FLORIDA POWER AND LIGHT COMPANY
TURKEY POINT UNITS 3 AND 4

# ENGINEERING EVALUATION

for

# VERIFICATION OF PSB-1 COMPUTER MODEL FOR SETTING OF UNDERVOLTAGE RELAYS

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## ATTACHMENTS

## 1.0 PURPOSE/SCOPE

This evaluation is provided in response to an NRC request (Reference 4.10) to verify by actual test that the computer model including inputs (i.e., cable sizes and equipment data) which was utilized to determine the Technical Specification 480 volt (480V) undervoltage relay setpoints correctly models the actual field configuration. This verification is required by NRC Power Systems Branch Technical Position 1 (PSB-1). This evaluation shall be classified as Safety Related.

This verification of the computer model (Ebasco Computer Program AUXSYS 4078 - 12/31/89), associated with Calculation EC-145 "PSB-1 Voltage Analysis for Electrical Auxiliary System", is performed by obtaining field measurements of the safety related bus loading and voltages during unit operation. The field measured bus loading is then input into the computer program and the resultant computer calculated voltages compared to the field measured voltages. These voltages shall be within 3%.

## 2.0 ANALYSIS

### 2.1 UNDERVOLTAGE RELAY TECHNICAL SPECIFICATION AMENDMENT

The setpoints of the 480V load center undervoltage relays were modified during the Emergency Power System (EPS) Enhancement Project. These setpoints were required to be modified as the EPS Enhancement Project added additional safety related busses and modified the loading on the existing safety related busses. As these settings are included in the Technical Specifications, a license amendment was submitted to obtain the required Technical Specification change. The NRC reviewed the amendment and issued Amendments Numbers 145 to Turkey Point Unit 3 and 140 to Turkey Point Unit 4 with a Safety Evaluation to incorporate the revised settings (Reference 4.10). This Safety Evaluation required the following:

> "Since the voltage and time delay trip settings have been calculated using a new computer program, the staff requires that the new software's analytical techniques and assumptions be verified by actual test and the results be provided to the NRC prior to the next refueling outage."

### 2.2 480V UNDERVOLTAGE RELAY SCHEME DESCRIPTION

This section provides a description of the 480V undervoltage relay scheme.

a. The undervoltage monitoring system on the 480V safety related load centers is provided so that degraded (loss of voltage) load center voltage concurrent with a safety injection signal (SIS) would initiate transfer to onsite power. A set of two instantaneous undervoltage relays on each safety related load center are installed to monitor the load center voltage. The

2.2 480V UNDERVOLTAGE RELAY SCHEME DESCRIPTION (continued)

two relays in each load center are connected in an "AND" logic and, when actuated due to a degraded (loss of voltage) voltage concurrent with a SIS and an open EDG breaker, would initiate, via time delay relay, load shedding, EDG start, onsite power connection and sequencing of the necessary loads.

b. Also, the undervoltage monitoring system on the 480V safety related load centers is provided so that, if the offsite source experiences sustained undervoltage, and to prevent damage to associated 460V motors, it would transfer to onsite power. To accomplish this function a set of two inverse time delay undervoltage relays is installed for each safety related 480V load center bus. These relays initiate load shedding, EDG start and onsite power connection, and sequencing in the same manner as the instantaneous undervoltage relays in Item (a) above.

2.3 ANALYSIS/EVALUATION

The setting of the undervoltage relays are designed to protect Class 1E motors from degraded voltage. These settings are also selected to prevent spurious separation of the plant distribution system from the offsite power source due to the actuation (starting a large load) of the undervoltage relays.

Calculations No. PTN-BFJE-92-022, Revision 0, "PSB-1 Voltage Analysis for Electrical Auxiliary System", (Reference 4.4) and EC-145, Revision 5, "PSB-1 Voltage Analysis for Electrical Auxiliary System", (Reference 4.6) provide the setpoints for the undervoltage relays. The undervoltage relay setpoints (with available margin) are shown in Attachment 1. Calculation No. PTN-BFJE-92-031, Revision 0, "Verification of PSB-1 Computer Model", (Reference 4.5) provides the verification that the computer model used for determining the undervoltage relay setpoints for PSB-1 correctly models the actual field configuration. The verification was performed by taking actual field readings (bus voltages and currents) on the plant AC system (References 4.2 and 4.3). The field readings were entered into the computer model (Reference 4.5) to demonstrate that the voltages obtained with the computer model are within 3% of the voltage values obtained using actual field readings. This would satisfy the requirements identified in Branch Technical Position PSB-1 (Reference 4.1).

The PSB-1 position states that the verification and testing should be performed in accordance with the four items listed in Section 4 of the branch position. These items and the method utilized to achieve resolution of these items are as follows:

2.3 ANALYSIS/EVALUATION (continued)

**A. PSB-1: Loading the station distribution buses, including all Class 1E buses down to the 120/208 v level, to at least 30%.**

Response: Both FPL Turkey Points Units 3 and 4 were at approximately 100% power and the station distribution busses were loaded at normal load which is well in excess of the required 30% loading. The measured bus loading are provided in Attachment 2.

**B. PSB-1: Recording the existing grid and Class 1E bus voltages and bus loading down to the 120/208 volt level at steady state conditions and during the starting of both a large Class 1E and non-Class 1E motor (not concurrently):**

Response: The voltages and bus loading were recorded down to the 480 volt level only. All low voltage AC (i.e., less then 480 volts) Class 1E power circuits and associated busses are powered by either the 125 volt DC safety related station batteries or by inverters supplied by the station batteries. Being independent of offsite power, these busses are not included in the computer voltage analysis and, accordingly, recording of actual voltages was not required.

The computer model calculates voltages based on bus loading and the electrical system impedance (i.e., resistance and reactance of feeder cable, transformers, etc.). As the electrical system impedance is constant for steady-state and transient conditions, the model can be utilized to analyze voltage drops due to steady-state running loads as well as instantaneous voltage drops due to starting transients. Accordingly, to verify the model, it was necessary only to measure steady-state conditions. Utilizing these steady-state measurements, the computer model was verified to be accurate.

**C. PSB-1: Using the analytical techniques and assumptions of the previous voltage analyses, and the measured existing grid voltage and bus loading conditions recorded during conduct of the test , calculate new set of voltages for all the Class 1E buses down to the 120/208 volt level.**

Response: As stated in this evaluation, this calculation was performed and the results are provided in Attachment 2.

2.3 ANALYSIS/EVALUATION (continued)

**D. PSB-1: Compare the analytically derived voltage values against the test results. In general, the test results should not be more than 3% lower then the analytical results; however, the difference between the two when subtracted from the voltage levels determined in the original analyses should never be less then the Class 1E equipment rated voltages.**

Response: The results of this analysis and the percent error from the measured values are provided in Attachment 2. In general, good (within 3%) correlation between the analytical and test results has been achieved.

The analytical results are all lower than the measured values except for Unit 4 busses LC A, LC D, MCC A, MCC D and MCC J which are all within 0.3% of the measured values. This difference will not result in any Class 1E equipment being powered at less than its rated voltage. This is due to the undervoltage relay settings being conservatively set higher (to provide margin for future addition of loads to the Class 1E busses) than the minimum analytical result which was previously calculated (Reference 4.4).

Based upon the above, the computer model Ebasco Computer Program AUXSYS 4078 - 12/31/89, including inputs are concluded to be accurate.

3.0 CONCLUSION

This evaluation in response to an NRC request (Reference 4.10) provided a verification by actual test that the computer model which was utilized to determine the undervoltage relay settings correctly models the as-installed field condition.

Section 2.3 provided and evaluated the setpoints for the undervoltage relays at Turkey Point Units 3 and 4. The evaluation shows that the computer model used for determining the setpoints for the undervoltage relays at Turkey Point Units 3 and 4 properly models the field conditions. This verification was done by showing that the field voltage measurements and computer calculated voltages (using equivalent field conditions when field voltage measurements were taken) are within 3% and do not exceed the undervoltage relay setpoints. This complies with NRC Branch Technical Position PSB-1 (Reference 4.1).

## 4.0 REFERENCES

4.1 Branch Technical Position PSB-1, "Adequacy of Station Electric Distribution System Voltages", Revision 0, July 1981

4.2 Test Procedure TP-788, "Electrical Measurements on Plant AC Systems to Validate Undervoltage Relay Setpoints"

4.3 Letter No. PTN-TECH-91-253, "Transmittal of Test Data for TP-788", dated November 26, 1991

4.4 FPL Calculation No. PTN-BFJE-92-022, Revision 0, "PSB-1 Voltage Analysis for Electrical Auxiliary System"

4.5 FPL Calculation No. PTN-BFJE-92-031, Revision 0, "Verification of PSB-1 Computer Model"

4.6 Ebasco Calculation EC-145, Revision 5, "PSB-1 Voltage Analysis for Electrical Auxiliary System

4.7 Turkey Point Units 3 and 4, Updated Final Safety Analysis Report (UFSAR) Revision 9, dated July 1991

4.8 Turkey Point Units 3 and 4, Technical Specifications, Amendments 151/146, effective February 7, 1992

4.9 JPN-QI 2.3, Revision 4, Safety Classifications

4.10 NRC Letter dated August 16, 1991, "Turkey Point Units 3 and 4 - Issuance of Amendments Re: Relay Setpoints, Fire Detection and Administrative Changes"

**ATTACHMENT 1**

**Undervoltage Relay Setpoints**
**for**
**FPL Turkey Point Units 3 and 4**

## FPL Turkey Point Unit 3 - Summary of Setpoint Voltages

| Load Center | 3A (3B01) | 3B (3B02) | 3C (3B03) | 3D (3B04) |
|---|---|---|---|---|
| 480V Instantaneous | 430 | 438 | 434 | 434 |
| 480V Inverse Time | 424 | 427 | 437 | 435 |

## FPL Turkey Point Unit 4 - Summary of Setpoint Voltages

| Load Center | 4A (4B01) | 4B (4B02) | 4C (4B03) | 4D (4B04) |
|---|---|---|---|---|
| 480V Instantaneous | 435 | 434 | 434 | 430 |
| 480V Inverse Time | 430 | 436 | 434 | 434 |

**ATTACHMENT 2**

**Measured Field Voltage and Loading Values**
**Versus**
**Calculated Voltage Values and Percentage Difference**

**TABLE 1**

**Field Measured Bus Voltages and Loads - FPL Turkey Point Unit #3**

| | Bus Voltage | Bus KVA |
|---|---|---|
| 4KV Bus A* | 4136.3 | 9642.7 |
| 4KV Bus A** | + + | 3825.7 |
| 4KV Bus B* | 4152.1 | 8919.1 |
| 4KV Bus B** | + + | 5536.6 |
| 4KV Bus D | 4119.5 | 333.9 |
| 480V LC A | 476 | 75.8 |
| 480V LC B | 481 | 73.4 |
| 480V LC C | 475 | 255.6 |
| 480V LC D | 479 | 136.8 |
| 480V LC H | 473 | 121.5 |
| 480V MCC A | 475 | 81.9 |
| 480V MCC B | 480 | 151.9 |
| 480V MCC C | 472 | 153.4 |
| 480V MCC D | 472 | 109.1 |
| 480V MCC K | 480 | 1.8 |

* High-side of current limiting reactor
** Low-side of current limiting reactor
+ + Bus voltage values are not available, as bus metering is only installed on the high-side of the current limiting reactor.

**TABLE 2**

**Field Measured Bus Voltages and Loads - FPL Turkey Point Unit #4**

| | Bus Voltage | Bus KVA |
|---|---|---|
| 4KV Bus A* | 4099.2 | 9809 |
| 4KV Bus A** | + + | 3291.3 |
| 4KV Bus B* | 4109.7 | 8728.0 |
| 4KV Bus B** | + + | 5567.5 |
| 4KV Bus D | 4085.9 | 331.2 |
| 480V LC A | 471.6 | 69.1 |
| 480V LC B | 477.2 | 182.1 |
| 480V LC C | 474.4 | 390.3 |
| 480V LC D | 475.5 | 30.1 |
| 480V LC H | 473.5 | 160.9 |
| 480V MCC A | 469.8 | 92.4 |
| 480V MCC B | 475.0 | 110.7 |
| 480V MCC C | 472.3 | 165.2 |
| 480V MCC D | 473.2 | 160.8 |
| 480V MCC K | 476.5 | 25.4 |
| 480V MCC J | 469.8 | 23.5 |

* High-side of current limiting reactor
** Low-side of current limiting reactor
+ + Bus voltage values are not available, as bus metering is only installed on the high-side of current limiting reactor.

## TABLE 3

## CALCULATED BUS VOLTAGES USING FIELD MEASUREMENTS - Turkey Point Unit 3

| | Calculated Bus Voltage | Percent Difference From Measured Voltages |
|---|---|---|
| 4KV Bus A* | 4082 | 1.3% |
| 4KV Bus A** | 4056 | + + |
| 4KV Bus B* | 4085 | 1.6% |
| 4KV Bus B** | 4057 | + + |
| 4KV Bus D | 4055 | 1.6% |
| 480V LC A | 473 | 0.63% |
| 480V LC B | 477 | 0.83% |
| 480V LC C | 470 | 1.05% |
| 480V LC D | 476 | 0.63% |
| 480V LC H | 465 | 1.70% |
| 480V MCC A | 472 | 0.63% |
| 480V MCC B | 474 | 1.25% |
| 480V MCC C | 466 | 1.27% |
| 480V MCC D | 464 | 1.69% |
| 480V MCC K | 476 | 0.83% |

* High-side of current limiting reactor
** Low-side of current limiting reactor
+ + Bus measured values are not available, as bus metering is only installed on the high-side of current limiting reactor.

## TABLE 4

## CALCULATED BUS VOLTAGES USING FIELD MEASUREMENTS - Turkey Point Unit 4

| | Calculated Bus Voltage | Percent Difference From Measured Voltages |
|---|---|---|
| 4KV Bus A* | 4078 | 0.5% |
| 4KV Bus A** | 4053 | + + |
| 4KV Bus B* | 4085 | 0.6% |
| 4KV Bus B** | 4056 | + + |
| 4KV Bus D | 4052 | 0.8% |
| 480V LC A | 472 | -0.08% |
| 480V LC B | 476 | 0.3% |
| 480V LC C | 471 | 0.7% |
| 480V LC D | 476 | -0.1% |
| 480V LC H | 475 | 0.3% |
| 480V MCC A | 471 | -0.3% |
| 480V MCC B | 475 | 0 |
| 480V MCC C | 468 | 0.9% |
| 480V MCC D | 474 | -0.1% |
| 480V MCC K | 475 | 0.3% |
| 480V MCC J | 471 | -0.2% |

* High-side of current limiting reactor
** Low-side of current limiting reactor
+ + Bus measured values are not available, as bus metering is only installed on the high-side of the current limiting reactor.