total)	160.32	79.69	179.04
EDG Excit &Crankcase Exhaust Motor	15.97	1.01	16.00
Cable Loss (ETAP Calculated)	16.75	21.15	26.98
Total Load Supplied by EDG (Sum)	1469.05	678.40	1618.13
Total Generation (EDG)	**1469.05**	**678.40**	**1618.13**
kW Mismatch (Summation - Gen)	0.00	0.00	0.00
EDG Rating (Cont.)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**24.66%**	**54.77%**	**35.27%**

Table 13 - MCC Detail - Low Head Recirculation Phase (when EDG is at rated voltage and frequency)

MCC	Motor Load		Static Load		Total Load	
	P(kW)	Q (kVAR)	P(kW)	Q (kVAR)	P(kW)	Q (kVAR)
MCCD	86.78	49.79	12.52	7.18	99.30	56.97
MCCJ	13.39	11.27	0.00	0.00	13.39	11.27
MCCM	2.73	2.57	0.00	0.00	2.73	2.57
MCCP_Xfmr	1.80	0.00	0.43	0.00	2.23	0.00
MCCP_Fan	16.46	8.88	0.00	0.00	16.46	8.88
MCCP_Heat	0.00	0.00	26.21	0.00	26.21	0.00
MCCP_Cool	0.00	0.00	0.00	0.00	0.00	0.00
MCCG	0.00	0.00	0.00	0.00	0.00	0.00
MCC Total	**121.16**	**72.51**	**39.16**	**7.18**	**160.32**	**79.69**
EDG Excit and ExMt	15.97	1.01	0.00	0.00	15.97	1.01

7.6 Evaluation of "Off Nominal" Voltage and Frequency operation.

7.6.1 Off Nominal Voltage Evaluation

PT-12.2 (Reference 4.1.4) indicates that the EDG voltage, after startup, has to be within the range of 470 volts (97.92%) to 504 volts (105%). It should be noted that this stated voltage range is for the case of the EDG unloaded and does not necessarily reflect the voltage range management capability of the EDG when it is supporting the accident mitigation loads. A more accurate measure of this capability can be obtained by reviewing the final "voltage setting" acceptance criteria (480 V to 490 V) in PT-12.2 and combine this with the actual steady state voltages obtained from the annual "Diesel Generator Load and Safeguard Sequence Test" (RSSP-2.2). A plot of the 1996 field results is shown below:

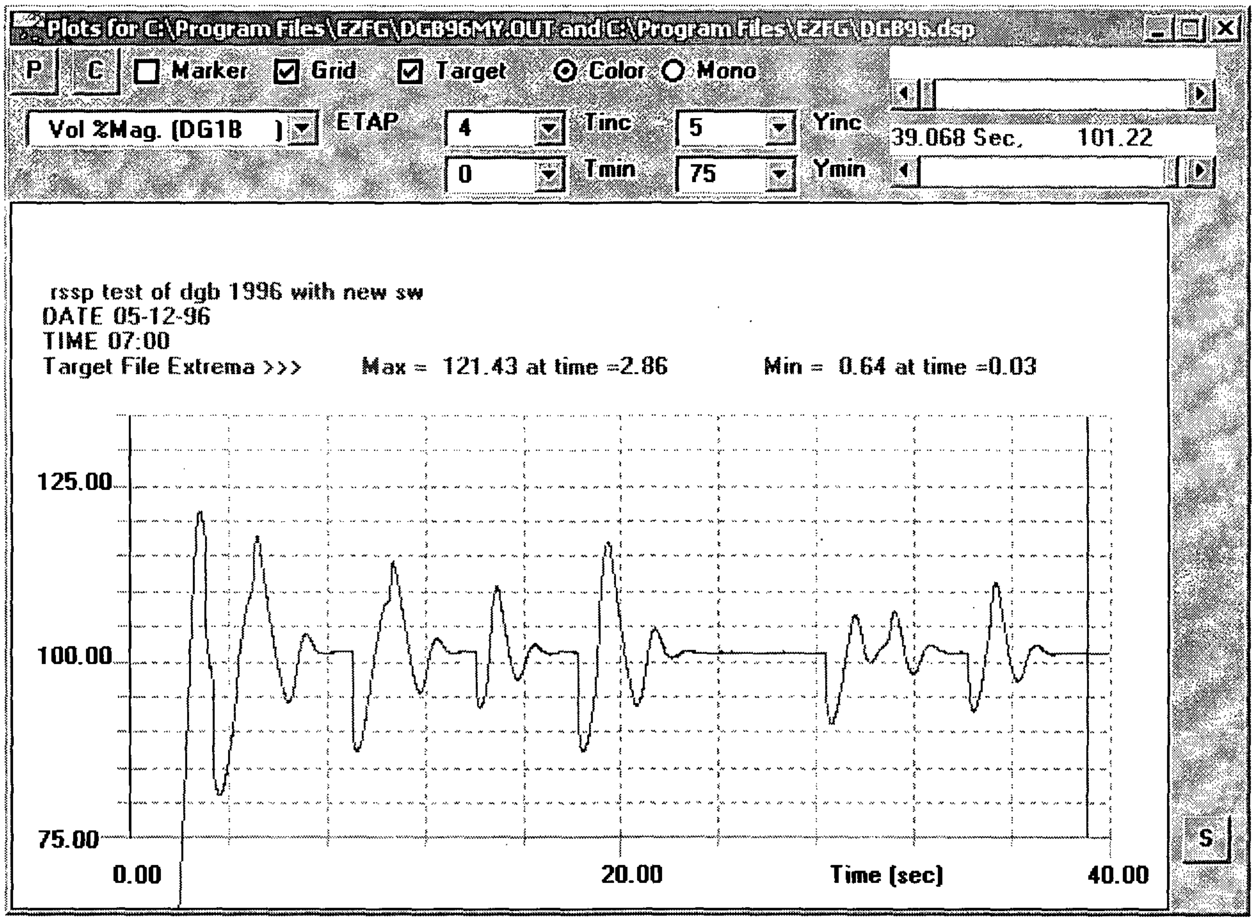


Figure 2 - EDGB Voltage (%480V) during 1996 RSSP2.2

The above figure demonstrates that the final voltage at the EDG terminals was 101.22% of 480 volts or 485.9 volts which is nearly in the middle of the final voltage setting acceptance criteria identified in PT-12.2. The final kW load on the EDG during the above test was 1150 kW. While this loading is below the anticipated injection phase loading of 1930 kW, the above test does give a good indication of the EDGs voltage management capability during loaded conditions. The above curve also demonstrates that this capability is not diminished as more load is added during the sequence. The most recent RSSP test (10/11/06) recorded a steady state voltage of 480 volts after the loads had been sequenced on. Based on the above results and discussions, it is concluded that a conservative estimate of the EDGs voltage management capability during accident conditions, according to the MCB meter, would be a voltage range between 470 volts and 504 volts. The accuracy of the meters on the main control board are +/- 1% so the actual steady state EDG voltage, during accident conditions, is expected to be within the following range: Vmax = 509.04 volts (106%), V min = 465.3 volts (96.94%).

The majority of the loads on the EDG are induction motors and those types of loads are routinely considered constant MVA loads for the voltage range under consideration. This implies that the kW and kVAR load associated with the induction motors will not be affected by the voltage variations. Higher voltages will cause the current flow to these motors to go down and hence there will be a reduction in the cable kW and kVAR losses. Conversely, a reduction in voltage will cause a slight increase in the cable losses. The loading associated with the small amount of static load will respond exactly opposite to the cable losses (i.e. an increase in voltage will cause the static kW loading to go up while a decrease in voltage will cause the static loading to go down). The kW and kVAR loading on the EDG is dominated by induction motors so it is reasonable to expect that for the voltage range of interest, the kW and kVAR loading on the EDG will not be impacted by the above mention voltage variations. In order to verify this conclusion the injection phase simulations were repeated for the voltage range of interest and the results are tabulated below:

Table 14 - Impact of Off Nominal Voltage on EDG Loading

EDGB Loading - Injection Phase				
EDG Voltage (Volts)	P (kW)	Q (kVAR)	S (kVA)	I amps RMS
480.00	1930	923	2139	2573
509.04	1928	919	2136	2422
465.30	1931	925	2141	2657

7.6.2 Off Nominal Frequency Evaluation

PT-12.2 (Reference 4.1.4) indicates that the EDG frequency, after startup, has to be within the range of 59.5 Hz to 60.5 Hz. It should be noted that this stated frequency range is for the case of the EDG unloaded and does not necessarily reflect the frequency range management capability of the EDG when it is supporting the accident mitigation loads. A more accurate measure of this capability can be obtained by reviewing the final "frequency setting" acceptance criteria (60 to 60.1 Hz.) in PT-12.2 and combine this with the actual steady state frequency obtained from the annual "Diesel Generator Load and Safeguard Sequence Test" (RSSP-2.2). A plot of the 1996 field results is shown below:

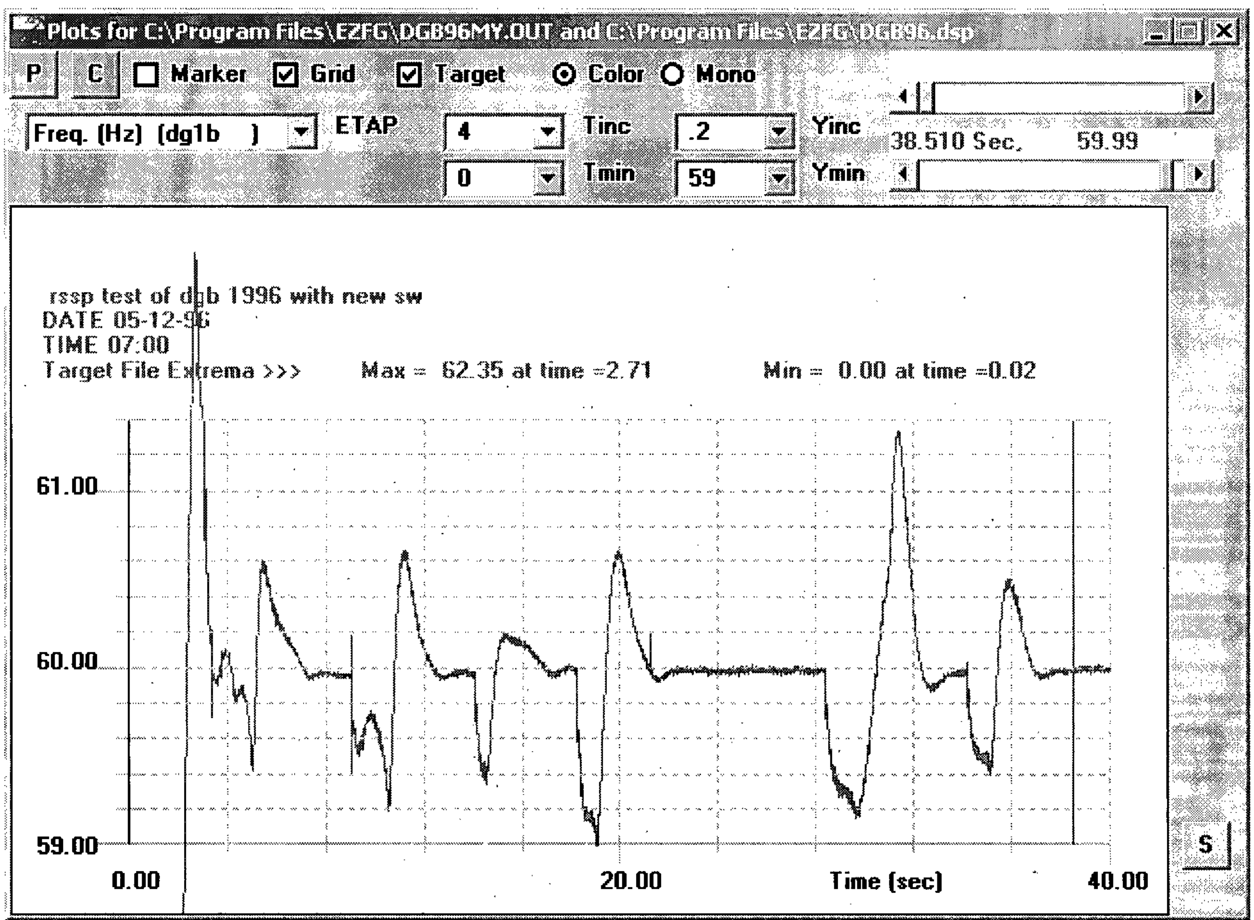


Figure 3 - EDGB Frequency (Hz) during 1996 RSSP2.2

The above figure demonstrates that the final frequency was 59.99 Hz which can be considered to be within the setting acceptance criteria identified in PT-12.2 (60.0 to 60.1 Hz) when the value is rounded to one significant digit. As previously mentioned, the final kW load on the EDG during the above test was 1150 kW. While this loading is below the anticipated injection phase loading of 1930 kW, the above test does give a good indication of the EDGs frequency management capability during loaded conditions. The above curve also demonstrates that this capability is not diminished as more load is added during the sequence. The most recent RSSP2.2 test (10/11/06) recorded a steady state frequency of 60 Hz after the loads had been sequenced on. Based on the above results and discussions, it can be concluded that a reasonable estimate of the EDGs frequency management capability during accident conditions, according to the MCB meter, would be a frequency range between 59.5 Hz and 60.1 Hz (Note that the upper frequency limit was reduced from the 60.5 Hz value noted in PT12.2 based on the 1996 field measurements).The accuracy of the meters on the main control board are +/- 0.3 Hz. so the actual steady state EDG frequency during accident conditions can be expected to be within the following range: Fmax = 60.4 Hz. , F min = 59.2 Hz.

The mechanical BHP loading of fans and pumps tend to go up as the cube of the speed and since the majority of the load on the EDG is this type of load, it is reasonable to assume that the kW load on the EDG would be 1.02 times greater at 60.4 Hz, as compared to the 60Hz kW loading value.

7.6.3 Determining maximum loading for off Nominal Voltage and Frequency

The effect of the stated voltage variations has been shown to be negligible and could therefore reasonably be ignored. Applying the 1.02 multiplying factor to all of the loads (small static loads as well as the motor loads) will tend to compensate for ignoring the small effect associated with voltage variations. Therefore the effect of both voltage variation and frequency variation can be incorporated into the results by simply multiplying each of the loads kW and kVAR values by 1.02. The power factor can be assumed to be unaffected by the small variations in voltage and/or frequency. The following tables summarize the individual loads that are expected if the diesel generator is operating at its worst case voltage and frequency (465.3 volts and 60.4 Hz).

Table 15 - Load Summary - Injection Phase (when EDG is operating at 465.3 volts and 60.4 Hz)

	Electrical Input to Load (ETAP Calculated)		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump B	296.12	134.91	325.41
Safety Injection Pump C	296.12	134.91	325.41
Residual Heat Removal Pump B	122.94	56.37	135.25
Containment Fan B	196.75	89.76	216.26
Containment Fan C	196.75	89.76	216.26
Service Water Pump B	0.00	0.00	0.00
Service Water Pump D (spare)	261.22	124.37	289.31
Auxiliary Feedwater Pump B	225.76	96.17	245.39
Containment Spray Pump B	187.68	89.41	207.89
Component Cooling Water Pump B	0.00	0.00	0.00
MCC Loading (total)	136.58	81.17	158.88
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	32.20	43.43	54.07
Total Load Supplied by EDG (Sum)	1968.42	941.29	2181.91
EDG Rating (2 hour)	**2250.00**	**1500.00**	**2868.00**
Percent Margin=(Rating - Duty) / Rating *100	**12.51%**	**37.25%**	**23.92%**

Table 16 - Load Summary - High Head Recirculation Phase (when EDG is operating at 465.3 volts and 60.4 Hz.)

	Electrical Input to Load		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump B	0.00	0.00	0.00
Safety Injection Pump C	296.12	134.91	325.41
Residual Heat Removal Pump B	142.62	65.39	156.89
Containment Fan B	142.78	69.65	158.86
Containment Fan C	142.78	69.65	158.86
Service Water Pump B	262.10	104.41	282.14
Service Water Pump D (spare)	261.22	124.37	289.31
Auxiliary Feedwater Pump B	225.76	96.17	245.39
Containment Spray Pump B	0.00	0.00	0.00
Component Cooling Water Pump B	124.30	58.43	137.34
MCC Loading (total)	163.26	81.24	182.35
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	23.01	29.75	37.61
Total Load Supplied by EDG (Sum)	1800.22	835.00	1984.45
EDG Rating (2 hour)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**7.68%**	**44.33%**	**20.62%**

Table 17 - Load Summary - Low Head Recirculation Phase (when EDG is operating at 465.3 volts and 60.4 Hz)

	Electrical Input to Load		
Load	**P (kW)**	**Q (kVAR)**	**S (kVA)**
Safety Injection Pump B	0.00	0.00	0.00
Safety Injection Pump C	0.00	0.00	0.00
Residual Heat Removal Pump B	142.62	65.39	156.89
Containment Fan B	142.78	69.65	158.86
Containment Fan C	142.78	69.65	158.86
Service Water Pump B	262.10	104.41	282.14
Service Water Pump D (spare)	261.22	124.37	289.31
Auxiliary Feedwater Pump B	225.76	96.17	245.39
Containment Spray Pump B	0.00	0.00	0.00
Component Cooling Water Pump B	124.30	58.43	137.34
MCC Loading (total)	163.53	81.29	182.62
EDG Excit &Crankcase Exhaust Motor	16.29	1.03	16.32
Cable Loss (ETAP Calculated)	17.08	21.57	27.51
Total Load Supplied by EDG (Sum)	1498.43	691.97	1650.49
EDG Rating (2 hour)	**1950.00**	**1500.00**	**2500.00**
Percent Margin=(Rating - Duty) / Rating *100	**23.16%**	**53.87%**	**33.98%**

8.0 Results

8.1 The most limiting case for the steady state kW loading on Emergency Diesel Generator B would be the injection phase during a large break LOCA event. Frequency and voltage deviations, from nominal, can increase the EDG loading with the worst case being high frequency and low voltage. The following table demonstrates that under worst case conditions, the injection phase loading on the EDGB will slightly exceed the continuous rating of the EDG. The table also compares the injection phase loading duty with the 2 hour capability of the EDG since the injection phase will be complete within 2 hours.

Table 18 - EDGB Loading and % Margin - Worst Case

Worst Case EDGB Loading - Injection Phase, Off nominal Voltage and Freq						
	Freq (Hz)	**EDG Voltage (Volts)**	**P (kW)**	**Q (kVAR)**	**S (kVA)**	**I amps RMS**
EDG Load	60.4	465.30	1968.42	941.29	2182	2707
EDG Rating - Continous			1950	1500	2500	3000
% Margin (Continuous Rating)			-0.9%	37.2%	12.7%	9.8%
EDG Rating - 2 Hour			2250	1500	2868	3450
% Margin (2 hour Rating)			12.5%	37.2%	23.9%	21.5%

Percent Margin=(Rating - Duty) / Rating *100

8.1.1 Even though the worst case kW loading (1968 kW) slightly exceeds the continuous rating of the EDG (1950 kW), this is not a violation of the actual EDG capability or rating since it does not exceed the two hour rating (2250 kW) and the injection phase will be completed within two hours

8.1.2 The worst case loading (1968 kW) does however slightly exceeds the minimum "Tech Spec" test limit (1950 kW) and therefore a "Tech Spec" change will be required.

8.2 The results of this analysis (see Table 3) indicate that there is significant margin between the loading duty that will be imposed on EDGB during accident conditions and the inherent capability of the diesel generator set. It is felt that the overall effect of any data uncertainties (motor characteristics, actual flows, pump characteristics, etc.) would be relatively small; recognizing that some of data uncertainties would increase EDG loading while others would decrease the loading.

8.3 The following is a list of conservatisms, inherent in this calculation, that provide additional margin from what has been tabulated above:

1. The service water pump was assumed to be operating at 326 BHP even though the maximum value on the pump curve was 312 BHP. Assuming 312 BHP would reduce the total loading by 11 kW which would increase the margin by another 0.5%.
2. The worst case injection phase loading (1968 kW) was determined by assuming that both the voltage and frequency deviations from nominal were in the direction to maximize the kW loading. In addition, the associated meters (V and Hz) were also assumed to have errors in a direction that maximized the kW loading. It is unlikely that these four independent issues would simultaneously hit their worst case positions.
3. The exciter load was assumed to be 14.5 kW even though it would probably be a few kW less.

8.4 This analysis demonstrates Diesel Generator B is adequately sized for the worst case steady state accident loading requirements.

THIS CALCULATION HAS BEEN ABRIDGED FOR SUBMITTAL IN THAT ITS SUPPORTING DOCUMENTATION, WHICH CONTAINS PROPRIETARY INFORMATION, HAS BEEN REMOVED. THIS SUPPORTING DOCUMENTATION WILL BE MADE AVAILABLE TO THE NRC UPON REQUEST.