FLORIDA POWER AND LIGHT COMPANY
ST. LUCIE UNIT 2

SAFETY EVALUATION FOR THE PROVISIONS TO TRIP EMERGENCY DIESEL GENERATOR OUTPUT BREAKER ON CIAS IN PLANT MODES 5 AND 6

JPN-PSL-SEES-95-034
REVISION 0

SAFETY RELATED

NUCLEAR ENGINEERING DEPARTMENT
JUNO BEACH, FLORIDA

Fax Transmittal Memo

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Inter-Office Correspondence

FPL

JPN-SPSL-95-0444

To: S. A. Valdez

From: D. J. Denver
Nuclear Engineering

Date: October 23, 1995

Department: JPN/PSL

Subject: ST. LUCIE UNIT 2
SAFETY EVALUATION FOR THE PROVISIONS TO TRIP EMERGENCY DIESEL GENERATOR OUTPUT BREAKER ON CIAS IN PLANT MODES 5 AND 6
JPN-PSL-SEES-95-034, Rev. 0

Attached for your use is Safety Evaluation (SE) JPN-PSL-SEES-95-034, Rev. 0 which evaluates provisions to trip Emergency Diesel Generator (EDG) output breakers on CIAS in plant modes 5 and 6.

The referenced SE is to be used to support the Jumper Lifted Lead which will be required to facilitate Unit 2, EDG testing, during modes 5 and 6. The SE evaluates the installation of jumpers in the ESFAS cabinets, in order to trip the EDG output breakers on receipt of a CIAS signal. The SE is in response to the 2A EDG test failure which occurred on October 12 (ref. STAR 951391) and is an interim EDG protective measure until a permanent modification can be implemented.

If you have any questions, please contact Warren Busch at ext. 7464.

WAB/ejs/st

cc/ R. Kulavich (with att.)
L. A. Rogers
C. H. Wood
L. J. Bossinger
file

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REVIEW AND APPROVAL RECORD

PLANT ST. LUCIE UNIT 2

TITLE PROVISIONS TO TRIP EMERGENCY DIESEL GENERATOR OUTPUT BREAKER ON CIAS IN PLANT MODES 5 AND 6

LEAD DISCIPLINE ELECTRICAL

ENGINEERING ORGANIZATION PRODUCTION ENGINEERING GROUP

REVIEW/APPROVAL:

GROUP	INTERFACE TYPE			PREPARED	VERIFIED	APPROVED	FPL APPROVED*
	INPUT	REVIEW	N/A				
MECH			X				N/A
ELECT	X			W [illegible]	[illegible]	[illegible]	N/A
I&C		X				[illegible]	N/A
CIVIL			X				N/A
NUC**		X				[illegible] for E.R. Schiffley	N/A
ESI			X				N/A
NUC FUEL			X				N/A
OTHER			X				N/A

* For Contractor Evals As Determined By Projects and PLAs

** Review Interface As A Min On All 10CFR50.59 Evals

FPL PROJECTS APPROVAL: [illegible] DATE: 10/23/95

OTHER INTERFACES

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ABSTRACT

On October 12, 1995, while performing a portion of the safeguards testing required by Technical Specification, an unexpected Emergency Diesel Generator (EDG) trip occurred. Review of the event revealed a sequence of events in which, by design, an EDG trip signal was blocked creating a scenario that could lead to EDG damage. During the test the EDG was operating paralleled to the grid when a CIAS (without SIAS) was initiated. This caused the EDG governor mode to switch from "droop" (load follow/share) to a fixed frequency reference. This condition led to a reverse power protective relay actuation. Since the protective signals are bypassed under emergency operating conditions, the EDG continued to run, which under long term exposure could potentially lead to degradation. The proposed modification will trip the EDG output breaker upon CIAS initiation in plant modes 5 and 6 only, therefore eliminating a potential EDG failure mode. This change will not affect plant operating practices and will enhance EDG protection in modes 5 and 6. This evaluation concluded that this modification does not constitute an unreviewed safety question and does not require a Technical Specification change

1.0 Purpose and Description

The purpose of this safety evaluation is to provide basis for a plant temporary modification (plant modes 5 and 6 only), involving tripping of an emergency diesel generator (either 2A or 2B) output breaker on a CIAS, which will eliminate potential for equipment damage if an actual or a spurious CIAS occurs while the EDG being tested is connected to the grid. The CIAS function is required by Technical Specification to be operational in all plant modes, including 5 and 6 if core alterations or fuel movement take place. The SIAS is not required in plant modes 5 and 6. This modification involves wiring any convenient "deenergize to close" CIAS spare contact in the ESFAS cabinet (A or B, as required) to trip the EDG output breaker and prevent the scenario described in the abstract. Attachment 1 shows the required connections and typical available contacts.

1.0 Purpose and Description (cont'd)

The proposed modification will result in following changes:

ASSUMPTIONS	PRESENT CONFIGURATION	PROPOSED CHANGE
• Plant in modes 5 or 6. • Off-site power available • EDG in test mode • EDG Connected to power Grid • CIAS Generated	SIAS is blocked. CIAS changes the governor mode to isochronous. EDG breaker remains closed resulting in a reverse power or an over current condition.	CIAS trips the EDG output breaker and EDG remains running awaiting manual operator action. No potential for equipment damage.
• Plant in modes 5 or 6. • Loss of Off-site Power Event. • EDG powering an isolated bus. • CIAS Generated	EDG breaker does not trip and the CIAS loads are loaded immediately.	CIAS trips output breaker, bus sheds loads, EDG breaker re-closes in approximately 1.2 ** seconds and LOOP/CIAS loading sequence is initiated.

** This delay is not a concern because under the analyzed loss of offsite power scenario the EDG does not reach full speed and begins the loading sequence until 10 seconds after receiving a CIAS or other start signal.

2.0 Licensing Requirements

St. Lucie Unit 2 FSAR, section 8.3.1.1.1.f, makes following statements concerning the EDG operational performance:

"1) The diesel generator sets start upon loss of voltage in the safety 4.16 KV buses or actuation of the engineered safety features actuation signals from the ESFAS which are safety injection actuation signal (SIAS), containment isolation actuation signal (CIAS) or containment spray actuation signal (CSAS).

2) Upon loss of voltage on the 4.16 kV safety buses, these buses are automatically separated from the non-safety supply buses.

2.0 **Licensing Requirements** (Cont'd)

3) After each diesel generator set has attained normal frequency and voltage, the respective breaker closes if preferred ac power has been lost, thus immediately starting all loads belonging to the first block for which "starting required" signals are present (from ESFAS) or from circuit conditions indicating that they were previously running. If preferred ac power is still present, the diesel generator breaker does not close but the set remains at full frequency and voltage until manual actions are taken.

4) The starting of subsequent loads are delayed by timing relays with three or five second intervals between them.

5) If preferred ac power is lost but no Engineered Safety Features actuation signal is present, only the loads shown under the column "Loss of Offsite Power" in Table 8.3-2 are automatically started.

6) If, while operating as per step (5) above an SIAS appears, all loads are stripped and loading is performed per Table 8.3-2.

7) Means are provided for periodic testing of the diesel generator sets under load when preferred bus supply is from the unit auxiliary transformer. If preferred ac power is lost or an accident occurs during this testing, the diesel generator breaker is opened and the sequence returns to step (3)."

FSAR section 8.3.1.1.2k(ii):

"If the diesel is started as a result of an SIAS, CIAS, CSAS or loss of offsite power, all but two of the diesel generator lockout signals are overridden. Those which remain functional are engine over speed and generator differential. ...This rationale is in accordance with the intent of BTP EICSB 17, "Diesel Generator Protective Trip Circuit Bypass"."

These commitments comply with Regulatory Guide 1.9 and IEEE 387 and are reflected in the present plant design.

FSAR section 15.7.4.1.2 discusses fuel handling accidents and bounds all in-containment accidents' radiological consequences by an accident of dropping a fuel element in a spent fuel pool (Fuel Handling Building).

2.0 **Licensing Requirements** (Cont'd)

The CIAS activates a minimum contingent of loads, namely a Shield Building Ventilation fans (HVE-6A and 6B), Control Room Isolation fans (HVE-13A and 13B) and a few valves. Should these loads be required to start with offsite power available or with EDG powering an isolated bus, they would start instantaneously. If the loss of off-site power occurs at approximately same time as CIAS, these loads are picked up in a loading sequence coordinated with the other required loads.

Technical Specification requires that the ESFAS CIAS function be operational during core alterations or movement of irradiated fuel within the containment. The high radiation CIAS set point is reset to a lower value in mode 6.

3.0 **Analysis of Effects on Safety**

The proposed temporary change will make the CIAS have the same effect on the EDG in modes 5 and 6 as SIAS in modes 1 through 4, that is, if the EDG is operational and connected to the grid, upon CIAS actuation the EDG breaker will open and the EDG will remain running awaiting manual action and, if loss of power occurs, the EDG breaker will close and the loading sequence will be initiated.

Since the proposed change will result in a system response bounded by the previously analyzed SIAS condition, it is concluded that this temporary modification is acceptable.

4.0 **Failure Modes and Effects Analysis**

The proposed modification will eliminate an existing failure mode of creating a potentially damaging operating condition for the EDG. The proposed changes will not create any new failure modes since they will result in EDG response identical to SIAS in modes 1 through 4.

5.0 **Plant Restrictions**

This temporary modification shall be implemented only in plant modes 5 and 6.

6.0 **Effect on Technical Specifications**

There is no effect on any existing Technical Specifications.

7.0 Unreviewed Safety Question Determination

As defined in 10 CFR 50.59, an unreviewed safety question exists; (i) if the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the Safety Analysis Report (SAR) may be increased; or (ii) if a possibility of an accident or malfunction of a different type than any previously evaluated in the SAR may be created; or (iii) if the margin of safety as defined in the basis of any Technical Specification is reduced.

In accordance with 10CFR50.59, the following evaluation serves to determine whether the temporary modification of tripping the EDG output breaker upon CIAS actuation in plant modes 5 and 6 addressed in this safety evaluation constitutes an unreviewed safety question:

7.1 Does the proposed activity increase the probability of occurrence of an accident previously evaluated in the SAR?

The scope of the proposed modification, to make the effects of CIAS on the EDG same as SIAS, do not increase the probability of an occurrence of an accident previously evaluated in the SAR. EDG start/trip are not accident initiating events.

7.2 Does the proposed activity increase the consequences of an accident previously evaluated in the SAR?

The proposed modification will not increase the consequences of an accident previously analyzed in the SAR. Tripping of the EDG under test in the event of any ESFAS actuation results in a return to an analyzed loading sequence and therefore do not affect the accident analysis.

7.3 Does the proposed activity increase the probability of an occurrence of a malfunction of equipment important to safety previously evaluated in the SAR?

The proposed modification will not increase the probability of occurrence of malfunction of equipment important to safety previously evaluated in the SAR. The modification of the EDG breaker trip circuit - addition of a CIAS trip - is within the normal operational parameters for the EDG and its output breaker.

Unreviewed Safety Question Determination (cont'd)

7.0 Does the proposed activity increase the consequences of a malfunction of equipment important to safety previously evaluated in the SAR?

7.4 The proposed physical modifications do not change the basic functions of the equipment affected. The modifications were analyzed and they do not increase the probability nor the consequences of a malfunction of the EDG or its output breaker. The proposed temporary modification will prevent a potential damage to an EDG.

7.5 Does the proposed activity create the possibility of an accident of a different type than any previously evaluated in the SAR?

The proposed modifications will result in the EDG responding to a CIAS the same way it responds to SIAS, which has been previously analyzed. The EDG or its breaker are not accident initiators, therefor the modification can not create the possibility of an accident of a different type than previously evaluated in the SAR.

7.6 Does the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the SAR?

Since the basic functions of the EDG system remain unchanged, the modification proposed does not create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the SAR.

7.7 Does the proposed activity reduce the margin of safety as defined in the basis for any Technical Specification?

The temporary modification proposed will increase the overall margin of safety for the plant by eliminating the potential failure mode of operating the EDG connected to the grid with its protective features bypassed and trip conditions almost certainly generated by such an operation.

As demonstrated above, the proposed modification is bounded by previously analyzed FSAR scenarios.

8.0 Actions Required

CIAS shall be incorporated into the trip circuit of the EDG output breaker by wiring any available "deenergize to close" spare CIAS contacts in parallel with the SIAS contact as shown in Attachment 1.

- The relay, contact of which will be used, should be verified to be operational prior to implementation of the modification. **Ensure that a CIAS A contact is used for A train logic and CIAS B contact is used for B train logic.**

- Verify by test that the CIAS contact provides an EDG breaker trip signal.

9.0 References

9.1 STAR 951391

9.2 Control Wiring Diagram 2998-B-327, Sh.957, Rev.17

9.3 Control Wiring Diagram 2998-B-327, Sh.967, Rev.14

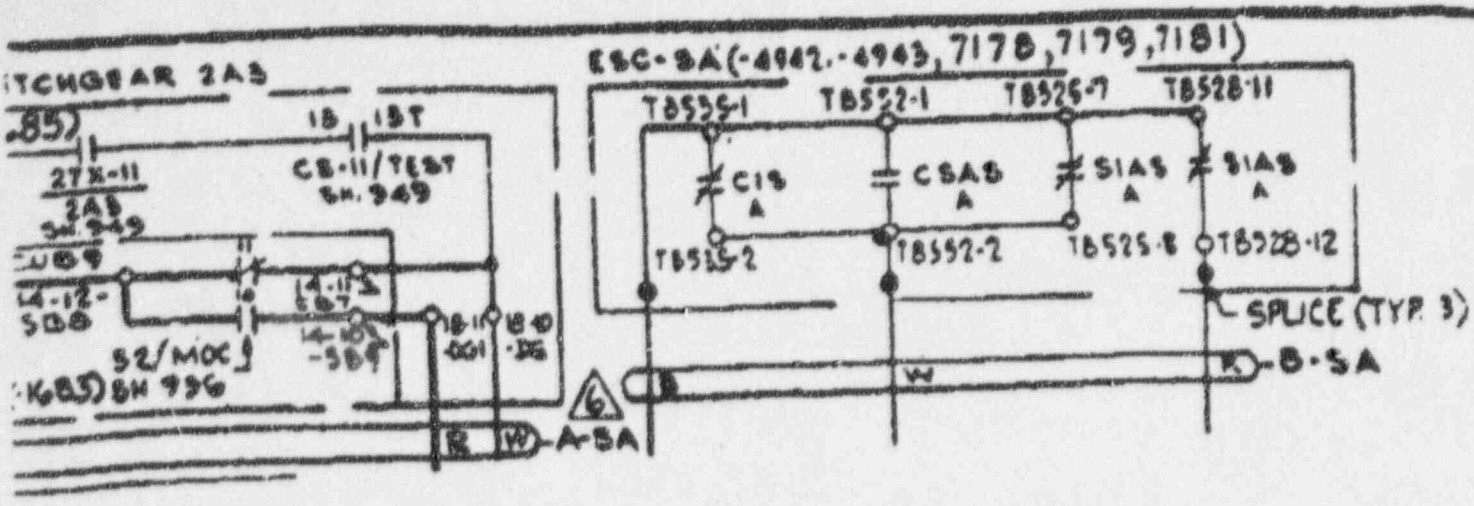
9.4 St. Lucie Unit 2 FSAR, Amendment 9

9.5 St. Lucie Unit 2 Technical Specification, Amendment 78

9.6 Instruction Manual 2998-15662, Rev.5

9.7 Regulatory Guide 1.9

9.10 IEEE Standard 387



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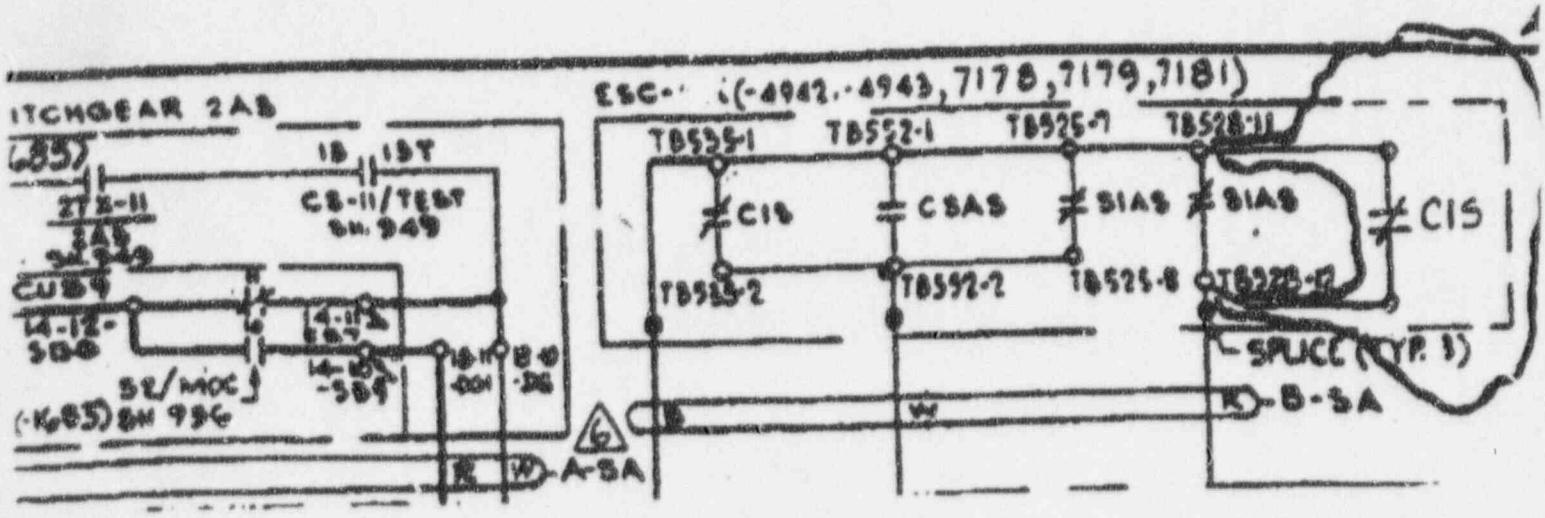

MODIFIED

REFERENCE : 2998-B-327, SH. 957 REV.17
2988-B-327, SH.967, REV.14

TYPICAL SPARE CONTACTS

SA	SB	
TB540(10,11)	TB637(7,8)	RECOMMENDED
TB539(3,4)	TB642(1,2)	
TB 539(6,7)	TB639(10,11)	
TB541(6,7)	TB636(10,11)	

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ATTACHMENT 1
REV. 0

The test was exited prior to completing step 8.5 and resumed at step 8.6.

Step 8.6

- Aligns both 2A and 2B EDGs with offsite power at or near full load
- Initiates a Channel A CIAS then resets
- Initaties a Channel B CIAS then resets
- Initiates a Channel A SIAS then resets
- Initaties a Channel B SIAS then resets
- Initiates a Channel A CSAS then resets
- Initaties a Channel B CSAS then resets

After each ESFAS Channel is actuated individual component actuations are verified.

This particular step of the procedure had been revised. The previous procedure Revision inserted a SIAS Signal prior to the CIAS Signal. This did not allow for separate verification of the CIAS Signal actuations since the SIAS also generated a CIAS Signal by design. The licensee believed that changing the order would enhance the procedure and provide more detailed ESFAS Signal verifications.

After the Channel A CIAS Signal was inserted and the component actuations verified, Channel A CIAS was reset. At this time the 2A EDG tripped on reverse power. The test was secured and the 2A EDG declared inoperable.

STAR #951391 was written which identified a design deficiency of the Unit 2 EDGs.

An investigation by the licensee determined that during the performance of Section 8.6 of OP 2-0400050, EDG 2A was running parallel to the grid and loaded to >3600kW. CIAS-A was manually initiated in accordance with step 12 of the test procedure. Actuation of CIAS inputs to the EDG governor circuit to change it from the droop mode (i.e. follows the grid frequency) to an isochronous mode (i.e. reverts to preset frequency and does not follow the grid frequency). The EDG 2A preset frequency was lower than that of the grid. This resulted in reducing fuel to slow the EDG down, leading to reverse power flow and causing the generator to act as a motor (or synchronous capacitor). The ERDADS printout of Bus 2A3 voltage and current and EDG current confirmed a sudden change at the approximate time CIAS was initiated. The reverse power relay actuated; however, due to the presence of the CIAS-A signal, the relay trip function was blocked. Upon resetting of the CIAS-A signal, the reverse power relay trip block was

removed and the EDG tripped. Total time of EDG operating under reverse power was approximately 45 seconds.

A review of the EDG control circuits by engineering found that the EDG starts on SIAS, CSAS or CIAS and that these signals cause the EDG to change from droop mode to isochronous mode (Ref. CWDs 957 & 958 and Vendor Manual 2998-7434). Opening the Bus 2A2-2A3 tie breaker will also change the EDG from droop to isochronous modes. In the case of SIAS and CSAS (CSAS will only occur with SIAS), the EDG circuit breaker will trip if closed, permitting the EDG to run separate from the offsite power source. However, CIAS without SIAS does not trip the EDG breaker, resulting in the EDG operating in isochronous mode while still connected to offsite power.

EDG 2A was operated in synchronism with the offsite source prior to manual initiation of CIAS-A. The isochronous mode frequency setpoint for EDG 2A is lower than that of the offsite source. Therefore, when the EDG 2A governor changed from droop to isochronous mode, the fuel racks acted to slow the EDG from the offsite source frequency to the isochronous frequency setpoint. This resulted in the EDG "motoring" (a reversal of power to the generator) with the generator trying to run the engine. (If the isochronous frequency setpoint is higher thant that of the offsite source, the EDG would attempt to speed the load (the grid) up.)

Steve - do we need this paragraph?

The situation described above could only occur with the EDG running in parallel with the offsite source and an actuation of the CIAS relay without SIAS. This condition is not expected during normal operation or any design basis event requiring the EDGs.

Following the trip of the 2A EDG due to the reverse power relay, the testing was halted. The 2A EDG voltage regulator was visually inspected with satisfactory results and the 2A EDG was started and loaded successfully as an operability check. The current drawn by the EDG 2A generator during the reverse power incident was approximately 330 amps, as shown by the ERDADS printout. From the ERDADS Printout the licensee determined that the 2A EDG output current of 477.54 amps reversed to 330.38 amps for a net change of 807.84 amps which was sufficient to actuate the reverse power relay. Concurrent with this, Bus 2A3 voltage changed from 4331.7 volts to 4360.2 as a result of the generator producing additional MVARS, i.e., acting as a synchronous capacitor with a high power factor.. This value is well within the 660 amp continuous rated capacity of the generator windings. Based on the above, ~~EDG 2A was not considered to have been~~ had not been damaged by the incident. Further, performance of the regular 18-month preventative maintenance (Maintenance Procedures 2-2200062 and 2-M-00180), ~~scheduled to begin on 10/15/95 will perform a~~ included a thorough inspection on the EDG ~~assuring identification of~~ and did not identify any damage as a result of this event.

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EDG 2B has not been tested with a manual CIAS actuation. therefore its operability was not affected.

The Unit 1 EDGs governor control design is different from the Unit 2 EDGs. The Unit 1 EDGs have been successfully tested using an essentially identical ESFAS test procedure. Therefore, there is no operability concern fron the Unit 1 EDGs.

Based on the above, the EDGs ~~are~~ were considered operable.

The Inspector reviewed the above assessment and noted that while actuation of the CIAS relay without SIAS is not expected during normal operation, both Unit 2 EDGs are tested monthly and operated a minimum of 1 hour ~~each~~ paralleled to the offsite power source. ~~Should an~~ actuation of CIAS occur under their conditions ~~substantial~~ damage to the EDG ~~is possible~~ could have resulted in.

The Inspector was concerned by several aspects related to ~~this~~ the design deficiency identified during testing:

1. Integrated Safeguards testing over the past 2 years had received a high level of management and technical support attention due to the licensee's misinterpretation of testing requirements particularly related to swing bus components. The current revision ~~reordered~~ changed the test sequence for initiating Test procedure

CIAS/SIAS/CSAS Signals in step 8.6 as a procedural enhancement. Although this same test was successfully performed earlier on Unit 1 and satisfactorily tested on the simulator, it was not reviewed in sufficient detail to assess the impact upon equipment or system operation on Unit 2.

2. This condition has existed since initial construction. There was no licensee identification of this failure mode. i.e. receiving a ~~CSA~~ CIAS Signal while paralleled to an offsite power source.

3. The 2A EDG was operated for approximately 45 seconds with a reverse power trip blocked. A review of the CWDs determined that a local reverse power alarm occurred which the licensee believes also generated a control room alarm. Since operators were either unaware or did not question these alarms, it's dubious whether operator actions would have prevented damage if the CIAS had not been reset unblocking the reverse power trip.

Steve →

The licensee has placed a temporary hold on EDG 2A/B testing pending resolution of their STAR. Options being considered include:

- Plant Change/Modification (Long Term)
- Jumper/Lifted Lead isolating the affected relay (Short Term) ?

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