SOUTHERN CALIFORNIA
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**Dwight E. Nunn**
Vice President

March 16, 2000

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Subject: **Docket Nos. 50-361 and 50-362**
**Response to Request for Additional Information Regarding Proposed Technical Specification Change Number 454**
**San Onofre Nuclear Generating Station Units 2 and 3**

References:

1. Letter dated November 8, 1999, from D. E. Nunn (SCE) to Document Control Desk (NRC), Subject: Docket Nos 50-361 and 50-362, Engineered Safety Features Timing, Proposed Technical Specification Change NPF-10/15-454, San Onofre Nuclear Generating Station, Units 2 and 3

2. Letter dated January 18, 2000, from L. Raghavan (NRC) to H. B. Ray (SCE), Subject: San Onofre Nuclear Generating Station, Units 1, 2, and 3 - Request For Additional Information On Technical Specification Surveillance Requirement Change re: AC Sources Operating (TAC Nos. MA7153 and M7154)

Gentlemen:

By Reference 1, Southern California Edison (SCE) submitted license Amendment Applications 191 and 176 for San Onofre Nuclear Generating Station Units 2 and 3 (SONGS 2 & 3), respectively. These Amendment Applications comprise Proposed Change Number 454 (PCN-454) to the SONGS 2 & 3 Technical Specifications requesting a revision to the acceptance criteria for the Agastat time delay relays used in the Engineered Safety Features load sequencer in Surveillance Requirement 3.8.1.18.

By Reference 2, NRC staff requested additional information to facilitate their review of our application. Our response is provided in the enclosure.

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A001

If you have further questions on this subject, please contact me or Jack Rainsberry at (949) 368-7420.

Sincerely,

Dwight E. Nunn

Enclosure

cc: E. W. Merschoff, Regional Administrator, NRC Region IV
J. A. Sloan, NRC Senior Resident Inspector, San Onofre Units 2 & 3
L. Raghavan, NRC Project Manager, San Onofre Units 2 and 3
S. Y. Hsu, California Department of Health Services

Subscribed on this 16th day of March, 2000.

Respectfully submitted,
SOUTHERN CALIFORNIA EDISON COMPANY

By: Dwight E. Nunn
Dwight E. Nunn

State of California
County of San Diego

On 3/16/00 before me, Mariane Sanchez,
personally appeared Dwight E. Nunn, personally known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

WITNESS my hand and official seal.

Signature Mariane Sanchez

MARIANE SANCHEZ
Commission #1196482
Notary Public - California
San Diego County
My Comm. Expires Oct 14, 2002

# ENCLOSURE

# SAN ONOFRE NUCLEAR GENERATING STATION
# UNITS 2 AND 3 (SONGS 2 & 3)
# RESPONSES TO NRC REQUEST
# FOR ADDITIONAL INFORMATION
# ON PCN-454

CALCULATION E4C-082

**QUESTION 1:**

Page 7 of the Calculation stated that the torque developed by the motor at any speed is inversely proportional to the square of the frequency. Please provide the basis for the above statement.

Response:

Section 1.2.A of CCN 9 (Preliminary CCN N-3) to calculation E4C-082 states: "Note that the torque developed by the motor at any speed is directly proportional to the square of the voltage and inversely proportional to the square of the frequency." This statement contains an editorial error and should have read: "... the torque developed by the motor at any speed is directly proportional to the square of the voltage and inversely proportional to the frequency." However, this editorial error does not impact the calculated results because the correct relationship of torque vs. frequency was used in this calculation.

Note: Preliminary CCN N-3 to calculation E4C-082 has been issued as CCN 9 to calculation E4C-082 with no change to the technical content.

**QUESTION 2:**

Page 133 - Table 2.1 lists Engineered Safety Features (ESF) motors out of sequence acceleration times. Please provide the basis of these times. How do these acceleration times compare with the vendor-provided times? If these are calculated times, please provide details for a few motors.

Response:

The motor acceleration times listed on page 133 of CCN 9 to calculation E4C-082 are calculated times. Motor acceleration time is the time to reach rated speed from standstill. Motor acceleration times are obtained from the motor rpm curves included in section 2.1 of CCN 9 to calculation E4C-082 as follows:

(1) Auxiliary Feedwater Pump motor P141/P504

a. From page 39 of CCN 9 (Case IIIAX - motor is fed from EDG)

When sequence time = 32.5 seconds, motor speed = 0. When sequence time = 35.8 seconds, motor rpm = rated speed. Therefore, the acceleration time of P141/P504 motors is 3.3 seconds. Steady state motor terminal voltage is approximately 1.05 per unit (p.u.). The motor terminal voltage varies from approximately 0.81 per unit voltage to 1.17 per unit voltage during motor starting.

b. From page 100 of CCN 9 (Case IVBX - motor is fed from switchyard through Unit 3 Main Transformer, Unit Auxiliary Transformer and Class 1E 4.16 KV bus)

When sequence time = 32.5 seconds, motor speed = 0. When sequence time = 37.5 seconds, motor rpm = rated speed. Therefore, the acceleration time of P141/P504 motors is 5.0 seconds. Steady state motor terminal voltage is approximately 0.93 per unit. The motor terminal voltage varies from approximately 0.925 per unit voltage to 0.93 per unit voltage during motor starting.

c. Approximate motor starting times provided by motor vendor (reference V/P SO23-405-6-155-3 - Siemens Electric Motor Data Sheets)

3.3 seconds at 1.0 per unit voltage,
7.4 seconds at 0.8 per unit voltage, and
9.1 seconds at 0.75 per unit voltage.

Note: These motor starting times are based on constant voltage sources. For example, the motor starting time of 3.3 seconds at 1.0 per unit voltage presumes that the motor terminal voltage will be maintained at 1.0 per unit voltage during motor starting.

d. Comparison of the calculated acceleration times with the vendor data

As noted in item c above, the motor starting times provided by the vendor presume a constant motor terminal voltage. However, the calculated motor terminal voltage during motor starting varies due to voltage drops in the motor power circuit and source. Therefore, we cannot directly compare the calculated motor starting time with the vendor data. The motor starting times are tabulated below:

| Motor terminal voltage | Calculated acceleration time (second) | Vendor acceleration time(second) |
|---|---|---|
| 0.75 p.u. (constant) | | 9.1 |
| 0.8 p.u.(constant) | | 7.4 |
| 0.925 p.u. - 0.93 p.u. (dynamic) | 5.0 | |
| 1.0 p.u.(constant) | | 3.3 |
| 0.81 p.u. - 1.17 p.u. (dynamic) | 3.3 | |

The calculated motor acceleration times are consistent with the vendor supplied acceleration times.

(2) High Pressure Safety Injection Pump motor P017/P019

a. From page 21 of CCN 9 (Case IIIAX - motor is fed from EDG)

When sequence time = 0 second, motor speed = 0. When sequence time = 1.07 seconds, motor rpm = rated speed. Therefore, the acceleration time of the P017/P019 motors is 1.07 seconds.

Steady state motor terminal voltage is approximately 1.05 per unit The motor terminal voltage varies from approximately 0.85 per unit voltage to 1.16 per unit voltage during motor starting.

b. From page 82 of CCN 9 (Case IVBX - motor is fed from switchyard through Unit 3 Main Transformer, Unit Aux. Transformer and Class 1E 4.16 KV bus)

   When sequence time = 0 second, motor speed = 0. When sequence time = 1.4 seconds, motor rpm = rated speed. Therefore, the acceleration time of the P017/P019 motors is 1.4 seconds. Steady state motor terminal voltage is approximately 0.975 per unit. The motor terminal voltage varies from approximately 0.91 per unit voltage to 0.975 per unit voltage during motor starting.

c. Approximate motor starting times provided by motor vendor (reference V/P SO23-933-68-4 - Motor starting time-current curve)

   1.04 seconds at 1.1 per unit voltage,
   1.3 seconds at 1.0 per unit voltage,
   1.7 seconds at 0.9 per unit voltage, and
   3.0 seconds at 0.75 per unit voltage.

   Note: These motor starting times are based on constant voltage sources. For example, the motor starting time of 1.3 seconds at 1.0 per unit voltage presumes that the motor terminal voltage will be maintained at 1.0 per unit voltage during motor starting.

d. Comparison of the calculated acceleration times with the vendor data

   As noted in item c above, the motor starting times provided by the vendor presume a constant motor terminal voltage. However, the calculated motor terminal voltage during motor starting varies due to voltage drops in the motor power circuit and source. Therefore, we cannot directly compare the calculated motor starting time with the vendor data. The motor starting times are tabulated below:

| Motor terminal voltage | Calculated acceleration time (second) | Vendor acceleration time (second) |
|---|---|---|
| 0.75 p.u. (constant) | | 3.0 |
| 0.9 p.u. (constant) | | 1.7 |
| 0.91 p.u. - 0.975 p.u. (dynamic) | 1.4 | |
| 1.0 p.u. (constant) | | 1.3 |
| 0.85 p.u. - 1.16 p.u. (dynamic) | 1.07 | |
| 1.10 p.u. (constant) | | 1.04 |

   The calculated motor acceleration times are consistent with the vendor supplied acceleration times.

   Other calculated motor acceleration times have been verified to be consistent with available vendor supplied acceleration times.

**QUESTION 3**

Page 135 - Section 2.2.B states that the momentary power surges above the 4700 kW rating during automatic sequencing are acceptable because each diesel generator unit is capable of being loaded to 5170 kW for 2 hours within a 24-hour period. Please provide the details of the transient loads in kW and kVA for different load sequence steps.

Responses:

Section 2.2.B of the CCN 9 states "... loading profiles for the emergency diesel generators show that the steady state loading in each generator is within its 4700 KW rating. The momentary power surges above the 4700 KW rating during automatic sequencing are acceptable because each diesel generator unit is capable of being loaded to 5170 KW for 2 hours within 24-hour period."

Power (MW) profiles for the diesel generators during load sequencing are provided on pages 12 and 44 of CCN 9. The power profiles indicate a sharp momentary increase in power above 5170 KW when motors from the last sequenced load group approach rated speed. This condition occurs because the generator must constantly adjust its power output to match the power demand of the motors while they start and accelerate to rated speed. As the motors attain rated speed, the power demand quickly diminishes. The drop in motor power demand occurs faster than the generator is able to compensate, resulting in a momentary surge in generator voltage (reference pages 11 and 43). The momentary surge in the generator voltage is translated into the generator power profiles as a momentary power surge. This generator response characteristic is normal and the momentary power surge above 5170 KW during load sequencing is acceptable.

**QUESTION 4:**

Page 139 - Section 3.4. Motor Control Center (MCC) Loading Assumptions, Item A.1, states that this equivalent load is a constant kVA load consisting of both static and motor loads at steady state running condition. When a diesel breaker is closed, the motor loads should be considered as constant impedance loads since the MCC buses are de-energized before the diesel generator breaker closure. Please explain.

Response:

When loads are powered from a diesel generator and the diesel breaker is closed, equivalent MCC motor loads are considered as constant impedance loads. As shown in Table 5.1 (load schedule) of CCN 9 to calculation E4C-082, when loads are fed from the emergency diesel generator (CASE III.AX and CASE III.AY), all loads in the initial condition are OFF, and will start when the diesel generator breaker closes. Starting motors are modeled as constant impedance loads. The Initial Condition Equivalent Load in section 3.4.A.1 is applicable only to the Unit 2 MCC load of CASE IV.BX and CASE IV.BY (loads are fed from switchyard). These cases consider bus alignment where the Unit 3 4-KV ESF buses are tied to the corresponding Unit 2 4-KV ESF buses with the Unit 2 Reserve Auxiliary transformers inoperable. A design basis accident is postulated in Unit 3 while Unit 2 is in Mode 5 or 6 with its ESF loads running at steady state due to a spurious accident signal postulated in Unit 2. Under those conditions, Unit 2 ESF MCC equivalent loads in the initial condition are running and Unit 3 ESF MCC equivalent loads are OFF. Therefore, the Unit 2 equivalent load is a constant kVA load consisting of both static and motor loads at steady state running condition. In summary, running motors are modeled as constant KVA loads and starting motors are modeled as constant impedance loads.

**QUESTION 5:**

Page 141 - Table 3.1 states that the MCC loads (MW and MVAR) are different from the Updated Final Safety Analysis Report (UFSAR), Table 8.3-1. Please justify.

Response:

The MCC load models used in Table 8.3.-1 of the UFSAR are different from those used in the dynamic voltage calculations. The UFSAR models do not consider transient or momentary loads such as MOVs. The dynamic voltage calculation models include these loads and are, therefore, slightly larger than the UFSAR models. Also, different calculations may consider different amounts of load margin for future load growth. In all calculations the MCC models are conservative with respective to actual loading conditions.

**QUESTION 6:**

Page 145 - Section 4.0 states that (1) ESF motors running and starting parameters are not available from the calculation to the staff, and (2) the Aux Feedwater Pump is 0.6832 MVA, whereas UFSAR lists the Aux Feedwater Pump as 0.6823 MW. Please clarify the differences.

Responses:

(1) Running and starting parameters for ESF motors

Running and starting parameters for ESF motors are not shown in calculation E4C-082. However, calculated parameters of ESF motors for the Power System Simulator program (PSS/E) are shown in the calculation, including such parameters as equivalent motor circuit data (RA, LA, LM, R1, L1, R2, & L2), motor base MVA, inertia constant H, initial slip, torque constant, etc. The calculated motor data for the PSS/E program were transferred from calculations E4C-086 (Unit 2) and E4C-087 (Unit 3), which were issued to collect, develop, and document equipment data for electrical system calculations (System Dynamic Voltage analysis, Short Circuit calculation, Voltage Regulation, etc.). As shown in the Attachment to this response document, the motor model parameters for the PSS/E program were calculated based on the vendor supplied running and starting parameters for the ESF motors.

(2) Rating of Auxiliary Feedwater Pump (AFWP) Motor

Both 0.6832 MVA and 0.6823 MW are correct as explained in the following.

The steady state load of 0.675 MW calculated in CCN 9 excludes cable loss and is different from the steady state load of 0.6823 MW in UFSAR. The load (0.6823 MW) of the AFWP motor in the UFSAR is the maximum steady state load. The motor model in CCN 9 is based on the AFWP spare motor because the dynamic characteristics of the spare motor while starting and accelerating to rated speed are more conservative than the characteristics of the installed AFWP motors.

The steady state AFWP motor load of 0.6823 MW in UFSAR is based on the brake HP (868 HP) and efficiency (0.95) of the installed motor, including the loss in the feeder cable. The MVA rating (0.6832 MVA) of the AFWP motor is the base MVA rating of the AFWP spare motor (800 HP, 0.91 PF, and 0.96 efficiency). However, as shown in the Attachment to this response document, the steady state MVA of the AFWP spare motor used in CCN 9, which excludes cable loss, is 0.741 MVA (0.6745 MW and 0.3073 MVAR) based on 868 brake HP, 0.91 PF, and 0.96 efficiency.

**QUESTION 7:**

Page 239 - Section 8.6.B calculates equivalent starting motor loads of 86.15 KW + j55.42 KVAR. The staff believes that motor starting power factor is very low and as a result, the KW component should be lower than the KVAR component. Please provide the basis of the above numbers.

Response:

The Equivalent Starting Motor Load of 86.15 KW + j55.42 KVAR is the equivalent steady state motor load which will start at t = 0 second. This load is shown on page 389 of CCN 9 as 2BY-M (86.2 KW + j55.4 KVAR). Power factor of the Equivalent Steady State Motor Load (86.15 KW + j55.42 KVAR) is 0.841 and correct for steady state operation. A typical starting power factor of 0.2 for the equivalent MCC motor load was used in this calculation (reference: Attachment 9.2.3 of base calculation E4C-082, revision 1).

**QUESTION 8:**

Please discuss the impact of starting multiple loads on breaker coordination study.

Response:

Relay setting calculations for ESF 4.16 KV load breakers were reviewed and determined to be adequate for starting overlapping load groups. Protective relays which could potentially trip the upstream supply breakers while starting multiple loads are discussed below. There are four incoming breakers for each ESF 4.16 KV bus as follows:

a. Diesel generator breaker

   There is no overcurrent relay (51 relay) in the diesel generator breaker protection scheme. The diesel generator is protected under a short circuit condition by 151/27 (voltage restraint overcurrent) relays. The 151/27 relays will not initiate tripping of the diesel generator breaker during multiple motor starting.

   (Reference calculation E4C-098 - 4 KV Switchgear Protection Relay Setting)

b. Bus tie breaker between ESF 4.16 KV buses 2A04 (2A06) and 3A04 (3A06)

   The overcurrent (151) relay for this breaker is set at 2400 A at 4.36 KV. This relay setting was established to protect the source transformer as the backup overcurrent relay of downstream overcurrent relays for 4.16 KV loads. The current (multiple motor starting current and maximum bus current) during multiple motor starting is much less than the relay setting current. The 151 relay will not initiate tripping of the bus tie breaker during multiple motor starting.

   (Reference calculation E4C-098 - 4 KV Switchgear Protection Relay Setting)

c. Bus incoming breaker from Reserve Auxiliary Transformer

The overcurrent (151) relay for this breaker is set at 4200 A at 4.36 KV. This relay setting was established to protect the source transformer. The relay functions as the backup overcurrent relay of downstream overcurrent relays for 4.16 KV loads. The current (multiple motor starting current and maximum bus current) during multiple motor starting is much less than the relay setting current. The 151 relay will not initiate tripping of the bus incoming breaker during multiple motor starting.

(Reference calculation E4C-098 - 4 KV Switchgear Protection Relay Setting)

d. Bus incoming breaker from Unit Auxiliary Transformer

The overcurrent (151) relay for this breaker is set at 4200 A at 4.36 KV. This relay setting was established to protect the source transformer. The relay functions as the backup overcurrent relay of downstream overcurrent relays for 4.16 KV loads. The current (multiple motor starting current and maximum bus current) during multiple motor starting is much less than the relay setting current. The 151 relay will not initiate tripping of the bus incoming breaker during multiple motor starting.

(Reference calculation E4C-098 - 4 KV Switchgear Protection Relay Setting)

ENCLOSURE 1 OF LETTER DATED NOVEMBER 8,1999

**QUESTION 1:**

Software Modeling Verification (Enclosure 1, Page 11 of 15) - You stated that analytical techniques and assumptions used in voltage analyses were verified against actual measurements. Please provide details (i.e., minimum voltage at the motor terminals, steady state voltage, acceleration time, and so forth).

Response:

PSS/E Program verification was accomplished by simulating a portion of the pre-operational Transformer Voltage Tap Verification test for SONGS Unit 2, and comparing the results of the test with the results of the PSS/E Program simulations. During this test, the dynamic and steady state voltages at the ESF 4.16 KV buses were monitored by a recorder. In the PSS/E dynamic simulation, system loads were adjusted to match the actual test conditions. Each ESF load was then simulated to start at the same time it was started in the actual test. The voltage profiles resulting from the dynamic simulations were then compared with the voltage profiles from the actual test. The resulting plots from the dynamic simulations and actual test were then superimposed for comparison (Figures 1 and 2 of the Attachment to this response document). The steady state voltages from the test and PSS/E verification are tabulated below for comparison.

| BUS NO. | TEST RESULTS | PSS/E RESULTS |
|---|---|---|
| 2A04 | 4.27 KV | 4.1966 KV |
| 2A06 | 4.24 KV | 4.1887 KV |

During the test, motor terminal voltages were not measured. Motor acceleration times can be verified by inspection of the voltage profiles.

(Note: the SONGS 2 & 3 submittal of January 18, 1995 described this methodology with respect to degraded bus voltage. In a Safety Evaluation Report issued March 17, 1995, NRC staff concluded, "...the techniques and assumptions used in voltage analysis are acceptable.")

**QUESTION 2:**

Enclosure 1, Page 11 of 15 - The containment spray pump motor start time is shown as 1.9 seconds. Does this include breaker closing time? Provide the basis for 1.9 seconds. Has this acceleration time been adjusted for the voltage and frequency variations?

Response:

The 1.9 seconds includes breaker closure time of 0.4 second. As shown in Figure 2 of Enclosure 1 to the letter of November 8, 1999, page 11 of 15, the existing Technical Specification Surveillance Requirement for the Containment Spray system allocates 0.5 second for Agastat relay tolerance and 3.9 seconds for the containment spray pump starting time. These intervals were reallocated as 2.5 seconds for timer tolerance and 1.9 seconds for pump acceleration with no overall increase to the system response time.

The Containment Spray pump acceleration time of 1.9 seconds is the assumed pump starting time used in the Containment Pressure analysis calculations. The assumed pump acceleration time consists of an assumed response time of 0.4 second for the circuit breaker closing (as described in Reference 2 of Enclosure 2 to the letter dated November 8, 1999) and assumed pump motor acceleration time of 1.5 seconds. The assumed circuit breaker closing time of 0.4 second is a conservative time because the actual average closing time of ITE 5 KV circuit breakers is 0.075 second (reference calculation E4C-098 - 4 KV Protective Relay Setting Calculation). The assumed pump motor acceleration time of 1.5 seconds is also a conservative value as shown in the response to NRC question 3, below. The assumed acceleration time has not been adjusted for voltage and frequency variations.

**QUESTION 3:**

Enclosure 1, Page 11 - This states that actual acceleration times were reviewed to ensure that the actual times were consistent with the electrical analyses and were less than the assumed time. How did you obtain actual acceleration times? Have these acceleration times been adjusted for the voltage and frequency variations?

Response:

During ESF surveillance testing, voltage and frequency of the Class 1E 4.16 KV bus were measured and recorded. The pump acceleration times were obtained from the voltage and frequency traces. Voltage traces from several ESF tests were reviewed for the pump acceleration times. The following pump acceleration times were derived from the recorder traces of voltage and frequency.

| Service | Pump ID | ESF Test date | Motor starting time (sec) | Calculated motor starting time (sec) | Assumed pump starting time* (sec) |
|---|---|---|---|---|---|
| LPSI pump | 2P015 | 11-13-89 | 0.8 | 0.87 | 22.5 |
| | | 11-11-89 | 0.75 | | |
| | | 07-27-93 | 0.9 | | |
| | 2P016 | 11-11-89 | 0.75 | | |
| | | 11-13-89 | 0.8 | | |
| | 3P015 | 03-14-92 | 0.95 | | |
| | | 06-08-90 | 0.95 | | |
| | 3P016 | 03-14-92 | 0.95 | | |
| | | 03-12-92 | 1.0 | | |
| Containment Spray pump | 2P012 | 07-27-93 | 0.9 | 0.87 | 1.9 |
| | | 11-11-89 | 0.75 | | |
| | 2P013 | 11-13-89 | 0.95 | | |
| | | 11-11-89 | 0.8 | | |
| | 3P012 | 03-14-92 | 0.95 | | |
| | | 03-14-92 | 0.95 | | |
| | 3P013 | 03-14-92 | 0.94 | | |
| | | 03-14-92 | 0.90 | | |
| | | 03-14-92 | 0.80 | | |
| Component Cooling Water pump | 2P024 | 11-13-89 | 0.75 | 0.73 | 2.5 |
| | 2P025 | 11-11-89 | 0.75 | | |
| | | 07-27-93 | 0.75 | | |
| | 2P026 | 11-11-89 | 0.75 | | |
| | | 07-28-93 | 0.75 | | |
| | 3P025 | 06-07-90 | 0.85 | | |
| | | 03-14-92 | 0.80 | | |
| | 3P026 | 03-14-92 | 0.80 | | |
| | | 03-14-92 | 0.80 | | |

| Service | Pump ID | ESF Test date | Motor starting time (sec) | Calculated motor starting time (sec) | Assumed pump starting time* (sec) |
|---|---|---|---|---|---|
| Auxiliary Feedwater pump | 2P141 | 11-11-89 | 2.2 | 3.3** | 8 |
| | | 11-13-89 | 2.4 | | |
| | 2P504 | 11-13-89 | 2.4 | | |
| | | 07-27-93 | 2.5 | | |
| | 3P141 | 03-14-92 | 2.3 | | |
| | | 03-14-92 | 2.5 | | |
| | 3P504 | 03-14-92 | 2.3 | | |
| | | 07-23-93 | 2.4 | | |

Notes: * This assumed pump starting time includes an assumed breaker closing time of 0.4 second, as described in the response to NRC question 2.

** Measured motor starting times are for the existing AFWP motors and calculated motor starting time is for the AFWP spare motor which has greater inertia and longer acceleration time than those of the installed motors.

The measured starting times are consistent with the calculated motor starting times. The test data support the assumed pump starting times used in the Safety Analyses. Since the diesel generator voltage and frequency during testing are nearly identical to the simulated values, these measured acceleration times were not adjusted for the voltage and frequency variations.

**QUESTION 4:**

The staff believes that most licensees are using Agastat time delay relays as their automatic load sequence timers. What is the Industry experience with these timers?

Response:

NRC Information Notice 92-77 addresses the suitability of application of Agastat electropneumatic E7000 time delay relays used in emergency diesel generator (EDG) load sequencer applications. Numerous time-delay relay setpoints have been found outside the required Technical Specification (TS) parameters during surveillance testings at several nuclear power plants, including SONGS 2 & 3. The inaccurate relay setpoints could cause equipment to start early, simultaneously or late. However, timing failures experienced at SONGS 2 & 3 during integrated ESF tests were evaluated and found not to affect EDG operability. Agastat relays do not have the repeat accuracy needed to meet the stringent SONGS 2 & 3 TS requirements.

# ATTACHMENT

EC&FS DEPARTMENT

# CALCULATION SHEET

| ICCN NO./ PRELIM. CCN NO. | PAGE ___ OF ___ |
|---|---|

CCN CONVERSION
CCN NO. **CCN -**

Project or DCP/FCN SONGS 2 Calc No. E4C-086

Subject SONGS 2 Data Development and Documentation Sheet No. 427 of

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 2 | G.E. MCALLISTER | | W. P. LENNARTZ | | | | | | |
| | | | | | | | | | |

## 2.2 - PSS/E DATA

EC&FS DEPARTMENT

# CALCULATION SHEET

| ICCN NO./ PRELIM. CCN NO. | PAGE ____ OF ____ |
|---|---|
| | CCN CONVERSION CCN NO. **CCN -** |

Project or DCP/FCN SONGS 2 Calc No. E4C-086

Subject SONGS 2 Data Development and Documentation Sheet No. 438 of ____

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 2 | G.E. MCALLISTER | | W. P. LENNARTZ | | | | | | |
| | | | | | | | | | |

**Load Name:** Auxiliary Feedwater Pump
MOTOR S/N: 8-5116-90614-01-1
**Applicable Tag Number(s):** (REPLACEMENT MOTOR)

| **Motor Data Parameter** | | **Data Source** |
|---|---|---|
| *Horsepower:* | 800 hp | S023-405-6-155-3 (Ref. 5.266) |
| *Rated Voltage:* | 4160 V | S023-405-6-155-3 (Ref. 5.266 |
| *Rated Power Factor:* | 0.91 | S023-405-6-155-3 (Ref. 5.266) |
| *Nameplate Efficiency:* | 96 % | S023-405-6-155-3 (Ref. 5.266) |
| *Full Load Current:* | 99.0 A | S023-405-6-155-3 (Ref. 5.266) |
| *Locked Rotor Current:* | 681.0 A | S023-405-6-155-3 (Ref. 5.266) |
| *Starting Power Factor:* | 0.17 | S023-405-6-155-3 (Ref. 5.266) |
| *Synchronous RPM:* | 3600 rpm | S023-405-6-155-3 (Ref. 5.266) |
| *Rated RPM:* | 3580 rpm | S023-405-6-155-3 (Ref. 5.266) |
| *$WK^2$ of Load:* | 13 $lb\text{-}ft^2$ | S023-405-6-155-3 (Ref. 5.266) |
| *$WK^2$ of Motor:* | 260 $lb\text{-}ft^2$ | S023-405-6-155-3 (Ref. 5.266) |
| *Starting Torque:* | 106 % | S023-405-6-155-3 (Ref. 5.266) |
| *Breakdown Torque:* | 292 % | S023-405-6-155-3 (Ref. 5.266) |
| *Brake Horsepower:* | 868.0 hp | M-DSC-235 (Ref. 5.3) |

**Constants used in PSS/E CMOTOR Models**

| | |
|---|---|
| *Rated MVA of Load:* | 0.6832 MVA |
| *Inertia Constant H:* | 1.1963 |
| *Initial Slip:* | 0.0060 |
| *Torque Constant:* | 0.9826 |
| *Rated Speed:* | 0.9944 pu |
| *Ratio of Starting Torque to Rated Torque:* | 1.0612 |
| *Powerflow Real Power P:* | 674.5 KW |
| *Powerflow Reactive Power Q:* | 307.3 KVAR |

**See Section 7.2.2 for the calculation of these constants**

# CALCULATION SHEET

| ICCN NO./ PRELIM. CCN NO. | PAGE ____ OF ____ |
|---|---|
| | CCN CONVERSION CCN NO. **CCN -** |

Project or DCP/FCN SONGS 2    Calc No. E4C-086

Subject SONGS 2 Data Development and Documentation    Sheet No. 479 of ____

| REV | ORIGINATOR | DATE | IRE | DATE | REV | ORIGINATOR | DATE | IRE | DATE |
|---|---|---|---|---|---|---|---|---|---|
| 2 | G.E. MCALLISTER | | W. P. LENNARTZ | | | | | | |
| | | | | | | | | | |

**Load Name:** Auxiliary Feedwater Pump

**Applicable Tag Number(s):** MOTOR S/N: 8-5116-90614-01-1 (REPLACEMENT MOTOR)

---

<u>Comparison Between Actual Motor Parameters and Model Parameters</u>

| Parameter | Actual | Model |
|---|---|---|
| Rated Power Factor | 0.91 | 0.91 |
| Locked Rotor Current (% of Rated) | 688 % | 688 % |
| Starting Power Factor | 0.17 | 0.17 |
| Starting Torque (% of Rated) | 106 % | 106 % |
| Breakdown Torque | 292 % | 292 % |

| ETERM | TYPE | RA | LA | LM | R1 | L1 | R2 | L2 |
|---|---|---|---|---|---|---|---|---|
| 1.000 | 2 | 0.0044 | 0.0650 | 3.6800 | 0.0290 | 0.0681 | 0.0042 | 0.0498 |

```
MOTOR BASE MVA     =  100.00000
SYSTEM BASE MVA    =  100.00000
AT PU SPEED OF          0.00000
AND PU VOLTAGE OF       1.00000
TORQUE             =    0.96113
CURRENT (MAG.)     =    6.87868
POWER FACTOR       =    0.16999
P + JQ (P.U.)      =    1.16932 +J    6.77856
YMOTOR (MOT BASE)  =    1.16932 +J   -6.77856
YMOTOR (SYS BASE)  =    1.16932 +J   -6.77856

MOTOR BASE MVA     =  100.00000
SYSTEM BASE MVA    =  100.00000
AT PU SPEED OF          0.99644
AND PU VOLTAGE OF       1.00000
TORQUE             =    0.90566
CURRENT (MAG.)     =    0.99999
POWER FACTOR       =    0.91007
P + JQ (P.U.)      =    0.91006 +J    0.41444
YMOTOR (MOT BASE)  =    0.91006 +J   -0.41444
YMOTOR (SYS BASE)  =    0.91006 +J   -0.41444
```

FIGuRE 1
PSS/E & TEST VOLTAGE PROFILES FOR 2A04

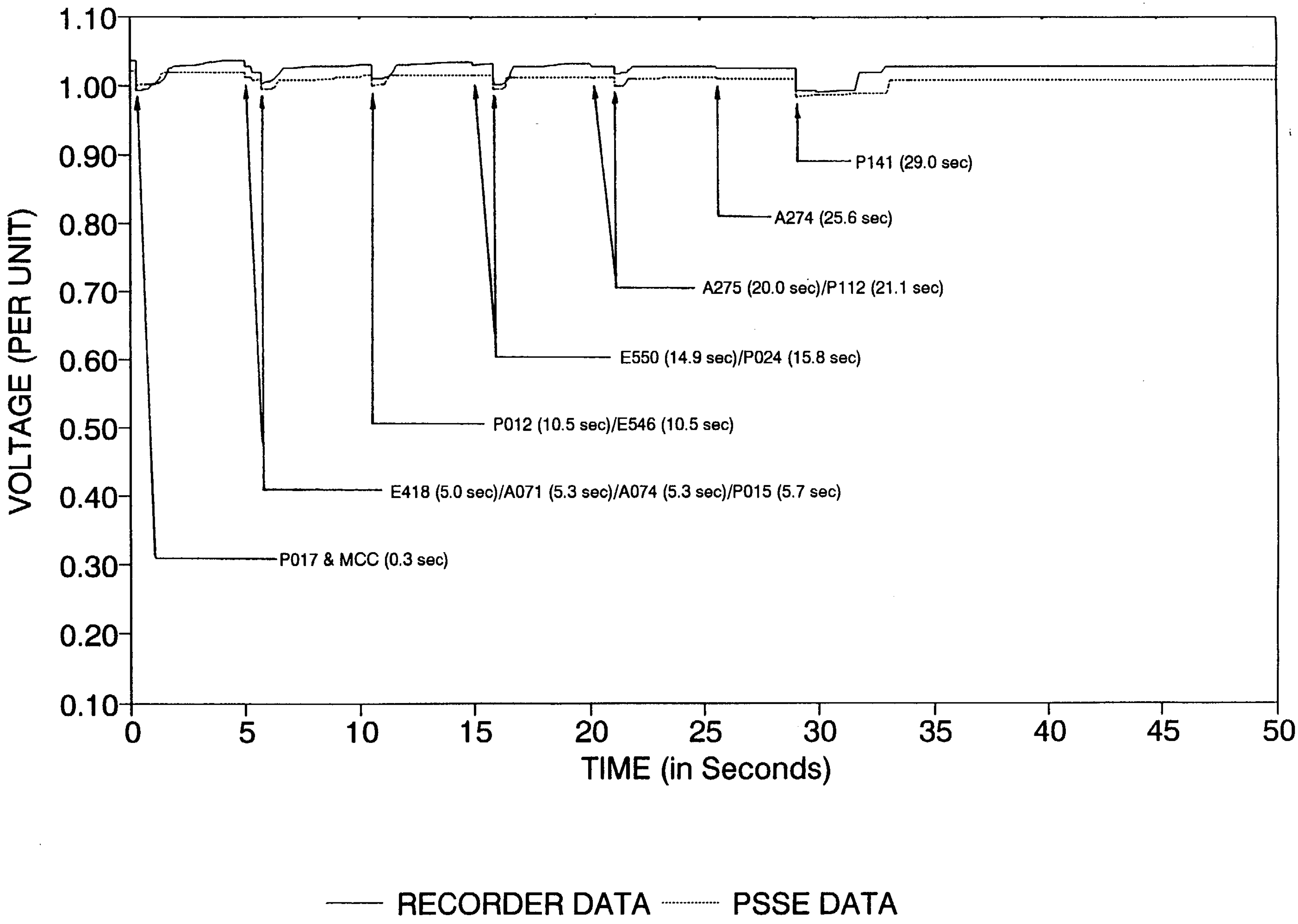

FIGURE 2
PSS/E & TEST VOLTAGE PROFILES FOR 2A06