



UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report No.: 50-302/89-17

Licensee: Florida Power Corporation
3201 34th Street, South
St. Petersburg, FL 33733

Docket No.: 50-302

License No.: DPR-72

Facility Name: Crystal River 3

Inspection Conducted: June 19-20, 1989

Inspectors: Charles A. Casto 8-10-89
C. Casto Date Signed

Albert B. Ruff 8-10-89
A. Ruff Date Signed

Approved by: Candice Julian for 8-10-89
T. Conlon Date Signed

SUMMARY

Scope:

This routine announced inspection was conducted as a follow-up to the events surrounding the loss of off-site power transient experienced on June 16, 1989. The scope of this inspection included review of the plant and operator response to the transient, the root cause, and corrective actions taken by the licensee to prevent future occurrences of this nature.

Results:

Increased management attention to control the interface between the Units 1 and 2, switchyard and the Unit 3 Start-up transformer is needed. The current plant design relies solely on the Unit 3 Start-up transformer as the primary source of power to the Emergency System and Unit buses. An additional source of off-site power would enhance the response to a single failure of the Unit 3 transformer. Additionally, during the event of June 16, 1989, the Emergency Feedwater Pump-1 failed to automatically start after the Emergency Diesel Generator powered the Emergency Buses. This failure may have been prevented had proper testing of the logic string for this sequence been tested. The inadequate testing was not identified during the root cause analysis completed by the licensee.

REPORT DETAILS

1. Persons Contracted

Licensee employees

- D. Beach, Supervisor, Technical Engineering Services
- M. Fitzgerald, Supervisor, Electrical Engineering
- *R. Fuller, Senior Nuclear Licensing Engineer
- E. Gallion, Shift Supervisor
- *S. Johnson, Manager, Site Nuclear Services
- B. Marckese, Electrical Engineer
- *P. Mckee, Director, Nuclear Plant Operations
- L. Moffatt, Supervisor, Nuclear Safety
- R. Murgatroyd, Superintendent, Maintenance
- B. Muzzi, Senior I&C Engineer
- V. Roppel, Manager, Nuclear Plant Maintenance
- *W. Rossfeld, Manager, Nuclear Compliance
- H. Tillman, System Protection and Control Technician (CR-1 and 2)
- E. Welch, Manager Nuclear Electrical/I&C Engineering Services
- *R. Widell, Director, Nuclear Operations Site Support
- *M. Williams, Nuclear Regulatory Specialist

A list of acronyms and initialisms used herein is provided at the end of this report. Figures 1 and 2 outline the Crystal River off-site power supplies.

2. Overview and Background Information

An alert was called by the licensee on June 16, 1989, when a LOSP occurred during the ascension of power for Crystal River Unit 3. CR-3's ES buses were being supplied with power from CR-3 Start-up transformer. The LOSP was the result of a personnel error and a failure of a Fault Detector Relay.

The FSAR states that the preferred off-site power source for CR-3's ES buses is the Unit 3 Start-up transformer and the alternate and independent source is the Units 1 and 2 (Fossil Units) Start-up transformer via a direct cable connection. Transfer to the alternate source is by manual operations. The on-site Emergency Diesel Generators assume the ES bus loads in the following manner:

- a. Manually if the ES bus voltage has not failed.
- b. Automatically if the ES bus voltage fails to approximately 55 percent of nominal ES bus voltage or degrades to approximately 90 percent of nominal ES bus voltage. The former involves a relay scheme where two out of three relays are activated and the later involves a relay scheme where three relays out of 3 relays are activated.

The NRC's 1974, SER states the CR-3 off-site power is from two separate feeders emanating from different breaker-and-a-half configuration bays in the 230KW switchyard. These power source are connected to two separate

Start-up transformers of which one is assigned to CR-3 and the other is shared between CR-1, 2, and 3. The shared Start-up transformer, feeder lines and associated breakers have sufficient capacity to handle all required load demands from the three units. The TS for CR-3 states that these two physically independent circuits between the off-site transmission network and the on-site ES bus are to be available for CR-3, when in operating Modes 1, 2, 3, and 4 (as defined in the TS). The TS also gives requirements that must be fulfilled when the conditions are not met.

The licensee issued a Licensee Event Report dated May 9, 1989, that described an event on April 9, 1989, where it was determined that the alternate power source could not supply power to CR-1, 2, and 3 for all operating configurations. The event happened when CR-3 was in a safe shut down condition with minimal decay heat and with all three units being supplied power from the alternate power source. A 3500 HP pump was started in Unit 1 and a voltage drop occurred on the ES buses (degraded voltage on ES buses). The Emergency Diesels Generators started on degraded voltage signals. None of the safeguards equipment was lost in this event. As a result of this event administrative controls were implemented to assure that the loads on CR-3's alternate off-site power source were regulated to satisfy the TS requirements for Crystal River 3 when it was in modes 1, 2, 3, or 4. In addition, a plant modification was made to annunciate any overloading conditions of this alternate power source. The annunciation is made in CR-3's control room so that operators can take the appropriate TS actions.

3. Response to the Event

a. Description of the Sequence of Events, June 16, 1989

- 0255 Could not receive control rod 100% Out Limit or Group Out Limit for Control Rod 5-3, complied with the actions of TS 3.1.3.3.
- 0315 Inserted all Regulating Rods back into the core and ensured a 1 percent Shutdown margin. Entered Mode II and initiated maintenance on Axial Position Indication for Rod 5-3. Exited the actions of TS 3.1.3.3.
- 0800 Completed surveillance testing for Control Rod 5-3.
- 0915 Unit 2 Start-up in progress, loading of the Units 1 and 2 Start-up Transformer exceeds 1500 KW; therefore, that source of offsite power is inoperable enter TS 3.8.1.1 (72 hour LCO).
- 0945 Units 1 and 2 Start-up Transformer loading is reduced to <1500 KW, exit actions of TS 3.8.1.1.
- 1110 Enter Mode II
- 1203 Enter Mode I

- 1325 Breaker 1691 opens due to an inadvertent test of the fault protection on the Brookridge 230 KV line. A fault detector relay sensed a failure of breaker 1691 to open (the breaker did operate successfully), causing breaker 1692 to open. This action de-energized the Unit 3 Start-up Transformer causing a loss of power to all AC buses. A reactor trip occurred and the EFW pumps started to supply feed to the Steam Generators. EFP-1 tripped on ES bus undervoltage, the Emergency Diesel Generators started and supplied power to the ES busses. EFP-1 did not sequence back on the bus; however, the operators were able to manually start the pump. An unexplained RPS trip was received on one channel for the flux/delta flux/flow trip and the vital inverters did not indicate an alternate source was available.
- 1330 When the emergency classification of the "Alert" was declared, the proper notifications were made and the TSC was manned. The conduct of business in the TSC was professional and timely.
- 1431 Breaker 1692 reclosed; Unit 3 Start-up Transformer re-energized.
- 1432 Breaker 1691 reclosed.
- 1445 "A" ES Bus paralleled to the Units 1 and 2 Start-up Transformer.
- 1447 "B" ES Bus paralleled to the Unit 3 Start-up Transformer.
- 1449 4160V Unit Buses are energized providing power to the secondary plant.
- 1500 All 4160V Buses have been restored, crews are restoring equipment and instrumentation as required. The Emergency Diesel Generators are still running, an RCP would be started when all attendant instrumentation had been restored. The cause of the loss of power is known to be a loss of the Brookridge line and subsequent failure of a fault sensing relay.
- 1620 Unit 2 tripped causing a loss of Units 1 and 2 Start-up Transformer, "A" ES loads are transferred to the Unit 3 Start-up Transformer.
- 1709 "B" RCP is started returning the RCS to forced circulation. All RCS parameters indicate satisfactory after the pump start.
- 1712 "C" RCP is started.
- 1715 Based on the successful start of two RCPs the event is downgraded from an Alert to a NOUE.

- 1728 Verification Procedure VP-580 has been completed, all parameters indicate normal. Intent is to de-classify emergency.
- 1732 Breaker 1691 has been closed back in restoring normal breaker alignment to the Start-up Transformer.
- 1735 Based upon successful completion of VP-580, NRC conference call and determination of the root-cause, the NOUE has been terminated.

b. Operator/Plant Response

The reactor was at 12 percent power with the main turbine latched and rolling at 400 rpm. The reactor tripped and an automatic initiation of EFW and Emergency Diesel Generators occurred. The loss of all RCPs placed the RCS in natural circulation. The operators responded by performing the immediate operator actions of the Emergency Operating Procedures (AP-580, 530, 450 and 770). Natural circulation was verified on "A" OTSG; However, due to an instrument malfunction, natural circulation could not be immediately verified on the "B" OTSG. Letdown was terminated due to the filter isolation valves closing (letdown would be re-established later in the transient). Due to the cool down from EFP-2, OTSG steam pressure dropped to ~450 psi at 1400 hrs. Manual Pressurizer and Makeup Tank level control were established. The plant was stabilized at ~1950 psi at a cool down rate of ~30 degrees F/hr. The plant was returning to service from an outage; therefore, the decay heat load was minimal. The operators attempted to minimize the steam flow and subsequent cool down by isolating non-essential equipment, e.g., closing the Main Steam Isolation Valves. During the event Hot Leg temperatures ranged from 537 degrees F. at 1400 hrs. to 440 degrees F. at 1555 hrs, Cold Leg temperatures ranged from 461 degrees F. at 1400 to 419 degrees F. at 1555 hrs.

The loss of the Unit 3 Start-up transformer was attributed to a relay technician who had inadvertently depressed a fault test pushbutton which cleared the Brookridge line, additionally, a fault sensing relay failed to sense the opening of breaker 1691 causing the relay to initiate the opening of breaker 1692. Crews were dispatched to determine the cause of the Unit 3 Start-up Transformer failure. Also, the control room operators dispatched personnel to survey the Diesel Generators and restore power when available. The licensee elected to stabilize the grid by waiting on Unit 2 to complete a Start-up before restoring off-site power through the Units 1 and 2 Start-up transformer. After this source of power was restored, the operators placed one division of ES on the Unit 3 transformer and one division of ES on the Units 1 and 2 transformer. Eventually, all loads were transferred to the Unit 3 transformer, two RCPs were started establishing forced circulation and the event terminated.

Operator response to this event was satisfactory. The operators were aware of electrical sources which had failed, and those available to them. The control room personnel dispatched personnel as necessary to take local actions as appropriate. Procedure actions appeared adequate in providing guidance to the operators in responding to this event.

c. Two weaknesses were noted during the recovery from this event:

- (1) The root cause analysis of the start failure of the motor driven emergency feed pump was less than adequate. It was later, after restart, shown by test that the failure of an untested relay string prevented the automatic start of EFP-1. The assumption was that the malfunction of a time delay was the cause of the start failure.
- (2) Lack of string testing of the start logics contributed to the failure to recognize the failure of the AJ relay in addition to the time delay relay. Also the lack of string testing of this logic string contributed to the existence of a relay that was not surveilled in the automatic start logic of a safety related component.

4. Specific Problems Discovered as result of LOSP on June 16, 1989.

a. Loss of Start-up Transformer for CR-3

The non-nuclear switch yard personnel were checking the carrier signals of the Brookridge transmission system from metering cabinets in CR-1 and 2 (fossil units) control room areas. This would normally have no effect on the transformer configuration and switch yard breaker line up that was supplying power to CR-3 Start-up transformer. However, a relay technician inadvertently hit a test circuit switch (a Push Button [PB] that is not normally used) that simulates a fault on the system's transmission lines and two switch-yard breakers opened (1690, 1691). One of these breakers (1691) is in parallel with another breaker (1692) that supplies power to CR-3 Start-up Transformer.

The opening of (1690, 1691) two breakers would not have caused the loss of CR-3 Start-up transformer since breaker 1692 should have remained closed. However, a fault detector relay, which should have indicated that breaker 1691 was open, failed and indicated that breaker 1691 was still closed. As a result the next breaker, 1692, automatically opened to clear the non-existent fault. This isolated CR-3 Start-up transformer and CR-3 had a LOSP event. The Emergency Diesel Generators started and assumed the ES loads.

The relay that failed in the above event was last calibrated in 1986, and was found to be satisfactory. The periodicity of calibration for this relay is on a normal two year cycle. It was not calibrated when its two year period became due because of more urgent work. The relay was removed after the event, checked out and re-calibrated successfully and returned to service.

These switchyard relays are scheduled for replacement by a solid state system that is more reliable. The replacement is anticipated to occur during the next CR-3 refueling. Since the PB circuit is only accessible by a hinged cover that is fastened by screws opposite the hinged end (The cover also has to be removed to check the carrier signals), it is considered by the licensee that no additional protection is needed for the PB. In the interim, before the solid state system is installed, the relay department is considering the permanent disabling of the PB switch since they are not used. This event was caused by personnel error and a faulty relay.

b. Emergency Feedwater Pump (EFP) One Failed to Start Automatically

The event caused the motor driven Emergency Feedwater Pump EFP-1 to receive an automatic start signal; it tripped off of the line shortly after initiating and failed to restart automatically when the Emergency Diesel Generator (3A) assumed the ES loads.

After the Diesel Generator's output breaker closes, one circuit is activated that energizes a relay that has a contact in a string for the automatic starting circuit for EFP-1. The contact in this starting string should have closed in five seconds after the DG's output breaker closed and EFP-1 should have started automatically. The operator noted this discrepancy and manually started the pump by positioning the switch in the control room.

The action taken after the event showed the following:

- (1) The relay with a five second time delay for closing a contact was checked. This check showed that the contact did not close. The relay was taken to the shop for further bench testing. In the shop it worked as designed. It was tested and cycled several times in the shop and was placed back in the circuit. It was tested in the installed configuration and worked as designed. It was cycled several times in its installed configuration and worked each time. It was considered that a poor electrical connection may have cause the relay to fail during the LOSP event.
- (2) The relay had been satisfactorily tested on October 19, 1988. The test at that time was in accordance with Crystal River's SP 137, Engineered Safeguards Actuation System Time Delay Relay Calibration. The installed tests, mentioned in 1. above, were the same, or similar, to this test.
- (3) As a result of NRC inquiries concerning the testing of the entire string for an automatic starting circuit for EFP-1, NRC was notified on June 23, 1989, that the AJ relay, which also provides a close contact in the EFP-1's string for automatic starting, has not been tested. The AJ relay was subsequently tested and found to be defective. Therefore, even if the five

second-time-delay relay had worked properly, the EFP-1 would not have started because of an open contact up stream of the time-delay relay. This is considered to be a violation identified as 50-302/89-17-01, Inadequate Testing to Prove Operability of a String for the Automatic Starting of EFP-1.

- c. Synchronizing Lights for Inverters A, B, and C were noted to be off after the LOSP Event

On Wednesday (June 14, 1989), prior to the event, the licensee was performing the SP-417 and transfer switch VB-XS-1A transferred to alternate supply which was not energized. VA-XS-1A remained in the correct position. The transfer switch changes positions when it senses an under voltage or over current condition. Extensive checks were performed to determine why this anomaly occurred and no circuit discrepancies or erroneous set-points could be found. As a result of the LOSP event on Friday (June 16, 1989), and the anomaly indicated above, the inverter panels were checked shortly after the LOSP event. The transfer switches functioned as designed, however, it was observed that the synchronizing lights for inverters A, B, and C were not on. The D inverter was on. The lights should indicate that power is available on the vital bus. In that the vital bus was energized by the DG assuming the ES bus loads, the lights should have been on.

It was observed that the lights did come on when the DG speed was increased during the paralleling and synchronizing operations to put the ES bus back on switch yard power. The inverter lights are set for a frequency of 59.3 to 60.7 cycles per second. They were re-adjusted to as close to the mid-band setting as possible. SP 417 in this area was repeated and the inverter circuitry functioned as designed. The DG high speed limit was set at the high end of the specification (900 RPM) and a MAR is being considered to increase this high speed limit to 905 RPM.

5. Acronyms and Initialism

CR	-	Crystal River
DG	-	Diesel Generator
EFW	-	Emergency Feedwater
EFP	-	Emergency Feedwater Pump
ES	-	Engineered Safeguard
HP	-	Horsepower
KV	-	Kilo-Volt
KW	-	Kilowatt
LCO	-	Limiting Condition for Operation
LOSP	-	Loss of Off-Site Power
MAR	-	Modification Approval Record
NOUE	-	Notification of Unusual Event
OTSG	-	Once Through Steam Generator
PB	-	Push Button
RCP	-	Reactor Coolant Pump

RCS - Reactor Coolant System
RPM - Revolutions per minute
SER - Safety Evaluation Report
SP - Surveillance Procedure
TS - Technical Specifications
TSC - Technical Support Center

FIGURE 1

230KV SWITCHYARD BUS

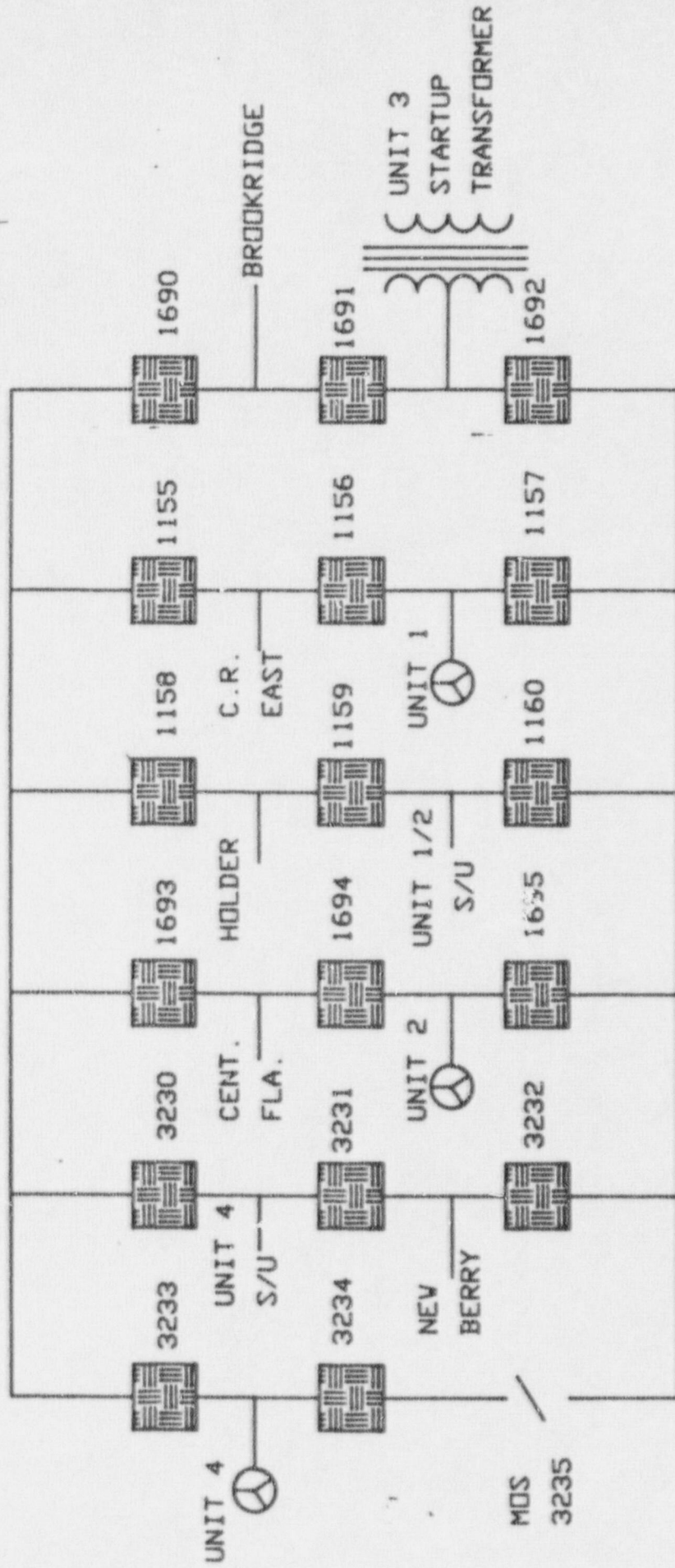
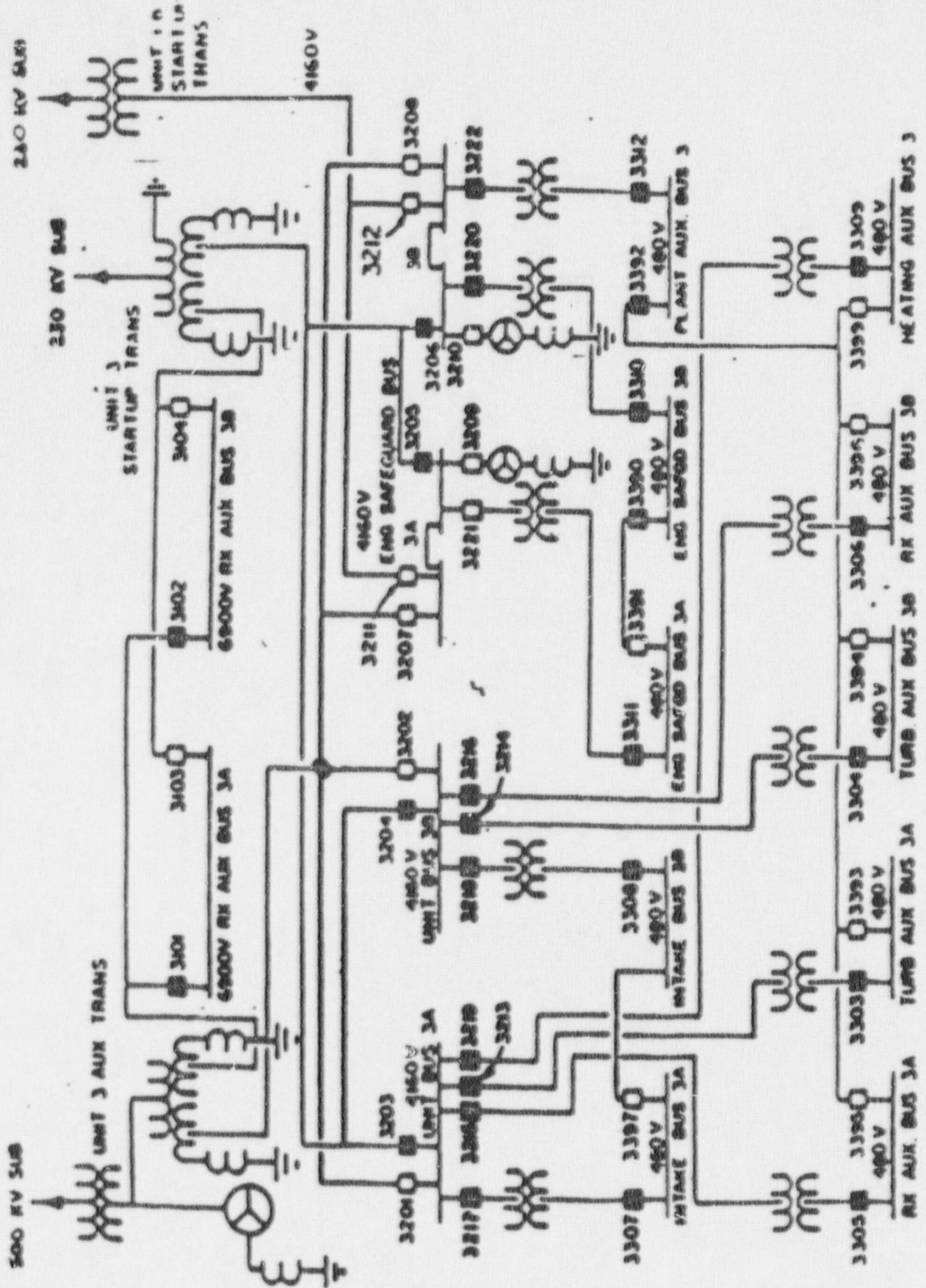


FIGURE 2

AC DISTRIBUTION SYSTEM



INSPECTION RESULTS AND SALP INPUT

Summary of Inspection Results

Facility Crystal River Report No. 89-17

AREAS INSPECTED

Loss of offsite power event on 6/11/88

NEW VIOLATIONS (SL), DEVIATIONS (DEV), OR OTHER NEW ITEMS (UNR & IFI)

1 SL 4 violation - Inadequate testing of EFW and subsequent startup LCD 3.0.4.

STATUS OF PREVIOUS ENFORCEMENT MATTERS AND OTHER ITEMS

N/A

MODULES INSPECTED, PERCENT FOR EACH UNIT (IF NOT 100%, LIST NUMBER OF LINE ITEMS COMPLETED)

530703 100%

INSPECTOR OBSERVATIONS AND AREAS OF CONCERN

Uncontrolled surveillance testing in the switchyard.
Lack of diverse offsite power supplies. 4.3
Starting transformer unreliable

SALP EVALUATION

Complete one SALP evaluation for each functional area inspected. Complete during inspection if time permits.

Key: 0 - Not inspected; 1 - Above average; 2 - Average; 3 - Below average

EVALUATION CRITERIA	ASSESSMENT
1. Management involvement in assuring quality	0 1 <u>2</u> 3
2. Resolution of technical issues from a safety standpoint	0 1 <u>2</u> 3
3. Responsiveness to NRC initiatives	<u>0</u> 1 2 3
4. Enforcement history	<u>0</u> 1 2 3
5. Reporting and analysis of reportable events	<u>0</u> 1 2 3
6. Staffing (including management)	<u>0</u> 1 2 3
7. Training and qualification effectiveness	<u>0</u> 1 2 3

AREA INSPECTED	OVERALL ASSESSMENT	0	1	2	3
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COMMENTS: Inadequate post trip analysis of EFW pump auto start failure.

NOTE: Please attach additional sheets if needed for comments or for other SALP functional areas.

LEAD INSPECTOR Cast

DATE 8/11/87

- DISTRIBUTION
- Branch Chief
 - Section Chief
 - Project Section Chief (for reactor inspections)

INSPECTOR'S REPORT
 Office of Inspection and Enforcement

C. Castro
 REVIEWER

INSPECTORS
Castro, Rust, Holmes-Lay
Tedlow

LICENSEE/VENDOR	TRANSACTION TYPE	DOCKET NO. (N Regs) OR LICENSE NO. (BY PRODUCT) (113 Regs)	REPORT				NEXT INSPEC DATE	
			NO	SSO	MO	YR	MO	YR
<i>FPC Crystal River-3</i>	<input checked="" type="checkbox"/> I - INSERT <input type="checkbox"/> M - MODIFY <input type="checkbox"/> D - DELETE <input type="checkbox"/> R - REPLACE	<i>50-362</i>	<i>89</i>	<i>17</i>	<i>A</i>			

PERIOD OF INVESTIGATION/INSPECTION						INSPECTION PERFORMED BY		ORGANIZATION CODE OF REGION (NO CONDUCTING ACTIVITY) (See NRC 05.30 - Manpower Reporting - Weekly Manpower Reporting to OES)		
FROM			TO			OTHER		REGION	DIVISION	BRANCH
<i>MO</i>	<i>DAY</i>	<i>YR</i>	<i>MO</i>	<i>DAY</i>	<i>YR</i>	<input checked="" type="checkbox"/> 1 - REGIONAL OFFICE STAFF <input type="checkbox"/> 2 - RESIDENT INSPECTOR <input type="checkbox"/> 3 - PERFORMANCE APPRAISAL TEAM		<i>2</i>	<i>III</i>	<i>4</i>

REGIONAL ACTION (Check one box only)	TYPE OF ACTIVITY CONDUCTED (Check one box only)								
<input type="checkbox"/> 1 - NRC FORM 801 <input type="checkbox"/> 2 - REGIONAL OFFICE LETTER	<input checked="" type="checkbox"/> 01 - SAFETY <input type="checkbox"/> 02 - INCIDENT <input type="checkbox"/> 03 - ENFORCEMENT <input type="checkbox"/> 04 - MGMT AUDIT	<input type="checkbox"/> 05 - MGMT VISIT <input type="checkbox"/> 07 - SPECIAL <input type="checkbox"/> 08 - VENDOR <input type="checkbox"/> 09 - MAT ACCT	<input type="checkbox"/> 10 - PLANT SEC. <input type="checkbox"/> 11 - INVENT VER. <input type="checkbox"/> 12 - SHIPMENT/EXPORT, <input type="checkbox"/> 13 - IMPORT	<input type="checkbox"/> 14 - INQUIRY <input type="checkbox"/> 15 - INVESTIGATION					

INSPECTION/INVESTIGATION FINDINGS (Check one box only)				TOTAL NUMBER OF VIOLATIONS AND DEVIATIONS				ENFORCEMENT CONFERENCE HELD				REPORT CONTAIN 278 INFORMATION				LETTER OR REPORT TRANSMITTAL DATE						
A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	MO	DAY	YR	MO	DAY	YR	
<input checked="" type="checkbox"/>																						

MODULE INFORMATION												MODULE INFORMATION													
REC NO	MODULE NUMBER INSP				PRIORITY	CORRECTIVE ACTION EFFORT BY STAFF HOURS EXPENDED THIS INSPECTION	PERCENTAGE COMPLETED TO DATE	STATUS	MODULE REC FOLLOWUP				REC NO	MODULE NUMBER INSP				PRIORITY	CORRECTIVE ACTION EFFORT BY STAFF HOURS EXPENDED THIS INSPECTION	PERCENTAGE COMPLETED TO DATE	STATUS	MODULE REC FOLLOWUP			
TYPE	NUMBER	PHASE	MANUAL CHAPTER	PROCEDURE NUMBER					LEVEL	TYPE	NUMBER	PHASE	MANUAL CHAPTER	PROCEDURE NUMBER	LEVEL	TYPE	NUMBER					PHASE	MANUAL CHAPTER	PROCEDURE NUMBER	LEVEL
<i>6</i>	<i>15</i>	<i>30</i>	<i>703</i>	<i>3</i>		<i>4</i>	<i>100%</i>	<i>C</i>				<i>6</i>	<i>15</i>	<i>30</i>	<i>703</i>	<i>3</i>									

© CIRCLE SEQUENCE # VIOLATION OR DEVIATION

NSIC FORM 700 A
(11-81)
16 NSIC 6000

INSPECTOR'S REPORT
(Continuation)
Office of Inspection and Enforcement

DOCKET NO. (8 digits) OR LICENSE
NO. (BY PRODUCT) (13 digits)

REPORT

MODULE NUMBER

NO.	SQD.	VIOLATION SEVENTH OF DEVIATION						D	SITE RELATE
		1	2	3	4	5	6		
	A								
	B								
	C								
	D								

VIOLATION OR DEVIATION (Enter up to 200 characters for each item. If the text exceeds the number, it will be necessary to paraphrase.) Limit does not apply to each item.

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50-302

Crystal River's
Facility Name

Case
Project Inspector

PT's Initials

Date Acknowledged

ITEM NUMBER 89-17-01

TYPE SLY

MODULE # B

AREA OAS

RESP. SAC [Signature]

ACTION DUE DATE

CLOSEOUT ACTION

Inadequate testings re placed by 4 of 5 sections for EPA

ITEM NUMBER

TYPE

MODULE # B

AREA

RESP. SAC [Signature]

ACTION DUE DATE

CLOSEOUT ACTION

Grid area for item 89-17-01

ITEM NUMBER

TYPE

MODULE # B

AREA

RESP. SAC [Signature]

ACTION DUE DATE

CLOSEOUT ACTION

Grid area for item 89-17-01

ITEM NUMBER

TYPE

MODULE # B

AREA

RESP. SAC [Signature]

ACTION DUE DATE

CLOSEOUT ACTION

Grid area for item 89-17-01

Information entered by MIS on / / by