APR 12 1993

Florida Power Corporation
Mr. Percy M. Beard, Jr.
Vice President, Nuclear Operations
ATTN: Manager, Nuclear Operator
Licensing
P. O. Box 219-NA-21
Crystal River, FL 32629

Gentlemen:

SUBJECT: MEETING SUMMARY - CRYSTAL RIVER UNIT 3

This letter refers to the meeting conducted at your request at the NRC Region II offices in Atlanta, Georgia, on March 16, 1993. The purpose of the meeting was to discuss plans for an electrical distribution system functional inspection at Crystal River Unit 3. A list of the attendees and a summary of the presentation are enclosed.

It is our opinion that this meeting was beneficial and provided a better understanding of the your efforts and progress in the area of electrical distribution systems.

Should you have any questions concerning this letter, please let us know.

Sincerely,

Ellis W. Mershoff, Director
Division of Reactor Projects

Enclosures:
1. List of Attendees
2. Presentation Summary

cc w/encl:
Gary L. Boldt
Vice President, Nuclear Production
Florida Power Corporation
P. O. Box 219-SA-2C
Crystal River, FL 34423-0219

cc w/encl cont'd: (See page 2)

9304210092 930412
PDR ADOCK 05000302
G PDR

IE01

cc w/encl cont'd:
B. J. Hickle, Director
Nuclear Plant Operations
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P. O. Box 219-NA-2C
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R. C. Widell, Director
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Attorney General
Department of Legal Affairs
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Administrator
Department of Environmental
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State of Florida
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Chairman
Board of County Commissioners
Citrus County
110 N. Apopka Avenue
Inverness, FL 36250

cc w/encl cont'd: (See page 3)

cc w/encl cont'd:
Robert B. Borsum
B&W Nuclear Technologies
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Rockville, MD 20852-1631

bcc w/encls:
K. Landis, RII
S. Vias, RII
H. Silver, NRR
Document Control Desk

NRC Resident Inspector
U. S. Nuclear Regulatory Commission
6745 N. Tallahassee Road
Crystal River, FL 32629

RII:DRP	RII:DRP	RII:DRP
ALong	KLandis	MSinkule
04/12/93	04/12/93	04/12/93

ENCLOSURE 1

LIST OF ATTENDEES

U. S. Nuclear Regulatory Commission

A. F. Gibson, Director, Division of Reactor Safety (DRS)
H. N. Berkow, Director, Project Directorate II-2, Office of Nuclear Reactor Regulation (NRR)
H. Silver, Project Manager, Crystal River, NRR
M. V. Sinkule, Chief, Branch 2, Division of Reactor Projects (DRP), RII
K. D. Landis, Chief, Section 2B, DRP, RII
C. A. Julian, Chief, Engineering Branch, DRS
E. H. Girard, Inspection Team Leader, DRS
R. C. Butcher, Senior Resident Inspector, Turkey Point Nuclear Plant
R. J. Freudenberger, Acting Senior Resident Inspector, Crystal River
A. R. Long, Project Engineer, DRP, RII
S. N. Saba, Electrical Engineering Branch, Division of Engineering, NRR
C. B. Parsons, Senior Project Officer, Power Reactor Division "B", Atomic Energy Control Board, Ontario, Canada

Florida Power Corporation

P. R. Tanguay, Director, Nuclear Operations Engineering and Projects
K. R. Wilson, Manager, Nuclear Licensing
J. R. Maseda, Manager, Nuclear Operations Engineering
A. E. Friend, Nuclear Principal Licensing Engineer
D. A. Shook, Nuclear Staff Engineer

ENCLOSURE 2

FPC - NRC MEETING

ON

ELECTRICAL DISTRIBUTION SYSTEM

FUNCTIONAL INSPECTION

FOR

CRYSTAL RIVER 3

MARCH 16, 1993

MEETING PURPOSE

OUR PURPOSE TODAY IS TO PROVIDE INFORMATION TO THE NRC TO ALLOW YOU TO CONCLUDE, AS WE HAVE, THAT A "STANDARD" EDSFI FOR CRYSTAL RIVER 3 WOULD NOT BE COST BENEFICIAL.

- FPC AGREES THAT EDSFI'S (AND TEAM INSPECTIONS IN GENERAL) HAVE SERVED AN APPROPRIATE ROLE IN THE REGULATION OF THE NUCLEAR POWER INDUSTRY. HOWEVER, THEY ARE VERY RESOURCE INTENSIVE AND SHOULD BE LIMITED TO SITUATIONS WHERE THE COSTS (TO THE AGENCY AS WELL AS THE LICENSEE) DO NOT EXCEED THE LIKELY BENEFITS.

- FPC HAS DONE EXTENSIVE WORK AND THE NRC HAS KEPT ABREAST OF OUR PROGRESS IN RELATED AREAS. THEREFORE, WE WOULD ENCOURAGE THE NRC TO REDUCE THE SCOPE OR LEVEL OF EFFORT OF THE INSPECTION PLANNED FOR JUNE/JULY 1993.

SUMMARY

- FPC HAS BEEN AWARE OF OUR DEFICIENCIES AND HAS AGGRESSIVELY PURSUED MANY ASPECTS OF THEIR RESOLUTION FOR SEVERAL YEARS. THE NRC HAS BEEN KEPT VERY FULLY INFORMED BY FPC AND HAS DEVOTED SIGNIFICANT RESOURCES TO MONITORING (REVIEWING AND INSPECTING) OUR EFFORT.

- MR. TANGUAY WILL REVIEW THE HIGHLIGHTS OF THAT HISTORY SO THAT WE CAN ALL BE REMINDED OF THE PROGRESS WE HAVE MADE IN THE LAST SEVERAL YEARS.

- MR. SHOOK WILL REVIEW THE PROGRESS WE HAVE MADE IN THE CALCULATIONAL AREA AND WILL BRIEFLY REVIEW OUR EFFORTS IN MAINTAINING AWARENESS OF EDSFI-RELATED ISSUES.

- OUR PROGRAM EVOLVED AS A RESULT OF SEVERAL COMPELLING INTERESTS:

    - THE LOGICAL EXTENSION OF OUR BROADER CM EFFORTS THAT WE PROJECTED WOULD BE NEEDED IN CERTAIN AREAS.

    - RESPONSE TO OUR OWN EXPERIENCES.

    - RESPONSE TO THE EXPERIENCE OF OTHER EVENTS AND INSPECTION RESULTS.

- WE DID NOT SET OUT TO AVOID AN EDSFI. IN FACT, WE HAVE LONG ASSUMED ITS INEVITABILITY. HOWEVER, WE BELIEVE THAT MOST OF THE RESULTS OF A STANDARD EDSFI HAVE ALREADY BEEN REALIZED. THEREFORE, AFTER WE HAVE FINISHED I WILL ASK YOU TO GIVE SERIOUS CONSIDERATION TO SIGNIFICANTLY REDUCING THE SCOPE OF THE CR-3 EDSFI.

FLORIDA POWER CORPORATION

CHRONOLOGY OF ELECTRICAL ISSUES
AT CRYSTAL RIVER UNIT #3

Paul R. Tanguay
3/16/93

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1987 - <u>EMERGENCY DIESEL GENERATORS:</u>

- THE EXPECTED WORST CASE LOADING EXCEEDED THE 3300KW OR 30 MINUTE RATING OF THE "A" DIESEL

<u>CORRECTIVE ACTIONS:</u>

- IMPLEMENTED LOAD MANAGEMENT PROGRAM
- INSTALLED LOAD REDUCTION MODIFICATIONS
- INSTALLED EDG UPGRADE PACKAGE
- TESTED MACHINES

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1989 - <u>OFFSITE POWER SOURCE:</u>

- WHILE CONNECTED TO THE UNIT 1&2 S/U TRANSFORMER (CR#3 ALTERNATE SOURCE) CR#1 BOILER FEED PUMP (3500 HP) STARTED AND CAUSED SLUR'S TO PICK UP
- EDG STARTED, BUT DID NOT PICKUP LOADS SINCE UNDERVOLTAGE CONDITION RECOVERED
- CR #1&2 S/U TRANSFORMER HAD INSUFFICIENT CAPABILITY FOR CR #1&2 LOADS COINCIDENT WITH SIMULTANEOUS LOADING OF BOTH ES BLOCK LOADS AT CR#3

<u>CORRECTIVE ACTION:</u>

- INSTALLED A NEW TRANSFORMER DEDICATED TO CR#3 IN 230KV SWITCHYARD

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1989 - <u>CR #3 BATTERIES:</u>

- NEAR END OF 20 YEAR DESIGN LIFE
- BATTERY PROFILE CALCULATIONS HAD ERRORS
- BASES FOR TSIP RELIEF REQUIRED ADDITIONAL CAPACITY
- SBO EVALUATION IDENTIFIED A NEED FOR ADDITIONAL CAPACITY TO MEET 4 HOUR COPING REQUIREMENTS

<u>CORRECTIVE ACTIONS:</u>

- REPLACED ALL 232 CELLS IN S.R. BATTERIES
- REVISED BATTERY CALCULATIONS TO CORRECT ERROR
- INSTALLED NON-SAFETY RELATED BATTERIES
- ALIGNED MOST NON-IE LOADS

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1989 - ELECTRICAL CALCULATION ENHANCEMENT PROGRAM:

- BASED UPON THE NUMBER OF ELECTRICAL ISSUES IDENTIFIED FPC ACKNOWLEDGED THAT ADDITIONAL EFFORT WAS WARRANTED.
- ACCELERATED THE ELECTRICAL PORTION OF CM EFFORT
- INITIATED THE CALCULATION ENHANCEMENT PROGRAM

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1990 - <u>ES 4160/480V TRANSFORMER FAILED (NEARING END OF SERVICE LIFE):</u>

- PROGRAM INITIATED TO REPLACE BOTH SAFETY AND NON-SAFETY TRANSFORMERS

\- <u>CALCULATION PROGRAM IDENTIFIED THAT DC COMPONENTS WERE OUTSIDE THEIR VOLTAGE RATINGS WHILE THE CHARGERS WERE ON EQUALIZE:</u>

- REPLACED COMPONENTS OR DEMONSTRATED QUALIFICATION

\- <u>EDG STARTED AND SLURS ACTUATED WHEN CR#3 CONDENSATE PUMP STARTED:</u>

- INSTALLING A SECOND ES TRANSFORMER

\- <u>EDG RESPONSE TESTING DID NOT ACHIEVE DESIRED PERFORMANCE REQUIREMENTS:</u>

- INSTALLED HIGH ACCURACY, SOLID STATE TIME DELAY RELAYS
- EDG TO BE RETESTED IN MIDCYCLE 9 OUTAGE

CRYSTAL RIVER UNIT #3
ELECTRICAL ISSUES

1991 - 1992 - ELECTRICAL CALCULATION PROGRAM CONTINUED:

- LARGER EFFORT THAN EXPECTED
- EXPANDED THE SCOPE TO ADDRESS ISSUES IDENTIFIED BY OTHER EDSFIs

1993 - ELECTRICAL ENHANCEMENT PROGRAM CONTINUING

- CALCs COMPLETE EXCEPT FOR POWER CABLE AMPACITY

- IMPLEMENTATION OF FIXES FOR ITEMS IDENTIFIED IS CONTINUING

- PREPARATION FOR A JUNE EDSFI HAS RESUMED

FLORIDA POWER CORPORATION

CONFIGURATION MANAGEMENT

ELECTRICAL CALCULATION

ENHANCEMENT PROGRAM

1993 OVERVIEW

MARCH 16, 1993

E.C. ENHANCEMENT PROGRAM

- PROGRAM SCOPE WAS DEVELOPED AS A RESULT OF FPC CONTINUING TO FIND ERRORS IN THE ORIGINAL ELECTRICAL CALCULATIONS.
  - OLD CALCULATIONS WERE HIGH LEVEL AND DONE WITH SLIDE RULES (1969 -- 1970).
  - OLD CALCULATIONS STOOD ALONE AND WERE NOT INTEGRATED.

ORIGINAL CALCULATIONS

DESCRIPTION	DATE ISSUED	PAGES
ISOLATED PHASE BUS DUCT CURRENT	4/29/69	4
GENERATOR NEUTRAL GROUNDING EQUIPMENT	5/6/69	3
AUXILIARY ELECTRICAL POWER FAULT CURRENT	9/8/69	18
UNIT AUXILIARY TRANSFORMER LOADING	5/13/69	1
ELECTRICAL IMPEDANCE CALCULATION UNIT AUX & START-UP TRANSFORMER	6/23/69	11
VOLTAGE DROP , CIRCULATING WATER PUMPS	4/27/70	3
BATTERY 3A - SIZING	10/1/70	14
BATTERY 3B - SIZING	10/1/70	12
BATTERY CHARGER SIZING, "A "BATTERY/"B"BATTERY	10/1/70	3
INVERTER SIZING	9/10/70	5
SHORT CIRCUIT STUDY, MISCELLANEOUS AC DISTRIBUTION	12/21/70	5
DC SHORT CIRCUIT STUDY	1/20/71	11
480V SWGR DISTRIBUTION PNLS, SHORT CIRCUIT	7/9/71	1
EMERGENCY DIESEL GENERATOR LOAD SUMMARY	12/26/72	11
FENCE GROUNDING STUDY	2/12/74	5
RELAY SETTING CALCULATIONS	12/73	37
	TOTAL	144

ELECTRICAL CALCULATION

ENHANCEMENT PROGRAM

- PROGRAM ENHANCEMENT INCLUDED THE FOLLOWING THREE AREAS:
  - EMERGENCY DIESEL GENERATORS.
  - AC SYSTEMS.
  - DC SYSTEMS.
- NEW CALCULATIONS NOT REVISION OF THE OLD CALCULATIONS.
- EDSFI ACTIVITIES.

LICENSING

- IN-DEPTH REVIEW:
  - CR3 LICENSE DOCUMENTS.
  - NRC GENERIC LETTERS.
  - NRC BULLETINS.
  - NRC NOTICES.

DIESEL GENERATOR

- EXTENSIVE CALCULATIONS.
- LOAD MANAGEMENT PROGRAM IN PLACE.
- DETAILED ENGINEERING PROCEDURES ARE IN PLACE.
- MACHINES RECEIVED HIGHER RATINGS AND A FOURTH RATING:

TIME DURATION	OLD RATING KW	NEW RATING KW
CONTINUOUS	0-2750	0-2850
2000 HOUR	2751-3000	2851-3000
200 HOUR	---------------	3001-3250
30 MINUTE	3001-3300	3251-3500

AC and DC CALCULATIONS
(Safety Related)

- SOFTWARE:
  - STATE OF THE ART PC BASED SOFTWARE , WHICH WAS EITHER :
    - BOUGHT ON THE OPEN MARKET
    - DEVELOPED SPECIFICALLY FOR CRYSTAL RIVER #3
  - VALIDATION WAS INCLUDED IN THE ENHANCEMENT EFFORT.
  - MODELS OF THE SYSTEMS ARE MAINTAINED
- THE CALCULATIONS ARE ACTIVE AND MAINTAINED AS PART OF THE DESIGN CONTROL PROCESS.
- DATA BASE:
  - COMPONENT INFORMATION.
  - CABLE LENGTHS.
- SHORT CIRCUIT ANALYSIS.
- VOLTAGE DROP ANALYSIS.
- LOAD FLOW ANALYSIS.
- CABLE AMPACITY.

AC and DC CALCULATIONS (continued)
(Safety Related)

- MAJOR EQUIPMENT RATINGS:
  - START UP TRANSFORMER.
  - NON SEGREGATED BUS DUCT.
  - SWITCHGEAR.
  - INVERTERS.
  - BATTERIES.
  - CHARGERS.
  - PANEL BOARDS.
- BATTERY (DC) DISCHARGE PROFILES.
- COORDINATION OF PROTECTIVE DEVICES.
- CALCULATIONS WERE PERFORMED AT THE FOLLOWING VOLTAGE LEVELS :

  4160VAC, 480VAC, 120VAC, 125VDC, 250VDC

  THE CALCULATIONS WERE PERFORMED DOWN TO THE COMPONENT LEVEL.

  - EXAMPLE: VOLTAGE DROP

EXPANSION OF THE CALCULATION PROGRAM

- CALCULATIONS WERE IDENTIFIED THAT WERE NOT INCLUDED IN THE ORIGINAL ENHANCEMENT PROGRAM AND WERE WARRANTED. THESE WERE IDENTIFIED BY THE ENGINEERS PERFORMING THE CALCULATIONS AND THROUGH THE REVIEWS OF EDSFI'S PERFORMED ON OTHER NUCLEAR FACILITIES.

- ADDITIONAL CALCULATIONS COVERED:

  - VOLTAGE DROP AND LOAD FLOW DURING HELB.

  - TRANSIENT MOTOR STARTING.

  - OVERLOAD SIZING FOR UNDERVOLTAGE.

  - CT/PT BURDEN.

  - STATION GROUND VALIDATION.

  - NEUTRAL GROUNDING RESISTOR SIZING.

EXPANSION OF THE CALCULATION PROGRAM CONTINUED

SIGNIFICANT NON-CALCULATIONAL ACTIVITIES IMPLEMENTED AS A RESULT OF OUR PREPARATION FOR THE EDSFI.

- SAFETY RELATED FUSE CONTROL PROGRAM IS BEING IMPLEMENTED:
  - ENGINEERING DEFINES THE CORRECT FUSE FOR EACH LOCATION.
  - TAG NUMBER IS ASSIGNED TO EACH FUSE.
  - DRAWINGS ARE BEING REVISED TO SHOW THE TAG NUMBERS.
  - COMPREHENSIVE DATA BASE IS BEING ADDED TO CMIS(CONFIGURATION MANAGEMENT INFORMATION SYSTEM).
  - DATA ENTERED INTO CMIS.
  - FIELD VALIDATION.
  - PROGRAM IS WELL ON ITS WAY.
- MOLDED CASE CIRCUIT BREAKER CALIBRATION PROGRAM IS BEING ESTABLISHED:
  - MAINTENANCE PROCEDURE HAS BEEN DEVELOPED AND ISSUED.
  - SCHEDULES AND SCOPE OF THE PROGRAM ARE NOW BEING DEVELOPED.

EXPANSION OF THE CALCULATION PROGRAM CONTINUED

- IMPROVED CONTROL OF OUR PROTECTIVE RELAY SETTINGS:
  - SINGLE LOCATION.
- IMPROVED INTERFACES:
  - SUBSTATION RELAY DESIGN.
  - RELAY CALCULATION GROUP.
  - SYSTEM DISPATCHER.
  - SYSTEM PLANNING.
  - SUBSTATION MAINTENANCE.
- PT/CT BURDEN CALCULATIONS FOR THE BREAKERS THAT ARE PART OF THE OFFSITE POWER.
  - SOME MODIFICATIONS ARE BEING MADE.

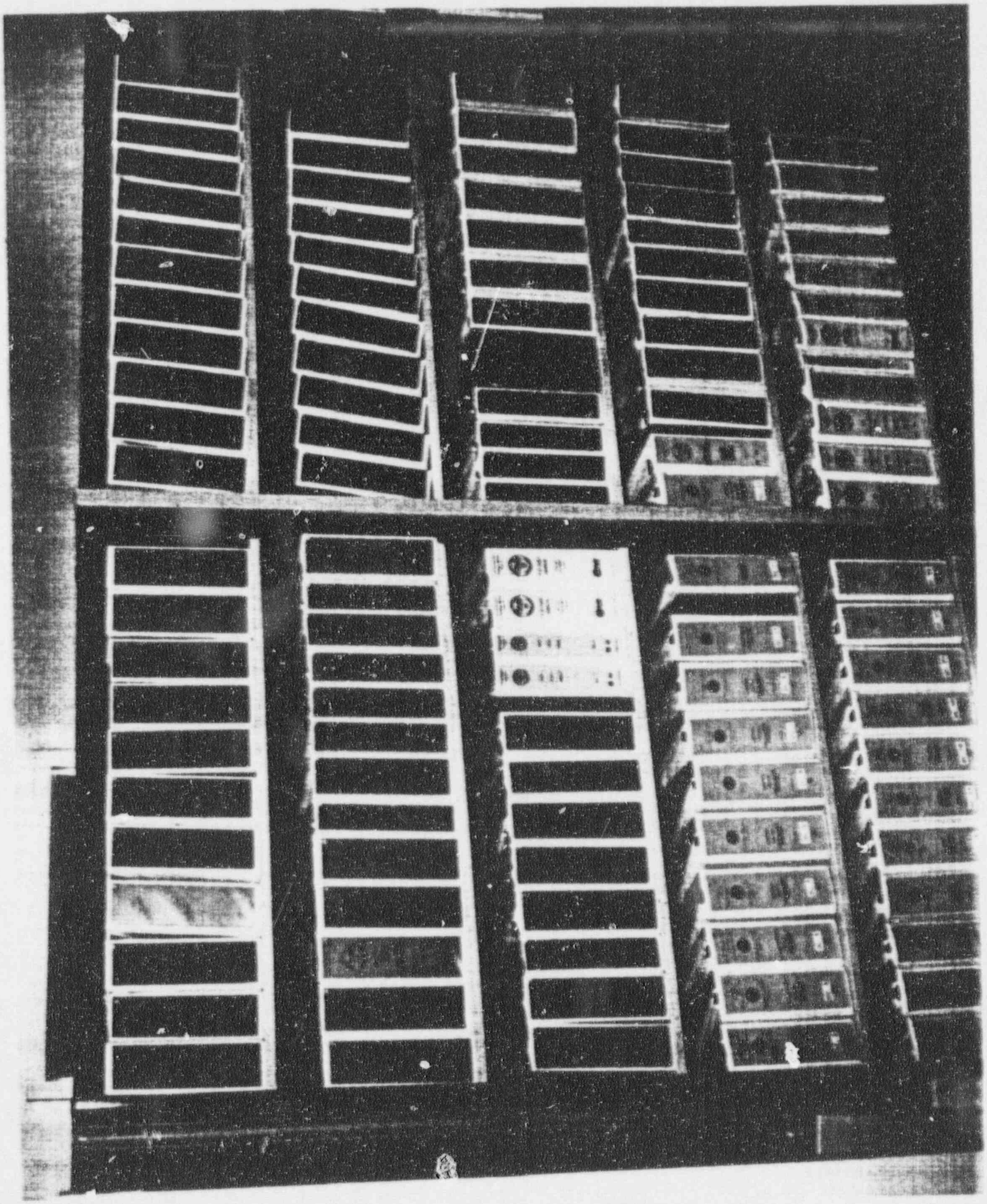
NEW CALCULATIONS

		Date Distributed	No. Pages
AC LOAD FLOW CALCULATIONS			
E-90-0044	FAULT ANALYSIS	06/19/90	2595
E-90-0077	VOLTAGE DROP/LOAD FLOW	02/26/91	3797
E-91-0018	TRANSIENT MOTOR STARTING	12/16/90	5937
E-91-0024	ELECT LARGE EQUIP LIST	09/27/91	32
E-91-0045	VOLTAGE DROP/LOAD FLOW DURING HELB	12/30/91	7
AC CONTROL PROTECTION CALCULATIONS			
E-90-0015	VBDP BREAKER/FUSE/CABLE SIZING	08/15/91	8
E-90-0076	IMPEDANCE DIAGRAMS - MCC/ACDP'S	11/07/90	301
E-91-0011	IMPEDANCE DIAGRAMS - VBDP'S	08/14/91	290
E-91-0012	MCC/ACDP VOLTAGE DROP	02/14/91	1308
E-91-0013	VBDP VOLTAGE DROP	05/22/92	1358
E-91-0016	LIST OF SR LOADS - VBDP'S	07/31/91	864
E-91-0043	MCC/ACDP MASTER DATA BASE	05/24/92	1216
E-91-0044	VBDP MASTER DATA BASE	09/13/91	2784
AC OVERLOAD PROTECTION CALCULATIONS			
E-90-0029	ES MCC 3A1	03/16/90	55
E-90-0030	ES MCC 3A2	03/22/90	40
E-90-0031	ES MCC 3B2	07/10/90	33
E-90-0032	ES MCC 3B1	07/10/90	44
E-90-0033	ES MCC 3AB	05/01/90	24
E-90-0035	ES MCC 3A3	10/12/90	56
E-90-0036	ES MCC 3B3	10/15/90	57
E-90-0073	MOV'S	10/04/90	46
E-90-0075	ES MCC CONTROL XFMR FUSE SIZING	10/03/90	28
E-91-0021	SR PANEL LOADS	12/06/91	98
E-92-0036	OVERLOAD SIZING FOR UNDERVOLTAGE	03/10/92	22
AC/DC CABLE CALCULATIONS			
E-91-0020	SR POWER CABLE EVALUATION (TO BE ISSUED)	03/21/91	
E-91-0051	CABLE CHARACTERISTICS	05/26/92	40
E-91-0056	AC\DC HELB CIRCUITS	11/20/91	112
DIESEL GENERATOR CALCULATIONS			
E-91-0026	EGDG 1A LOADING	05/24/91	267
E-91-0027	EGDG-1B LOADING EVALUATION	05/24/91	257
DC CALCULATIONS			
E-90-0014	INTRODUCTION	09/04/91	8
E-90-0099	BATTERY & CHARGER SIZING	12/12/90	137
E-90-0100	VOLTAGE PROFILE	12/20/90	324
E-90-0101	SHORT CIRCUIT	12/12/90	157
E-90-0102	COORDINATION	12/12/90	339
E-90-0103	CONTROL CIRCUIT VOLTAGE DROP	12/12/90	1883
E-90-0105	MASTER DATA BASE	12/12/90	3689
E-91-0006	NON-1E BATTERY COORDINATION	02/21/91	96
E-91-0017	WRAPPED CABLE AMPACITY EVALUATION	04/30/91	49

(CONTINUATION)

NEW CALCULATIONS

		Date Distributed	No. Pages
PROTECTIVE RELAY SETTINGS			
E-90-0077	STARTUP & UNIT AUX XFMRS, PL3 GENERATOR	02/26/91	3797
E-90-0049	230/4.16KV STARTUP XFMR #9	06/04/90	75
E-91-0028	6.9KV & 4.16KV BUS UNDERVOLTAGE	04/30/91	148
E-90-0108	6.9KV REACTOR BUS 3A &3B	12/17/91	55
E-90-0050	6.9KV MOTORS	06/11/90	58
E-91-0003	4.16KV UNIT ES BUSSES INCOMING BREAKERS	02/06/91	114
E-90-0109	4.16KV UNIT & ES BUSSES	12/17/90	40
E-91-0041	4.16KV REACTOR BUS 3 & XFMR #3	08/22/91	2784
E-90-0051	4.16KV SR MOTORS	06/19/90	157
E-90-0052	4.16KV NSR MOTORS	06/22/90	163
E-90-0071	EGDG-1A	06/22/90	85
E-90-0072	EGDG-1B	10/17/90	85
E-90-0078	480V ES BUS 3A	07/31/91	197
E-90-0079	480V ES BUS 3B	07/31/91	177
E-90-0080	480V PLANT AUX BUS 3	07/31/91	179
E-90-0080	480V HEATING AUX BUS 3	07/31/91	195
E-90-0082	480V INTAKE BUS 3	07/31/91	211
E-90-0083	480V REACTOR AUX BUS 3A	07/31/91	212
E-90-0084	480V REACTOR AUX BUS 3B	07/31/91	183
E-90-0085	480V TURBINE AUX BUS 3A	07/31/91	275
E-90-0086	480V TURBINE AUX BUS 3B	07/31/91	273
E-91-0060	PL4 PT BURDEN	02/26/92	11
E-91-0021	INSTRUMENT XFMR PERFORMANCE REVIEW	12/06/91	98
E-90-0091	IMPEDANCE DIAGRAMS FOR CT/PT BURDEN	08/16/91	113
		TOTAL	**38,043**



MAJOR ELECTRICAL MODIFICATIONS

THE FOLLOWING LIST OF ITEMS IS IN VARIOUS STATES OF COMPLETION.:

OFFSITE POWER
CRYSTAL RIVER #3 IN ITS ORIGINAL DESIGN USED ITS START-UP TRANSFORMER AND THE CRYSTAL RIVER #1 & # 2 START-UP TRANSFORMER (COAL PLANTS) AS THE TWO SOURCES OF OFFSITE POWER TO THE ES LOADS. THE CRYSTAL RIVER #3 ES LOADS NOW WILL BE FED FROM SEPARATE 230KV/4160V TRANSFORMERS. ONE NEW TRANSFORMER HAS BEEN INSTALLED AND THE OTHER NEW TRANSFORMER IS BEING INSTALLED.

- ORIGINAL CONFIGURATION (SLIDE)
- FINAL CONFIGURATION (SLIDE)

BATTERIES
ADDED A NON-SAFETY RELATED BATTERY AND REMOVED MOST OF THE NON SAFETY RELATED LOADS FROM THE SAFETY RELATED BATTERIES.

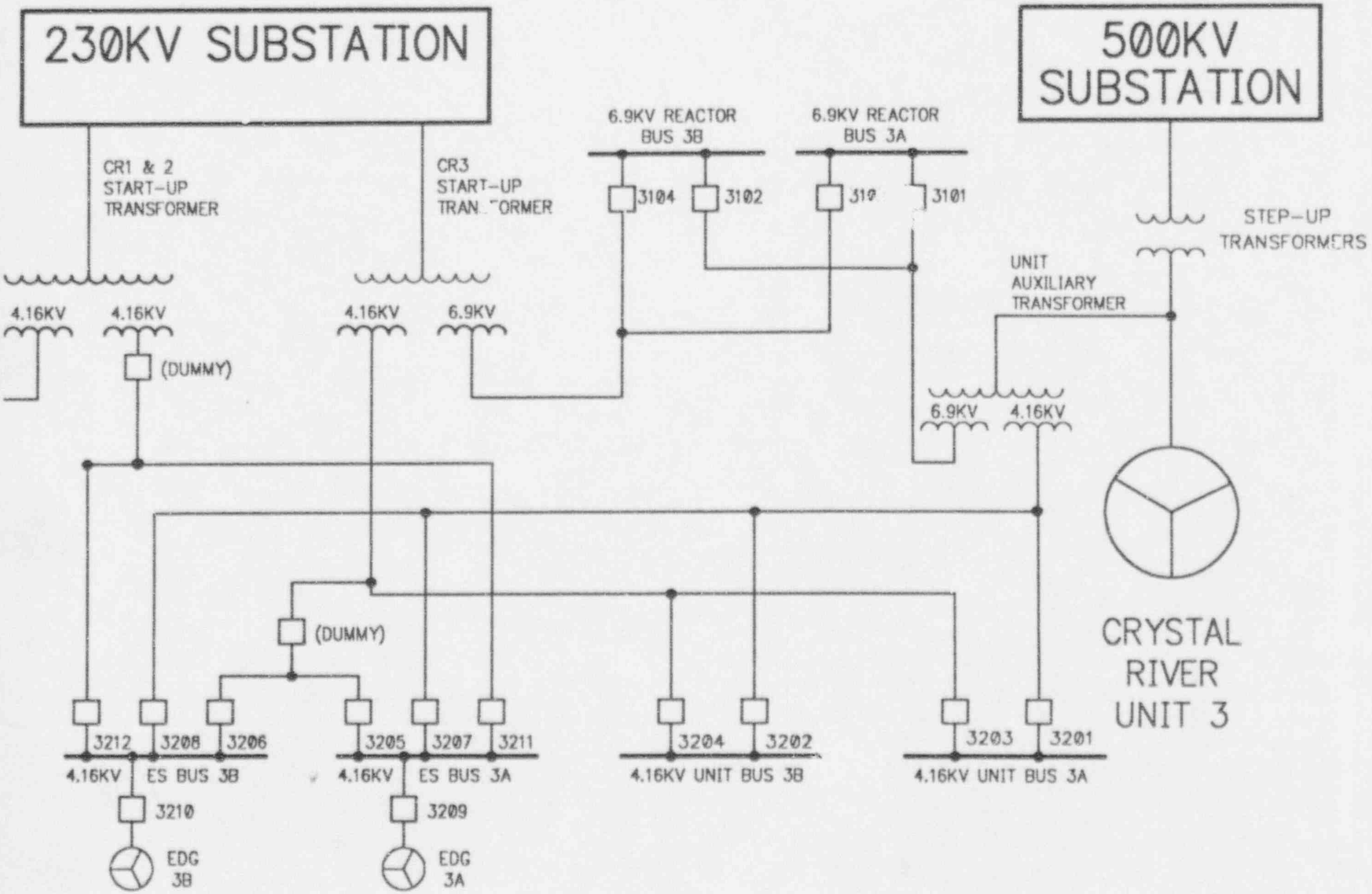
BATTERIES
REPLACED BOTH OF THE SAFETY RELATED BATTERIES WITH NEW BATTERIES THAT ARE SLIGHTLY LARGER.

DIESEL GENERATORS
UPGRADED BOTH OF THE EMERGENCY DIESEL GENERATORS TO HIGHER CAPACITY MACHINES.

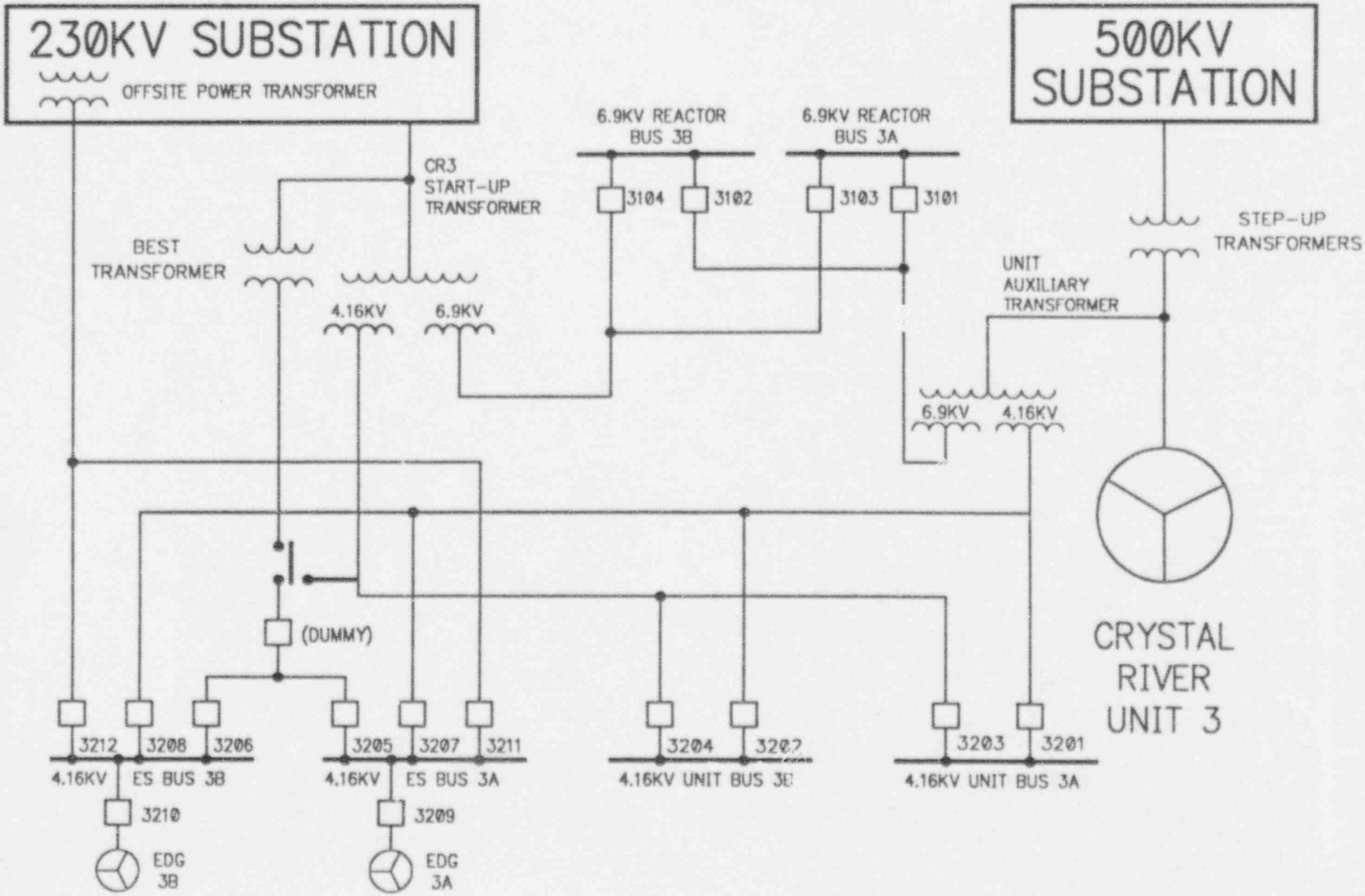
BREAKERS
REPLACED/ REPLACING MOLDED CASE CIRCUIT BREAKERS FOR THE FOLLOWING REASONS:

- INSTANTANEOUS SETPOINT WAS SET TOO HIGH .
- WAS LARGER (CURRENT RATING) THAN ALLOWED BY THE NATIONAL ELECTRIC CODE.
- DID NOT COORDINATE WITH THE DOWN STREAM DEVICE.
- WERE UNDERSIZED.

CRYSTAL RIVER #3 (ORIGINAL)



CRYSTAL RIVER #3 (FUTURE)



MAJOR ELECTRICAL MODIFICATIONS
CONTINUED

OVERLOAD ELEMENTS
REPLACED/REPLACING THE OVERLOAD ELEMENTS TO MOTORS FOR THE FOLLOWING REASONS:

- COORDINATION WITH OTHER DEVICES.
- PREVENT A NUISANCE TRIP DUE TO OPERATION AT THE SECOND LEVEL UNDERVOLTAGE RELAY SETPOINT (SLURS).
- THE ELEMENT SELECTED WAS TOO HIGH.

CONTROL CIRCUITS
THE FOLLOWING CHANGES WERE/ARE MADE TO CONTROL CIRCUITS:

- REPLACE THE CONTROL TRANSFORMERS WITH LARGER CONTROL TRANSFORMERS TO REDUCE VOLTAGE DROP.
- REWIRE RELAYS TO ELIMINATE THE INRUSH OF SEVERAL RELAYS AT ONE TIME, CAUSING HIGH VOLTAGE DROP (INTERPOSING RELAYS) .
- ELIMINATE SPACE HEATERS TO REDUCE VOLTAGE DROP. THIS WAS DONE IN MOTORS AND MOTOR OPERATED VALVES.
- CABLES REPLACED, PARALLEL, OR RECONFIGURED.

FUSES
FUSES WERE/ARE CHANGED OUT FOR THE FOLLOWING REASONS:

- DC CIRCUITS HAD AC RATED FUSES.
- TO PROVIDE COORDINATION.
- TO ALLOW FUSES DOWN STREAM OF THE INVERTERS TO BLOW IN AN ACCEPTABLE TIME.
- PROVIDE CABLE PROTECTION.

MAJOR ELECTRICAL MODIFICATIONS
CONTINUED

POWER CABLES
POWER CABLES HAVE BEEN/ARE REPLACED FOR THE FOLLOWING REASONS:

- CABLE AMPACITY IS LESS THAN WHAT IT WOULD BE WITH AN ADEQUATE MARGIN.
- CORRECT VOLTAGE DROP PROBLEMS AND PROVIDE FOR BETTER COORDINATION.
- REPLACED THE FOUR (4160 VOLT) CABLES TO THE CIRCULATING WATER PUMPS. THESE ARE NON-SAFETY RELATED.

MOTOR OPERATED VALVES
MOTOR OPERATED VALVES HAVE /WILL HAVE THEIR MOTORS AND GEARS CHANGED OUT TO OPERATE AT THE SLURS SETPOINT.

DISTRIBUTION
A NEW SAFETY RELATED DISTRIBUTION PANEL WAS ADDED TO REMOVE SAFETY RELATED LOADS FROM A NON SAFETY RELATED DISTRIBUTION PANEL..

PROTECTIVE RELAYS
PROTECTIVE RELAYS ARE BEING RESET TO PROVIDE BETTER COORDINATION.

BREAKERS
TRIP ELEMENTS WERE REPLACED ON SEVERAL 480 VOLT SWITCHGEAR BREAKERS TO OPERATE THE BREAKER WITHIN ITS SHORT CIRCUIT INTERRUPTING RATING.

DIESEL GENERATOR
CHANGED THE EMERGENCY DIESEL GENERATOR BLOCK TIMING RELAYS TO MORE ACCURATE SOLID STATE RELAYS.

MAJOR ELECTRICAL MODIFICATIONS
CONTINUED

DIESEL GENERATOR
REARRANGED THE EMERGENCY DIESEL GENERATOR BLOCK LOADING SEQUENCES TO IMPROVE THE VOLTAGE DROP DURING STARTING. BLOCK LOADING WAS INCREASED FROM FIVE STEPS TO SIX STEPS.

TRANSFORMERS
REPLACEMENT OF THE 4160/480 VOLT ES TRANSFORMERS:

- ONE IS COMPLETE.
- ONE IS BEING DONE IN THE FUTURE.

OFFSITE POWER
A NEW NON SAFETY POWER SOURCE WAS ADDED TO THE SOUTHWEST BERM.

OFFSITE POWER
THE SECOND LEVEL UNDERVOLTAGE RELAYS (SLURS) HAD THEIR SETPOINT CHANGED TO HELP SOLVE VOLTAGE DROP PROBLEMS.

CALCULATION WRITE-UPS

FROM

MARCH 12, 1991

NRC/FPC MEETING

IN

WASHINGTON

TECHNICAL DISCUSSIONS FOR

ELECTRICAL DC SYSTEM REVALIDATION PROGRAM

A total of thirteen calculations have been prepared and issued in FPC system to complete the Electrical DC System Revalidation Program. The following is the brief description of all the calculations.

1. E-90-0099 - Class 1E Battery and Charger Sizing Calculation

   Purpose:
   The purpose of this calculation is to verify the adequacy of the capacity or size (number of positive plates/cell) of presently installed 125V DC C&D type LCR-25 batteries and evaluate the adequacy of the ampere size of the existing station battery chargers.

   Methodology:
   The adequacy of the equipment is determined from a comparison of actual battery and battery charger sizes to the calculated required battery and battery charger sizes. Battery sizing and battery charger sizing calculations utilized the methodologies described in IEEE Standard 485-1983 and IEEE Standard 946-1985 respectively. Calculated battery and charger sizes are based on load profiles established for each of the following plant operating scenarios:

   1. 2-HR design profile with all existing loads prior to Refuel 8.
   2. 2-HR design profile with loads that will exist after Refuel 8.
   3. 4-HR Station Blackout (SBO) loads that will exist after Refuel 8.

2. E-90-0101 - DC system Short Circuit Calculation

   Purpose:
   The purpose of this calculation is to determine the maximum fault current levels of the buses on the existing Class 1E 250/125V dc System for the Pre-Refuel 8 and Post Refuel 8 configuration of the system. It is the intent of this analysis to check the rating of the dc distribution panel bus bracing for adequacy and the interrupting ability of protective devices.

   Methodology:
   dcVOLTPRO program performed the short circuit calculations. It requires the network topology, branch circuit parameters, and equivalent short circuit resistance of the sources of short circuit current of the system analyzed. Common sources of short circuit current include generators, motors, battery chargers, synchronous converters, and electrolytic cells.

Once these are established, dcVOLTPRO transforms the network parameters into a series of simultaneous equations ([E] = [R] X [I]) and the program obtains a Thevenin's equivalent circuit for each fault and solves for the Thevenin's equivalent current.

Since the main purpose of this study is to check the adequacy of the rating of the dc distribution panel bus bracing and the interrupting ability of protective devices, the most stringent operating condition is considered. All motors which could possibly contribute to the fault are assumed to be operating prior to the fault. This includes valves, back up dc pumps, alternate dc air compressors, and spring charging motors of switchgear breakers that could trip at the same time.

The 250/125 dc system is subject to three different types of faults.

1. Line to neutral fault.
2. Line to line fault.
3. Line to line to neutral fault.

Among the three types of faults, the line to line to neutral fault was considered to be the worst short circuit current producing fault and the calculated short circuit current values are based on this scenario and most conservative assumptions such as:

1. Battery chargers ampere contribution to be 125% of the rating.
2. Battery chargers float voltage to be 132V dc.
3. Short circuit contributions for the MOVs and breaker spring charging motors are included for conservatism even though these motors have a short time, intermittent duty operation.
4. Battery temperature factor of 1.02.
5. Battery aging factor of 1.0, etc.

This calculation determined the fault levels on the trains A and B systems for pre Refuel 8 and post Refuel 8 loading conditions.

3. <u>E-90-0100</u> - DC System Voltage Profile Calculations

<u>Purpose</u>:
The purpose of this calculation is to analyze voltage drops on the Class 1E, 250/125V dc system and identify instances when the voltage across the Class 1E inverter and motor loads in the dc system are outside the manufacturers' recommended limit for proper operation. Only the minimum operating voltage for the equipment is a concern for this study because the study is based upon the battery chargers not being available to support the operation of the battery.

This calculation also determines whether the voltages across the terminals of the Class 1E 250/125V dc batteries 3A and 3B prior to and after the Refuel 8 outage and during the worst loading scenario are within the limits identified in Section 8.2.2.6 of the Final Safety Analysis Report and the Design Basis Document for the Class 1E dc System.

Methodology:
The voltage profile of the dc system is calculated by dcVOLTPRO program. This program is applicable to radial type system applications only. The program obtains the dc system topology, branch data parameters and load profile from the master data base. The data along with the cable impedance (resistance) data and battery discharge characteristics from the library database file are used in a system solution to determine the bus and load voltages and currents at each time interval defined in the battery duty cycle.

dcVOLTPRO calculates the per unit resistance, converts it to per unit admittance, resolves the system data into the equation listed below, then solves for [E].

$$[I] = [Y] * [E]$$

To compensate for the non-linear characteristics of the battery and the effect of voltage dependent loads, dcVOLTPRO uses an iterative method of solution for calculating systems voltage or current for each time interval of the duty cycle. The iteration continues until the difference between the assumed value and the resulting value is between +0.2 and -0.2 percent.

This calculation calculates the voltages and currents at each panel and major power loads, such as inverters and motors, of the dc system for the following scenarios.

a. Loss of off-site power with loss of coolant accident (LOOP/LOCA) considering the system configuration prior to the Cycle 8 Refueling Outage (Pre Refuel 8, 2-HR). The battery chargers are unavailable as the diesel generator fails to start.

b. LOOP/LOCA considering the system configuration after the Cycle 8 Refueling Outage (Post Refuel 8, 2-HR). The battery chargers are unavailable as the diesel generator fails to start.

c. Four-hour Station Blackout (SBO) considering the system configuration after the Cycle 8 Refueling Outage (Post Refuel 8, 4-HR).

During the Cycle 8 Refuel Outage, a large portion of the non-1E loads on the dc system will be moved to a new non-1E dc system with its own battery.

The voltage of the components in the dc control circuits such as auxiliary relays, starters, lights, etc. are calculated and analyzed in another calculation.

4. E-90-0103 - DC Control Circuit Voltage Drop Calculation

Purpose:
The purpose of this calculation is to evaluate the adequacy of the calculated operating voltage available at individual Class 1E dc control circuit components during their required time of operation. The operating voltage available at individual Class 1E dc control circuit components is calculated for the 2-Hour Design Profile for all loads (safety-related and non safety-related) connected to the safety-related batteries (2-Hour, Pre-Refuel 8), for the 2-Hour Design Profile for safety-related and those non safety-related loads that are to remain connected to the safety-related batteries (2-Hour, Post Refuel 8), and for the 4-Hour Station Blackout scenario for safety-related loads and those non safety-related loads that are to remain connected to the safety-related batteries (4-Hour, Post Refuel 8). The analyses of these three plant operating scenarios included the evaluation of those Class 1E dc control circuits that operate under conditions of ac power unavailable and those Class 1E dc control circuits that operate under conditions of ac power available (battery chargers in service).

Methodology:
The program "VDROP" was used to calculate the operating voltages at safety-related dc control circuit devices.

In order to calculate the operating voltages at dc control components in any safety-related circuit resistance diagrams were developed. The resistance diagrams were generated through a five-step process:

1. Analysis of the elementary (schematic) diagrams, which represent the operation of the dc system control circuit devices, to determine which devices would be operating and to identify any mutually exclusive devices (i.e. two or more devices that cannot operate simultaneously).

2. Review of the elementary diagram to identify any devices other than cables (i.e. resistors and fuses) which will contribute to the voltage drop to an operating control circuit device.

3. Review of the block diagram(s) associated with a given elementary diagram to identify the control circuit cable number(s) and the cable conductors required for the operation of the various control circuit components.

4. Review of the CR3 Cable Inventory and the CR3 Cable Routing Circuit List to determine conductor lengths and sizes for the control circuit cable number(s) identified in item 3 above.

5. Manual calculations of cable resistances (lengths) were performed for alternative current paths to each operating control circuit component to identify the worst case resistance (maximum voltage drop) path. It should be noted that worst case resistance (maximum voltage drop) path is determined with consideration of both the magnitude of current flowing through a given cable and the size and length of that cable.

The final version of the Resistance Diagrams represent the worst case operating situation for an individual control circuit. That is, they represent the simultaneous operation of control devices at their worst case current (inrush if applicable) values with the highest resistance current path (maximum voltage drop) to the device.

VDROP Program Operation
The VDROP computer program finds the equivalent circuit resistances using standard resistance reduction methods and, for any given source bus voltage, calculates the cable voltage drops and available operating voltages at the dc load component terminals based on nodal analysis using basic electrical circuit theory (i.e. Kirchoff's Law). Since the computer program can be used for calculating ac or dc voltage drop, a power factor of one (1.0) and a phase angle of zero (0 degrees) were input for dc circuit evaluations.

Output Reports
Each Resistance Diagram corresponding to a particular 125-volt battery section (i.e., Battery "A" Positive, Battery "A" Negative, Battery "B" Positive, and Battery "B" Negative) has a maximum of six sets of output reports. The first set of output reports was produced for calculations which considered all dc loads for a given battery section for the 2-Hour Design Profile scenario and for a given battery section for ac power unavailable conditions (2-Hour, Pre-Refuel 8). The second set of output reports was produced for calculations which considered all safety-related loads and those non safety-related loads which were to remain on the safety-related batteries for the 2-Hour Design Profile scenario for a given battery section for ac power unavailable conditions (2-Hour, Post-Refuel 8). The third set of output reports was produced for calculations which considered all safety-related loads and those non safety-related loads which were to remain on the safety-related batteries for the 4-Hour Station Blackout scenario for a given battery section for ac power unavailable conditions (4-Hour, Post Refuel 8). The fourth, fifth, and

sixth set of output reports are similar to the first three sets except they are for ac power (battery charger) available conditions.

The Results of Circuit Evaluation Report provides a summary by resistance Diagram, component tag, component operating voltage ranges, component calculated operating voltage values, and an identification of which components have a calculated operating voltage below the minimum recommended operating voltage.

5. E-90-0102 - DC System Coordination Calculation

Purpose:
The purpose of this calculation is to determine whether there is selective time-current coordination between dc System protective devices and whether dc System cables are protected from overload and short circuit conditions.

In general, this calculation evaluates the following concerns:

1. Are the ampacity rating of the feeder cables adequate relative to their steady state loads?
2. Are the ampere ratings of the branch circuit fuses adequate relative to the branch circuit cables' derated, continuous current rating?
3. Is each branch circuit cable protected by its branch circuit fuses from the flow of short circuit current in the event of a fault?
4. Will the fuse protecting the branch circuit cable clear a fault, rather than the fuse protecting the feeder circuit cable to the dc Distribution Panel, in the event of a fault on the branch circuit (i.e. fuses are selective)?

Methodology:
To satisfy the purpose of the calculation, the following six bases were developed:

1. Whether the derated current carrying capacity of the branch circuit cable exceeds 125% of its load's steady state current value and whether the derated current carrying capacity of the feeder cable to a dc Distribution Panel exceeds the main bus ampere rating of the panel.

2. Whether the derated current carrying capacity of the branch circuit cable exceeds the ampere rating of a fuse one size smaller than the installed branch circuit fuse.

3. Whether the peak let-thru current values of the branch circuit fuses are less than, or equal to, the short circuit withstand current rating of the branch circuit cable at .008 seconds.

4. Whether the short circuit current curve for each feeder circuit cable exceeds, for all current values, the melting time-current curve for the fuse of the feeder circuit to the dc Distribution Panel containing the branch circuit under fault. In addition, the peak let-thru current of the fuse for the feeder circuit is compared to the sum of the peak let-thru current of the worst case branch circuit with which it must coordinate and the summation of the connected current values of all the other branch circuits on the dc Distribution Panel.

5. Whether the melting time-current curve for the fuse of the feeder circuit to the dc Distribution Panel exceeds, for all current values, the adjusted melting time-current curve for the branch circuit protective fuse. This adjusted melting time-current curve is the melting time curve of the worst case fuse plus the maximum, total connected steady state current (positive side or negative side) on the panel. This adjustment factor is conservative since it includes the steady state contribution of the branch circuit under evaluation.

6. Whether the melting "I squared-t" value of the fuse of the feeder circuit to the dc Distribution Panel containing the branch circuit under fault, exceeds the sum of the clearing "I squared-t" value of the worst case branch circuit fuse and the "I squared-t" value for .008 seconds representing the summation of the values of all the other branch circuits on the dc Distribution Panel.

In order to conclude that the feeder and branch circuit fuses are selective, the characteristic plots must be drawn to prove that the melting time-current curve for the fuse protecting the feeder cable exceeds the adjusted melting time-current curve for the branch circuit under fault. In addition, the melting "I squared-t" value of the fuse protecting the feeder cable must exceed the adjusted clearing "I squared-t" value of the branch circuit. The adjusted clearing "I squared-t value" is the sum of the clearing "I squared-t value" for the branch circuit fuse under fault and the "I squared-t" value for .008 seconds representing the summation of the values of all the other branch circuits on the dc Distribution Panel.

An evaluation was performed in this calculation to satisfy the requirements of Items 1, 2, and 3 for each branch cable and panel feeder cable and to satisfy the requirements of Items 4, 5, 6 for the worst case branch circuit on each dc Distribution Panel.

6. E-90-0104 and E-90-0105 - DC Master Database

These calculations include the complete master database for the electrical dc system.

7. E-90-0093 through E-90-0098 - Program User's Manuals

These calculations include the program user's manuals for the six verified/validated computer programs used for performing dc system revalidation program calculation described above.

TECHNICAL DISCUSSION FOR ELECTRICAL AC SYSTEM REVALIDATION PROGRAM

Title: CR 3 AC Short Circuit Analysis:

Purpose: This analysis determines the maximum fault duties at various equipment and busses under accident conditions.

Methodology: The fault analysis was performed for accident conditions when the plant was operating at full power prior to accident conditions, with the offsite power available through the CR 3 start-up transformer. Under these conditions, all the non safety related busses, the safety related busses and the Reactor Coolant Pumps are on the start-up transformer. Therefore the contribution of nearly all non safety related motors is applied, the contribution from nearly all safety related motors is applied and also the contribution of the RCP motors is applied. The switchyard contribution is applied to the primary of the start-up transformer. For further conservatism the switchyard voltage is assumed to be 243.6 KV which is the high end of switchyard design voltage.

The analysis was performed using Computer programs Lotus 123 and AFault 300. All the design information needed to perform short circuit calculations was gathered from design documents. As much as possible, the design information was field walkdown. Before inputting the design information into the fault analysis program AFault 300, certain calculations were performed using Lotus 123 on the design information to put it in a form acceptable by AFault. For example, Lotus 123 was used to calculate motor Xd" from the motor nameplate information and then changed from nameplate voltage base to bus voltage base. The Xd" at bus voltage base was then input into AFault 300.

AFault 300 was used to calculate fault duties at various busses and equipment. For 480V level, the symmetrical fault duties were calculated for all safety related as well as non safety related switchgear, Motor Control centers and selected distribution panels. At 4160V and 6900V levels momentary duty utilizing the actual X/R ratio at the fault location was calculated and Interrupting duty for symmetrically rated 5 cycle breakers was calculated. For relay applications minimum fault duty at 30 cycles was calculated. The momentary and interrupting duty at the 6900V busses was calculated when fed from the Unit Auxiliary transformer side as well as the start-up transformer side.

Title: CR 3 Voltage Drop and Load Flow Analysis

Purpose: This calculation determines steady-state voltages and loading at safety related busses and equipment under anticipated accident and operating conditions.

Methodology: The voltage drop and load flow analysis was performed using computer programs Lotus 123 and Dapper 1000, for several accident and non accident scenarios when ES busses are fed from the CR 3 Start-Up Transformer or the New Offsite Source Transformer. The methodology for the limiting case for each offsite source and evaluation under minimum acceptable ES busses voltage is explained below:

1. The analysis was performed for accident conditions when the plant was operating at full power prior to accident conditions, with offsite power available through the CR 3 start-up transformer. Under these conditions the loads of non safety related busses, the loads of the safety related busses and the Reactor Coolant Pumps are on start-up transformer. For further conservatism, the switchyard voltage was assumed to be 236.4 KV which is the low end of switchyard design voltage.

2. The analysis was performed for accident conditions when the plant was operating at full power prior to accident conditions, with offsite power available through the New Offsite source transformer. This transformer is rated the same as the CR 3 start-up transformer. Under these conditions the loads of safety related busses are on the New Offsite source transformer. There are no loads from the non safety related Unit busses or Reactor Coolant Pumps on this transformer. For further conservatism, the switchyard voltage was assumed to be 236.4 KV which is the low end of switchyard design voltage.

3. The analysis was performed for accident conditions with minimum acceptable voltage of 3852V at ES 4160V busses. This minimum acceptable voltage level is the low end of the Second Level Undervoltage Relays (SLUR) setpoint. These relays provide protection against sustained degraded grid conditions.

All the design information needed to perform voltage drop and load flow calculations was gathered from design documents. As much as possible, the design information was field walkdown. Before inputting the design information into voltage drop and load flow program Dapper 1000, loading information was created from design information using Lotus 123. Where field test information was available, it was used. In certain cases calculated loading was validated with loading information from simulator run. For miscellaneous loads such as those fed from AC distribution panels it was conservatively assumed that at any given time 75 % of the panel connected load is operating. Field testing is currently being performed on selected panels to validate this assumption. Rather than using design cable lengths actual pulled cable lengths were used.

The Program Dapper 1000 was used to calculate voltages at all modelled busses and load flow in all modelled feeders connected to each bus. The load flow is in amps, KVA, KVAR and KW.

Title: ACDP breaker, fuse, overload and cable sizing.

Purpose: This calculation sizes breaker, fuse and overload heaters and also sizes and evaluates protection of the cables feeding the safety related equipment fed from AC distribution panels.

Methodology:

Cable Evaluation: For each cable the following evaluations are performed.

1. Cable Derated Ampacity: The cable derated ampacity is calculated. This calculation accounts for the cable installation (tray or conduit), ambient temperature and any other applicable derating.

2. Cable Required Ampacity:The cable required ampacity is calculated at 1.25 times full load amps and it is ensured that the derated ampacity is equal to or greater than the required ampacity.

3. Cable Overload Protection: For thermal magnetic breaker protecting the cable against overload it is evaluated that the derated ampacity of the cable is equal to or greater than the breaker rating. Where overload heater is protecting the cable, it is evaluated that the derated ampacity of the cable is equal to or greater than the overload heater trip range.

4. Cable Short Circuit Protection: The maximum short circuit that the cable will see at the first termination point downstream from the panel is calculated. This first termination point can be, for example, a terminal box between the panel and load or the termination point at the load. For termination point between load and panel, the short circuit from the panel side as well as the load side is calculated. The respective cable section is evaluated for applicable short circuit. Cable short circuit withstand curves from Std. IEEE 242-1986 are then utilized to evaluate if the cable can withstand this short circuit before the circuit breaker will interrupt the short circuit.

Load Evaluation: The ACDP loads are evaluated as follows for protection:

1. Non Motor Loads: These are normally fed from thermal magnetic breakers. The breaker rating is chosen to be the value closest to 1.25 times the full load amps. The magnetic setting on most of these breakers is not adjustable and is usually 10 to 13 times breaker rating.

2. Motor Loads: The overload protection for the motors is provided by the overload heaters which are sized in accordance with vendor recommendations and any applicable FSAR commitments. The short circuit protection is provided by adjustable magnetic breakers, that are adjusted to values between 1.6 times locked rotor amps and 13 times full load amps.

Title: Safety Related AC control circuit voltage drop calculations.

Purpose: This calculation determines the voltage drop in all safety related 120V control circuits and calculates minimum voltage available at the actuating device terminals during steady state and in-rush conditions. This minimum voltage is then compared to the minimum acceptable voltage rating of the actuating devices and those cases that do not meet the design minimum ratings are identified.

Methodology:

1. Create impedance diagrams for all safety-related control circuits. This includes determining basis for preparing impedance diagrams, the worst case circuitry, cable lengths and other pertinent equipment data for each actuating device.
2. Input voltage at the primary of the control transformer will be the worst case steady state voltage obtained from CR 3 AC Voltage Drop and Load Flow Analysis.
3. Voltages at the space heaters and indicating light terminals shall not be calculated; however, the current contributions by these devices shall be included in the voltage drop calculations.
4. Develop basis for these calculations.
5. Based on the results of these calculations, the actuating control voltage at the terminals of these devices during steady state and in-rush conditions will be determined and compared to the minimum acceptable rated voltage. Devices that do not comply with these minimum ratings will be identified.

<u>Title</u>: Vital Bus Safety-Related circuit voltage drop calculations.

<u>Purpose</u>: This calculation performs voltage drop calculations for safety related circuits and determines the voltage at the terminals of actuating devices during steady state and in-rush conditions. Source Vital bus panel voltage will be assumed minimum output voltage rating of the inverter.

<u>Methodology</u>:

1. Create impedance diagrams for all safety-related circuits fed from vital bus distribution panels. This includes determining basis for preparing impedance diagrams, the worst case circuitry, cable lengths, and other pertinent equipment data for each actuating device.
2. Source Vital bus panel voltage will be assumed minimum output voltage rating of the inverter.
3. Develop basis for these calculations.
4. Based on the results of these calculations, the voltage at the terminals of the actuating devices during steady state and in-rush conditions will be determined and compared to minimum acceptable rated voltage. Devices that do not comply with these minimum ratings will be identified.

<u>Title</u>: Vital Bus Distribution Panels Circuit Breaker/Fuse and cable sizing calculations.

<u>Purpose</u>: This calculation determines the coincidental load on each safety-related circuit fed from the vital bus distribution panels and determines the size of each breaker/fuse combination is adequate from overload protection standpoint to protect the load(s) as well as the cable. Vital bus short circuit protection has already been reviewed under calculation E-90-0034, Rev.0

<u>Methodology</u>:

1. Develop the criteria and basis for performing the calculation.
2. Cable derated ampacity shall be determined in accordance with FPC cable design criteria.
3. For each panel, calculate the coincidental load on each safety-related circuit and determine the adequacy of the breaker/fuse sizes to protect cables and loads against overload.
4. Identify circuits that do not have adequate breaker/fuse sizes to protect cables and/or loads.

ST. Pete DISCUSSION WITH NRC 8/22/91

TECHNICAL DISCUSSIONS OF

AC PROTECTIVE DEVICES COORDINATION STUDY

1. High, Medium and Low Voltages Protective Devices Coordination Calculations

Purpose:

a) Review existing protective devices set points from the selectivity standpoints. This should include review of additions and/or changes to power distribution transformers, unit auxiliary buses and power distribution center connected loads.

Complete selectivity is the ultimate goal, although compromises may have to be made due to existing breaker characteristics, equipment features and criteria instructions.

b) Prepare new time current curves to show coordination of all breakers.

c) Prepare new calibration data sheets for those devices whose existing settings are different than the calculated settings.

d) Prepare new calibration data sheets for each air power circuit breaker in the facilities, in 480V system.

e) Provide supporting documentation for tasks (a) through (d).

Methodology:

1) Developed 6900V and 4160V motor protective relays setting criteria in accordance with the guidelines of Westinghouse PRSC-2C, July 1986, ANSI Standard C-37.96 and NEC Code 1984, Section 430. This included the settings of:

   a) Time Unit
   b) Standard Instantaneous Unit
   c) HI-Dropout Instantaneous Unit
   d) Time Dial
   e) Instantaneous Ground Overcurrent Relay
   f) Self-Balance Differential Relay

2) Developed the criteria for 480V system protective devices coordination set points in accordance with NEC Codes 1990, Articles 430, IEEE Standard 242-1975 and ANSI Standard C37.96-1976. This included the criteria for:

a) Motor Feeder Breakers (Devices 51, 50, 49)
b) Feeder Breakers (Device 52)
c) Tie Breakers (Device 51)
d) Main Breakers (Protected by non-directional phase over current relays.)
e) 4.16kv/480V Transformers

3) Developed the standardized forms for facilitating the performance of calculations of different types of protective devices in a consistent manner.

4) Plot the relays and breakers characteristic curves to ascertain proper coordination with down stream protective devices and cable damages curves is achieved.

5) Prepare the new calibration data sheets for those protective devices which have different settings than the calculated settings.

6) In the 480V system, prepare the new calibration data sheets for all the protective devices irrespective of whether the settings are different or not from the existing settings. This is because of the revised format of the calibration data sheets.

7) A total of nine (9) calculations have been prepared and issued in the system. These include all the protective devices for:

   a) Start-up and Unit Auxiliary Transformers
   b) 230kv Plant Line 4
   c) Main Generator and Emergency Diesel Generators
   d) 6.9kv Unit Auxiliary Buses and 6.9kv Motors
   e) 4.16kv Unit Buses and 4.16kv Motors

8) Eight (8) more calculations are being prepared for 480V system power distribution centers, 480V motors, and 4.16kv/480V unit transformers protective devices.

2. E-90-0034 REV 0 VITAL BUS FAULT ANALYSIS

PURPOSE
The analysis determines the ability of the fuses located on Vital Bus distribution panels to clear faults at the load when the panels are fed from the regulating transformer. Cable overcurrent protection for continuous loads is not addressed by this calculation.

METHODOLOGY
1) Construct circuit model.

2) Calculate transformer impedance, Vital Bus panel impedance and cable impedance.

3) For each panel, determine the minimum fault current by selecting the cable fed from the panel with the highest impedance and then using the model, reduce the combination of series and parallel impedances to an equivalent impedance and by current division, and find the current through the faulted cable.

5) Determine if the fuse will clear within 0.01 seconds by utilizing the appropriate melting time vs. current curves.

   In order to avoid the necessity of determining the fault clearing capability of every circuit on the panel, the following reasoning is used:

   The circuit with the highest impedance on the panel also represents the minimum fault current on the panel for all other circuits that utilize the same size fuse. If the circuit with the minimum fault current will clear, then all other circuits (which have a smaller impedance and thus higher fault current) with the same size fuse will clear also and need not be analyzed individually.

   Therefore, after the circuit with the minimum fault current for each panel is determined, the remainder of the panel is analyzed by categorizing the panel circuits by fuse size and selecting the circuit with the highest impedance for each fuse size. The fault current for this circuit is calculated and compared with the fuse melting time curves for fuse clearing time. This process is repeated for every fuse size class for each panel.

3. E-90-0075 REV 0 MCC CONTROL TRANSFORMER FUSE SIZING

PURPOSE
This calculation determines if the existing control transformer fuses are sized properly and are capable of protecting the control transformers located in the motor control centers.

METHODOLOGY
1) Control transformer fuse criteria is established by using the vendor instruction manuals and the appropriate section of the National Electric Code (NEC), 1990.

2) The rating of fuses currently installed in the MCC's are verified by walkdown and are tabulated in the calculation.

3) The installed fuses are compared with the established control transformer fuse criteria.

Title: Motor Control Centers

Purpose:

This calculation sizes the overload elements, instantaneous breakers, thermomagnetic breakers and the magnetic setting for each motor control center loads.

Methodology:

Field data was gathered during the first six months of 1989. The actual field data was used to verify design information on the drawing. When there was a discrepancy, the field device was again read. This verified field data was used in place of the drawing information when there was a difference.

The motor nameplate was used along with the manufacturers recommended methodology to establish the overload size. Additional conservatism was added as covered in the FSAR.

The maximum asymmetrical in-rush current was also calculated. The breaker instantaneous setting was selected between this value and 13 time motor full load current (NEC requirement).

For non-motor loads, the load current was established and the thermomagnetic breaker was selected per the NEC.

FLORIDA POWER CORPORATION

EDSFI AWARENESS

MARCH 16, 1993

AWARENESS ACTIVITIES

FLORIDA POWER HAS BEEN PROACTIVE IN MAINTAINING AWARENESS OF EDSFI ACTIVITIES SINCE 1989.

- WE HAVE DEVELOPED AND COMPLETED THE ELECTRICAL CALCULATION PROGRAM.
- WE HAVE REVIEWED THE REPORTS ON EDSFI INSPECTIONS PERFORMED.
- WE ARE ORIGINAL MEMBERS OF THE EDS CLEARINGHOUSE, WHICH RELIES ON DEVONRUE FOR ITS TECHNICAL EXPERTISE.

THE SUMMER OF 1991 OUR QUALITY PROGRAMS DEPARTMENT PERFORMED A SELF ASSESSMENT AUDIT. THE NRC TEMPORARY INSTRUCTIONS(TI) WERE USED AS A GUIDELINE.

- DEVONRUE WAS USED AS A CONSULTANT.
- THE ACTIVITY TOOK APPROXIMATELY 3 WEEKS.
- THERE WERE 10 OPEN ITEMS AND 3 OBSERVATIONS.

AWARENESS ACTIVITIES (continued)

OVER 300 POTENTIAL QUESTIONS WERE PLACED IN A DATA BASE(NOT 300 DIFFERENT QUESTIONS AS SOME WERE SIMILAR BUT STATED DIFFERENTLY). THESE QUESTIONS CAME FROM TWO SOURCES:

- 130 QUESTION DATA BASE FROM OUR SELF ASSESSMENT WAS CAPTURED.

- 180 POTENTIAL QUESTIONS WERE DEVELOPED FROM REVIEWING THE NRC EDSFI INSPECTION REPORTS.

- A TEAM WAS ESTABLISHED TO EVALUATE AND RESPOND TO THE 300 QUESTIONS.

FLORIDA POWER IS CONTINUING IT AWARENESS ACTIVITIES ON EDSFI:

- NRC NEW EDSFI INSPECTIONS.

- MAINTAIN CURRENT ALL OF THE ANSWERS TO THE 300 QUESTIONS TO ENSURE WE STILL HAVE THE BEST ANSWERS.

- SHARPENING OUR TECHNICAL SKILLS.

    - THE EMERGENCY DIESEL GENERATORS (SLIDE).

EXAMPLE
EMERGENCY DIESEL GENERATORS

I. SEISMIC ADEQUACY

ASSEMBLED ORIGINAL , OR RECREATED SEISMIC CALCULATIONS AND ANALYSES ON KEY COMPONENTS:

- HVAC DUCTWORK (ROOM COOLING AND COMBUSTION AIR).
- ENGINE-GENERATOR SKID.
- RADIATOR-FAN ASSEMBLY.
- LUBE OIL FILTERS AND STRAINERS.
- FUEL OIL DAY TANKS AND UNDERGROUND TANKS.
- AIR COMPRESSOR SKID.
- UPGRADED LUBE OIL COOLERS.

II. FUEL OIL STORAGE AND AVAILABILITY:

- CONFIRMED ADEQUACY OF FUEL OIL STORAGE TO SUPPORT OPERATION OF ONE DIESEL FOR SEVEN (7) DAYS.

- CONFIRMED FUEL OIL TRANSFER PUMP CAPACITY EXCEEDS WORST CASE FUEL CONSUMPTION RATE. (PUMPS ARE IN THE ISI PROGRAM).

- CONFIRM ADEQUACY OF FUEL OIL TANK LEVEL MONITORING AND ADMINISTRATIVE LIMITS.

- CONSIDERED AND ADDRESSED POTENTIAL FOR AIR BINDING OF FUEL OIL TRANSFER PUMPS (FOCUSED ON MINIMUM USABLE TANK VOLUMES).

- CONFIRMED ADDITION OF BIOCIDE TO STORAGE FUEL.

EXAMPLE
EMERGENCY DIESEL GENERATORS
CONTINUED

III. EDG, HVAC, AND AMBIENT AIR TEMPERATURE LIMITATIONS:

- CONFIRMED SINGLE FAILURE PROOF DESIGN (100% REDUNDANT FANS, FAIL SAFE DAMPERS).
- DETERMINED THE ACTUAL EDG ROOM HEAT LOAD AT RATED CONTINUOUS LOAD BY TEST AND SUPPORTING ANALYSIS.
- CONFIRMED ADEQUATE EDG ROOM COOLING WITH AND WITHOUT EDG OPERATION.
- ENSURE ACTIVE CALCULATIONS AND ANALYSIS REFLECT THE "AS-BUILT" CONFIGURATION OF THE UPGRADED EDG HVAC SYSTEMS (ROOM COOLING AND COMBUSTION AIR SYSTEMS ARE NOW SEPARATE).

IV. EDG AUXILIARY SYSTEMS:

- CONFIRMED DESIGN BASIS AND ADEQUACY OF EDG AIR START SYSTEM.
- CONFIRMED ACCEPTABILITY OF INSTRUMENT SETPOINTS (AIR START, LUBE OIL THERMOSTATS, SWITCHES AND ALARMS, JACKET COOLING THERMOSTATS, SWITCHES AND ALARMS).
- CONFIRM ACCEPTABILITY OF EDG FAN COOLING SYSTEM (RADIATORS) IN MAXIMUM EXPECTED AMBIENT AIR TEMPERATURES.

CONCLUSIONS

- WE BELIEVE THAT THE PROGRAM WE HAVE NEARLY COMPLETED WAS VERY WELL CONCEIVED AND IMPLEMENTED. HOWEVER, IT HAS BEEN COSTLY. WE HAVE INVESTED OVER 100,000 MANHOURS AND 5.5 M$, THUS FAR, IN DEVELOPING THE PROGRAM. THIS DOES NOT INCLUDE THE COST OF THE IMPROVEMENTS WE HAVE, ARE OR WILL BE IMPLEMENTING. THUS, WE HAVE DEMONSTRATED OUR COMMITMENT TO INVESTING THE RESOURCES NECESSARY TO ASSURE OUR ELECTRICAL SYSTEMS ARE HIGHLY RELIABLE.

- WE HAVE CONTINUED TO GIVE HIGH PRIORITY TO LEARNING FROM INDUSTRY EXPERIENCES IN THIS AREA. UNLIKE OTHER AREAS (EQ) WHERE THE NRC FAIRLY CRITICIZED US FOR LOSING TRACK OF EVOLVING CONCERNS, WE HAVE CAREFULLY MONITORED THIS AREA AND RESPONDED TO LESSONS LEARNED FROM OTHER PLANTS.

- WE HAVE GIVEN EMPHASIS TO SELF-ASSESSMENTS IN THIS AREA. BOTH OUR DESIGN AND SYSTEM ENGINEERING STAFFS HAVE BEEN AGGRESSIVE IN FOLLOWING-UP ON CONCERNS RAISED DURING THE ASSESSMENT.

CONCLUSIONS (CONTINUED)

- FPC DOES NOT BELIEVE THAT A STANDARD EDSFI IS WARRANTED.
- IF SOME FORM OF EDSFI IS STILL CONSIDERED NECESSARY WE WOULD SUGGEST THAT:
    - THE RESOURCES COMMITTED BY THE STAFF BE REDUCED TO A SMALLER TEAM.
    - THE DURATION BE REDUCED.
    - THE LOCATION BE ADJUSTED TO TAKE ADVANTAGE OF THE STAFF AND RESOURCES AVAILABLE IN OUR ST. PETERSBURG OFFICE.

NRC EDSFI TEMPORARY INSTRUCTION

ALL OR THESE ISSUES HAVE BEEN ADDRESSED AT CR-3.

- EDG LOAD GROWTH NOT CONTROLLED
- BATTERIES AND INVERTERS NOT MONITORED AND CONTROLLED
- MODIFICATIONS PERFORMED WITHOUT DETAILED KNOWLEDGE OF EDS DESIGN BASIS
- MODIFICATIONS PERFORMED WITHOUT CONSIDERATION OF SYSTEM INTERACTIONS OR SAFETY SYSTEM FUNCTIONALITY
- TEMPORARY MODIFICATIONS INSTALLED WITHOUT 10 CFR 50.59 REVIEW
- ELECTRICAL CALCULATIONS NOT TECHNICALLY ADEQUATE OR REFLECTIVE OF FACILITY CONFIGURATION
- EQUIPMENT UNDERSIZED
- PROTECTIVE DEVICES NOT COORDINATED
- PROTECTIVE RELAY SETPOINT C LCULATIONS
    - NOT PERFORMED
    - NOT UPDATED
- SURVEILLANCE, POST-MODIFICATION AND POST-MAINTENANCE TESTING NOT ADEQUATE
- COMMERCIAL GRADE OR DIFFERENT COMPONENTS USED WITHOUT PROPER DEDICATION
- FUSE CONTROL LACKING
- IMPROPERLY SIZED FUSES INSTALLED
- ELECTRICAL CONNECTIONS NOT PROPERLY INSTALLED

PAST ISSUES

Changes Since Self-Assessment of 1991

- Self assessment performed in December of 1991 "Generic Implications of Reactor Trip Events"
- Resulted in recommendations in the following areas:

  Operations
  Maintenance
  Training
  Engineering

KEY ACTIONS
TAKEN IN OPERATIONS

- Trained operators on lessons learned from the December 1991 trips.
- Established guidance for bypassing ES systems.
- Reviewed and balanced shift composition.
- Increased the number of Chief Nuclear Operators to assure experienced operators remained at the controls. Many of the CNO's are SRO licensed.
- Provide startup training to operating crews prior to plant startups from midcycle or refueling outages.

KEY ACTIONS
(Continued)

- Reinforced the roles of the:
  Shift supervisor (SRO) - command and control
  Manager on Call - backup resources/approvals
  Shift technical advisor - technical advice
    and event oversight to assist the shift
    supervisor

- Added new position of Shift Manager
  Currently on two shifts/day, 5 days/week
  Department head level managers, current or
  ex-SRO

- Placed shift technical advisors on-shift

KEY ACTIONS
(Continued)

- Revised annunciator response procedures (ARP's) and emphasized their proper use
- Completed revision to emergency operating procedures (EOP's) - implementation to occur in 1993
- Made changes to the production organization to:
  - A. Flatten layers and improve communication
  - B. Improve maintenance support for operations
  - C. Improve engineering support for operations
  - D. Improve outage support for operations