Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-16-093

June 17, 2016

10 CFR 50.90

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU) - Supplement 19, Responses to Requests for Additional Information**

References:
1. Letter from TVA to NRC, CNL-15-169, "Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU)," dated September 21, 2015 (ML15282A152)
2. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Request for Additional Information Related to License Amendment Request Regarding Extended Power Uprate (CAC Nos. MF6741, MF6742, and MF6743)," dated May 6, 2016 (ML16119A440)

By the Reference 1 letter, Tennessee Valley Authority (TVA) submitted a license amendment request (LAR) for the Extended Power Uprate (EPU) of Browns Ferry Nuclear Plant (BFN) Units 1, 2 and 3. The proposed LAR modifies the renewed operating licenses to increase the maximum authorized core thermal power level from the current licensed thermal power of 3458 megawatts to 3952 megawatts. During the technical review of the LAR, the Nuclear Regulatory Commission (NRC) identified the need for additional information. The Reference 2 letter provided NRC Electrical Engineering Branch Requests for Additional Information (RAIs) EEEB-RAIs 5 through 25. The due date for the responses to the NRC RAIs provided by the Reference 2 letter is June 10, 2016. Subsequently, it was determined that additional time was needed to complete the responses to these RAIs and the due date for submittal of the responses to EEEB-RAIs 5 through 25 was extended to June 17, 2016, per communication with the NRC Project Manager. The enclosures to this letter provide the responses to the RAIs included in the Reference 2 letter.

Enclosure 1 contains the responses to EEEB-RAIs 5 through 25. Enclosure 2 to this letter provides a supplement to the Power Uprate Safety Analysis Report (PUSAR) (NEDC-33860P, Revision 0). GE-Hitachi Nuclear Energy Americas LLC (GEH) considers portions of the information provided in Enclosure 2 of this letter to be proprietary and therefore, exempt from public disclosure pursuant to Title 10 of the *Code of Federal Regulations* (10CFR), Part 2.390, Public inspections, exemptions, requests for withholding. An affidavit for withholding information, executed by GEH, is provided in Enclosure 4. Enclosure 3 to this letter provides a supplement to PUSAR (NEDO-33860, Revision 0). Enclosure 3 is a non-proprietary version of the supplements provided in Enclosure 2. Therefore, on behalf of GEH, TVA requests that Enclosure 2 be withheld from public disclosure in accordance with the GEH affidavit and the provisions of 10 CFR 2.390.

Enclosure 5 provides the single line diagrams requested by EEEB-RAI 18.

TVA has reviewed the information supporting a finding of no significant hazards consideration and the environmental consideration provided to the NRC in the Reference 1 letter. The supplemental information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the supplemental information in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed license amendment. Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter to the Alabama State Department of Public Health.

There are no new regulatory commitments associated with this submittal. If there are any questions or if additional information is needed, please contact Mr. Edward D. Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 17th day of June 2016.

Respectfully,

[signature] for

J. W. Shea
Vice President, Nuclear Licensing

Enclosure

cc: See Page

Enclosures:

1. Responses to NRC Electrical Engineering Branch Requests for Additional Information EEEB-RAIs 5 through 25
2. Supplement to PUSAR (NEDC-33860P, Revision 0) - (Proprietary version)
3. Supplement to PUSAR (NEDO-33860, Revision 0) - (Non-proprietary version)
4. General Electric Hitachi Affidavit for NEDC-33860P, Revision 0
5. Single Line Diagrams Requested by EEEB-RAI 18

cc:

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
State Health Officer, Alabama Department of Public Health (w/o Enclosure 2)

ENCLOSURE 1

Responses to NRC Electrical Engineering Branch Requests for Additional Information EEEB-RAIs 5 through 25

ENCLOSURE 1

EEEB-RAI 5[1]

In Section 2.3.1 of Attachment 7 (ADAMS Accession No. ML15282A181) of the LAR, the licensee identified changes to existing environmental qualification (EQ) parameters (temperatures, pressures, radiation and humidity) for electrical equipment in some areas inside and outside primary containment due to the extended power uprate (EPU). However, the licensee did not specify if these changes (also shown in Tables 2.3-1, 2.3-2, 2.3-3, and 2.3-5, Figure 2.3-1, and Figure 2.3-2) apply to all three BFN units.

Confirm if these changes in Section 2.3.1 and above mentioned tables and figures are applicable to all three BFN units. If not, provide unit-specific evaluation, tables, and figures for EQ parameters.

TVA Response:

TVA confirms that the changes in Section 2.3.1 of Attachment 7 of the LAR along with Tables 2.3-1, 2.3-2, 2.3-3 and 2.3-5, Figure 2.3.1 and Figure 2.3-2 apply to all three Browns Ferry Nuclear Plant units.

[1] *Refer to TVA letter dated February 16, 2016, for EEEB-RAI 1 through 4.*

EEEB-RAI 6

On page 2-130 of Attachment 7 of the LAR, in the BFN Current Licensing Basis section, the licensee stated that the BFN EQ program for electrical equipment is described in the BFN Updated Final Safety Analysis Report (UFSAR), Section 8.9, "Safety Systems Independence Criteria and Bases for Electrical Cable Installation." However, Section 8.9 of the UFSAR does not contain the description of the BFN EQ program.

Provide the current licensing basis (include the history) for the BFN EQ of electrical equipment, and a mark-up of the UFSAR's relevant sections showing the requested information.

TVA Response:

The Environmental Qualification (EQ) of Electrical Equipment for the Browns Ferry Nuclear Plant (BFN) is described in Section 7.1.6 of the UFSAR. Corrected mark-ups of the affected page of the PUSAR (proprietary and non-proprietary) are provided in Enclosures 2 and 3, respectively. The current licensing basis (including the history) for the BFN EQ of electrical equipment is provided in the attached mark-up (Attachment 1) of the proposed change to Section 7.1.6 of the BFN UFSAR.

Attachment 1

UFSAR Section 7.1.6 Mark-up

6. Activated Device--An activated device is a mechanical module in a system used to accomplish an action. An activated device is controlled by an actuation device. See Figure 7.1-1.

7. Trip--A trip is the change of state of a bistable device which represents the change from a normal condition. A trip signal, which results from a trip, is generated in the channels of a trip system and produces subsequent trips and trip signals throughout the system as directed by the logic.

8. Setpoint--A setpoint is that value of the monitored plant variable which causes a channel trip.

9. Component--A component includes those items from which the system is assembled (e.g., resistors, capacitors, wires, connectors, transistors, switches, springs, pumps, valves, piping, heat exchangers, vessels, etc.).

10. Module--A module is any assembly of interconnected components which constitutes an identifiable device, instrument, or piece of equipment.

11. Incident Detection Circuitry--Incident detection circuitry includes those trip systems which are used to sense the occurrence of an incident. Such circuitry is described and evaluated separately where the incident detection circuitry is common to several systems.

12. Channel calibration, channel check, channel functional test, and logic system functional definitions are provided in Technical Specification Section 1.1.

7.1.6 Environmental Qualification of Electrical Equipment

~~Safety-related electrical equipment is capable of performing its safety-related function under environmental conditions associated with all normal, abnormal, and plant accident operation (See subsection 1.5).~~

Insert A

INSERT A

7.1.6 Environmental Qualification of Electrical Equipment

The electrical equipment, within the scope of 10CFR50.49, at BFN must be qualified to the acceptance criteria specified in Category II of NUREG-0588 or the Division of Operating Reactor (DOR) guidelines of NRC Inspection and Enforcement (IE) Bulletin 79-01B (Institute of Electrical and Electronics Engineers (IEEE) 323-1971).

NRC IE Bulletin 79-01B "Environmental Qualification of Class 1E Equipment," was issued January 14, 1980. Subsequent supplements were issued February 29, 1980, September 30, 1980, and October 24, 1980. This bulletin requires the licensee to perform a detailed review of the environmental qualification of Class 1E electrical equipment to ensure that the equipment will function under postulated accident conditions.

TVA evaluated the electrical qualification of the safety-related electrical components in harsh environments during accident conditions and responded to the NRC on October 31, 1980.

The NRC issued a Safety Evaluation, dated June 3, 1981, for the Environmental Qualification of Safety-Related Electrical Equipment, noting several deficiencies. TVA responded in a letter dated September 29, 1981, to address these deficiencies.

The NRC Safety Evaluation, dated January 11, 1983, requested additional information from TVA. The TVA response, dated January 29, 1985, provided resolution to the NRC questions/deficiencies. In a letter dated August 8, 1985, the NRC concluded that BFN was in compliance with 10CFR50.49, and that proposed resolution to deficiencies noted was acceptable.

In July 1985, a TVA Environmental Qualification (EQ) program audit revealed significant deficiencies in the BFN EQ program. On August 6, 1985, the NRC issued Generic Letter 85-15 related to the deadlines for 10CFR50.49 compliance. Based on these developments, TVA subsequently voluntarily maintained BFN Units 1, 2, and 3, in shutdown conditions with the intent to correct deficiencies and establish and implement an EQ program that would assure compliance with 10CFR50.49.

Following shutdown, extensive rework of the BFN EQ program took place. The Environmental Qualification Project (EQP) was established to verify, with auditable records, that all plant equipment covered under 10CFR50.49 was qualified for its application and met its specified performance requirements when subjected to the conditions predicted to be present when it must perform its safety function; up to the end of its qualified life. Supplemental procedures were written, approved, and implemented. The purpose of Environmental Qualification Documentation Packages (EQDPs) is to document, in one place, everything needed about how a given piece of equipment was qualified, and what is necessary to maintain qualification for the life of the plant. In May of 1988 the NRC performed an inspection of BFN's partially completed EQ program. On October 21, 1988, the NRC issued a Safety Evaluation that concluded the BFN EQ program complied with the requirements of 10CFR50.49.

TVA letter dated October 24, 1988, committed to implement the EQ Program prior to the restart of each unit. The NRC Safety Evaluation for the BFN EQ Program was issued on January 23, 1991.

During the license renewal process for Units 1, 2, and 3, TVA was required to demonstrate that the equipment and components in the scope of the EQ program meet the requirements of 10CFR54.21(c)(1). Section 4.4 of the License Renewal Amendment addressed this requirement. In the Safety Evaluation dated April 2006, the NRC concluded that these components will be adequately managed for the period of extended operation.

The effects of Extended Power Uprate (EPU) on the environmental conditions for the qualification of electrical equipment have been evaluated. The evaluation indicates that the electrical equipment will continue to meet the relevant requirements of 10 CFR 50.49 following implementation of EPU.

TVA has a program in place to environmentally qualify safety-related electrical equipment (including cable) that is within the scope of 10CFR50.49 to ensure that the equipment will perform its safety-related function under environmental conditions associated with all normal, abnormal, and plant accident conditions.

The method of assuring that electrical components of safety-related equipment are qualified for their potential normal operational and worst-case accident environments is described in this section.

7.1.6.1 Equipment Identification and Environmental Conditions

7.1.6.1.1 Identification of Safety Systems

Systems that are required to function to mitigate a loss-of-coolant accident (LOCA) or high-energy line break (HELB) are listed in Table 7.1.6-1; systems required to support these systems are also identified.

7.1.6.1.2 Identification of Equipment in Harsh Environments

For the safety systems listed in Table 7.1.6-1, safety-related equipment within the harsh environment of the Design Basis Events (DBEs) was identified. This was based on a review of electrical instrument tabulations, mechanical piping drawings, mechanical heating and ventilation drawings, conduit and grounding drawings, Technical Specifications, the UFSAR, and Emergency Operating Instructions.

7.1.6.1.3 Environmental Conditions

7.1.6.1.3.1 Mild Environments

Mild environments are those areas where: (1) the environmental conditions related to temperature, pressure, or relative humidity resulting from the direct effects of a DBE are no more severe than those which would occur during an abnormal plant operational condition; (2) the temperature will not exceed 130°F due to the indirect effects of a DBE (e.g., increased heat loads from electrical equipment); (3) the accident radiation dose is less than or equal to 1.0×10^4 rads; and (4) the total accident plus 60 year total integrated dose (TID) is less than or equal to 5.0×10^4 rads.

For equipment located in a harsh zone, that is required to function or not fail for mitigation of a specific DBA, if (for the specific DBA) the accident environment in the area in which the device is located would at no time be significantly more severe than the environment for normal operation, including anticipated operational occurrences, then the environment may be considered to be essentially mild for classification purposes. Essentially mild calculations are performed for the associated area to document that the accident environmental conditions do not impose significant environmental stresses over and above normal operating conditions (including anticipated operational transients) on the device in the associated area.

7.1.6.1.3.2 Harsh Environments

Harsh area environmental conditions are defined as those conditions that exceed those of mild spaces. Environmental conditions have been established for all harsh environment areas resulting from a design basis event. Temperature, pressure, humidity, radiation, and submergence were the parameters considered.

7.1.6.2 Electrical Equipment within the Scope of 10CFR50.49

A systems analysis was conducted to identify for each UFSAR design basis accident, the equipment which must operate or stay “as-is” to ensure completion of safety related functions as defined in 10CFR50.49. These devices became the Master Components Electrical List (MCEL). This list includes devices in both harsh and mild environmental zones.

The BFN Component Master List (CML) was derived from the MCEL. The CML is a compilation, for areas designated as harsh on the environmental data drawings, of all safety-related equipment, any required nonsafety-related equipment, and any equipment added to comply with commitments to NUREG-0737 and/or NUREG-0578 and post-accident monitoring equipment (10CFR50.49b(3)). All MCEL supporting/ancillary equipment was then identified. All components were field verified. The 10CFR50.49 list is a compilation of data for electrical equipment which has been determined to be within the scope of 10CFR50.49 via the process beginning with the CML database through the evaluations performed in preparing a qualification EQDP (or “EQ binder”). Auditable documentation that supports environmental qualification for the equipment type is compiled and placed in the EQ binder or is referenced therein. The 10CFR50.49 list will be maintained for the life of the plant as a permanent record. This includes revisions resulting from changes occurring in the plant design and configuration which impact the equipment within the scope of 10CFR50.49. The 10CFR50.49 list for Units 1, 2, and 3 is maintained as part of the plant Master Equipment List (MEL) data. Post-accident Monitoring (PAM) equipment instrumentation (all Category 1 and 2 equipment, with the exception of Emergency Equipment Cooling Water flow) is qualified to the requirements of 10CFR50.49.

7.1.6.3 Qualification Tests and Analysis

Qualification tests and analyses for safety-related electrical equipment were conducted in accordance with the requirements of 10CFR50.49, IE Bulletin 79-01B, and the guidelines of NUREG-0588.

7.1.6.4 Qualification Test Results

Qualification test results are included or referenced in the EQ binder for safety-related electrical equipment in the 10CFR50.49 program.

References

NRC IE Bulletin 79-01B, Environmental Qualification of Class IE Equipment," dated January 14, 1980.

NRC Division of Operating Reactors, "Guidelines for Evaluating Environmental Qualification of Class IE Electrical Equipment in Operating Reactors," dated November 13, 1979.

TVA Response to NRC IE Bulletin 79-01B, dated October 31, 1980.

NRC Safety Evaluation for Environmental Qualification of Safety-Related Electrical Equipment, dated June 3, 1981.

NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Revision 1, dated July 1981.

BFN Letter to NRC, "Response to NRC Safety Evaluation deficiencies," dated September 29, 1981.

NRC Safety Evaluation for Environmental Qualification of Safety-Related Electrical Equipment, dated January 11, 1983.

TVA Letter to NRC, "Summary Status of TVA's Compliance with 10CFR50.49," dated January 29, 1985.

NRC Safety Evaluation for Environmental Qualification of Electric Equipment Important to Safety, dated August 8, 1985.

"NRC Safety Evaluation for the Browns Ferry Nuclear Performance Plan," dated October 21, 1988.

NUREG-1843, "Safety Evaluation Report Related to the License Renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3," dated April 2006.

NRC Code of Federal Regulations, 10CFR50.49.

NRC Safety Evaluation Report on Tennessee Valley Authority: Browns Ferry Nuclear Performance Plan – Browns Ferry Unit 2 Restart, April 1989.

Table 7.1.6.1 Systems (or Portions of Systems) Required to Mitigate LOCA and/or HELB

Neutron Monitoring System

Auxiliary Power

Main Steam Supply

Reactor Feedwater System

RHR Service Water System

Raw Cooling Water

Control Air System

Sampling and Water Quality

Standby Liquid Control System

Primary Containment System

Standby Gas Treatment

Emergency Equipment Cooling Water System

Reactor Water Recirculation

Reactor Water Cleanup System

Reactor Building Closed Cooling Water System

Reactor Core Isolation Cooling

High Pressure Core Injection

Residual Heat Removal

Core Spray System

Containment Inerting

HPCI Torus Room

Radwaste System

Fuel Pool Cooling and Demineralizing System

Containment Atmosphere Dilution System

CRD Hydraulic System

Radiation Monitoring System

Cables, Control Stations, Junction Boxes, and Terminal Blocks

EEEB-RAI 7

In Figure 2.3-1 of Attachment 7 of the LAR, the licensee provided the worst case drywell EQ accident temperature profiles for current licensed thermal power (CLTP) and EPU for 100 days. On page 2-132 of Attachment 7, the licensee stated that the profiles were developed by combining the bounding curves for both the steamline break and loss-of-coolant accident (LOCA) design basis accidents. Based on the figure, the staff noted that the EPU drywell temperature profile exceeds the existing drywell temperature profile over the entire 100 days. Note 1 of Table 2.3-1 states: "Current component qualification testing bounds the temperature increases."

Provide the current component qualification temperature profile of EQ electrical equipment (considering the qualified temperature of worst case components) inside primary containment to confirm that it bounds the EPU drywell temperature profile shown in Figure 2.3-1. Also, discuss how the temperature margins in the Institute for Electrical and Electronics Engineers Standard 323-1974 will be maintained under EPU conditions.

TVA Response:

With respect to providing the current component qualification temperature profile of EQ electrical equipment inside containment to confirm it bounds the EPU drywell temperature profile, the following response is provided.

> Although Figure 2.3-1 of Attachment 7 of the BFN LAR shows that the EPU drywell profile exceeds the CLTP drywell profile, the individual component qualification temperature testing still bounds the EPU drywell temperature profile. Note 1 of Table 2.3-1 states that "Current component qualification testing bounds the temperature increase." This statement is based on the result of accident degradation equivalency (ADE) calculations which support that the current component qualification testing exceeds the EPU drywell temperature profile. This is an industry accepted method of comparing the test and plant accident temperature profiles to demonstrate acceptable post-accident qualification.
>
> The three worst case examples of Environmental Qualified (EQ) Electrical equipment inside primary containment for temperature margin are Limitorque AC actuators inside containment, Rockbestos Company cable Type PXJ/PXMJ and Okonite Company cable type PXJ/PXMJ. The ADE calculations and profiles for the three worst cases are shown in Tables EEEB-RAI 7-1 through 7-3 and Figures EEEB RAI 7-1 through 7-3. These ADE calculations are derived from the Curtis-Wright EQ-System 1000 computer program. System 1000 is an industry accepted and widely used database and calculation program which provides a wide range of thermal information, thermal calculations and radiation effects data for a wide range of organic material used in various environments. The results of these ADE calculations show that each of these component qualification temperature tests exceed the EPU drywell temperature profile.

ENCLOSURE 1

With respect to maintaining the temperature margins in the Institute for Electrical and Electronics Engineers (IEEE) 323-1974 under EPU conditions, the following response is provided.

Browns Ferry Nuclear Plant (BFN) has EQ components qualified to Division of Operating Reactors (DOR) "Guidelines for Evaluating Qualification of Class IE Electrical Equipment in Operating Reactors," NUREG-0588, "Interim Staff Positon on Environmental Qualification of Safety-Related Electrical Equipment," and 10CFR50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants."

The DOR Guidelines, Section 6.0, do not provide explicit margin requirements because of implicit conservatisms included in the guideline criteria. Qualification requirements of the DOR Guidelines and NUREG-0588 Category II are compatible and provide equivalent qualification criteria. Therefore, BFN does not apply the IEEE 323-1974 suggested temperature margin, except as a guide, for evaluating both DOR and NUREG-0588 Category II electrical components.

BFN treats NUREG-0588 Category I components the same as 10CFR50.59 components. For both NUREG-0588 Category I and 10CFR50.49 components, a current component qualification temperature profile was either verified to provide the IEEE 323-1974 suggested temperature margin or a technical justification provided why adequate margin is maintained. Attached Table EEEB-RAI 7-4 lists those BFN 10CFR50.49 components that do not meet the suggested IEEE 323-1974 temperature margin and provides technical justification why adequate temperature margin is still maintained.

Table EEEB-RAI 7-1

CURTISS-WRIGHT

System 1000 Revision 17.0.d TVR Report

TEST VS. REQUIREMENTS CALCULATION

Description: EPU DW vs Limitorque AC Actuators Inside Contaihment

USER PREFERENCES USED IN THIS CALCULATION

Temperature (C to K) Conversion Factor: 273.00
Ramp Integration Interval: 0.1

CALCULATION INPUTS

Activation Energy: 1.02

Reference Temperature: 115.00 Fahrenheit

Requirements Profile:

Time	Units	Temperature	Units
1.00	Seconds	223.40	Fahrenheit
8.00	Seconds	301.10	Fahrenheit
10.00	Seconds	309.20	Fahrenheit
15.00	Seconds	314.10	Fahrenheit
20.00	Seconds	314.90	Fahrenheit
25.00	Seconds	315.50	Fahrenheit
30.00	Seconds	316.60	Fahrenheit
60.00	Seconds	325.70	Fahrenheit
600.00	Seconds	336.90	Fahrenheit
1200.00	Seconds	322.30	Fahrenheit
1800.00	Seconds	225.20	Fahrenheit
2400.00	Seconds	226.10	Fahrenheit
3000.00	Seconds	227.80	Fahrenheit
3600.00	Seconds	227.70	Fahrenheit
86400.00	Seconds	157.50	Fahrenheit
172800.00	Seconds	145.60	Fahrenheit
432000.00	Seconds	132.50	Fahrenheit
864000.00	Seconds	126.70	Fahrenheit
3456000.00	Seconds	118.70	Fahrenheit
5184000.00	Seconds	116.90	Fahrenheit
8640000.00	Seconds	115.10	Fahrenheit

Test Profile:

Time	Units	Temperature	Units
1.00	Seconds	162.00	Fahrenheit
23.00	Seconds	336.00	Fahrenheit
240.00	Seconds	340.00	Fahrenheit
3.00	Hours	340.00	Fahrenheit
3.25	Hours	332.00	Fahrenheit
3.50	Hours	325.00	Fahrenheit
3.75	Hours	322.00	Fahrenheit

Table EEEB-RAI 7-1 (continued)

CURTISS - WRIGHT

System 1000 Revision 17.0.d TVR Report

Accident Profile (continued):

Time	Units	Temperature	Units
4.00	Hours	320.00	Fahrenheit
6.00	Hours	320.00	Fahrenheit
7.00	Hours	252.00	Fahrenheit
7.50	Hours	249.00	Fahrenheit
24.00	Hours	249.00	Fahrenheit
4.00	Days	249.00	Fahrenheit
4.00	Days	190.00	Fahrenheit
30.00	Days	190.00	Fahrenheit

CALCULATION RESULTS

Requirements Equivalent Time: 1.8070 Years
Test Equivalent Time: 35.4232 Years
Margin: 1,860.35 %

ENCLOSURE 1

Figure EEEB-RAI 7-1

CURTISS - WRIGHT

System 1000 Revision 17.0.d TVR Report

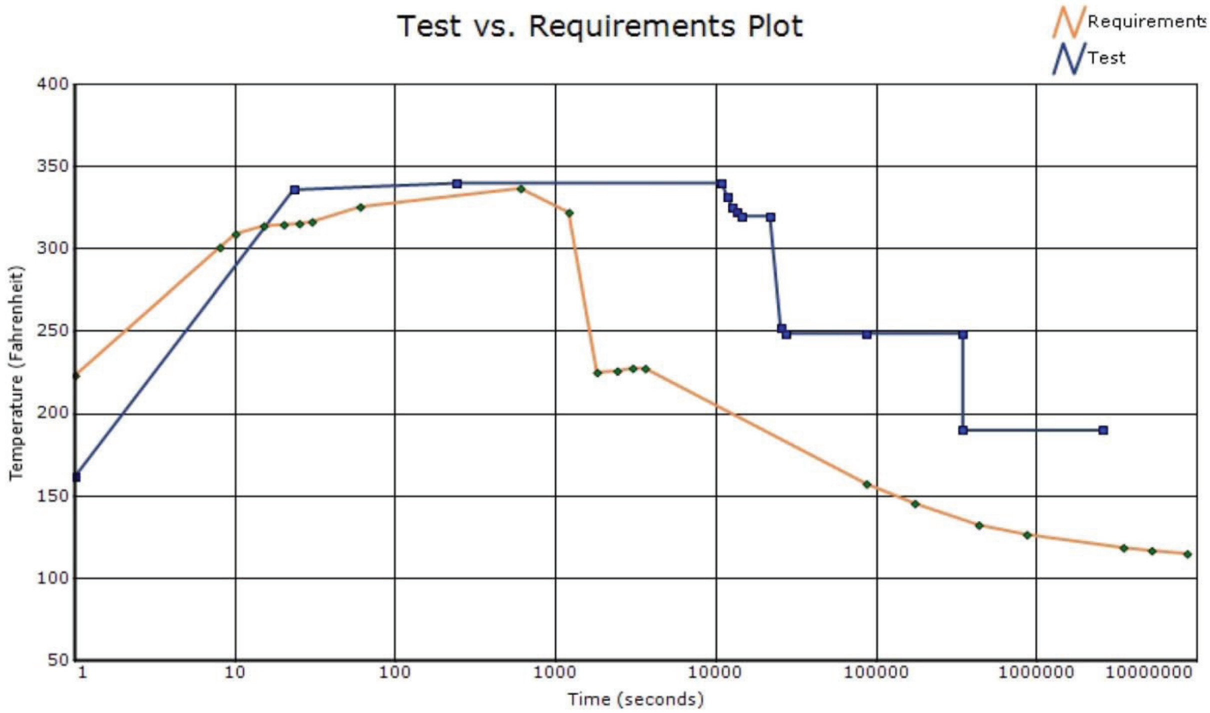

Table EEEB-RAI 7-2

CURTISS-WRIGHT

System 1000 Revision 17.0.d TVR Report

TEST VS. REQUIREMENTS CALCULATION

Description:EPU DW vs Rockbestos Company Cable Type PXJ/PXMJ

USER PREFERENCES USED IN THIS CALCULATION

Temperature (C to K) Conversion Factor: 273.00
Ramp Integration Interval: 0.1

CALCULATION INPUTS

Activation Energy: 1.34

Reference Temperature: 115.00 Fahrenheit

Requirements Profile:

Time	Units	Temperature	Units
1.00	Seconds	223.40	Fahrenheit
8.00	Seconds	301.10	Fahrenheit
10.00	Seconds	309.20	Fahrenheit
15.00	Seconds	314.10	Fahrenheit
20.00	Seconds	314.90	Fahrenheit
25.00	Seconds	315.50	Fahrenheit
30.00	Seconds	316.60	Fahrenheit
60.00	Seconds	325.70	Fahrenheit
600.00	Seconds	336.90	Fahrenheit
1200.00	Seconds	322.30	Fahrenheit
1800.00	Seconds	225.20	Fahrenheit
2400.00	Seconds	226.10	Fahrenheit
3000.00	Seconds	227.80	Fahrenheit
3600.00	Seconds	227.70	Fahrenheit
86400.00	Seconds	157.50	Fahrenheit
172800.00	Seconds	145.60	Fahrenheit
432000.00	Seconds	132.50	Fahrenheit
864000.00	Seconds	126.70	Fahrenheit
3456000.00	Seconds	118.70	Fahrenheit
5184000.00	Seconds	116.90	Fahrenheit
8640000.00	Seconds	115.10	Fahrenheit

Test Profile:

Time	Units	Temperature	Units
1.00	Seconds	342.00	Fahrenheit
3260.00	Seconds	340.00	Fahrenheit
21260.00	Seconds	319.00	Fahrenheit
24860.00	Seconds	302.00	Fahrenheit
28460.00	Seconds	300.00	Fahrenheit
35660.00	Seconds	300.00	Fahrenheit
39260.00	Seconds	253.00	Fahrenheit

Table EEEB-RAI 7-2 (continued)

CURTISS-WRIGHT

System 1000 Revision 17.0.d TVR Report

Accident Profile (continued):

Time	Units	Temperature	Units
53660.00	Seconds	249.00	Fahrenheit
64460.00	Seconds	250.00	Fahrenheit
71600.00	Seconds	249.00	Fahrenheit
75260.00	Seconds	259.00	Fahrenheit
78860.00	Seconds	261.00	Fahrenheit
86400.00	Seconds	257.00	Fahrenheit
111260.00	Seconds	254.00	Fahrenheit
348860.00	Seconds	222.00	Fahrenheit
586460.00	Seconds	227.00	Fahrenheit
672860.00	Seconds	223.00	Fahrenheit
1018460.00	Seconds	218.00	Fahrenheit
1277660.00	Seconds	233.00	Fahrenheit
1364060.00	Seconds	233.00	Fahrenheit
1623260.00	Seconds	222.00	Fahrenheit
3610460.00	Seconds	222.00	Fahrenheit
8621660.00	Seconds	224.00	Fahrenheit

CALCULATION RESULTS

Requirements Equivalent Time: 26.4621 Years
Test Equivalent Time: 1,181.4493 Years
Margin: 4,364.68 %

Figure EEEB-RAI 7-2

System 1000 Revision 17.0.d TVR Report

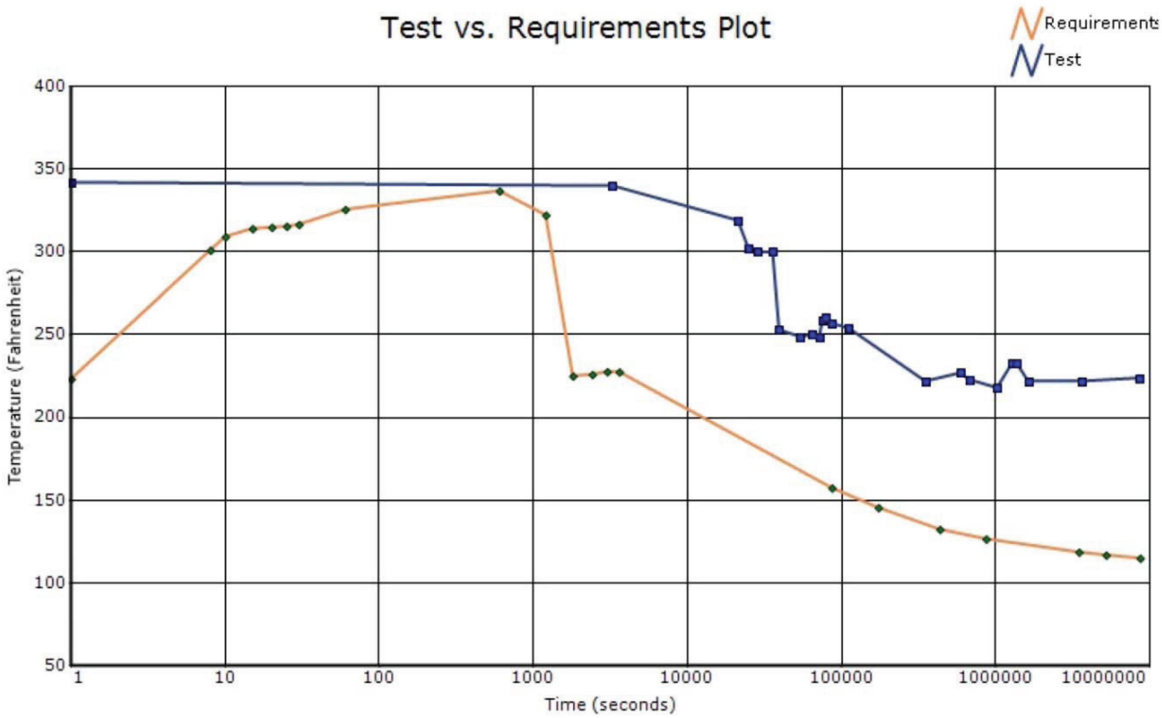

Table EEEB-RAI 7-3

CURTISS-WRIGHT

System 1000 Revision 17.0.d TVR Report

TEST VS. REQUIREMENTS CALCULATION

Description: EPU DW vs Okonite Company Cable Type PXJ/PXMJ

USER PREFERENCES USED IN THIS CALCULATION

Temperature (C to K) Conversion Factor: 273.00
Ramp Integration Interval: 0.1

CALCULATION INPUTS

Activation Energy: 1.07

Reference Temperature: 115.00 Fahrenheit

Requirements Profile:

Time	Units	Temperature	Units
1.00	Seconds	223.40	Fahrenheit
8.00	Seconds	301.10	Fahrenheit
10.00	Seconds	309.20	Fahrenheit
15.00	Seconds	314.10	Fahrenheit
20.00	Seconds	314.90	Fahrenheit
25.00	Seconds	315.50	Fahrenheit
30.00	Seconds	316.60	Fahrenheit
60.00	Seconds	325.70	Fahrenheit
600.00	Seconds	336.90	Fahrenheit
1200.00	Seconds	322.30	Fahrenheit
1800.00	Seconds	225.20	Fahrenheit
2400.00	Seconds	226.10	Fahrenheit
3000.00	Seconds	227.80	Fahrenheit
3600.00	Seconds	227.70	Fahrenheit
86400.00	Seconds	157.50	Fahrenheit
172800.00	Seconds	145.60	Fahrenheit
432000.00	Seconds	132.50	Fahrenheit
864000.00	Seconds	126.70	Fahrenheit
3456000.00	Seconds	118.70	Fahrenheit
5184000.00	Seconds	116.90	Fahrenheit
8640000.00	Seconds	115.10	Fahrenheit

Test Profile:

Time	Units	Temperature	Units
1.00	Seconds	168.00	Fahrenheit
30.00	Seconds	333.00	Fahrenheit
300.00	Seconds	394.00	Fahrenheit
10800.00	Seconds	394.00	Fahrenheit
10800.00	Seconds	388.00	Fahrenheit
21600.00	Seconds	388.00	Fahrenheit
21600.00	Seconds	368.00	Fahrenheit

Table EEEB-RAI 7-3 (continued)

CURTISS-WRIGHT

System 1000 Revision 17.0.d TVR Report

Accident Profile (continued):

Time	Units	Temperature	Units
36000.00	Seconds	368.00	Fahrenheit
36000.00	Seconds	318.00	Fahrenheit
86400.00	Seconds	318.00	Fahrenheit
91.00	Hours	318.00	Fahrenheit
91.00	Hours	265.00	Fahrenheit
3155.00	Hours	265.00	Fahrenheit

CALCULATION RESULTS

Requirements Equivalent Time: 2.5785 Years
Test Equivalent Time: 1,618.7473 Years
Margin: 62,678.47 %

Figure EEEB-RAI 7-3

System 1000 Revision 17.0.d TVR Report

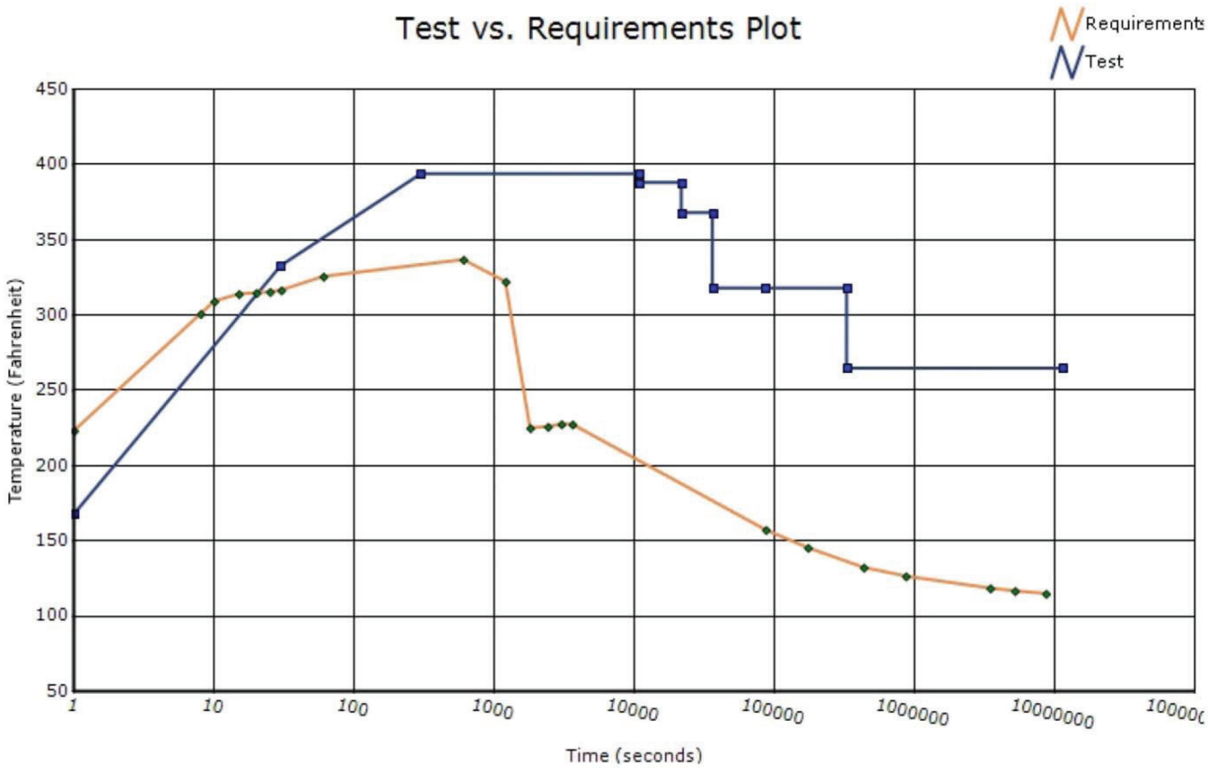

Table EEEB-RAI 7-4
BFN Components With Technical Justification for Temperature Margin

Component	Justification
Cable - Rockbestos Company [Type PXJ/PXMJ]	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F (EPU maximum Design Basis Accident (DBA) temperature in the Drywell) for total of more than 2 hours during the transients; whereas, the BFN EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Cable – Okonite Company [Type PX, PXJ & PXMJ]	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F for a total of more than 4.5 hours during the transients; whereas, the BFN EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Cable - Rockbestos Company [Type SIS]	The test temperature during the second of two transients applied during the testing was maintained at 340°F for 2.9 hours whereas, the plant accident profile remains above 300°F (with a peak at 337°F) for approximately 20 minutes. In addition, SIS wire is used inside MOVs, junctions boxes, etc., which will insulate the wire from the full ambient temperature rise during the transient. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Cable - Rockbestos Company [Type PXJ/PXMJ]	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F (EPU maximum DBA temperature in the Drywell) for total of one hour during the transients; whereas, the BFN EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Cable - Rockbestos Company [Type MS]	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F (EPU maximum DBA temperature in the Drywell) for total of one hour during the transients; whereas, the BFN EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.

Table EEEB-RAI 7-4
BFN Components With Technical Justification for Temperature Margin (continued)

Component	Justification
Cable – Okonite Company [Type PXJ & PXMJ]	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F for more than 1 hour during both transients; whereas, the EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Namco Limit Switch Model EA-740	A double transient was applied during the test in accordance with IEEE-323-1974. The test profile transient temperature remained above 337°F for more than 3 hour during both transients; whereas, the EPU accident profile drops below 300°F in less than 20 minutes. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.
Limitorque AC Actuators Inside Containment	Testing demonstrated that an actuator at 492°F superheated steam will remain at the 315°F saturated steam temperature for 17 minutes. Therefore it is conservative to state that actuator at 337°F superheated steam will remain at a 298°F saturate steam temperature for 12 minutes. Even though this only provides a 13°F margin, this is acceptable because the transient conditions were applied twice in the test.
Limitorque AC Actuators Outside Containment	The test profile transient temperature remained above 250°F for more than 24 hours during both transients; whereas, the EPU accident profile peaks at 250°F (lasting for 10 seconds) then decreases to 220°F after 30 seconds and continues to decrease thereafter. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement
Raymond Controls - Control Sure 24-10-4	Based on thermal aging assessment the non-metallic components of the actuators they possess an expected life in excess of end of plant life at the abnormal ambient temperature plus an 110 day accident equivalent temperature.
Raymond Controls - Control Sure 25-10-4CW	Based on thermal aging assessment the non-metallic components of the actuators they possess an expected life in excess of end of plant life at the abnormal ambient temperature plus an 110 day accident equivalent temperature.
Static-O-Ring -141 Series Flow Switches	The test profile transient temperature remained above 215°F for more than 7 hours during; whereas, the BFN EPU accident temperature remains above 215°F for approximately one minute,. Therefore, there is sufficient margin in the peak temperature demonstrated during the test as compared to the plant accident temperature requirement.

EEEB-RAI 8

On page 2-132 of Attachment 7 of the LAR, the licensee states:

> *The maximum normal and maximum abnormal temperatures [inside primary containment] will increase by 0.12°F [degrees Fahrenheit], which will be rounded to 1°F. This small temperature increase will have a minor effect on thermal qualified life and will be addressed as part of normal EQ maintenance replacement.*

Also, on page 2-133 of Attachment 7, the licensee states:

> *The Steam Tunnel (EQ room 7) bulk temperature [outside primary containment] at EPU conditions will increase by 0.37°F and is conservatively rounded up to a 1°F increase for the EPU evaluation. This temperature increase has a minor effect on thermal qualified life and is addressed as part of normal EQ maintenance replacement.*

a. *Provide the EPU maximum normal and abnormal temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment inside the primary containment preferably in a tabular form. Also, provide the EPU temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment in the steam tunnel preferably in a tabular form.*

b. *Discuss the effects of the increased temperatures on the equipment thermal qualified life and how the equipment will be maintained during its lifetime to ensure that it remains qualified and capable of performing its intended design function under EPU conditions.*

TVA Response:

a. The EPU maximum normal and abnormal temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment inside the primary containment are provided in Table EEEB-RAI 8-1. The EPU maximum normal and abnormal temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment in the steam tunnel are provided in Table EEEB-RAI 8-2.

b. Any increase in the ambient temperature that an environmentally qualified component experiences would result in a reduction of its thermal qualified life. However, the small increases in ambient temperature due to EPU will have an insignificant effect on the equipment qualified life. Requirements for maintenance and periodic replacement of 10CFR50.49 components are tracked by the BFN EQ program. The effects of environmental conditions due to EPU on the qualification of electrical equipment have been evaluated and the EQ program maintenance and periodic replacement requirements will be changed, as required, to ensure all 10CFR50.49 components will remain qualified and capable of performing their intended designed function under EPU conditions. The resulting EQ maintenance and periodic replacement requirements are incorporated in, and tracked by, the BFN preventative maintenance program.

Table EEEB-RAI 8-1
Temperatures and Qualified Lives for Components Inside Containment at EPU

Component Description	EPU Maximum Normal Temperature (°F)	EPU Maximum Abnormal Temperature (°F)	Qualification Temperature Limits (°F)[1]	Thermal Qualified Life (Years)
Rockbestos Cable [Type PXJ/PXMJ]	148	165	341.9	60.67
Eaton Cable [Type MS]	148	165	375	67.87
Brand Rex Cable [Type PXJ/PXMJ]	148	165	385	60.71
Okonite Cable [Type PX/PXJ/PXMJ]	148	165	341	96.57
Rockbestos Cable [Type SIS]	145	159	341.8	60.67
Rockbestos Cable [Type PXJ/PXMJ]	148	165	341	60.90
Rockbestos Cable [Type MS]	148	165	341	60.67
Rockbestos [Coaxial Cable]	148	165	353	97.37
Okonite Cable [Type PXJ/PXMJ]	148	165	341	60
Conax Corp. ECSA	148	165	375	69.16
Conax Coaxial Connector	136	141	445	Teflon Connector - 20.16 (U2) Rexolite Connector - 3861.06 (U1 and U3)
Temperature Element - Weed SP611-1A-A-3-C-2-75-4D4-2, 1B1D/612D-1A-C-6-C-17-00	136	141	500	39.99
Special Measure Transmitter - TEC VFMS22773A, 504A, 160-2 and 2273-C2	145	159	510	Charge Converter - 3.38 Transient Shield - 6.45 BNC Adaptor - 289.39
Limit Switch Namco EA-740 (QTR-180)	136[2] /148[3]	141[2] / 165[3]	387	10.25[2]/5.69[3]
MOV - Limitorque AC/IPC SMB-000, 00, 0, 2, and SB-3	145	159	340	Fiberite - 40.47 Phenolic - 94.32 Motor Insulation - 103.27 SIS Wire - 60.67
EPA - Conax 7504-10001-03-04, -05, and 7F02-10000-01	136	141	371	60.2 (U1 and U2)

ENCLOSURE 1

Table EEEB-RAI 8-1
Temperatures and Qualified Lives for Components Inside Containment at EPU (continued)

Component Description	EPU Maximum Normal Temperature (°F)	EPU Maximum Abnormal Temperature (°F)	Qualification Temperature Limits (°F)[1]	Thermal Qualified Life (Years)
EPA - GE 100 Series (TVA ID Nos. EA & EF)	136	141	340	Flamatrol Cable - 113 Epoxy - 1614 (U1 and U2)
EPA - GE Canister 238X600RH	136	141	340	Vulkene Cable - 52.07 XR-5126 Epoxy - 70.82 Flamtrol Cable - 58.78 (U3)
ASCO NP Series, 206 Series Solenoid Valves	148	165	535	206 Series Elastomers - 19.59 NP8316 Elastomers - 48.65 206 and NP8316 Coil - 3501.09
Automatic Valve C-5497 Solenoid Valves	136	141	360	Manifold Block - 11.13 250 VDC H Coil/ O-Rings - 5.62 250 VAC H Coil - 11.13 3-Way Solenoid Valve - 49.05 4-Way Solenoid Valve - 49.05 Terminal Block - 16.03
Target Rock 1/2 SMS-S-02-05 Solenoid Valves	145	159	355	Solenoid Coil - 10.52 Solenoid Enclosure - 25.51 Viton O-Ring - 10
Raychem WCSF-N Splices (Old formulation Raychem)	148	165	390	60.12
Raychem NPKV, NPKC,NPKP, NPKS, NMCK, NCBK, NESK Splices (Old formulation Raychem)	148	165	390	60.12
Raychem WCSF-N Series, NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK Splices (New formulation Raychem)	148	165	425	54.65

1 Maximum DBA qualification test temperature
2 Drywell Elevation (El.) 549.92' to El. 585'
3 Drywell El. 617' to El. 639'

Table EEEB-RAI 8-2
Temperatures and Qualified Lives for Components Inside the Steam Tunnel (Rm. 7) at EPU

Component Description	EPU Maximum Normal Temperature (°F)	EPU Maximum Abnormal Temperature (°F)	Qualification Temperature Limits (°F)[1]	Thermal Qualified Life (Years)
Rockbestos Cable [Type PXJ / PXMJ]	161	181	341.9	60.67
Eaton Cable [Type MS]	161	181	375	67.67
Okonite Cable [Type PXJ]	161	181	345	60
Brand Rex Cable [Type PXJ/PXMJ]	161	181	385	49.61
Rockbestos Cable [Type SIS]	161	181	341.8	60.67
Conax Corp. ECSA	161	181	375	69.16
EGS Quick Disconnect	161	181	435	Insulator Material - 20.75 EPDM O-Rings - 4.50 Epoxy Potting Material - 20.20 SIS Wire - 60.67
Temperature Element - Weed SP611-1A-A-3-C-2-75-4D4-2, 1B1D/612D-1A-C-6-C-17-00	161	181	500	12.77
Temperature Switch - EGS (Fenwal) 01-170230-090	161	181	350	5.39
Namco EA-740	161	181	387	3.11
Limitorque DC/OPC SMB-000, 00, 0, 2, 3, 4T, and SB-0	161	181	340	Motor Insulation - 7.07 Terminal Blocks - 22.21 Fiberite Switches - 8.09 SIS Wire - 60.67
Automatic Valve C-5497	161	181	360	Manifold Block - 9.06 3-Way Solenoid Valve - 9.06 4-Way Solenoid Valve - 9.06 250VDC H Coil/O-Ring - 5.23 250VAC H Coil - 10.48 Terminal Block - 8.46
Raychem WCSF-N Series Splices (Old formulation Raychem)	161	181	390	60.12

Table EEEB-RAI 8-2
Temperatures and Qualified Lives for Components Inside the Steam Tunnel (Rm. 7) at EPU (continued)

Component Description	EPU Maximum Normal Temperature (°F)	EPU Maximum Abnormal Temperature (°F)	Qualification Temperature Limits (°F)[1]	Thermal Qualified Life (Years)
Raychem NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK Splices (Old formulation Raychem)	161	181	390	60.12
Raychem WCSF-N Series, NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK1 (New formulation Raychem)	161	181	425	54.65

1 Maximum DBA qualification test temperature

EEEB-RAI 9

On page 2-133 of Attachment 7 of the LAR, the licensee stated that the reactor water cleanup (RWCU) high energy line break (HELB) outside primary containment will change peak temperatures in some EQ rooms at EPU conditions. Table 2.3-1 indicated that RWCU HELB peak temperatures will increase 5 to 20°F in EQ rooms 6B, 8, 9A, 9D, 12, 13, 16, 19 and 20, and will decrease in EQ room 18 due to the EPU. In Table 2.3-5, the licensee provided a listing of the EQ components affected by the increase in RWCU LOCA/HELB peak accident temperatures and their qualification limits for rooms 6B, 8, 9D, 12, and 16, but not for rooms 9A, 13, 18, 19 and 20.

a. Provide the RWCU HELB temperature evaluation as shown in Table 2.3-5 for rooms 9A, 13, 18, 19 and 20; and identify the information that pertains to RWCU HELB (differentiate from LOCA) for rooms 6B, 8, 9D, 12, and 16 in Table 2.3-5. Also, explain why there is a temperature decrease in EQ room 18 (cleanup demineralizer valve room per Table 2.3-4) during a RWCU HELB at EPU conditions.

b. In Table 2.3-1, the licensee states:

> *LOCA - All but a few EQ locations will fractionally increase in temperature. The Torus Room and NE [northeast] Pump Room will increase by 6.3°F and 1.2°F, respectively.*

Specify the EQ location(s) of the LOCA, and provide the LOCA temperature evaluation, preferably in a tabular form similar to Table 2.3-5, for all EQ locations affected by the LOCA outside primary containment.

TVA Response:

a. The attached Table EEEB-RAI 9-1, which is based on Table 2.3-5 in Attachment 7 (PUSAR) of the LAR, provides the peak RWCU HELB accident temperature for each of the original listed EQ Rooms and also includes EQ Rooms 9A, 13, 18, 19 and 20, as requested.

In a previous revision of Reference 81 of the PUSAR, the RWCU HELB temperature profile for Room 16 was conservatively used to also represent Room 18, because Room 18 was not explicitly modeled. When subsequently re-evaluated for EPU, it was documented that the temperature in Room 18 is unaffected by an RWCU HELB. As such, the maximum temperature in this room was reduced during an RWCU HELB to the room's maximum abnormal temperature. Consequently, although the evaluation performed for EPU appropriately resulted in a documented temperature decrease for Room 18 during an RWCU HELB; the actual temperature in Room 18 during an RWCU HELB would be the same at CLTP and EPU.

b. The outside primary containment EQ locations which experience environmental changes as a result of a Loss-of-Coolant Accident (LOCA) event are provided in the attached Table EEEB-RAI 9-2. Table EEEB-RAI 9-2 identifies the affected EQ components in each EQ location and provides the results of the LOCA temperature evaluation.

ENCLOSURE 1

Table EEEB-RAI 9-1
RWCU HELB Temperature Evaluation Outside Containment

Room Number[2]	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
6B	RX. Bldg. EL. 519.0 Torus Room	MOV – DC Limitorque Outside Primary Containment	340	165
8	RX. Bldg. EL. 565.0 General Floor Area	Limit switches (NAMCO)	350	175
8	RX. Bldg. EL. 565.0 General Floor Area	Penetrations (Conax, GE)	340	175
8	RX. Bldg. EL. 565.0 General Floor Area	Level Switches (FCI)	203	175
8	RX. Bldg. EL. 565.0 General Floor Area	Connector (Conax)	445	175
9A	RHR Heat Exchanger Rooms	Cable –Various Vendors	205[3]	145
9D	RX. Bldg. EL. 593.0 General Area [4]	Cable –Various Vendors	205[3]	180
9D	RX. Bldg. EL. 593.0 General Area [4]	MOV – AC Limitorque Outside Primary Containment	250	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Raychem	240	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Transmitters (Rosemount, Weed, Gould)	260	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Solenoids (ASCO, Target Rock)	420	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Temperature Switch (SOR)	227	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Conduit Seals (Conax, Rosemount, EGS)	375	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Hand Switches (Cutler-Hammer, GE)	330	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Pressure Switches (SOR)	227	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Terminal Block (GE)	350	180
9D	RX. Bldg. EL. 593.0 General Area [4]	HVAC (Ellis-Watts)	206.6	180
9D	RX. Bldg. EL. 593.0 General Area [4]	Flow Switch (SOR)	325	180
12	RX. Bldg. EL. 621.25General Floor Area	Cable –Various Vendors	205[3]	145
12	RX. Bldg. EL. 621.25General Floor Area	Transformer (Brown Boveri)	447	160
13	RX. Bldg. EL. 639.0 General Floor Area (South)	Cable –Various Vendors	205[3]	145
13	RX. Bldg. EL. 639.0 General Floor Area (South)	Raychem	390	145
16	RX. Bldg. EL. 593 RWCU Backwash Receiving Tank Room	Cable –Various Vendors	205[3]	215 (for ~60 seconds)
18	RX. Bldg. EL. 621.5 Cleanup Demineralizer Valve Room	No EQ components installed in Room	N/A	105

Table EEEB-RAI 9-1
RWCU HELB Temperature Evaluation Outside Containment (continued)

Room Number[2]	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
19	RX. Bldg. EL. 565.0 Drywell Access Area	Raychem	390	175
19	RX. Bldg. EL. 565.0 Drywell Access Area	Terminal Block (GE)	350	175
19	RX. Bldg. EL. 565.0 Drywell Access Area	Cable –Various Vendors	341	175
20	RX. Bldg. EL. 565.0 Traversing In-Core Probe System Room	Cable –Various Vendors	341.9	175

1 Lowest qualification peak LOCA/HELB temperature for the component type.

2 Worst case EQ Location (Room)

3 DOR cable is worst case limited to 205°F long term peak temperature but may exceed 205°F for approximately 10 minutes as long it is under a maximum temperature of 300°F (TVA Letter to the NRC Dated 05/11/1989 (Docket no. 50-260)).

4 Room 9D is the Northeast Quadrant in Units 2 and 3 and the Northwest Quadrant in Unit 1.

ENCLOSURE 1

Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
1	RX. Bldg. EL 510.0 HPCI Room	Cable – Various Vendors	205[2]	132
1	RX. Bldg. EL 510.0 HPCI Room	Raychem	390	132
1	RX. Bldg. EL 510.0 HPCI Room	Handswitches (GE, Cutler-Hammer)	330	132
1	RX. Bldg. EL 510.0 HPCI Room	MOV – DC Limitorque Outside Primary Containment	340	132
1	RX. Bldg. EL 510.0 HPCI Room	Terminal Block (GE)	350	132
1	RX. Bldg. EL 510.0 HPCI Room	Temperature Switches (Fenwal)	350	132
2	RX. Bldg. EL 510.0 Southwest Pump Room	Cable – Various Vendors	205[2]	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Raychem	358	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Conduit Seal (Conax, EGS, Rosemount)	375	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Flow Switches (SOR)	227	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Terminal Block (GE)	350	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Transmitters (Gould, Rosemount)	260	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Handswitches (GE, Cutler-Hammer)	330	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Motor (460V, Reliance)	491	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Motor (4160V, Reliance/Baldor)	310	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Motor (4160V, GE) – Refurbished	235	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	MOV – DC Limitorque Outside Primary Containment	340	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	MOV – AC Limitorque Outside Primary Containment	250	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Temperature Switch (SOR)	350	130
2	RX. Bldg. EL 510.0 Southwest Pump Room	Pressure Switches (SOR)	350	130
3	RX. Bldg. EL 510.0 Northwest Pump Room	Raychem	358	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Cable – Various Vendors	320	119

Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
3	RX. Bldg. EL 510.0 Northwest Pump Room	Conduit Seal (Conax, EGS, Rosemount)	375	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Flow Switches (SOR)	227	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Solenoid Valves (ASCO)	535	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Transmitters (Rosemount) Various Models	318	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Handswitches (GE, Cutler-Hammer)	330	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Motor (4160V, Reliance/Baldor)	310	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Motor (4160V, GE) – Refurbished	235	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	MOV – DC Limitorque Outside Primary Containment	340	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	MOV – AC Limitorque Outside Primary Containment	250	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Pressure Switches (SOR)	227	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Terminal Block (GE)	350	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Temperature Switches (Fenwal)	350	119
3	RX. Bldg. EL 510.0 Northwest Pump Room	Limitswitch (Honeywell)	308	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Raychem	358	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Cable – Various Vendors	205[2]	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Conduit Seal (Conax, EGS, Rosemount)	375	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Flow Switches (SOR)	227	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Transmitters (Rosemount) Various Models	318	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Handswitch – Cutler-Hammer	330	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Level Switch (Magnetrol)	281	119

ENCLOSURE 1

Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
4	RX. Bldg. EL 510.0 Northeast Pump Room	Motor (4160V, Reliance/Baldor)	310	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Motor (460V, Reliance)	491	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	MOV – AC Limitorque Outside Primary Containment	250	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Pressure Switches (SOR) Various Models	227	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Terminal Block (GE)	350	119
4	RX. Bldg. EL 510.0 Northeast Pump Room	Temperature Switch (SOR)	350	119
5	RX. Bldg. EL 510.0 Southeast Pump Room	Raychem -Various	358	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Cable – Various Vendors	205[2]	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Conduit Seal (EGS, Rosemount)	420	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Flow Switch (SOR)	227	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Transmitters (Rosemount)	318	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Handswitches (GE, Cutler-Hammer)	330	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Motor (460V, Reliance)	491	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Motor (4160V, Reliance/Baldor)	310	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Motor (4160V. GE) - Refurbished	235	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Pressure Switch (SOR)	227	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Terminal Block (GE)	350	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	Temperature Switch (SOR)	350	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	MOV – DC Limitorque Outside Primary Containment	340	132
5	RX. Bldg. EL 510.0 Southeast Pump Room	MOV – AC Limitorque Outside Primary Containment	250	132

Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
6A-D	RX. Bldg. EL. 519.0 Torus Room	Raychem -Various	390	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Cable – Various Vendors	205[3]	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Conduit Seal (Conax, EGS, Rosemount)	375	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Connector (Conax)	445	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Solenoid (ASCO, Target Rock, Valcor)	346	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Handswitches (GE, Cutler-Hammer)	330	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	MOV – DC Limitorque Outside Primary Containment	340	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	MOV – AC Limitorque Outside Primary Containment	250	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Transmitters (Rosemount)	420	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Terminal Block (GE)	350	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Temperature Elements (Fenwal, Weed)	350	140
6A-D	RX. Bldg. EL. 519.0 Torus Room	Limit Switch (NAMCO)	350	140
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	Raychem	390	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	Cable – Various Vendors	341	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	MSIV Pneumatic Control Manifold (AVCO)	360	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	Conduit Seal (Conax, EGS)	375	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	MOV – DC Limitorque Outside Primary Containment	340	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	Temperature Element (Fenwal, Weed)	350	181
7	Main Steam Valve Vault/Main Steam Tunnel (including Main Steam Control/Stop Valves)	Limit Switch (NAMCO)	387	181
8	RX. Bldg. EL. 565.0 General Floor Area	Raychem	240	130
8	RX. Bldg. EL. 565.0 General Floor Area	Cable – Various Vendors	205[2]	130
8	RX. Bldg. EL. 565.0 General Floor Area	Limit switches (NAMCO)	373	130

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Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak EPU Accident Temperature (°F)
8	RX. Bldg. EL. 565.0 General Floor Area	Penetrations (Conax, GE)	340	130
8	RX. Bldg. EL. 565.0 General Floor Area	Level Switches (FCI, Magnetrol, SOR.)	203	130
8	RX. Bldg. EL. 565.0 General Floor Area	Connector (Conax)	445	130
8	RX. Bldg. EL. 565.0 General Floor Area	Pressure Switch (SOR)	350	130
8	RX. Bldg. EL. 565.0 General Floor Area	Terminal Block (GE)	350	130
8	RX. Bldg. EL. 565.0 General Floor Area	Solenoid Valve (ASCO, Target Rock, Valcor)	346	130
8	RX. Bldg. EL. 565.0 General Floor Area	Conduit Seal (EGS, Rosemount)	420	130
8	RX. Bldg. EL. 565.0 General Floor Area	Scram Solenoid Pilot Valve (AVCO)	327	130
8	RX. Bldg. EL. 565.0 General Floor Area	MOV – DC Limitorque Outside Primary Containment	340	130
8	RX. Bldg. EL. 565.0 General Floor Area	Transmitter (Rosemount, Weed)	271	130
8	RX. Bldg. EL. 565.0 General Floor Area	Temperature Element (Weed)	500	130
8	RX. Bldg. EL. 565.0 General Floor Area	Handswitches (GE, Cutler-Hammer)	330	130
9A	RHR Heat Exchanger Rooms	Cable – Various Vendors	205[3]	132
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	MOV – AC Limitorque Outside Primary Containment	250	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Raychem	271	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Cable – Various Vendors	205[2]	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Transmitters (Gould, Rosemount, Weed)	180	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Solenoids (Valcor, ASCO, AVCO, Target Rock)	535	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Temperature Elements (Weed, Fenwal, SOR)	350	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Conduit Seals (Conax, Rosemount, EGS)	375	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Hand Switches (Cutler-Hammer, GE)	330	134

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Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak LOCA EPU Accident Temperature (°F)
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Pressure Switches (SOR)	227	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Terminal Block (GE)	350	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	HVAC (Ellis-Watts)	215	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	Flow Switch (SOR)	325	134
9B-E	RX. Bldg. EL. 593.0 General Floor Area (SW, NW, NE & SE Quadrant)	AC Unit (Ellis-Watts) Toshiba Motor Anutnies Control Airflow Switches Sporlan Solenoid Valve East Coast Compressor Control Solenoid Valves Johnson Controls Suction Pressure Controller Johnson Controls Temperature Switch Ellis & Watts Motor	 301 206.6 206.6 206.6 208.4 206.6 215.5	134
11	RWCU Pump Rooms	Raychem -Various	390	134
11	RWCU Pump Rooms	Cable – Various Vendors	341	134
11	RWCU Pump Rooms	Hand Switches (Cutler-Hammer, GE)	330	134
11	RWCU Pump Rooms	Conduit Seal (Conax, EGS)	375	134
11	RWCU Pump Rooms	MOV – DC Limitorque Outside Primary Containment	340	134
11	RWCU Pump Rooms	Temperature Element (Weed)	500	134
12	RX. Bldg. EL. 621.25General Floor Area	Raychem –Various	390	136
12	RX. Bldg. EL. 621.25General Floor Area	Cable – Various Vendors	205[2]	136
12	RX. Bldg. EL. 621.25General Floor Area	Transformer (Brown Boveri)	447.98	136
12	RX. Bldg. EL. 621.25General Floor Area	Connector (EGS)	435	136
12	RX. Bldg. EL. 621.25General Floor Area	Solenoid Valve (ASCO)	535	136
12	RX. Bldg. EL. 621.25General Floor Area	Pressure Switch (SOR)	227	136
12	RX. Bldg. EL. 621.25General Floor Area	Terminal Block (GE)	350	136

ENCLOSURE 1

Table EEEB-RAI 9-2
LOCA Temperature Evaluation Outside Containment (continued)

Room Number	Room Description	Component	Qualification Limit (°F)[1]	Peak LOCA EPU Accident Temperature (°F)
12	RX. Bldg. EL. 621.25General Floor Area	Limit Switch (NAMCO)	350	136
12	RX. Bldg. EL. 621.25General Floor Area	Conduit Seal (Conax)	375	136
12	RX. Bldg. EL. 621.25General Floor Area	Handswitch (Cutler-Hammer)	330	136
12	RX. Bldg. EL. 621.25General Floor Area	Limit Switch (Honeywell)	308	136
13	RX. Bldg. EL. 639.0 General Floor Area (South)	Cable –Various Vendors	205[2]	128
13	RX. Bldg. EL. 639.0 General Floor Area (South)	Raychem	390	128
14	RX. Bldg. EL. 639.0 General Floor Area (North)	Cable –Various Vendors	318	128
15	RX. Bldg. EL. 664.0 Refueling Floor Area	Cable –Various Vendors	318	123
16	RX. Bldg. EL. 593 RWCU Backwash Receiving Tank Room	Cable –Various Vendors	205[2]	215 (for ~60 seconds)
18	RX. Bldg. EL. 621.5 Cleanup Demineralizer Valve Room	No EQ components installed in Room	N/A	Note 3
19	RX. Bldg. EL. 565.0 Drywell Access Area	Raychem	390	128
19	RX. Bldg. EL. 565.0 Drywell Access Area	Cable –Various Vendors	341	128
19	RX. Bldg. EL. 565.0 Drywell Access Area	Terminal Blocks (GE)	350	128
20	RX. Bldg. EL. 565.0 Traversing In-Core Probe System Room	Cable –Various Vendors	341.9	135

1 Lowest qualification peak temperature for the component type.

2 DOR cable is worst case limited to 205°F long term peak temperature but may exceed 205°F for approximately 10 minutes as long it is under a maximum temperature of 300°F (TVA Letter to the NRC Dated 05/11/1989 (Docket no. 50-260)).

3 Room 18 was not modeled for LOCA temperature response.

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In Table 2.3-3 of Attachment 7 of the LAR, the licensee provided the radiation qualification doses and the EPU total integrated doses (normal plus accident) for equipment located inside and outside primary containment. The radiation qualification doses for some cables, solenoids, splices, and motor operated valves' components are less than the EPU total integrated doses. Note 3 of Table 2.3-3 stated that these components have a limited life of less than 60 years due to EPU radiation, and they will be replaced periodically as part of the normal EQ maintenance program.

Provide the radiation qualified life for the above components. Also, describe the approach for assessing the effects of radiation aging and determining the periodic replacement for these components. Also, explain why certain splices of Raychem, such as NPkV, NPKC etc., have been listed twice with different qualified doses.

TVA Response:

The radiation qualified life for components with less than a 60 year radiation qualified life are as follows.

Component	Radiation Qualified Life (Years)
Cable - Rockbestos Company [Type PXJ / PXMJ]	44.51
Cable - Eaton Cable [Type MS]	49.92
Cable - Triangle / PWC Inc. [Type PN / PNJ]	51.83
Cable - Brand Rex [Type PXJ / PXMJ]	43.57
Cable - Okonite Company [Type PX/PXJ/PXMJ]	40.72
Cable - Rockbestos Company [Type PXJ / PXMJ]	53.69
Cable - Rockbestos Company [Type MS]	50.84
Cable - Rockbestos Company [Type Coaxial Cable]	52.4
MOV - Limitorque AC/IPC SMB-000, 00, 0, 2, and SB-3	Motor Insulation - 39.34 Wiring Insulation - 56.33
MOV - Limitorque DC/OPC SMB-000, 00, 0, 2, 3, 4T and SB-0 (MOVs motor and all other components have separate qualification doses and Total Integrated Doses (TIDs))	50.40 (Unit 1) 52.6 (Units 2 and 3)
MSIV Pneumatic Control Manifold C-5497	3-Way Valve - 47.01 4-Way Valve - 47.01 Manifold Block - 9.68 250VDC H Coil - 39.9 Internals - 9.68 250 VAC H Coil - 9.68 Terminal Block - 39.9
Target Rock 1/2 SMS-S-02-5 (O-Rings and all other non-metallics)	8.19
Splices - Raychem WCSF-N Series (Old formula Raychem)	46.75
Splices - Raychem NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK (Old formula Raychem)	55.89
Raychem WCSF-N Series, NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK (New formula Raychem)	44.52

The approach for assessing the effects of radiation aging and determining the periodic replacement for these components is as follows.

> The predicted accident dose (for the worst case applicable accident) is subtracted from the tested dose and this difference is used as the service life radiation limit (i.e. normal dose limit). The accident dose consists of both the gamma and the beta dose. Normal dose consists of gamma dose, except in the drywell, were normal dose consists of neutron plus gamma dose. The length of time, at normal operation, it would take to reach this service life radiation limit is then calculated. This time frame represents the length of time that the component can operate at normal conditions and still be qualified to mitigate the postulated accident conditions.

The reason certain splices of Raychem such as NPKV, NPKC, etc. have been listed twice with different qualified doses is as follows.

> These splices have different formulas of construction as indicated in the different test reports of the two different EQ binders. The older formula splice material was tested to a higher Total Integrated Dose than the newer formula splice material.

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On page 2-134 of Attachment 7 of the LAR, the licensee states:

> *The HELB pressure profiles [outside primary containment] for CLTP conditions were determined to be bounding for EPU conditions.*

Table 2.3-1 indicates that “there will be no change” in accident pressure outside primary containment as a result of the EPU.

a. Provide:

i. the HELB pressure profiles for CLTP and EPU conditions to show that the HELB pressure profiles are bounding for EPU conditions; and

ii. the component qualification pressure profile for electrical equipment outside primary containment to show that it bounds the HELB pressure profiles at EPU conditions.

b. Explain why the pressure considered for EQ of electrical equipment remains the same for CLTP and EPU conditions.

TVA Response:

a.i. The BFN EQ program only utilizes the HELB accident peak pressure, in a given EQ room, for performing an EQ component analysis. Table EEEB-RAI 11-1 is provided to show the current Unit 2 peak CLTP HELB pressures used for EQ evaluation in each EQ location affected by an HELB event. The values in Table EEEB-RAI 11-1 are the result of rounding up the Table EEEB-RAI 11-2 CLTP values to the nearest 0.25 psia.

The RWCU (Reactor Water Cleanup) and MS/FW (Main Steam/Feedwater) HELBs were determined to be potentially impacted by EPU. These systems were reevaluated due to the changes in RWCU and Feedwater temperatures and/or flow rates. The Reactor Core Injection Cooling (RCIC) and High Pressure Coolant Injection (HPCI) HELBs were determined to not be impacted by EPU because the reactor vessel pressure remains at the CLTP value. Table EEEB-RAI 11-2 is provided to show both the calculated Unit 2 CLTP and EPU Gothic computer program peak HELB pressures prior to rounding up for EQ application. Unit 2 is used as a representative example for both Unit 1 and 3 since Units 1 and 3 are similar in construction and operation.

Based on rounding up of the results shown in Table EEEB-RAI 11-2 to the nearest 0.25 psig, the Unit 2 CLTP EQ Room Peak HELB Pressures listed in Table EEEB-RAI 11-1 are still valid and binding for EPU.

a.ii. As stated in the response to a.i., BFN only uses the peak outside primary containment HELB pressures to ensure EQ component qualification. Table EEEB-RAI 11-3 is provided to show the peak qualification pressure for each of the Unit 2 BFN EQ components outside primary containment using Unit 2 as a representative example for all three BFN units. The qualification peak pressures shown in Table EEEB-RAI 11-3 bound the EPU HELB peak pressures (Table EEEB-RAI 11-1) for the EQ Rooms in which the components are installed.

b. The RCIC and HPCI HELBs EQ room accident peak pressures did not change because the reactor vessel pressure and temperature did not change from CLTP to EPU. There are small changes in RWCU and MS/FW HELB EPU peak accident pressures due to EPU. However, because both the CLTP and EPU results are rounded up to the nearest 0.25 psig for EQ qualification, the resulting EQ Room accident peak pressures remain the same for both CLTP and EPU.

Table EEEB-RAI 11-1
Unit 2 CLTP EQ Room Peak HELB Pressures

EQ Room[1] No.	Unit 2 PEAK HELB PRESSURE (psia)[2]			
	CLTP RWCU	CLTP HPCI	CLTP RCIC	CLTP MS/FW
1	15.00	16.00	15.00	15.00
2	15.00	15.00	15.00	15.00
3	15.00	15.00	15.00	15.00
4	15.00	15.00	15.00	15.00
5	15.00	15.00	15.00	15.00
6A	15.00	15.50	15.00	15.00
6B	15.00	15.25	15.00	15.00
6C	15.00	15.25	15.00	15.00
6D	15.00	15.50	15.00	15.00
7	15.25	15.00	15.25	21.75
8	15.00	15.00	15.00	15.00
9A	15.00	15.00	15.00	15.00
9B	15.00	15.00	15.00	15.00
9C	15.00	15.00	15.00	15.00
9D	15.00	15.00	15.00	15.00
9E	15.00	15.00	15.00	15.00
10	16.50	15.00	15.00	15.00
11	17.00	15.00	15.00	15.00
12	15.00	15.00	15.00	15.00
13	15.00	15.00	15.00	15.00
14	15.00	15.00	15.00	15.00
15	15.00	15.00	15.00	15.00
16	16.75	15.00	15.00	15.00
19	15.00	15.00	15.00	15.00
20	15.00	15.00	15.00	15.00

[1] EQ Rooms 17 and 18 not explicitly modeled since they were determined to be unaffected by HELB. The Room temperature goes to and remains at its maximum abnormal temperature until normal Heating Ventilating and Air Conditioning (HVAC) is restored. EQ Room 22 (Standby Gas Treatment) and Room 23 (Offgas Stack) are not addressed because they are EQ Rooms separate from the Units 1, 2 and 3 Reactor Buildings. Rooms 22 and 23 are not significantly affected by an outside primary containment HELB.

[2] For EQ purposes the peak pressure is rounded up to the nearest 0.25 psia from the pressures shown in Table EEEB-RAI 11-2 for CLTP.

Table EEEB-RAI 11-2
Unit 2 GOTHIC Room Peak HELB Pressures

EQ Room[1] No.	PEAK HELB PRESSURE (psia)					
	U2 CLTP RWCU	U2 EPU RWCU	U2 CLTP/EPU HPCI	U2 CLTP/EPU RCIC	U2 CLTP MS/FW	U2 EPU MS/FW
1	14.91	14.97	15.85	14.75	14.92	14.92
2	14.89	14.94	14.88	14.72	14.88	14.88
3	14.90	14.95	14.92	14.75	14.92	14.92
4	14.92	14.97	14.95	14.75	14.89	14.89
5	14.89	14.95	14.89	14.73	14.89	14.89
6A	14.91	14.96	15.30	14.75	14.90	14.90
6B	14.90	14.96	15.18	14.75	14.90	14.90
6C	14.90	14.97	15.20	14.75	14.90	14.90
6D	14.91	14.96	15.29	14.75	14.90	14.90
7	15.04	15.06	14.92	15.03	21.62	21.62
8	14.88	14.94	14.87	14.71	14.87	14.87
9A	14.87	14.91	14.86	14.69	14.85	14.85
9B	14.84	14.88	14.84	14.67	14.83	14.83
9C	14.88	14.90	14.84	14.72	14.88	14.87
9D	14.87	14.90	14.84	14.69	14.87	14.84
9E	14.87	14.89	14.84	14.68	14.84	14.84
10	16.38	16.42	14.80	14.66	14.79	14.79
11	16.84	16.76	14.79	14.65	14.79	14.79
12	14.89	14.91	14.86	14.68	14.91	14.91
13	14.78	14.81	14.79	14.65	14.78	14.78
14	14.91	14.93	14.91	14.69	14.95	14.95
15	14.74	14.75	14.75	14.59	14.75	14.75
16	16.66	16.59	14.78	14.66	14.78	14.78
19	14.90	14.96	14.99	14.73	14.89	14.89
20	14.88	14.93	14.86	14.73	14.87	14.87

[1] EQ Rooms 17 and 18 not explicitly modeled since they were determined to be unaffected by HELB. The Room temperature goes to and remains at its maximum abnormal temperature until normal HVAC is restored. EQ Room 22 (Standby Gas Treatment) and Room 23 (Offgas Stack) are not addressed because they are EQ Rooms separate from the Units 1, 2 and 3 Reactor Buildings.

Table EEEB-RAI 11-3
Qualification Pressure of EQ Components Outside Primary Containment

EQ Room(s)	Component	Qualification Pressure (psig)	Qualification Pressure[6] (psia)
8, 9	Cable - American Insulated Wire [Type PXJ / PXMJ]	5[1]	19.4
5, 8, 9	Cable - American Insulated Wire [Type PXJ / PXMJ	112	126.4
1, 8, 9, 12	Cable - Anaconda Power and Control [Type PXMJ]	66	80.4
1-9, 12, 19, 22	Cable - Rockbestos Company [Type PXJ / PXMJ]	117.2	131.6
2 - 5, 8, 9, 12	Cable - Continental (Anaconda) [Type MS]	9.75	24.15
8, 9, 12,22	Cable - Anaconda Cable Co. [Type PJJ]	7.7	22.1
1-6, 8, 9, 12, 13, 15, 19	Cable - Brand-Rex Company [Type PN / PNJ]	7.7	22.1
1 – 6, 8, 9, 11, 12	Cable - Brand Rex Company [Type MS]	66	86.4
4, 6, 7, 8, 9, 12	Cable - Eaton Cable [Type MS]	72	86.4
2, 4, 6, 8, 9, 12	Cable - Essex International, Inc. [Type CPJ / CPJJ]	5[1]	19.4
8, 9	Cable - Essex Cable [Type PXMJ]	5[1]	19.4
1 - 4, 6, 8, 9, 12	Cable - Essex Group, Inc. [Type PXJ / PXMJ]	113	127.4
9, 12	Cable - General Cable Corporation [Type PNJ]	7.7	22.1
4, 8, 9, 12, 13	Cable - General Cable Corporation [Type CPSJ]	5[1]	19.4
9, 13, 22	Cable - General Cable Corporation [Type CPJ]	5[1]	19.4
8, 9	Cable - Okonite Company [Type PXJ]	114	128.4
6, 8, 9, 22	Cable - Phelps Dodge Cable [Type CPJ]	5[1]	19.4
1 - 6, 8, 9, 12, 15, 16, 19, 22	Cable - Triangle / PWC Inc. [Type PN / PNJ]	7.7	22,1
1, 8, 9, 12, 19, 22	Cable - Triangle / PWC Inc. [Type CPJ / CPJJ]	5[1]	19.4
8, 9, 12	Cable - Triangle / PWC Inc. [Type CPSJ]	5[1]	19.4
8, 9	Cable - Rockbestos KXL-780, Firewall III [Type MS]	34	48.4
6, 8, 9, 12, 22	Cable - Rome Cable [Type CPJ / CPJJ]	5[1]	19.4
1 - 6, 8, 9, 12, 19, 20, 22	Cable - Rome (Cyprus) [Type PJJ]	17	31.4
1, 8, 9, 12	Cable - Simplex Wire & Cable Co.[Type CPJ]	5[1]	19.4
1, 5, 6, 8, 9, 12	Cable - Sumitomo Electric Industries, Ltd. [Type CPJJ]	7.7	22.1
1, 2, 4, 8, 9, 12, 14, 22	Cable - Tamaqua - Products Cable Corp. [Type PNJ]	7.7	22.1
1, 8, 9	Cable - Times Wire and Cable [Type MS]	1.8	16.2
1, 3 -12, 19, 22	Cable - Brand Rex [Type PXJ / PXMJ]	113	127.4
8, 9	Cable - Simplex Wire & Cable Co.[Type CPSJ]	5[1]	19.4
6, 8, 9, 12	Cable - Triangle / PWC Inc. [Type PJJ]	19.8	34.2
1, 2, 5, 6, 8, 9, 14, 22	Cable - Okonite Company [Type PX / PXJ / PXMJ]	112	126.4
1 - 9, 11, 12, 22	Cable - Rockbestos Company [Type SIS]	117.2	131.6

Table EEEB-RAI 11-3
Qualification Pressure of EQ Components Outside Primary Containment (continued)

EQ Room(s)	Component	Qualification Pressure (psig)	Qualification Pressure[6] (psia)
2, 5, 8, 9, 12, 22	Cable - Okonite Company [Type EPSJ]	114	128.4
1, 2, 3, 5 - 9, 11, 12, 19, 22	Cable - Rockbestos Company [Type PXJ / PXMJ]	107	121.4
1 - 5, 7 - 11	Cable - Rockbestos Company [Type MS]	117.2	131.6
6, 8, 9	Cable - Rockbestos Company [Type Coaxial Cable]	113	127.4
1, 6, 8, 9, 12	Cable - Okonite Company [Type PXJ / PXMJ]	112	126.4
3, 4, 6 - 12	Conduit Seal - CONAX Corp. ECSA	75	89.4
2 - 6, 8, 9	Conduit Seal - Rosemount Inc. 353C	120	134.4
7, 8, 9	Conduit Seal - EGS Quick Disconnect	77	91.4
6	Connector - CONAX Coaxial Connector	80.4	94.8
2 - 6, 8, 9, 12, 22	Handswitch - Cutler-Hammer 1025OT	17.5	31.9
1- 6, 8, 9, 11	Handswitch - General Electric CR2940	7.5	21.9
2, 3, 4, 5	Flow Switch - SOR 103AS	25	39.4
N/A	Flow Switch - SOR 141 Series	7	21.4
8	Flow/Level Switch - Fluid Components Inc. FR72-45A, FR72-4HTR-DLL, FR72-1R	10	24.4
4, 6	Level Switch - Magnetrol 291 Series	18	32.4
8	Level Switch - Magnetrol 402 Series	18	32.4
2, 3, 4, 5, 12	Pressure Switch - SOR 5N/6N/12N	7	21.4
2, 3, 5, 8, 9	Pressure Switch - SOR Test Report 9058-102	40	54.4
6, 7, 8, 10, 11	Temperature Element - Weed SP611-1A-A-3-C-2-75-4D4-2, 1B1D/612D-1A-C-6-C-17-00	75	89.4
1, 3, 6, 7	Temperature Switch – EGS (Fenwal) 01-170230-090, 01-170020-090	26	40.4
2, 3, 4, 5	Temperature Switch - SOR 201, 205	7	21.4
6, 8, 12	Limit Switch - NAMCO EA-740	75	89.4
8, 12	Limit Switch - NAMCO EA-180	76.4	90.8
3, 12, 22	Limit Switch - Honeywell/Microswitch OP-AR/OPD-AR/OPD-AR-30	21	35.4
7	Limit Switch - NAMCO EA-740 (QTR-180)	127	141.4
2, 3	Motors - GE 5K6348XC23A & 5K6336XC198A	1.32	14.72
2, 3, 4, 5	Motor - Reliance TEFC-XT Type P, Random Wound Motors	See footnote 2	See footnote 2
2, 4, 5	Motor - Reliance 4160VAC	12	26.4
2 - 6, 8, 9	MOV - Limitorque AC/OPC SMB-000- Thru SMB-5T	25	39.4
1, 3, 6, 7, 11	MOV - Limitorque DC/OPC SMB-000, 00, 0, 2, 3, 4T & SB-0	120	134.4
8	EPA - Conax 7504-10001-03, -04, -05 & 7FO2-10000-01	55	69.4
8	EPA - GE 100 Series	103	117.4

Table EEEB-RAI 11-3
Qualification Pressure of EQ Components Outside Primary Containment (continued)

EQ Room(s)	Component	Qualification Pressure (psig)	Qualification Pressure[6] (psia)
9	HVAC - Ellis-Watts ACH275.LC39 Toshiba Motors Atunes Control Air Flow Switches Sporlan Solenoid Valves East Coast Compressor Solenoids Johnson Controls Suction Pressure Controller Johnson Controls Temperature Switch Ellis-Watts Motors	 35 ATM[3] ATM[3] ATM[3] ATM[3] ATM[3] 10.1	 49.4 ATM[3] ATM[3] ATM[3] ATM[3] ATM[3] 24.5
22	Damper Motor Actuators - Raymond Controls Sure 24-10-4	N/A[4]	N/A[4]
22	Damper Motor Actuators - Raymond Controls Sure 25-10-4CW	N/A[4]	N/A[4]
6, 8	Solenoid - VALCOR V526-529-2	73.7	88.1
3, 6, 8, 9, 12	Solenoid - ASCO NP Series, 206 Series	113.8	127.2
7	Solenoid - Automatic Valve C-5497	65	79.4
6, 8, 9D	Solenoid - Target Rock 81NN, 92Z	66	80.4
8	Solenoid – AVCO Scram Solenoid Pilot Valve	11.4	25.8
2 - 9, 11, 12, 19	Splices - Raychem WCSF-N Series (old formula, before 2006)	66	80.4
1 -12, 19	Splices - Raychem NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK (old formula, before 2006)	66	80.4
2, 3, 4, 5	Splices - Raychem NMCK8/NHVT	25.3	39.7
2 - 4, 6 - 9, 12	Raychem WCSF-N Series, NPKV, NPKC, NPKP, NPKS, NMCK, NCBK, NESK (New formula, after 2006)	120	134.4
1- 6, 8, 9, 11, 12, 19	Terminal Block - General Electric CR151A, CR151B, EB-5, EB-25	16	30.4
12	Transformer - BBC VPE	Not Determined[5]	Not Determined[5]
2 - 5, 8, 9	Pressure Transmitter - Rosemount 1153 B	73	87.4
2, 4, 6, 8, 9	Pressure Transmitter - Rosemount 1153D/1154/115 Series	90	104.4
9B, 9D	Pressure Transmitter - Gould PD3200-100 Series, 400, PDH3200-030	17.6	32.0
8, 9	Pressure Transmitter – Weed DTN2010	20	34.4

Footnotes to Table EEEB-RAI 11-3 (continued)

[1] DOR cable is worst case limited to 5 psi above normal atmospheric conditions. (TVA Letter to the NRC Dated 05/11/1989 (Docket no. 50-260)). Normal atmospheric pressure at BFN is approximately 14.4 psia.

[2] Pressure testing is not required since the accident pressure parameter for the plant installed equipment is slightly above atmospheric pressure (peak of 0.6 psig) which is not detrimental to the motors due to their rugged construction and pressure equalization of the motor internals.

[3] Although the pressure during the test was not determined, the 0.6 psig requirement is considered to be negligible with respect to qualification of the EQ Room 9 HVAC components since this low accident pressure would have no significant effect on the functional operation of the HVAC components during an accident.

[4] Standby Gas Treatment Building (EQ Room 22) is separate from the Units 1, 2 and 3 Reactor Building and does not have significant changes in pressure.

[5] Although the pressure during the test was not determined, the 0.6 psig requirement is considered to be negligible with respect to qualification of the EQ Room 12 transformer since this low accident pressure would have no significant effect on the functional operation of the transformers during an accident. Transformer cabinets are louvered for natural convection cooling and cannot retain pressure other than ambient.

[6] Obtained by adding the BFN atmospheric pressure of 14.4 psia to the qualification pressure measured in psig.

EEEB-RAI 12

In Table 2.3-6 of Attachment 7 of the LAR, the licensee provided the megavolts amperes (MVA) ratings of the Unit Station Service Transformers (USSTs) and the Common Station Service Transformers (CSSTs) of the offsite power system and their respective EPU duties.

a. The CLTP duties and margins for the USSTs and CSSTs are not provided in Table 2.3-6. Provide the missing parameters or justify their omission.

b. The loadings/duties of USSTs are provided at normal loading. Provide maximum loadings of USSTs under the accident/shutdown conditions also.

TVA Response:

a. Provided in Table EEEB-RAI 12-1 are the last three rows of Table 2.3-6 of Attachment 7 of the BFN LAR. Values have been updated for Normal Operating Loading. Unit 1 restarted from an extended shutdown in 2007. Many EPU modifications were installed while Unit 1 was shutdown, including the larger condensate pump motors, condensate booster pump motors, and recirculation pump motors. The EPU horsepower ratings were entered into the load flow calculations for these new pump motors. As such, after the Unit 1 re-start, no true set of "CLTP" load data exists as the Unit 1 loads were set to EPU values. The CLTP Duties presented in this response reflect Unit 1 equipment at EPU loadings.

Table EEEB-RAI 12-1
Offsite Electrical Equipment Ratings and Margins

Component	Component Rating	CLTP Duty	CLTP Margin (%)	EPU Duty	EPU Margin (%)
Unit Station Service Transformers A (MVA)	24/32/40 MVA OA/FA/FOA[3] @55°C	26.1 U1[1] 23.5 U2 18.8 U3	34.7 U1 41.3 U2 53.0 U3	26.0 U1 26.3 U2 21.6 U3	35.0 34.3 46.0
Unit Station Service Transformers B (MVA)	24/32 MVA OA/FA @55°C	17.4U1[1] 13.8 U2 15.9 U3	45.6 U1 56.9 U2 50.3 U3	18.5 U1 16.8 U2 19.0 U3	42.2 47.5 40.6
Common Station Service Transformers (A and B) (MVA)[2]	21.9/29.2/36.5 MVA OA/FA/FOA @55°C	0.0 A 0.0 B	100.0 A 100.0 B	0.0 A 0.0 B	100.0 100.0

[1] Unit 1 restarted in 2007 with many EPU modifications installed. The CLTP Duty reflects these modifications.
[2] CSSTs have zero loading during normal operations.
[3] OA= Oil-Air, self cooled, no fans or pumps. FA= Forced Air, cooling fans. FOA=Forced Oil -Air, fans and pumps.

At normal operating loading, the USSTs show positive margin at CLTP and EPU conditions.

b. The Electrical Transients Analysis Program (ETAP) runs, for the different possible electrical lineups and unit accident combinations, were evaluated for the worst case loadings on each of the USSTs under accident/shutdown conditions. The worst case loading results are presented in Table EEEB-RAI 12-2.

Table EEEB-RAI 12-2
Maximum Loadings of USSTs Under Accident/Shutdown Conditions

Component	Component Rating	CLTP Duty[1]	CLTP Margin (%)	EPU Duty[1]	EPU Margin (%)
Unit Station Service Transformers A (MVA)	24/32/40 MVA OA/FA/FOA @55°C	26.2 U1[2] 23.6 U2 19.0 U3	34.5 U1 41.0 U2 52.5 U3	26.4 U1 26.7 U2 22.2 U3	34.0 33.3 44.5
Unit Station Service Transformers B (MVA)	24/32 MVA OA/FA @55°C	31.1 U1[2] 28.7 U2 25.0 U3	2.8 U1 10.3 U2 21.9 U3	28.5 U1 28.5 U2 29.0 U3	10.9 10.9 9.4

[1] Loads associated with the shutdown of the non-accident units are included.
[2] Unit 1 restarted in 2007 with many EPU modifications installed. The CLTP Duty reflects these modifications.

In conclusion, at maximum loadings under accident/shutdown conditions, the USSTs show positive margin at CLTP and EPU conditions.

EEEB-RAI 13

On page 2-138 of Attachment 7 of the LAR, the licensee stated that the main generators have been rewound to increase their maximum ratings to 1,330 MVA for Unit 1 and 1,332 MVA for Units 2 and 3; and the generator step-up transformers (GSUTs) have been replaced and upgraded at a rating of 1,500 MVA at 65°C to support the increase in generator output. On page 2-136, the licensee stated that no changes are required for the protective relaying for the main generator for operation at EPU.

Provide a summary of evaluation performed to determine that the settings of the protective relays, which are described in Section 8.2 of BFN UFSAR, for the rewound generator and the upgraded GSUTs remain adequate to protect the equipment at EPU conditions.

TVA Response:

In 2007, the TVA Transmission System Protection and Analysis department performed a review of the Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3 main generator protective relaying for Extended Power Uprate (EPU). This review concluded that the J1K (Generator Field Over-excitation) relay settings needed to be revised for EPU conditions. All other protective relay settings were found to be fully adequate to support the unit uprates.

In 2011 and 2012, on all three units, BFN replaced the existing General Electric (GE) Alterrex Automatic Voltage Regulators (AVRs) with Asea Brown Boveri (ABB) Unitrol 5000 AVRs. Installation of these modifications made the following changes to the generator protective relaying:

Relay	Function	Change
J1K	Field Over-excitation for Generator	Eliminated relay as it was no longer needed due to replacement of GE Alterrex Voltage Regulator.
VC	Generator- Over-excitation	Replaced by Volts (V)/Hertz (Hz) 1st Level Relay.
64EF	Field Ground Detector relay	Replaced by new relay. No settings required.
64GF	Field Ground Detector relay	Replaced by new relay. No settings required.
F24.1	Generator Over-excitation 1st Level	Replaced by new relay.
F24.2	Generator Over-excitation 2nd Level	Replaced by new relay.
32	Reverse Power Relays	Adjusted relay settings per GE Technical Information Letter TIL 964-2 R1. (Non-EPU related.)

Between 2010 and 2013, on all three units, BFN replaced the Generator Step-up (GSU) Main Power Transformers (MTs). At the same time, the existing MT electro-mechanical differential relays were replaced with microprocessor type differential relays.

ENCLOSURE 1

The following table lists the protective relaying described in the FSAR Section 8.2 and summarizes the evaluation of the adequacy of the current relay settings for all three units at EPU conditions.

Function from FSAR Section 8.2	Relay	Evaluation
High-speed, induction-type, percentage-differential relays	87G	Change of machine MVA will not affect differential pickup. No setting change is needed.
Inverse-time overcurrent relay with voltage restraint	51G	Relay picks up at 155% of new machine MVA rating at unity power factor vs. 161% of old machine rating. No setting change is needed.
Induction-type overvoltage relays on the neutral transformer	59GN	No change to generator terminal voltage, therefore no setting change is needed.
Reverse power relays	32	Relay is designed to operate between 0.5%-1.0% of rated machine MVA at unity power factor or 6,650-13,300 kW. Pickup of relay is 9,360 kW. No setting change is needed.
Loss of field relays	40	No change to generator synchronous impedance on system 100 MVA base. No setting change is needed.
Volts / Hertz relays	V/Hz Relay 1st Level	Relays were set for EPU conditions based on BFN calculation when they were installed as part of the ABB Unitrol 5000 AVR modifications.
Volts / Hertz relays	V/Hz Relay 2nd Level	Relays were set for EPU conditions based on a BFN calculation when they were installed as part of the ABB Unitrol 5000 AVR modifications.
Negative sequence relay	46	Setting is based on rated machine current unbalance limits; I_2^2t. Present setting will not limit maximum allowable unbalance current. No setting change is needed.
Generator field ground relays	64EF	Relays require no settings. Alarm only
Generator field ground relays	64GF	Relays require no settings. Alarm only.
Phase unbalance relays	60	Setting is based on secondary generator voltage used to detect relaying potential transformer failure. As there is no change to generator terminal voltage, no setting change is needed. Alarm only.
Generator breaker failure relays	50	Setting is based on rated generator breaker interrupting time which has not changed. No setting change is needed.

Function from FSAR Section 8.2	Relay	Evaluation
Generator backup relay 1*	21 GB1*	Setting is based on generator synchronous impedance and MT impedance. No change to generator synchronous impedance on system 100 MVA base and new MTs have lower impedance which increases margin. No setting change is needed.
Generator backup relay 2*	21 GB2*	Setting is based on generator synchronous impedance and MT impedance. No change to generator synchronous impedance on system 100 MVA base and new MTs have lower impedance which increases margin. No setting change is needed.
Main Power Transformer variable percentage differential relays with harmonic restraints	87T	Relays were set for EPU conditions based on a BFN calculation when they were installed as part of the MT replacement modifications.

* Backup protection. Not described in the FSAR Section 8.2.

In conclusion, the current settings of the protective relays for the main generators and MTs are adequate to protect the equipment at EPU conditions.

EEEB-RAI 14

On page 2-138 of Attachment 7 of the LAR, the licensee stated that the existing 500 kilovolts (KV) switchyard components (i.e., bus, breakers, switches, transformers, and lines) are adequate for the increased generator output associated with EPU.

Provide a summary of evaluation for the above components, including ratings and margins under CLTP and EPU duties, to confirm that the above components remain adequate under EPU conditions. Also, provide a discussion for the adequacy of the 161 KV switchyard components to support operation at EPU conditions.

TVA Response:

500kV Switchyard

The scope of this response will include from the high side of the Main Power Transformers (MPTs), to the 500 kV switchyard, the switchyard buswork itself, and include information on the sub-bays and their associated transmission lines. In Table EEEB-RAI14-1, the 500 kV offsite electrical equipment ratings and margins are evaluated. The duty is based on the generator maximum output at minimum system voltage (495 kV) and with no house loads deducted (50 MVA) which will provide a conservatively high duty loading. The transmission line loading is under the control of Transmission Operations and Power Supply and varies daily. The transmission Interconnection System Impact Study (SIS), performed at EPU conditions, evaluated numerous possible configurations of the transmission system with many different combinations of lines and generators out of service at expected worst case loadings, and in all cases, the most limiting components in the BFN 500kV and 161kV switchyards were never identified as overloaded. The interconnection SIS does not report actual loading values or margins, so this data cannot be provided. The interconnection SIS does show that all components are adequately rated for the worst case loading conditions at EPU. As reflected in Table EEEB-RAI 14-1, margin exists for all of the 500 kV switchyard components at EPU conditions.

161 kV Switchyard

BFN does not supply power to the 161 kV switchyard. The 161 kV switchyard supplies power to the Common Station Service Transformers (CSSTs) and Cooling Tower Transformers (CTTs). In Table EEEB-RAI 14-2, the 161 kV offsite electrical equipment ratings and margins are evaluated. The duty is based on the maximum allowable load on the CSSTs with the 161 kV system as a delayed source, plus the load expected from the CTTs, using the minimum system voltage that still qualifies as a delayed source (157 kV). This will maximize the duty loading. As reflected on Table EEEB-RAI 14-2, margin exists for all of the 161 kV switchyard components at EPU conditions.

Table EEEB-RAI 14-1
500 kV Offsite Electrical Equipment Ratings and Margins

Component	Rating (Amps)[1]	CLTP Duty (Amps)	Margin (%)	EPU Duty (Amps)	Margin (%)
MPT #1	1732	1493	13.8	1554	10.3
Most Limiting Buswork Element (MLBE) - 3" Aluminum (Al) Tube	2275	1493	34.4	1554	31.7
MPT #2	1732	1493	13.8	1554	10.3
MLBE - 3" Aluminum (Al) Tube	2275	1493	34.4	1554	31.7
MPT #3	1732	1493	13.8	1554	10.3
MLBE - 3" Al Tube	2275	1493	34.4	1554	31.7
500kV Switchyard - General					
Bus Bars - 5" Aluminum (Al) Tube	3683	1493	59.5	1554	57.8
Bus Bars - 6" Al Tube	4448	1493	66.4	1554	65.1
Disconnect Switches	3000	1493	50.2	1554	48.2
Circuit Breakers	3000	1493	50.2	1554	48.2
Transmission Line to West Point	2000	See Note 2			
MLBE - 4" Al Tube	2949				
Transmission Line to Madison	2949				
MLBE - 4" Al Tube	2949				
Transmission Line to Trinity#1	2262				
MLBE - 2-2500 mcm conductors	3314				
Transmission Line to Maury	2949				
MLBE - 4" Al Tube	2949				
Transmission Line to Union	2000				
MLBE - 4" Al Tube	2949				
Transmission Line to Limestone	2949				
MLBE - 4" Al Tube	2949				
Transmission Line to Trinity#2	2262				
MLBE - 2-2500 mcm conductors	3314				

[1] Ratings for all conductors are "summer continuous" ratings which are the most restrictive.
[2] Though specific duty and margins are not available, the interconnection SIS study found no overloading conditions for the most limiting component of the BFN 500 kV switchyard for the worst case transmission system configurations and loading conditions at EPU.

Table EEEB-RAI 14-2
161 kV Offsite Electrical Equipment Ratings and Margins

Component	Rating (Amps)[1]	CLTP Duty (Amps)	Margin (%)	EPU Duty (Amps)	Margin (%)
161kV Switchyard- General					
Bus Bars - 4" Aluminum (Al) Tube	2949	348	88.2	417	85.8
Bus Bars - 6" Al Tube	4448	348	92.2	417	90.6
Disconnect Switches	1600	348	78.3	417	73.9
Circuit Breakers	3000	348	88.4	417	86.1
Transmission Line (TL) from Athens	1335	348	73.9	417	68.7
Most Limiting Buswork Element (MLBE) - Stinger[2]/Wave Trap Jumper (2500AAC)	1657	348	79.0	417	74.8
Transmission Line from Trinity	1593	348	78.2	417	73.8
MLBE - Stinger (2500AAC)	1657	348	79.0	417	74.8
Bus-Tie Facility	1600	348	78.3	417	73.9
MLBE - 3" Al Tube	2275	348	84.7	417	81.7

[1] Ratings for all conductors are "summer continuous" ratings which are the most restrictive.
[2] A "stinger" is the jumper that connects the transmission line to the bus.

EEEB-RAI 15

By letter dated December 18, 2015, the licensee provided the interconnection system impact study (SIS) and a revised transmission system stability evaluation, which was originally provided in Attachment 43 of the LAR, to supplement the LAR per request of the EEEB staff.

The transmission system stability evaluation, revision 1, provided the results of the transmission system study (TSS)-grid voltage study and the evaluation of the impacts of the transmission system upgrades identified by the SIS on the results of the TSS. The TSS evaluated the impact of BFN operation at EPU conditions on its continued compliance with Title 10 of Code of Federal Regulation, Part 50, Appendix A, General Design Criterion (GDC) 17. In the TSS, the licensee stated that each BFN unit will be uprated to provide a maximum power (winter) output of 1,318 megawatts (MW) and approximately 1,260 MW during the summer months post-EPU. The TSS assumed all three units operation at the winter output of 1318 MW and used base cases from summer 2015 (pre-EPU) and summer 2019 (post-EPU) peak system loads.

Explain why the study was performed using the generators' winter maximum power output with the system summer peak load cases instead of winter peak load cases.

TVA Response:

Load forecasts predicts that the overall TVA transmission system load will peak in the summer. Therefore, a summer peak case was selected to have bounding transmission system load conditions. The winter peak output of 1,318 MWs represents the maximum BFN main generator supply and therefore bounds the lower summer output of 1,260 MW with respect to BFN main generator influence on the TVA transmission system. Using the bounding conditions during model simulation runs assures that the results are conservative.

EEEB-RAI 16

The SIS identified three upgrades on the TVA transmission system that are required for the BFN, Units 1, 2, and 3 EPU. The upgrades include installing of 774 megavolts amperes reactive capacitor banks at four locations throughout the TVA transmission system to meet all reactive power requirements for the incremental increase in MW output from each BFN unit.

Discuss the actions the licensee will take, such as reduction in BFN unit power output prior to the capacitor bank installations.

TVA Response:

TVA Transmission Planning does not require the BFN to take actions based on the capacitor banks not being in service prior to the BFN units operating at EPU conditions. The Transmission System Stability Evaluation shows that the capacitor banks are not required for compliance with GDC 17. The Federal Energy Reliability Commission (FERC) requires a 0.95 power factor (pf) capability on all new synchronous generation sources. TVA enforces this requirement for all new synchronous generation sources. The capacitor banks are being installed to address the FERC 0.95 pf requirement for the new generation associated with the BFN units operating at EPU conditions. As documented in the BFN Interconnection System Impact Study, Revision 1, TVA does not preclude BFN from operating at EPU conditions during capacitor bank installation. The BFN units may operate at the EPU condition during the interim period between BFN uprate and completion of the capacitor banks.

EEEB-RAI 17

In response to EEEB-RAI-1, the licensee stated, in letter dated February 16, 2016, that the TSS study evaluated the performance of the 500 KV and 161 KV offsite power systems during a design-basis event under EPU conditions. Bus voltages observed during the simulation are compared to acceptance criteria to determine adequacy of the offsite power supply. The licensee provided the results for loss of the largest load, loss of the largest generator, and loss of the most critical 500 KV transmission line. The minimum voltage acceptance criteria for the 500 KV source were met in all cases.

a. Provide the voltages obtained for the 161 KV offsite source for the most critical 161 KV transmission line out-of-service scenarios to verify that the acceptance voltage criteria at 161 KV are met under EPU conditions.

b. The loadings provided for CSSTs A and B are different for three scenarios: (1) 161 KV Immediate Source for T = 0 to 2.5 seconds; (2) 161 KV Immediate Source for T = 2.5 second and beyond; (3) 161 KV Delayed Source. Provide a discussion of the CSSTs A and B loadings under the three scenarios.

TVA Response:

a. As previously stated in TVA response to EEEB-RAI-1, the 161 kilovolt (kV) acceptance criteria for crediting the 161kV line as an immediate source are as follows:

161 kV IMMEDIATE SOURCE ACCEPTANCE CRITERIA:
At T=0+s: Voltage ≥ 152 kV and Voltage Drop ≤ 10 kV
With an associated load of:

CSST A Load (Pri.)	CSST B Load (Pri.)	TCT 1 Load (Sec.)	TCT 2 Load (Sec.)
22.8 + j23.3	16.3 + j8.9	32.1 + j20.9	34.1 + j20.5

At T= 2.5s and beyond: Voltage ≥ 159 kV and Voltage Drop ≤ 4 kV
With an associated load of:

CSST A Load (Pri.)	CSST B Load (Pri.)	TCT 1 Load (Sec.)	TCT 2 Load (Sec.)
25.6 + j18.9	20.3 + j15.3	32.1 + j20.9	34.1 + j20.5

The most critical transmission line for the 161kV source at BFN is the BFN to Trinity 161 kV transmission line. The voltage response is shown below in Table EEEB-RAI-17 -1, 161 kV System Voltage Response at 1,318 MW, with this line out of service pre-event.

ENCLOSURE 1

Table EEEB-RAI-17-1
161 kV System Voltage Response at 1,318 MW

Pre-Event	T=Pre-Event	T=0	T=0 Delta	T=1.75	T=2.5	T=2.5 Delta	T=5.6	T=7	T=14	T=21	T=28	T=60
3 Unit Operation												
BFN-Trinity 161 kV TL	155.7	149.3	6.4	156.2	162.1	-6.4	163.6	161.6	161.3	161.1	161.2	162.5
2 Unit Operation												
BFN-Trinity 161 kV TL	155.8	148.6	7.2	155.5	161.3	-5.5	162.9	160.8	160.5	160.3	160.4	161.7
1 Unit Operation												
BFN-Trinity 161 kV TL	156.0	147.9	8.0	154.9	160.7	-4.7	162.2	160.1	159.8	159.6	159.8	161.0

The pre-event outage of the BFN - Trinity 161 kV transmission line scenario passes the delta voltage requirements, however, the T= 0 voltage is below the 152 kV requirement and would not qualify as an immediate source.

As previously stated in TVA response to EEEB-RAI-1, the 161kV acceptance criteria for crediting the 161kV line as a delayed source are as follows:

161 kV Delayed Source Acceptance Criteria

Voltage ≥ 157 kV with the associated load of:

CSST A Load (Pri)	CSST B Load (Pri)	TCT 1 Load (Sec)	TCT 2 Load (Sec)
32.04+j16.74	32.04+j16.74	32.1 +j20.9	34.1 +j20.5

The pre-event outage of the BFN - Trinity 161 kV transmission line out of service scenario was rerun with the delayed source CSST load and then compared to the delayed source criteria. As shown in Table EEEB-RAI-17-2, 161 kV System Response-Delayed Source Load, the pre-event outage of the BFN - Trinity 161 kV transmission line scenario meets the delayed source criteria. This is not unique to extended power uprate (EPU) because the same scenario at current licensed thermal power has similar results.

Table EEEB-RAI-17-2
161 kV System Response-Delayed Source Load

Pre-Event **BFN-Trinity 161 kV**	**Voltage With Delayed Source Load (kV)**
3-Unit Operation	161.2
2-Unit Operation	161.0
1-Unit Operation	160.5

b. In the normal electrical configuration (all ties closed), the 161 kV system is qualified as an alternate immediate off-site power supply for Unit 3 only. Units 1 and 2 do not rely on the 161 kV system as an alternate immediate off-site power source during the loss of coolant accident (LOCA) shutdown. All three units may rely on the 161 kV system as a delayed off-site power source.

As noted in the BFN EPU license amendment request (LAR), Attachment 43, Transmission System Stability Evaluation, the 161 kV off-site circuit can provide power to the Unit 3 shutdown boards via the common station service transformers (CSSTs). Prior to initiation of the event (design basis LOCA) the 161 kV system is in the normal configuration with capacitor banks available, but switched off. Unit 3 is being supplied pre-event from the unit station service transformers (USSTs), which are tied to the 500 kV system with the CSSTs having no pre-load. At the initiation of the design basis LOCA (T=0s), the supply through the USSTs 500 kV system is assumed lost causing the Unit 3 shutdown boards to fast transfer to the 161 kV system via the CSSTs. Also, at the initiation of the event, the auto sequenced loads are applied to the boards according to their defined load sequence timers (T=0s through T=60s). Large sequenced loads such as residual heat removal (RHR), core spray (CS), and residual heat removal service water (RHRSW) are sequenced on line at discrete times (T=0s, T=7s, T=14s, T=21s, and T=28s). Sequence of large loads is shown in Table EEEB RAI 17-3, Unit 3 Shutdown Board Load Sequence. It is assumed that by T=60s, all required loads are operating and post-LOCA steady state load conditions exist. The load applied to the CSST at each time step in the sequence is shown in Table EEEB RAI 17-4, CSST (A/B) No Pre-Load.

Table EEEB RAI 17-3
Unit 3 Shutdown Board Load Sequence

Time (From Accident Signal)	4 kV Shutdown Board 3EA	4 kV Shutdown Board 3EC	4 kV Shutdown Board 3B	4 kV Shutdown Board 3D
0≤T≤1 second	RHR, CS			
6≤T≤8 second		RHR, CS		
12≤T≤16 second			RHR, CS	
18≤T≤24 second				RHR, CS
27≤T≤29 second	RHRSW	RHRSW	RHRSW	RHRSW

Table EEEB RAI 17-4
CSST (A/B) No Pre-Load

Time (From Accident Signal)	CSST A (MW + MVAR)	CSST B (MW + MVAR)
0+s	22.8 + j23.3	16.3 + j8.9
1.75s	22.7 + j22.1	16.2 + j8.7
2.5s	23.0 + j22.0	16.2 + j8.5
5.6s	22.5 + j12.3	16.3 + j8.4
7s	22.5 + j12.3	18.2 + j21.1
14s	24.4 + j25.8	17.5 + j9.1
21s	24.3 + j13.5	19.5 + j22.3
28s	25.6 + j18.9	20.3 + j15.3
60s	25.9 + j14.6	20.8 + j11.3

b.(1) Unit 3 LOCA Shutdown-161 kV System-Immediate Source (0 ≤ T ≤ 2.5s):
As shown above shown in Table EEEB RAI 17-1, Unit 3 Shutdown Board Load Sequence, one RHR pump and one CS pump start between T=0+s and T=2.5s. The loads on the CSSTs between T=0+s and T=2.5s would be those that were running prior to the event plus any sequenced loads that started according to their sequence timers (one RHR pump and one CS pump start at T=0+s). The 161 kV acceptance criteria is established at the load that would exist at T=0+s.

b.(2) Unit 3 LOCA Shutdown-161 kV System-Immediate Source (2.5s ≤ T ≤ 60s):
The effect of the 161 kV capacitor banks is considered in the analysis. By T=2.5s, all 161 kV capacitor banks are switched on. The time beyond T=2.5s is analyzed with capacitor banks switched on at the specified load for each time step. The loads on the CSSTs at time steps between T=2.5s and T=60s would be those that were running prior to T=2.5s plus any sequenced loads that started according to their sequence timers. The acceptance criteria is established at the load that would exist at T=28s. At the completion of this sequence load step, four RHR pumps, four CS pumps, and four RHRSW pumps would be running.

b.(3) BFN Units 1, 2, or 3 - 161 kV System - Delayed Source:
If pre-load exists on a CSST (any USST out of service), the 161 kV source does not qualify as an immediate source and the auto transfer of the operating units is blocked. All three units may rely on the 161 kV system as a delayed off-site power source.

For the 161 kV delayed source analysis, the safety related shutdown boards of the affected unit are assumed to be initially supplied from the unit's emergency diesel generators (DGs)..Loading on the CSST to establish the acceptance criteria is based upon the loading on the buses supplied by the X and Y windings of the CSSTs. The analysis is performed at the minimum bus voltage required to reset the degraded voltage relays (3983V). The X- windings of the CSSTs supply start buses 1A and 1B. Start buses 1A and 1B are assumed loaded to their maximum bus rating of 3000 amperes (A) each. The Y-winding of the CSSTs supply start buses 2A and 2B which are alternate supplies for the 4 kV Recirculation Boards. Each start bus is limited to two recirculation pump motors, based upon the rating of the CSST Y-winding. Therefore, start buses 2A and 2B are each assumed loaded with two recirculation pump motors operating at 100 percent. Each recirculation pump motor is rated at 1066A and 3965V.

To support long term recovery of an accident unit, or shutdown of a non-accident unit, the 4 kV unit boards can be manually transferred to the 4 kV start buses. The 4 kV shutdown boards can then be manually transferred from the DGs to the CSSTs via the 4 kV unit boards and 4 kV start buses. During this evolution, loading is managed to maintain each start bus below 3000A.

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On page 2-140 of Attachment 7 of the LAR, the licensee stated that equipment are operated at or below the nameplate ratings in both normal and emergency conditions at the EPU power level. Table 2.3-7 shows that the nameplate rating of the condensate booster pumps (CBPs) in all three units is 3,000 horsepower (hp), but the maximum transient load on the CBPs assuming a trip of one out of three CBPs or condensate pumps (CPs) is 3,720 brake hp. This shows that the CBPs are overloaded during the transient, and thus are operated above the nameplate ratings.

a. *Identify the balance of plant buses/boards that power the CPs and CBPs, and provide the worst case loading of these buses/boards and margin available at CLTP and EPU conditions. Also, provide a copy of all the Single Line Diagrams listed on page E5-5 provided in response to EEEB-RAI-2.*

b. *Provide a summary of relay settings to show that CBPs and their associated boards remain adequately protected during transient loading. Also, provide a duration of the transient loading.*

TVA Response:

The overload condition for the condensate booster pumps (CBP) shown in Table 2.3-7 of Attachment 7 of the Extended Power Uprate (EPU) License Amendment Request (LAR) are from system hydraulic analyses for each Browns Ferry Nuclear Plant (BFN) units that were designed to maximize the loading of the BFN Unit boards. The electrical buses that supply power to the condensate pump (CP) and CBP motors also are the normal supply for the safety-related shutdown buses. In the event of a loss of coolant accident (LOCA) or high energy line break, the electrical load flow analyses assume that the CP and CBP flow can potentially increase such that the brake horsepower requirements of the pumps will exceed the motor ratings. As a result, the maximum horsepower is computed at the maximum possible flow across CPs and CBPs. These maximum loads were then input into the BFN electrical load flow analyses for the determination of the maximum bus loads, adequacy of degraded voltage settings (See the TVA response to EEEB-RAI 2), motor terminal voltages, and short circuit analyses where a LOCA without loss of offsite power is postulated to occur after a trip of a CBP. In order to maximize the brake horsepower (BHP) loading of the CBPs, the hydraulic analyses for the CBP trip allowed the two remaining CBP to either go into runout flow conditions or to operate with no net positive suction head (NPSH) margin. These analysis conditions are very conservative versus the actual CBP BHP results upon a trip of a CBP at EPU power levels from an initial 3/3/3 CP/CBP/feedwater pump running configuration. The maximum CBP BHP upon trip of a CBP at EPU rated thermal power is 3,377 hp. While this power demand is above the CBP motor nameplate rating of 3,000 hp, it is within the 1.15 service factor (SF) rating of the motor (3,450 hp). Upon a trip of a CBP, the BFN operators would perform increased monitoring of the CBP motor parameters and a load reduction would be initiated to prevent exceeding the pump motor winding temperature alarm of 266°F.

a. The balance of plant (BOP) boards that power the condensate pumps (CP) and CBPs are shown in Table EEEB-RAI 18-1. The requested drawings identified in the TVA response to EEEB-RAI 2 are provided in Attachment 2 of this RAI response.

Table EEEB-RAI 18-1

Pump Motors	Board
1A CP and 1A CBP	Unit Board 1A
1B CP and 1B CBP	Unit Board 1B
1C CP and 1C CBP	Unit Board 1C
2A CP and 2A CBP	Unit Board 2A
2B CP and 2B CBP	Unit Board 2B
2C CP and 2C CBP	Unit Board 2C
3A CP and 3A CBP	Unit Board 3A
3B CP and 3B CBP	Unit Board 3B
3C CP and 3C CBP	Unit Board 3C

The worst case loading for the BFN Unit Boards is shown in Table EEEB-RAI 18-2. The Unit Board loads in Table EEEB-RAI 18-2 represents the highest individual board load for all load flow analysis conditions that include normal and alternate feeds to the 4KV unit boards, 4KV shutdown boards, 480V shutdown boards and 480V RMOV boards. The limiting load flow analyses assume a trip of a CBP in one BFN unit followed by LOCA without loss of off-site power. This worst case loading condition is applicable to BFN current licensed thermal power (CLTP) and EPU conditions. The hydraulic analyses that determined the maximum CBP and CP loadings are independent of the plant initial power level because the analyses artificially placed the remaining CP and CBP in runout conditions and/or set the pumps into conditions of zero NPSH margin. These analysis conditions are characteristics of the pumps and the condensate/feedwater piping and not the initial plant power level. In addition, the CP and CBP upgrades were performed for Unit 1 prior to Unit 1 restart. Previous load flow analyses prior to Unit 1 restart considered Unit 1 in a shutdown and defueled condition, i.e. there was no loading on the Unit 1 unit boards 1A, 1B, and 1C. Therefore, there is no direct comparison analysis between CLTP and EPU power for the limiting load flows. The CBP and CP upgrades have been field implemented at all three BFN units where the last implementation was the CBP upgrade for BFN Unit 3 in the Spring 2016 refueling outage.

Table EEEB-RAI 18-2

Unit Board	Maximum LOCA Loads (amps)	Board rating (amps)	Margin to Board Rating (%)
1A	1992	2000	0.4
1B	1992	2000	0.4
1C	935	1200	22.1
2A	1990	2000	0.5
2B	1997	2000	0.1
2C	895	1200	25.4
3A	1952	2000	2.4
3B	1975	2000	1.3
3C	898	1200	25.2

b. Motor breaker relay settings for the upgraded CPs and CBPs as well as the Unit Board normal and alternate feeder breakers are shown in Table EEEB-RAI 18-3.

Summary information concerning the calculation of the CBP relay settings and coordination with the feeder breakers is as follows:

The below data is for the 3000 hp CBP motors. All BFN Unit 1, 2, and 3 CBP motors are identical.

HP	Power Factor	Efficiency	Rated Voltage	Full Load Amps	Locked Rotor Current (LRC)	LRC Time (cold)
3000	0.907	0.958	4000 Volts	372 amperes	2325 amperes	9 seconds

The following are requirements for the breaker relay settings:

- The service factor of the CBP motors is 1.15. The device 51 (time overcurrent (OC) relay) is set to protect against overload conditions, and its minimum pickup (overcurrent tap setting) should not exceed 125% of full load current.
- Device 50 (instantaneous overcurrent relay) is set to actuate between 150% and 200% of motor locked-rotor current at 100% of rated voltage
- The time dial is set to provide an operating time to allow the motor start and protect the motor against locked rotor condition and running overload.
- The high drop out is set between 130 and 200% of motor full load current.
- Coordination curves between the motor breaker settings and the bus (Unit board) feeder breakers are drawn.

The following is a summary computation of the CBP breaker relay settings:

A. Inputs

Device: 50/51

Type of relay: 121AC66K8A

Current transformer (CT) Ratio: 500/5 = 100

B. Current Tap Setting (OC Tap Setting)

Set at approximately 125% of full load current

OC Tap setting = (1.25 x 372)/100 = 4.65 amp

Set at 4.5 amp (121% of full load current)

C. Normal Dropout Instantaneous (Norm. Inst.)

Set at approximately 200% of locked rotor current (LRC)

Norm. Inst. = (2 x 2325)/100 = 46.5 amp

Set at 46.5 (200% of locked rotor current)

D. High Drop Out Instantaneous (High D.O. Inst.)

Set between 130% and 200% of load current

(1.3 x 372)/100 = 4.84

(2 x 372)/100 = 7.44

Set at 7.0 (188% of full load current)

E. Time Dial

Set the time dial at 1.0 to protect the motor and allow the motor to start.

The coordination curves, Figures EEEB-RAI 18-2, 18-3, and 18-4, show that the settings are acceptable.

Figure EEEB-RAI 18-1 provides a schematic of the normal and alternate board feeds and the CBP motor feed.

Figure EEEB-RAI 18-2 coordination curve is applicable to CBP 1A, 1B, 2A, 2B, 3A, and 3B.

Figure EEEB-RAI 18-3 coordination curve is applicable to CBP 1C, 2C, and 3C.

Figure EEEB-RAI 18-4 coordination curve is applicable to all CBPs. Observation of Figure EEEB-RAI 18-4 shows that a 124% overload of a CBP, the BHP associated with the limiting CBP BHP used as input into the limiting electrical load flow analysis, would result in a trip of the CBP in approximately 40 seconds. The BFN load flow analysis does not credit any tripping of the running CBP during the 65 second duration of the LOCA load flow analysis.

The total transient loading duration for the 4KV Unit Boards supplying power to the CBPs, as well as the 4KV shutdown boards and 480V boards, is 61 seconds during the worst-case LOCA loading condition. At 61 seconds following the LOCA initiation, all large accident loads such as residual heat removal, core spray and residual heat removal service water pumps that are brought on line at discrete time sequences will have been loaded onto the plant electrical boards and all motor operated valves will have started and stroked to their required configuration. The BFN LOCA load flow analysis is run for a duration of 65 seconds to ensure that a steady state load flow is achieved. Therefore, the analyzed transient duration for the BFN electrical load flow analyses is 65 seconds.

The following drawings listed in the TVA response to EEEB-RAI 2 are provided in Enclosure 5.

4kV SHUTDOWN BD A	(0-45E724-1)
4kV SHUTDOWN BD B	(0-45E724-2)
4kV SHUTDOWN BD C	(0-45E724-3)
4kV SHUTDOWN BD D	(0-45E724-4)
4kV SHUTDOWN BD 3EA	(3-45E724-6)
4kV SHUTDOWN BD 3EB	(3-45E724-7)
4kV SHUTDOWN BD 3EC	(3-45E724-8)
4kV SHUTDOWN BD 3ED	(3-45E724-9)
4kV UNIT BD 1A	(1-45E721)
4kV UNIT BD 1B	(1-45E721)
4kV UNIT BD 1C	(1-45E721)
4kV UNIT BD 2A	(2-45E721)
4kV UNIT BD 2B	(2-45E721)
4kV UNIT BD 2C	(2-45E721)
4kV UNIT BD 3A	(3-45E721)
4kV UNIT BD 3B	(3-45E721)
4kV UNIT BD 3C	(3-45E721)
4kV COMMON BD A	(0-15E500-2)
4kV COMMON BD B	(0-15E500-2)
Key Diagram of Standby Auxiliary Power System	(0-15E500-1)
Key Diagram of Normal & Standby Auxiliary Power System	(3-15E500-3)

Table EEEB-RAI 18-3 CP, CBP, and Unit Board Feeder Breaker Information at EPU

Unit Board	Equipment	Breaker Size (Amps)	CT Ratio	Over-current Tap (Setting)	Over-current Trip Setting (Amps)	Over-current Time Delay (Setting)
1A	Norm Feed Bkr 1112	2000	400	8.0	3200	7.7
1A	Unit Start Bkr 1424	2000	400	8.0	3200	7.7
1A	CP Bkr 1A	1200	40	5.0	200	4.0
1A	CBP Bkr 1A	1200	100	4.5	450	1.0
1B	Norm Feed Bkr 1114	2000	400	8.0	3200	7.7
1B	Unit Start Bkr 1524	2000	400	8.0	3200	7.7
1B	CP Bkr 1B	1200	40	5.0	200	4.0
1B	CBP Bkr 1B	1200	100	4.5	450	1.0
1C	Norm Feed Bkr 1116	1200	300	10.0	450	6.0
1C	Unit Start Bkr 1532	1200	300	10.0	3000	6.0
1C	CP Bkr 1C	1200	40	5.0	200	4.0
1C	CBP Bkr 1C	1200	100	4.5	450	1.0
2A	Norm Feed Bkr 1212	2000	400	8.0	3200	7.7
2A	Unit Start Bkr 1428	2000	400	8.0	3200	7.7
2A	CP Bkr 2A	1200	40	5.0	200	4.0
2A	CBP Bkr 2A	1200	100	4.5	450	1.0
2B	Norm Feed Bkr 1214	2000	400	8.0	3200	7.7
2B	Unit Start Bkr 1526	2000	400	8.0	3200	7.7
2B	CP Bkr 2B	1200	40	5.0	200	4.0
2B	CBP Bkr 2B	1200	100	4.5	450	1.0
2C	Norm Feed Bkr 1216	1200	300	10.0	3000	6.0
2C	Unit Start Bkr 1426	1200	300	10.0	3000	6.0
2C	CP Bkr 2C	1200	40	5.0	200	4.0

ENCLOSURE 1

Unit Board	Equipment	Breaker Size (Amps)	CT Ratio	Over-current Tap (Setting)	Over-current Trip Setting (Amps)	Over-current Time Delay (Setting)
2C	CBP Bkr 2C	1200	100	4.5	450	1.0
3A	Norm Feed Bkr 1312	2000	400	8.0	3200	7.7
3A	Unit Start Bkr 1432	2000	400	8.0	3200	7.7
3A	CP Bkr 3A	1200	40	5.0	200	4.0
3A	CBP Bkr 3A	1200	100	4.5	450	1.0
3B	Norm Feed Bkr 1314	2000	400	8.0	3200	7.7
3B	Unit Start Bkr 1528	2000	400	8.0	3200	7.7
3B	CP Bkr 3B	1200	40	5.0	200	4.0
3B	CBP Bkr 3B	1200	100	4.5	450	1.0
3C	Norm Feed Bkr 1316	1200	300	10.0	3000	6.0
3C	Unit Start Bkr 1434	1200	300	10.0	3000	6.0
3C	CP Bkr 3C	1200	40	5.0	200	4.0
3C	CBP Bkr 3C	1200	100	4.5	450	1.0

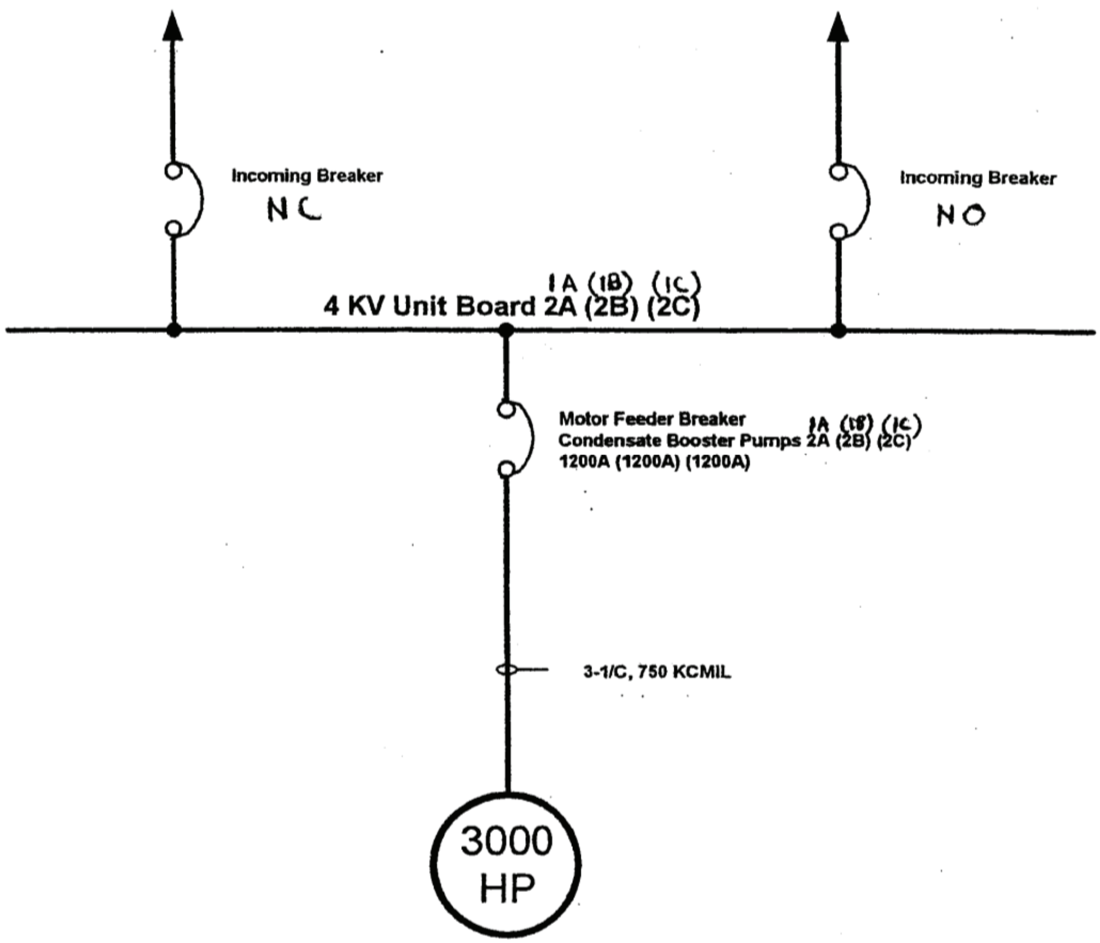

Figure EEEB-RAI 18-1 (This figure is applicable to all Unit 1, 2, and 3 4KV Unit Boards)

ENCLOSURE 1

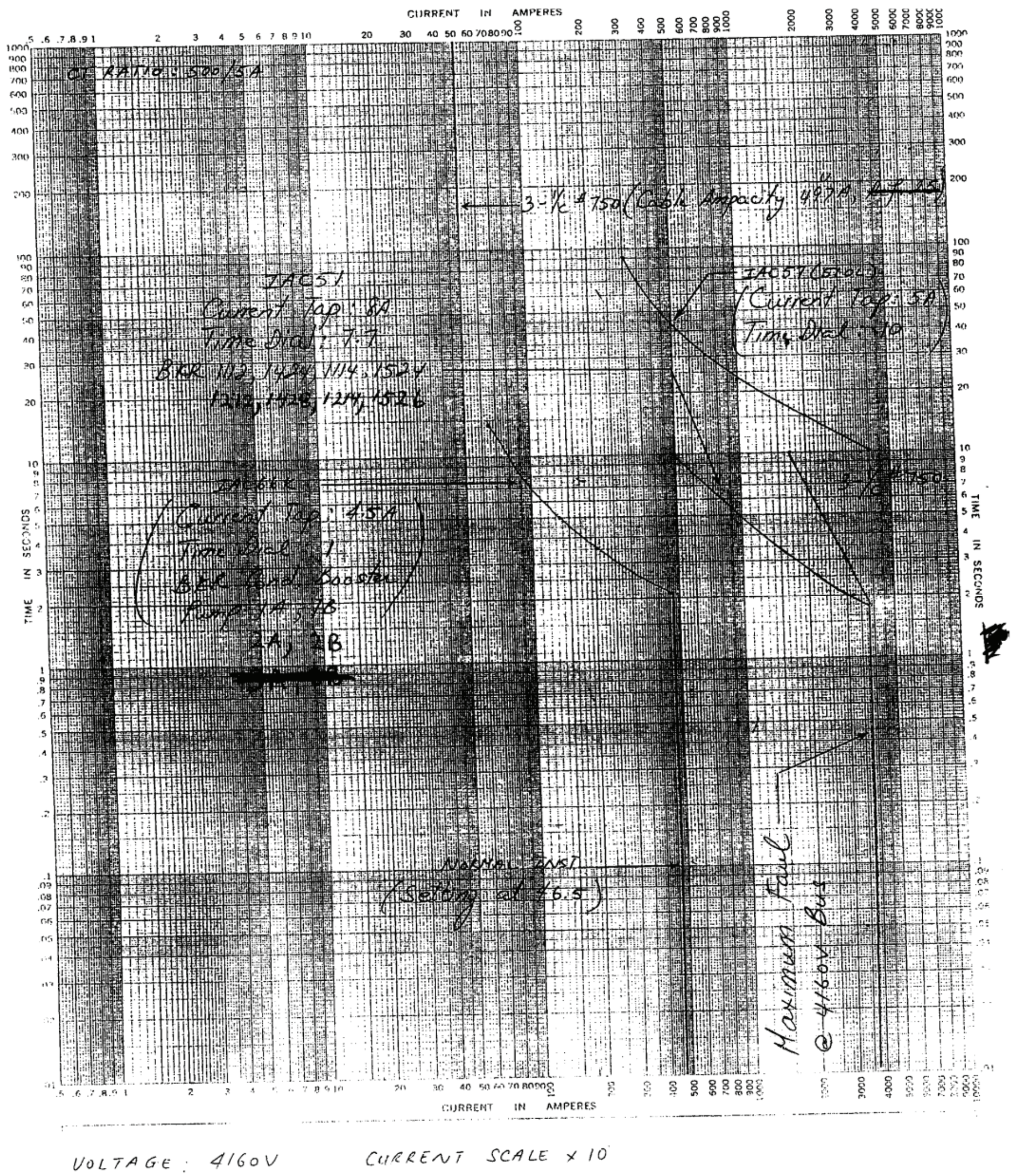

Figure EEEB-RAI 18-2

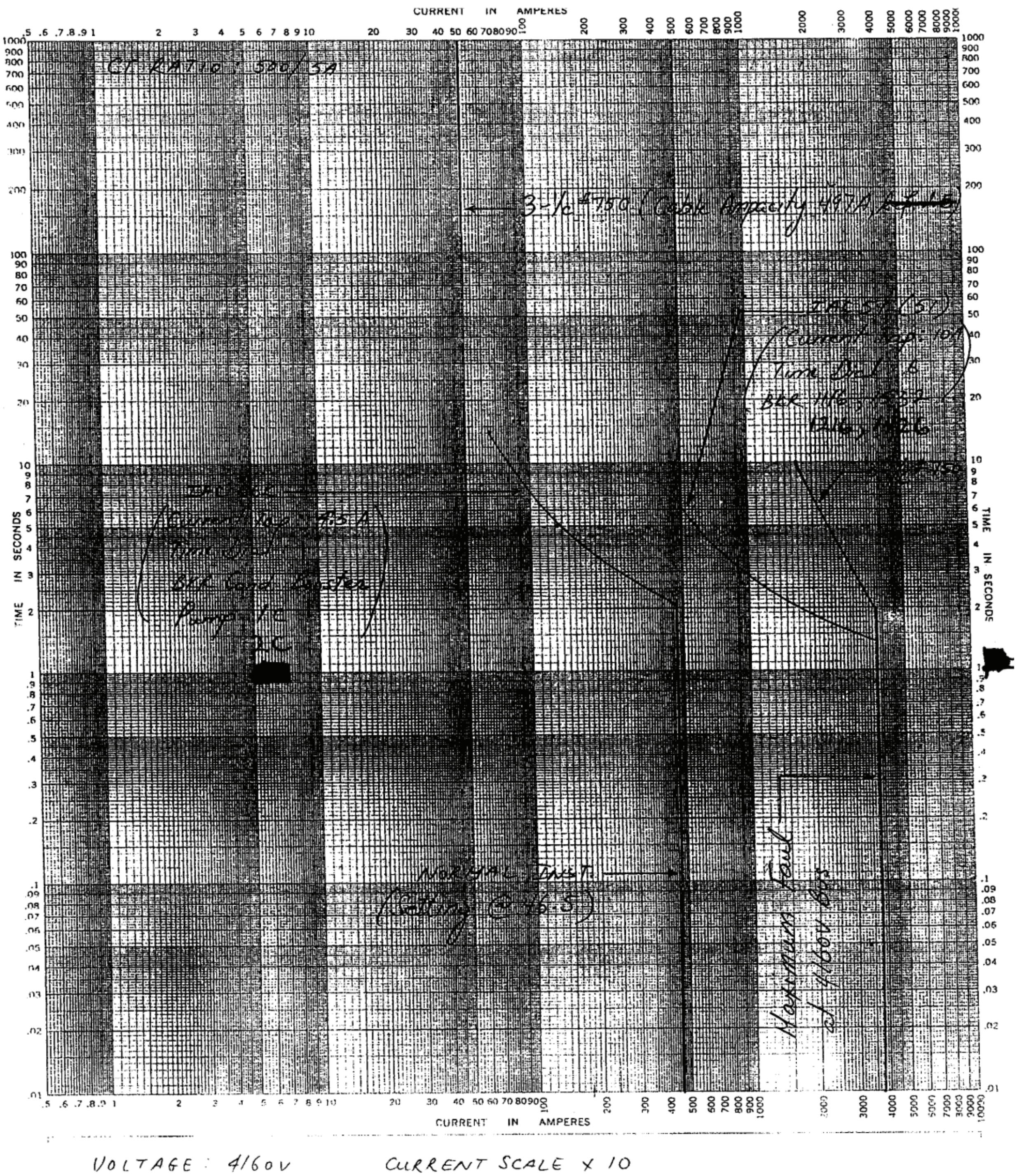

Figure EEEB-RAI 18-3

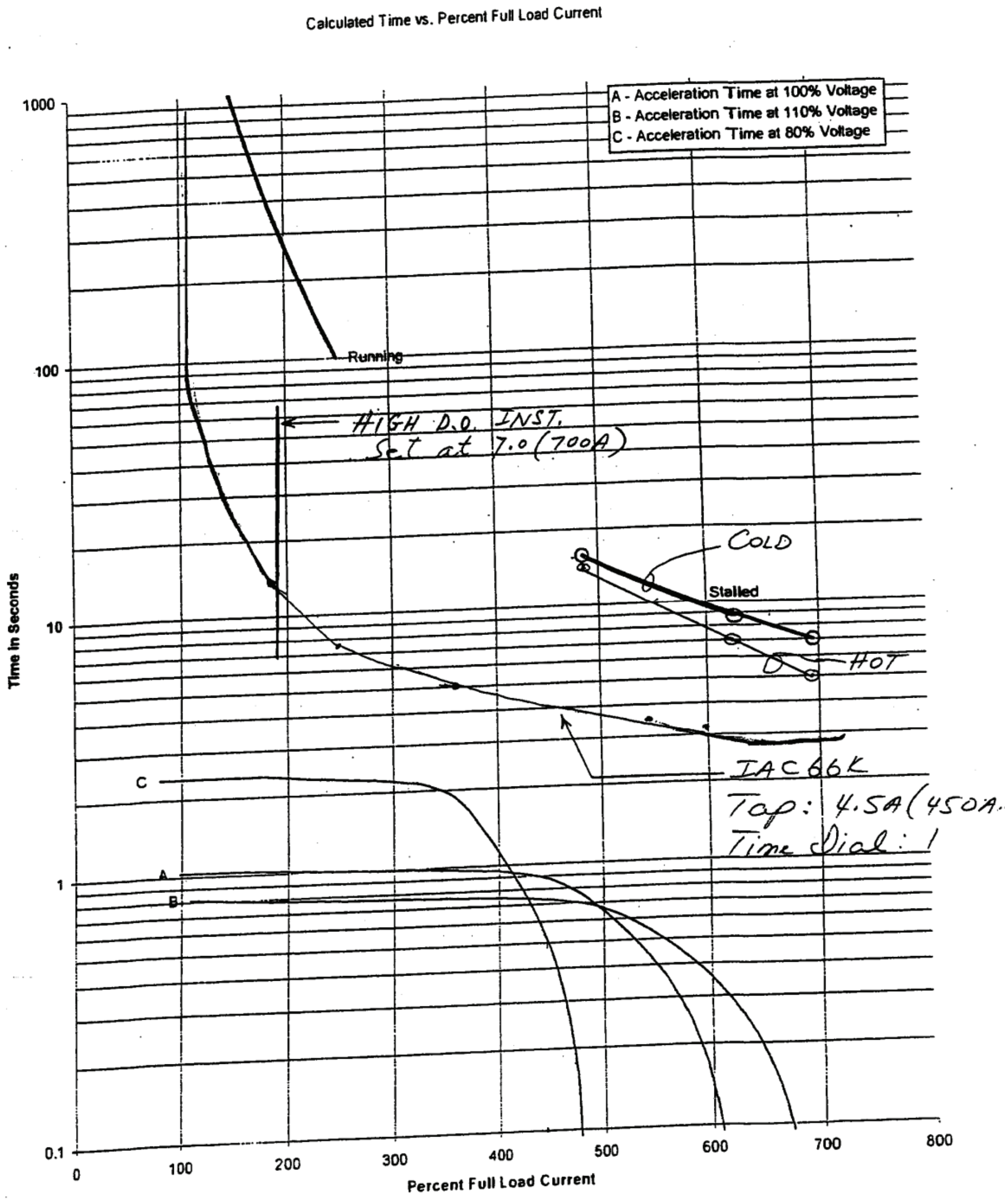

Figure EEEB-RAI 18-4

EEEB-RAI 19

On page 2-139 of Attachment 7 of the LAR, the licensee states:

> *The AC onsite power system consists of equipment and systems required to provide AC power to safety-related and nonsafety-related loads as long as offsite power is available. This includes 500 KV transformers, 161 KV transformers, 22 KV transformers, 4.16 KV transformers, 4.16 KV switchgears, 480 V [volt] transformers, 480 V load centers and motor control centers, 208/120 V distribution panels, and Uninterruptible Power Supply (UPS) systems.*

In Table 2.3-6, the licensee provided the ratings, duties, and margins of offsite electrical equipment including the 500 KV (main GSUTs), 161 KV (CSSTs), and 22 KV (USSTs) transformers at CLTP and EPU conditions.

Provide the ratings, worst case loading and margins of the 4.16 KV transformers, 4.16 KV switchgears, 480 V transformers, 480 V load centers and motor control centers, 208/120 V distribution panels, and UPS systems at CLTP and EPU conditions to show that the above electrical distribution equipment and systems are adequately sized to support plant operation at EPU conditions.

TVA Response:

BFN Unit 1 restarted from an extended shutdown in 2007. Many EPU modifications were installed while the unit was shutdown including the larger condensate pump motors, condensate booster pump motors, and recirculation pump motors. The EPU horsepower ratings were entered into the load flow calculations for these new pump motors. As such, after the BFN Unit 1 restart, no true set of “CLTP” load data exists as Unit 1 loads were set to EPU values. The CLTP Duties presented in this response reflect Unit 1 equipment at EPU loadings.

The ETAP runs, for the different possible electrical lineups and unit accident combinations, were evaluated for the worst case loadings on the electrical distribution equipment and systems (under 4.16 kV) under accident/shutdown conditions. The worst case loading results are presented in Table EEEB-RAI 19-1. Loads associated with the shutdown of the non-accident units are included. The transformers with 4.16 kV on the secondary are the USSTs and CSSTs and the loadings, ratings, and margin for these components can be found in the TVA response to EEEB-RAI 12.

Steady state loading for the 120V AC distribution systems is provided in Table EEEB-RAI 19-2. Only EPU data is presented since the calculations for these systems are based on existing nameplate data and these systems do not experience a change in load related to EPU conditions. Data for the following systems is presented.

- 120/208V AC Instrument and Control (I&C) Power System - This system provides two independent sources of Class 1E power per unit to the instruments and controls.

- 120/240V AC Unit Preferred System - This system provides, on a per unit basis, a reliable source of non-class 1E power to important non-safety related loads. (For Unit 1, the normal feed is a UPS. For Units 2 and 3, the normal feeds are from motor generator sets (MG Sets).
- Reactor Protection System (RPS) - The RPS system provides two independent channels per unit. Each channels' normal feed is from an MG Set.

In conclusion, the BFN electrical distribution equipment and systems, from 4kV down to 120 VAC, are adequately sized to support plant operation at EPU conditions.

ENCLOSURE 1

Table EEEB-RAI 19-1
Worst Case Loading for Components Under 4 kV at CLTP and EPU Conditions

Unit	Component	Rating (Amps)	CLTP Duty[1] (Amps)	CLTP Margin (%)	EPU Duty (Amps)	EPU Margin (%)
Unit 1	4kV UB 1A	2000	1992	0.4	1992	0.4
	4kV UB 1B	2000	1992	0.4	1992	0.4
	4kV UB 1C	1200	902	24.8	935	22.1
	4kV COM BD A	1200	571	52.4	571	52.4
	4kV SD BD A	1200	645	46.3	562	53.2
	4kV SD BD B	1200	768	36.0	573	52.3
	480V SD BD 1A	1600	1365	14.7	1357	15.2
	480V SD BD 1B	1600	1026	35.9	1036	35.3
	480V RMOV BD 1A	600	374	37.7	371	38.2
	480V RMOV BD 1B	600	303	49.5	302	49.7
	480V RMOV BD 1C	600	135	77.5	143	76.2
	480V CONT BAY VENT BD A	600	222	63.0	221	63.2
	480V DSL AUX BD A	600	338	43.7	338	43.7
	Component	**Rating (kVA)**	**CLTP Duty (kVA)**	**CLTP Margin (%)**	**EPU Duty (kVA)**	**EPU Margin (%)**
	480V TRANS TDA	0.3	0.282	6.0	0.282	6.0
	480V TRANS TS1E	1.15	0.782	32.0	0.849	26.2
	480V TRANS TDE	0.3	0.246	18.0	0.248	17.3
Unit 2	**Component**	**Rating (Amps)**	**CLTP Duty (Amps)**	**CLTP Margin (%)**	**EPU Duty (Amps)**	**EPU Margin (%)**
	4kV UB 2A	2000	1784	10.8	1990	0.5
	4kV UB 2B	2000	1953	2.4	1997	0.1
	4kV UB 2C	1200	665	44.6	895	25.4
	4kV COM BD B	1200	630	47.5	615	48.8
	4kV SD BD C	1200	613	48.9	509	57.6
	4kV SD BD D	1200	589	50.9	598	50.2
	480V SD BD 2A	1600	1288	19.5	1343	16.1
	480V SD BD 2B	1600	1105	30.9	1174	26.6
	480V RMOV BD 2A	600	285	52.5	284	52.7
	480V RMOV BD 2B	600	299	50.2	300	50.0
	480V RMOV BD 2C	600	133	77.8	142	76.3
	480V RMOV BD 2D	90	0	100.0	0	100.0
	480V RMOV BD 2E	250	0	100.0	0	100.0
	480V DSL AUX BD B	600	298	50.3	298	50.3
	Component	**Rating (kVA)**	**CLTP Duty (kVA)**	**CLTP Margin (%)**	**EPU Duty (kVA)**	**EPU Margin (%)**
	480V TRANS TS2E	1.15	0.96	16.5	0.865	24.8
	480V TRANS TDB	0.3	0.249	17.0	0.25	16.7
Unit 3	**Component**	**Rating (Amps)**	**CLTP Duty (Amps)**	**CLTP Margin (%)**	**EPU Duty (Amps)**	**EPU Margin (%)**
	4kV UB 3A	2000	1663	16.9	1952	2.4
	4kV UB 3B	2000	1705	14.8	1975	1.3
	4kV UB 3C	1200	640	46.7	898	25.2
	4kV SD BD 3EA	1200	505	57.9	519	56.8
	4kV SD BD 3EB	1200	443	63.1	451	62.4
	4kV SD BD 3EC	1200	536	55.3	546	54.5
	4kV SD BD 3ED	1200	384	68.0	392	67.3
	480V SD BD 3A	1600	1246	22.1	1261	21.2
	480V SD BD 3B	1600	1415	11.6	1434	10.4
	480V RMOV BD 3A	600	406	32.3	415	30.8
	480V RMOV BD 3B	600	461	23.2	465	22.5
	480V RMOV BD 3C	600	129	78.5	140	76.7
	480V RMOV BD 3D	225	0	100.0	0	100.0
	480V RMOV BD 3E	225	0	100.0	0	100.0
	480V DSL AUX BD 3EA	600	131	78.2	131	78.2
	480V DSL AUX BD 3EB	600	106	82.3	107	82.2
	480V CONT BAY VENT BD B	600	194	67.7	197	67.2
	480V HVAC BD B	1600	362	77.4	367	77.1
	480 SGT BD	600	103	82.8	103	82.8
	Component	**Rating (kVA)**	**CLTP Duty (kVA)**	**CLTP Margin (%)**	**EPU Duty (kVA)**	**EPU Margin (%)**
	480V TRANS TS3E	1.15	0.791	31.2	0.807	29.8
	480V TRANS THB	1.333	0.302	77.3	0.302	77.3
	480V TRANS TSG1A	0.3	0.087	71.0	0.088	70.7

Table EEEB-RAI 19-2
120V AC Systems at EPU Conditions

Component		Rating (kVA)	EPU Loading (kVA)	Margin (%)
Instrument and Control (I&C)				
U1 Panel 9-9 I&C Bus A		50.0	16.2	67.6
U1 Panel 9-9 I&C Bus B		50.0	13.9	72.2
U2 Panel 9-9 I&C Bus A		50.0	14.7	70.5
U2 Panel 9-9 I&C Bus B		50.0	14.3	71.3
U3 Panel 9-9 I&C Bus A		50.0	12.2	75.7
U3 Panel 9-9 I&C Bus B		50.0	15.2	69.5
Reactor Protection System (RPS)				
Bus 1A		18.75	12.3	34.7
Bus 1B		18.75	10.9	41.9
Bus 2A		18.75	12.0	36.0
Bus 2B		18.75	13.9	25.9
Bus 3A		18.75	15.3	18.6
Bus 3B		18.75	13.7	27.1
Unit Preferred 120V AC				
U1 from UPS	L1	8.4	6.7	20.4
U1 from UPS	L2	8.4	6.3	25.0
U2 from MG Set	L1	8.4	6.4	24.4
U2 from MG Set	L2	8.4	3.8	55.2
U3 from MG Set	L1	8.4	5.5	34.6
U3 from MG Set	L2	8.4	3.0	64.7

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In Section 2.3.4 of Attachment 7 of the LAR, the licensee stated that the current licensing basis for BFN onsite DC power systems is based on the 1967 Atomic Energy Commission proposed GDC or draft-GDC 24 and 39. The licensee also stated in Sections 2.3.2 and 2.3.3 that the final GDC 17 is applicable to BFN offsite and onsite AC power systems, as described in UFSAR Section 8.3.

Explain to what extent the GDC 17 is applicable to the BFN DC power systems.

TVA Response:

As discussed in the Browns Ferry Nuclear Plant (BFN) Technical Specifications Bases B 3.8.4, "DC Sources - Operating," the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure, as required by 10 CFR 50, Appendix A, GDC 17.

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On page 2-143 of Attachment 7 of the LAR, the licensee states:

> *The results of the battery sizing calculation for the LOCA/LOOP [loss of offsite power] analysis scenario show that the existing batteries have adequate voltage at the end of the duty cycle. It also shows all required DC devices are within their design voltage range.*

Provide a summary of the battery (identify the batteries) sizing calculation, including assumptions, voltages and margin, for the LOCA/LOOP scenario corresponding to EPU conditions.

TVA Response:

The summary of the battery sizing calculation for the LOCA/LOOP scenario corresponding to EPU conditions is as follows.

1.0 <u>PURPOSE</u>

1.1 Perform the DC load study for all three units on 250V DC unit batteries 1, 2 and 3 to verify that the size of the existing batteries is adequate during a DBA on one unit and spurious DBA on another unit (Loss of Coolant Accident (LOCA) and Loss of Offsite Power (LOOP)) with one battery system out of service and the safe shutdown and cooldown of the remaining non-DBA unit.

1.2 Establish the voltage profile for each battery duty cycle to determine the minimum available voltage at the terminals of each unit battery, battery boards, Reactor Motor Operated Valve (RMOV) boards, and Shutdown Boards for each case of study and verify that these calculated voltages are higher than the bus voltage used to perform control circuit voltage drop (CCVD) calculations.

2.0 <u>SYSTEM DESCRIPTION</u>

The existing 250V DC system at BFN serves the three unit plant with a continuous source of DC power to both safety-related and non-safety related loads. It also provides power for unit control functions, operative power for unit control loads, control power for 4kV and 480V switchgear, common plant and transmission system control functions, and drive power for motor loads.

2.1 The 250V DC Power System at BFN has two sub-systems.

2.1.a The 250V DC plant system consists of three unit batteries 1, 2, and 3 and their associated battery chargers and distribution boards. These batteries supply all the required safety related loads.

Three station batteries 4, 5 and 6 and their associated battery chargers and distribution boards supply loads that are not essential to safe shutdown and cooldown of the units and are therefore not discussed further.

Each unit battery is a 120 cell lead-acid battery of C&D make, type LCUN-33. They have a one-minute rating of 2080 amps and an 8-hour discharge rating of 2320 ampere-hours. Both ratings are based on a battery terminal voltage of 210V (at 77°F) at end of discharge (1.75V/Cell).

The three unit batteries are for three units and feed Class 1E battery boards 1, 2, and 3. These three unit batteries have all the engineered safeguards loads for the three units distributed among them so that redundant systems on each unit have separate normal and alternate power supplies, each capable of providing sufficient power for engineered safeguard loads. Safety-related DC Motor Operated Valve (MOV) boards have power supplies from two different batteries designated as normal and alternate power supply. All transfers from normal to alternate sources are performed manually.

2.1.b 250V DC control power supply system consists of five shutdown batteries (SB) SB-A, B, C, D and 3EB and their associated battery chargers and distribution boards. This system supplies control power to 4160V Shutdown Boards A, B, C, D and 3EB and 480 Shutdown Boards 1A, 1B, 2A, and 2B.

Each shutdown board battery is a 120 cell lead-acid battery of C&D make, type KCR·11. They have a one-minute discharge rating of 500 amperes and an 8-hour discharge rating of 410 ampere-hours. Both ratings are based on a battery terminal voltage of 210V (at 77°F).

3.0 ACCEPTANCE CRITERIA

3.1 Battery Sizing - The batteries' cells must contain more positive plates than the number of positive plates required as calculated by the ETAP program.

3.2 Battery Capacity - The capacity of the battery shall be considered adequate for minimum required battery terminal voltage of 210.0V (1.75V/Cell). However, higher minimum voltage at the battery terminals shall be maintained for maintaining the minimum voltages for various boards in order to have adequate voltage at the control devices evaluated in control circuit voltage drop calculations. (See Section 3.3) The battery's duty cycle is 30 minutes.

3.3 Minimum Board Voltages - The minimum available voltages necessary at the end devices are calculated by the ETAP using actual minimum voltage at the upstream buses of the end devices. The following minimum voltages have been used at the 250V DC boards to perform control circuit voltage drop calculations and therefore these minimum voltages must be maintained:

4kV Shutdown Board A	206.0V
4kV Shutdown Board B	207.5V
4kV Shutdown Board C	208.0V
4kV Shutdown Board D	207.5V
4kV Shutdown Board 3EA, 3EB, 3EC, 3ED	204.5V

480V Shutdown Board 1A, 1B, 2A, 2B, 3A, 3B	202.0V
250V RMOV Board 2A	210.0V
250V RMOV Boards 2C and 2B	210.0V
250V RMOV Boards 3A, 3B and 3C	210.0V
250V RMOV Boards 1A, 1B and 1C	210.0V

4.0 ANALYSIS

4.1 The 250V DC load study calculation is performed using the TVA verified ETAP software, Version 5.0.3.

4.2 The worst case loading condition for the batteries, based on the operation of valves, pumps, etc., is used in the 30 minute battery duty cycle. Both HPCI and RCIC systems will automatically start at time t=0 seconds for the Units in the real, as well as spurious, DBA events. Even though HPCI and RCIC do not start simultaneously, loading is considered at t=0 seconds for conservatism. The HPCI and RCIC systems for the Unit, which will not be in a DBA event, will initiate after 25 seconds of the battery duty cycle. Even though Unit 1 is not in a DBA event, the applied loads at 25 seconds are considered to be the LOCA loads. Units 2 and 3 loads are initiated at 0 seconds in the battery duty cycle and Unit 1 at 25 seconds. The worst load peak is at 0 seconds due to Units 2 and 3 transient loads. This worst case loading is considered for the entire minute. Therefore, any combination of DBA and non-DBA events configuration (for e.g., "U1 in LOCA, U2 in spurious LOCA and U3 in normal cold shutdown" or "U3 in LOCA, U1 in spurious LOCA and U2 in normal cold shutdown mode") will be enveloped by the analyzed configuration of U2 in LOCA, U3 in Spurious LOCA and U1 in normal cold shutdown mode. Hence, separate battery loading evaluation has not been performed for different combination of DBA events between the units.

Also, the minimum available voltage at the end devices will be the same as computed with these DBA events, because ETAP performs voltage drop computations with the minimum calculated voltage during the entire first minute. The voltage drop computation has been performed with actual cable data for all units which have been input in the ETAP. Therefore, the minimum available voltages will be the same in different combinations of DBA events between units.

4.3 Battery load is calculated to verify the adequacy of the 250V DC system to perform its design functions. Unit batteries are required to carry the accident load with one battery out of service. Also, any one shutdown battery may be removed from service. The 250V DC distribution system provides alternate feeds to all loads to allow one battery to be removed from service. Considering combination of each unit battery with no unit batteries out of service and with each battery out of service one at a time results in the following cases of study.

Establish 30 minute duty cycles for Battery Board #1 with:

- Case 1: Shutdown Battery C* out of service.
- Case 2: Unit Battery 2 out of service.
- Case 3: Unit Battery 3 out of service.

Establish 30 minute duty cycles for Battery Board #2 with:
- Case 4: Unit Shutdown Battery A* out of service.
- Case 5: Unit Battery 1 out of service.
- Case 6: Unit Battery 3 out of service.

Establish 30 minute duty cycles for Battery Board #3 with
- Case 7: Shutdown Battery D* out of service.
- Case 8: Unit Battery 1 out of service.
- Case 9: Unit Battery 2 out of service.

* For consideration of shutdown batteries out of service, only the worst case load on each unit battery is calculated.

Unit batteries 1, 2 and 3 supply all safety related loads and station batteries 4, 5 and 6 supply all non-safety related loads. Only loads for the following board/panel equipment can be transferred between the unit and station batteries.
- 4KV Cooling Tower Switchgear D (From BB4 (Norm) to BB1 (Alt))
- Electrical Distribution Circuit Breaker Panel 9-24 (From BB4 (Norm) to BB2 (Alt))

The ETAP has been modeled as showing the alternate breakers as closed. The alternate breakers would normally only be closed if unit battery 4 were out of service. Modeling the alternate breakers as closed is conservative and eliminates the need to run a special case for each unit battery 1, 2 and 3, with unit battery 4 out of service.

4.4 The total load on each battery board for each of the three cases of study is compiled and the battery duty cycle is established for all cases. Battery sizing calculations, to determine the required number of positive plates, are then performed for each case using ETAP. The battery voltage profile is also determined for each battery duty cycle for every case using the same ETAP model.

4.5 The following cell sizing correction factors are used in this calculation.

1.11 - Temperature correction for 60°F.
1.25 - Compensating for aging factor for 80% of rated capacity at the end life.
1.02 - Design Margin (BFN being an operational plant, minimum 2% Design Margin is used).

4.6 The DC buses are considered to have negligible resistance and inductance. The inductance of cables is not considered in the calculations.

4.7 The impedance of circuit breakers and fused disconnect switches is considered to be negligible.

4.8 Battery internal cell resistance used is 0.01416 Ohms (0.000118 Ohms/Cell x 120 Cells),

4.9 Battery initial voltage used in "ETAP" at t=0 seconds is considered to be Battery Open Cell voltage of 2.055V/Cell (246.6V) for battery load flow and battery discharge calculations.

4.10 Initiation of HPCI and RCIC valves are analyzed for the entire duty cycle. For conservative battery loading, the "ON & OFF" cycling of the valves has been considered to initiate at the beginning of each time interval. This will result in conservative battery loading since the loads are stacked on the top of each other.

4.11 The operating stroke times for all Units' MOVs, required to operate during a DBA event, is less than or equal to one minute. However, all stroke times are entered into ETAP as one minute for conservatism.

4.12 Control loads such as indicating lights in spare cubicles of switchgear are negligible and are not considered.

4.13 All motor starting loads are modeled as constant resistance. The load current for constant resistance loads is adjusted by ETAP based on available battery voltage. This is conservative.

4.14 All safety-related control operations shall be automatic for the first 10 minutes after a loss of off-site power and/or any other accident condition.

4.15 The full load current for the MOVs is normally based on 20% running torque. As per Limitorque Corp., the MOV motor should be adequate to accommodate a running torque of 10% to 25% of the seating force (torque). Hence a full load (running) current corresponding to 25% running torque will be used. The increase in 5% running torque is equivalent to 20% increase of the rated full load current and these values are used in the ETAP calculation. This will also result in conservative battery loading.

4.16 The pump motors are assumed to reach rated speed within five seconds. This assumption in the battery load duty cycle that the DC pump motor inrush current lasts for five seconds is conservative based on the following:

DC pump motors have the reduced voltage starting circuit. The reduced voltage starting resistance in the motor armature circuit cuts out after 2 seconds. The timer is typically chosen such that the motor will be close to, or equal to, full speed (free running) before the starting resistor is cut out. This means by two seconds, there is sufficient counter emf generated in the motor such that the current won't be excessive when the starting resistor is removed from the circuit. The remaining acceleration time to full speed will be negligible. Therefore, the maximum duration of inrush current will be two seconds.

4.17 HPCI Gland Seal condensate pump is cycling on and off and is considered as a cyclic load. Also the HPCI auxiliary oil pump is considered to run continuously during the 30-minute duty cycle. This represents conservative loading for the auxiliary oil pump.

4.18 Continuous 4.0 ampere margin is added to each of the following boards during each step of the thirty minute duty cycle to account for the effects of the incorporation of future design changes into this calculation and is conservative.

Battery Board 1, 2 and 3
250V RMOV Board 1A, 1 B and 1C
250V RMOV Board 2A, 2B and 2C
250V RMOV Board 3A, 3B and 3C

4.19 A continuous design margin of 5.0 amps has been added to each 4kV shutdown board DC distribution panel for the entire 30 minute battery duty cycle. This margin is included to account for the effects of the incorporation of future design changes into this calculation and is conservative.

5.0 RESULTS

5.1 Battery Sizing

Table 5.1
Unit Batteries - Sizing

Battery/Case	Number of Positive Plates Calculated	Number of Positive Plates Supplied	Positive Plate Margin (%)
UNIT BATTERY 1, CASE 1	11.83	16	26.1
UNIT BATTERY 1, CASE 2	7.44	16	53.5
UNIT BATTERY 1, CASE 3	8.83	16	44.8
UNIT BATTERY 2, CASE 4	11.75	16	26.6
UNIT BATTERY 2, CASE 5	10.11	16	36.8
UNIT BATTERY 2, CASE 6	10.22	16	36.1
UNIT BATTERY 3, CASE 7	11.42	16	28.6
UNIT BATTERY 3, CASE 8	6.85	16	57.2
UNIT BATTERY 3, CASE 9	11.04	16	31.0

Table 5.2
Shutdown Batteries - Sizing

Shutdown Battery	Number of Positive Plates Calculated	Number of Positive Plates Supplied	Positive Plate Margin (%)
SB-A	2.37	5	52.6
SB-B	3.00	5	40.0
SB-C	3.00	5	40.0
SB-D	3.00	5	40.0
SB-3EB	3.00	5	40.0

Unit batteries 1, 2, and 3 and Shutdown Batteries SB-A, B, C, D, 3EB are adequately sized as the number of positive plates supplied in the cells exceeds the number of positive plates required by ETAP calculation.

5.2 Battery Capacity

Table 5.3
Unit Batteries - Capacity

Battery/Case	Minimum Voltage (Volts) (0-30 minutes)	Required Minimum Voltage (Volts)	Voltage Margin (%)
UNIT BATTERY 1, CASE 1	221.91	210.00	32.5
UNIT BATTERY 1, CASE 2	227.24	210.00	47.1
UNIT BATTERY 1, CASE 3	225.06	210.00	41.1
UNIT BATTERY 2, CASE 4	222.05	210.00	32.9
UNIT BATTERY 2, CASE 5	223.88	210.00	37.9
UNIT BATTERY 2, CASE 6	223.27	210.00	36.3
UNIT BATTERY 3, CASE 7	222.25	210.00	33.5
UNIT BATTERY 3, CASE 8	228.03	210.00	49.3
UNIT BATTERY 3, CASE 9	222.34	210.00	33.7

Table 5.4
Shutdown Batteries - Capacity

Shutdown Board Battery	Minimum Voltage (Volts) (0-30 minutes)	Required Minimum Voltage (Volts)	Voltage Margin (%)
SB-A[1] SB-B SB-C SB-D SB-3EB	225.06	210.00	41.1

[1] Calculation was performed using the worst case profile for battery SB-A which bounds the load profiles of the other batteries.

Unit batteries 1, 2, and 3 and Shutdown Batteries SB-A, B, C, D, 3EB have adequate capacity as the minimum voltages, calculated by ETAP, were all greater than the required minimum voltage of 210.0V (1.75V/Cell). However, higher minimum voltage at the battery terminals shall be required for maintaining the minimum voltages for various boards in order to have adequate voltage at the control devices evaluated in control circuit voltage drop calculations. (See Results Section 5.3 - Minimum Board Voltages.)

5.3 Minimum Board Voltages

Table 5.5
Unit Batteries - Minimum Board Voltages

Shutdown Board ID	Minimum Acceptable Bus Voltage (Volts)	250V DC BUS VOLTAGE			
		NORMAL SOURCE[1]		ALTERNATE SOURCE[1]	
		Minimum (Volts)	Margin (%)	Minimum (Volts)	Margin (%)
4kV SHUTDOWN BD 3EA	204.5	219.44	35.5	221.97	43.8
4kV SHUTDOWN BD 3EC	204.5	219.13	38.3	215.81	41.5
4kV SHUTDOWN BD 3ED	204.5	221.19	34.8	220.62	26.9
4kV BUS TIE BD	204.5	221.32	39.6	222.92	38.3
480V SHUTDOWN BD 3A	202.0	215.48	30.2	222.86	46.8
480V SHUTDOWN BD 3B	202.0	217.35	34.4	217.35	34.4

1 The three unit batteries, batteries 1, 2, and 3 have all the engineered safeguards loads for the three units distributed among them so that redundant systems on each unit have separate normal and alternate supplies.

Table 5.6
Shutdown Batteries - Minimum Board Voltages

Shutdown Board ID	Minimum Acceptable Bus Voltage (Volts)	250V DC BUS VOLTAGE			
		NORMAL SOURCE[1]		ALTERNATE SOURCE[1]	
		Minimum (Volts)	Margin (%)	Minimum (Volts)	Margin (%)
4kV SHUTDOWN BD A	206.0	220.61	36.0	220.28	35.2
4kV SHUTDOWN BD B	207.5	220.61	33.5	217.17	24.7
4kV SHUTDOWN BD C	208.0	220.61	32.7	212.09	10.6
4kV SHUTDOWN BD D	207.5	220.61	33.5	221.30	35.3
4kV SHUTDOWN BD 3EB	204.5	220.61	38.3	215.27	25.6
480V SHUTDOWN BD 1A	202.0	207.84	13.1	216.40	32.3
480V SHUTDOWN BD 1B	202.0	207.84	13.1	225.67	53.1
480V SHUTDOWN BD 2A	202.0	207.84	13.1	209.72	17.3
480V SHUTDOWN BD 2B	202.0	207.84	13.1	225.67	53.1
RMOV BOARD 1A	210.0	218.81	24.1	See Footnote 2	N/A
RMOV BOARD 1B	210.0	221.12	30.4	See Footnote 2	N/A
RMOV BOARD 1C	210.0	220.81	29.5	See Footnote 2	N/A
RMOV BOARD 2A	210.0	217.60	20.8	See Footnote 2	N/A
RMOV BOARD 2B	210.0	220.58	28.9	See Footnote 2	N/A
RMOV BOARD 2C	210.0	220.91	29.8	See Footnote 2	N/A
RMOV BOARD 3A	210.0	218.40	23.0	See Footnote 2	N/A
RMOV BOARD 3B	210.0	220.21	27.9	See Footnote 2	N/A
RMOV BOARD 3C	210.0	219.96	27.2	See Footnote 2	N/A

[1] The three unit batteries, batteries 1, 2, and 3 have all the engineered safeguards loads for the three units distributed among them so that redundant systems on each unit have separate normal and alternate supplies.

[2] RMOV Board voltages calculated for the alternate source are not available. However, the minimum voltages for every load fed from the RMOV Boards were calculated and all met their minimum acceptable voltages. Therefore, by definition, it follows that the RMOV Board voltages also met their minimum acceptable voltages.

Unit batteries 1, 2, and 3 and Shutdown Batteries SB-A, B, C, D, 3EB provide adequate voltages to all boards as the calculated voltages supplied, from the normal source and the alternate source to each board, are greater than the minimum voltages, required to ensure the most limiting load on each board, functions properly.

6.0 CONCLUSION

The 250V DC system has sufficient battery (Unit and Shutdown) capacity, at EPU conditions, to power the necessary loads during a LOOP/LOCA event and maintain adequate voltage levels to all required DC equipment during the 30 minute duty cycle.

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On page 2-143 of Attachment 7 of the LAR, the licensee stated that changes are not required to Class 1E DC power load for EPU implementation. As stated in UFSAR Section 8.6.3, the BFN 250 V DC power system supplies the engineered safeguards system and some nonsafety related loads.

Discuss changes, if any, required for the nonsafety related DC loads required for operation at EPU conditions.

TVA Response:

Only one change was required for the non-safety related 250V DC load for operation at EPU conditions. When the Main Transformers were changed out for EPU, the existing electro-mechanical, differential over-current relays were replaced with micro-processor based relays. The new relays draw 0.1 amps constantly therefore 0.3 amps total were added to the non-safety related 250V DC system for the three new relays (one per unit). The battery sizing calculation of record considers nine different possible configurations of the battery system and in each case, the battery is found to be adequate to support the present load profile.

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On page 2-146 of Attachment 7 of the LAR, the licensee also states:

> *The battery capacity analysis of record is conservative in that it includes an assumption in the model that various HPCI [high pressure coolant injection] System loads, which are relatively large, operate for long periods during the SBO [station blackout] mitigation sequence. The CLTP mitigation sequence includes a single and relatively short HPCI cycle, and the resulting HPCI loads are bounded by the analysis. EPU does not significantly increase the HPCI loading, and similar to CLTP, only one relatively short HPCI cycle (approximately 7 minutes) is predicted by the EPU containment analysis analytical model (SHEX) model for SBO mitigation. Similarly, the number of required RCIC [reactor core isolation cooling] cycles in the CLTP and EPU mitigation sequence as predicted by the model is well below the RCIC initiations assumed in the analysis of record.*

Table 2.3-8b, "Browns Ferry Station Blackout Sequence of Events," indicated that HPCI injection will last 6 minutes 14 seconds and RCIC injection will last 2 hours 22 minutes at EPU conditions. The licensee stated that the calculations were performed using the NRC-approved SHEX computer program.

a. Provide the HPCI and RCIC loads and their duration of operation as assumed in the battery capacity analysis for comparison with the HPCI and RCIC cycles calculated with the SHEX program. Also, discuss changes, if any, in the HPCI loading due to the EPU.

b. Provide a summary of the battery capacity analysis including assumptions, duty cycles, required voltages and available margin, for the 4-hour SBO mitigation at EPU conditions. Also, provide available battery capacity margin corresponding to CLTP conditions.

TVA Response:

a. The battery capacity analysis identified the worst case load sequence to which the station batteries could be exposed for HPCI and RCIC operation during a Station Blackout (SBO) event. The loads associated with HPCI are the motor operated valves that are stroked when the system is placed into or removed from service, the HPCI turbine auxiliary oil pump (assumed to run continuously during HPCI operation), the HPCI Gland Seal Condenser Blower (assumed to run continuously during HPCI operation), and the HPCI Gland Seal Condenser Condensate Pump (assumed to run continuously during HPCI operation). The loads associated with RCIC are the motor operated valves that are stroked when the system is placed into or removed from service, the gland seal vacuum tank condensate pump (assumed to run continuously during RCIC operation), and the gland seal vacuum pump (assumed to run continuously during RCIC operation). The following is a listing of times and event descriptions from the battery capacity analysis of record for the worst case event sequence:

Time	Event Description
T= 0 secs	Initiation of SBO event.
T= 5 secs	Reactor core is fully scrammed and Main Steam Relief Valves (MSRVs) begin to lift to reduce Reactor Pressure Vessel (RPV) pressure.
T= 25 secs	HPCI/RCIC automatically initiate to restore RPV water level.
T= 6 min	HPCI/RCIC trip on high RPV water level (Level 8).
T= 16 min	Operators realign HPCI into test mode for decay heat removal.
T= 24 min	Operators restart RCIC to restore RPV water level Duration: 12.0 min
T= 51 min	Operators restart RCIC to restore RPV water level Duration: 14.3 min
T= 80 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 108 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 147 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 186 min	Operators restart RCIC to restore RPV water level Duration: 24.0 min

As can be seen above in the worst case event that is assumed in the CLTP battery capacity analysis, RCIC cycles seven times and HPCI injects once and then is cycled again to be placed in test mode for decay heat removal for the duration of the event. Using the SHEX program results for EPU and the mitigation sequence as stated in PUSAR, RCIC is cycled once and HPCI is cycled once (and not placed in test mode for decay heat removal). Therefore, there is no increase in HPCI loading due to EPU as compared to the CLTP battery capacity analysis and battery capacity remains adequate for EPU conditions.

b. The following is a summary of battery capacity analysis.

PURPOSE

Perform a DC load study for all three units on BFN Class 1E 250V DC unit batteries 1, 2, and 3 to verify their adequacy when called upon to supply High Pressure Coolant Injection / Reactor Core Isolation Cooling and other miscellaneous loads required to cope with a 4-hour SBO event pursuant to the requirements of 10CFR50.63, “Loss of All Alternating Current Power.”

SYSTEM DESCRIPTION

The existing 250V DC system at BFN serves the three unit plant with a continuous source of DC power to both safety-related and non-safety related loads. It also provides power for unit control functions, operative power for unit control loads, control power for 4kV and 480V switchgear, common plant and transmission system control functions, and drive power for motor loads.

The 250V DC Power System at BFN has two sub-systems.

The 250V DC plant system consists of three unit batteries 1, 2, and 3 and their associated battery chargers and distribution boards. These batteries supply all the required safety related loads.

Three station batteries 4, 5 and 6 and their associated battery chargers and distribution boards supply loads that are not essential to safe shutdown and cooldown of the units and are therefore not discussed further.

Each unit battery is a 120 cell lead-acid battery of C&D make, type LCUN-33. They have a one-minute rating of 2080 amps and an 8-hour discharge rating of 2320 ampere-hours. Both ratings are based on a battery terminal voltage of 210V (at 77°F) at end of discharge (1.75V/Cell).

The three unit batteries are for three units and feed Class 1E battery boards 1, 2, and 3. These three unit batteries have all the engineered safeguards loads for the three units distributed among them so that redundant systems on each unit have separate normal and alternate power supplies, each capable of providing sufficient power for engineered safeguard loads. Safety-related DC MOV boards have power supplies from two different batteries designated as normal and alternate power supply. All transfers from normal to alternate sources are performed manually.

<u>ACCEPTANCE CRITERIA</u>

1. Battery Sizing - The batteries' cells must contain more positive plates than the number of positive plates required as calculated by the ETAP program.

2. Battery Capacity - The capacity of the battery shall be considered adequate for minimum required battery terminal voltage of 210.0V (1.75V/Cell). However, higher minimum voltage at the battery terminals shall be maintained for maintaining the minimum voltages for various boards in order to have adequate voltage at the control devices evaluated in control circuit voltage drop calculations.

3. Minimum Board Voltages -The minimum available voltages necessary at the end devices are calculated by the Electrical Transients Analysis Program (ETAP) using actual minimum voltage at the upstream buses of the end devices. The following minimum voltages have been used at the 250V DC boards to perform control circuit voltage drop calculations and therefore these minimum voltages must be maintained:

250V RMOV Boards 2A, 2B, 2C	210.0V
250V RMOV Boards 3A, 3B, 3C	210.0V
250V RMOV Boards 1A, 1B, 1C	210.0V

INITIAL CONDITIONS/ASSUMPTIONS

1. Battery capacity has been conservatively estimated assuming end-of-battery life condition (80% original capacity), lowest electrolyte temperature (minimum Unit battery room temperature applicable for SBO is 69°F, calculated minimum steady state temperature in the battery room is 67.6°F therefore case runs are performed at 67°F.), a 5% load design margin and an additional 4.0 amp design margin to account for future design changes.
2. All batteries are fully charged prior to SBO event initiation.
3. No loads other than valves operations required for RPV level and pressure control (RCIC and HPCI) will be added after 30 minutes into the SBO event.
4. The HPCI System will be placed in the test mode of operation by an operator within 16 minutes after an SBO event occurs.
5. The SBO event occurs while the reactors are operating at full rated power and have been at this power for at least 100 days.
6. Immediately prior to the postulated SBO event, the reactors and their supporting systems are within normal operating range for pressure, temperature, and water level. All plant equipment is either normally operating or available from the standby state.
7. The initiating event is assumed to be a LOOP at the plant site resulting from a switchyard related event due to random faults or an external disturbance (e.g., weather-initiated grid disturbance). The LOOP is assumed to affect all BFN) units.
8. The occurrence of a design basis accident or other event is not postulated to occur immediately prior to or during the SBO event.
9. Cycling loads are superimposed (i.e. start at the beginning of each defined time period as shown in Table EEEB-RAI 23-1 (see below) and run continuously during the entire period for conservative loading) on each section of the battery duty cycle.
10. The load which comes ON and OFF during various times which are greater than one minute in the battery load duty cycle as indicated in Table EEEB-RAI 23-1 (see below) are applied at the beginning of each period of the battery duty cycle. This will result in conservative battery loading, since the loads are stacked on the top of each other.

METHODOLOGY

Worst Case, Credible Event Sequence:

The sequence of events that have been determined to result in the worst case voltage profile for the battery system is the operation of both HPCI and RCIC as shown in Table EEEB-RAI 23-1.

Table EEEB-RAI 23-1

Time	Event Description
T= 0 secs	Initiation of SBO event.
T= 5 secs	Reactor core is fully scrammed and Main Steam Relief Valves (MSRVs) begin to lift to reduce Reactor Pressure Vessel (RPV) pressure.
T= 25 secs	HPCI/RCIC automatically initiate to restore RPV water level.
T= 6 min	HPCI/RCIC trip on high RPV water level (Level 8).
T= 16 min	Operators realign HPCI into test mode for decay heat removal.
T= 24 min	Operators restart RCIC to restore RPV water level Duration: 12.0 min
T= 51 min	Operators restart RCIC to restore RPV water level Duration: 14.3 min
T= 80 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 108 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 147 min	Operators restart RCIC to restore RPV water level Duration: 19.0 min
T= 186 min	Operators restart RCIC to restore RPV water level Duration: 24.0 min

The SBO duty cycle is constructed using the load data from LOCA/LOOP battery analysis and is extended to 4 hours for continuous loads to comply with SBO duty cycle. This load data contains all the loads which are applicable to the battery load duty cycle during a SBO event. The load data contains the board load for an accident concurrent with loss of offsite power for all three Unit Batteries in service and one Shutdown Battery A, C, or D out of service. Since normal configuration is applicable for SBO, Shutdown Boards A, C and D loads are not applied to the SBO duty cycle and are not transferred since no other failure has been considered in conjunction with SBO. All other continuous loads from LOCA/LOOP battery analysis are included in the load duty cycle. Each non-continuous load is reviewed and dispositioned against the SBO duty cycle.

RESULTS

Battery Sizing

A review of the ETAP output report in SBO Appendices indicates that the following cell sizes (number of positive plates) are required:

Battery	Number of Positive Plates Calculated	Number of Positive Plates Supplied	Positive Plate Margin (%)
UNIT BATTERY 1	12.44	16	22.2
UNIT BATTERY 2	12.35	16	22.8
UNIT BATTERY 3	12.09	16	24.4

Unit batteries 1, 2, and 3 are adequately sized as the number of positive plates supplied in the cells exceeds the number of positive plates required by ETAP calculation.

Battery Capacity/Minimum Terminal Voltage

The value for minimum voltage (in Volts) at the battery terminals, battery boards, and RMOVs are obtained from ETAP output report. In all cases, the tabulated worst case minimum voltage occurs during the first minute.

Battery	Minimum Voltage (Volts)	Required Minimum Voltage (Volts)
UNIT BATTERY 1	222.53	210.00
UNIT BATTERY 2	221.51	210.00
UNIT BATTERY 3	223.81	210.00
UNIT BATTERY BOARD 1	222.19	210.00
UNIT BATTERY BOARD 2	221.20	210.00
UNIT BATTERY BOARD 3	223.50	210.00
250V RMOV BOARD 1A	219.53	210.00
250V RMOV BOARD 1B	222.41	210.00
250V RMOV BOARD 1C	218.84	210.00
250V RMOV BOARD 2A	217.10	210.00
250V RMOV BOARD 2B	223.01	210.00
250V RMOV BOARD 2C	220.18	210.00
250V RMOV BOARD 3A	220.16	210.00
250V RMOV BOARD 3B	221.11	210.00
250V RMOV BOARD 3C	219.40	210.00

Unit batteries 1, 2, and 3 have adequate capacity as the minimum battery terminal voltages and board voltages were all greater than the required minimum voltage of 210.0V.

CONCLUSION

The 250VDC system has sufficient battery capacity at EPU conditions to power the necessary loads during an SBO event and maintain adequate voltage levels to all required DC equipment

EEEB-RAI 24

On page 2-147 of Attachment 7 of the LAR, the licensee states:

> *Outside the drywell, the SBO loss-of-ventilation evaluation for the Control Building Rooms, Reactor Building Shutdown Board Rooms/Electrical Board Rooms, RCIC Room, HPCI Room, Main Steam Tunnel, Reactor Building General Floor Area, and Torus Room determined that, compared to CLTP, equipment operability is maintained because the SBO environment is milder than the existing design and qualification bases.*

Provide a summary of the evaluation showing the maximum temperatures calculated for the SBO conditions for the above areas versus the existing design and qualification temperatures of the equipment required for coping with the SBO.

TVA Response:

Locations	Evaluation
Control Building Rooms, Reactor Building Shutdown Board and Electrical Board Rooms	Heating Ventilation and Air Conditioning (HVAC) remains available in these areas during a Station Blackout (SBO) Event. NUMARC 87-00, Section 2.7.1 addresses Control Room ventilation and does not require an analysis for loss of ventilation if a portion of the HVAC is powered from a non-blacked out unit.
Reactor Core Isolation Cooling (RCIC) Room	Extended Power Uprate (EPU) evaluated maximum RCIC pump room temperatures during SBO event: U1: 114°F; U2: 115°F; U3: 120°F. Qualification temperature: 135°F.
High Pressure Coolant Injection (HPCI) Room	EPU evaluated maximum HPCI pump room temperatures during SBO event: U1: 113°F; U2: 112°F; U3: 113°F. Qualification temperature: 135°F.
Main Steam Tunnel	EPU evaluated maximum Main Steam Tunnel temperatures during SBO event: 180°F (coping time period of 4 hours). Qualification temperature: 180°F (for an 8 hour time period).
Reactor Building General Floor Area	EPU evaluated maximum Reactor Building General Floor Area temperatures during SBO event: U1: 109°F; U2: 109°F; U3: 110°F. Qualification temperatures: U1: 130°F; U2: 127°F; U3: 130°F.
Torus Room	EPU evaluated maximum Torus Room temperature during SBO event: U1: 139.8°F; U2: 138.4°F; U3:139.97°F. Qualification temperature: 140°F.

EEEB-RAI 25

Provide an evaluation of any impacts of the EPU on reactor coolant inventory, procedures and training, plant modifications, quality assurance, and emergency diesel generator reliability program, considering the guidance provided in Regulatory Guidance 1.155, "Station Blackout," August 1988.

TVA Response:

The BFN EPU evaluation of the above Regulatory Guide (RG) 1.155 categories is as follows.

<u>Reactor Coolant Inventory - RG 1.155, Section 3.2.3</u>

The EPU evaluation for station blackout (SBO) is contained in the Power Uprate Safety Analysis Report (PUSAR) Section 2.3.5. The evaluation was performed using the initial conditions stated in PUSAR Table 2.3-8a. Separate SBO analysis cases were run using the GE-Hitachi Nuclear Energy (GEH) SHEX code with both zero reactor coolant system (RCS) leakage and 61 gpm RCS leakage because previous GEH EPU analysis experience had demonstrated that different assumed leakage rates can be limiting for different output parameters. Consistent with the methodology of Reference 1, the SBO analysis assumed 61 gpm RCS leakage (the combined leakage of 18 gpm per reactor recirculation pump seal plus 25 gpm other RCS leakage). This assumed RCS leakage for the EPU SBO analysis is unchanged from previous BFN SBO analysis supporting BFN operation at 3458 MWt. The results of the EPU SBO analyses demonstrate that high pressure coolant injection (HPCI) and/or reactor core isolation cooling (RCIC) are capable of maintaining reactor coolant inventory during the SBO coping period with pump suction from the condensate storage tank (CST). The maximum CST usage at EPU conditions resulted from the SBO analysis case with the assumption of 61 gpm RCS leakage. As stated in PUSAR Section 2.3.5 under the topic <u>Condensate Inventory for Decay Heat Removal</u>, the current CST inventory reserve (135,000 gallons) for RCIC and HPCI use ensures that adequate water volume is available to remove decay heat, depressurize the reactor and maintain reactor vessel level above the top of active fuel (approximately 114,000 gallons required at EPU conditions) during the coping period.

<u>Plant Modifications - RG 1.155, Section 3.3</u>

EPU results in no change to the currently licensed BFN SBO coping duration of four hours. No plant modifications are required for BFN EPU in order to meet SBO requirements.

<u>Procedures and Training - RG 1.155, Section 3.4</u>

The single procedural and training change identified as a result of the BFN EPU for meeting SBO requirements is for the operator to cross-tie drywell control air to the containment atmospheric dilution (CAD) system. This operator action is discussed in PUSAR Section 2.3.5 under the topic <u>Compressed Gas Capability</u> and in PUSAR Section 2.11.1.2.1. The Tennessee Valley Authority (TVA) response to APHB RAI 1 discusses in detail the TVA implementation of this procedure change and the validation activities for time critical tasks.

Quality Assurance - RG 1.155, Section 3.5

The RG 1.55 Appendices A and B guidance on quality assurance (QA) is not power dependent. EPU has no impact on these QA activities.

Emergency Diesel Generator Reliability Program - RG 1.155, Section 1.2

The emergency diesel generator reliability program is not power dependent. EPU has no impact on the emergency diesel generator reliability program.

Reference

1. NUMARC 87-00, Revision 1, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, dated August 1991.

ENCLOSURE 3
Supplement to PUSAR (NEDO-33860, Revision 0)

(Non-proprietary version)

2.3 Electrical Engineering

2.3.1 Environmental Qualification of Electrical Equipment

Regulatory Evaluation

Environmental qualification (EQ) of electrical equipment involves demonstrating that the equipment is capable of performing its safety function under significant environmental stresses that could result from DBAs.

The NRC's acceptance criteria for EQ of electrical equipment are based on 10 CFR 50.49, which sets forth requirements for the qualification of electrical equipment important to safety that is located in a harsh environment.

Specific NRC review criteria are contained in SRP Section 3.11.

Browns Ferry Current Licensing Basis

The Browns Ferry program for environmental qualification of electrical equipment is described in Browns Ferry UFSAR Section ~~8.9, "Safety Systems Independence Criteria and Bases for Electrical Cable Installation."~~

7.1.6, "Environmental Qualification of Electrical Equipment."

In addition to the evaluations described in the Browns Ferry UFSAR, Browns Ferry's environmental qualification of electrical equipment was evaluated for license renewal. Systems and system component materials of construction, operating history, and programs used to manage aging effects were evaluated for plant license renewal and documented in the Browns Ferry License Renewal Safety Evaluation Report (SER), NUREG-1843, dated April 2006 (Reference 11). The environmental qualification of electrical equipment for license renewal is discussed in NUREG-1843, Sections 2.6.1.4 and 4.4.

Technical Evaluation

NEDC-33004P-A, Revision 4, "Constant Pressure Power Uprate," Class III, July 2003 (also referred to as CLTR) was approved by the NRC as an acceptable method for evaluating the effects of EPUs. Section 10.3.1 of the CLTR addresses the effect of EPU on the Environmental Qualification of Electrical Equipment. The results of this evaluation are described below.

Browns Ferry meets all CLTR dispositions. The topics addressed in this evaluation are:

Topic	CLTR Disposition	Browns Ferry Result
Electrical Equipment	Plant Specific	Meets CLTR Disposition

Enclosure 4

General Electric Hitachi Affidavit for NEDC-33860P, Revision 0

GE-Hitachi Nuclear Energy Americas LLC
AFFIDAVIT

I, James F. Harrison, state as follows:

(1) I am Vice President, Fuel Licensing, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in GEH proprietary report, NEDC-33860P, *Safety Analysis Report for Browns Ferry Nuclear Plant Units 1, 2, and 3 Extended Power Uprate*, Revision 0, dated September 2015. GEH proprietary information within text is identified by a dotted underline within double square brackets. [[This sentence is an example.{3}]] Figures and large objects containing GEH proprietary information are identified with double square brackets before and after the object. In all cases, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2.d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2.d 1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed results and conclusions regarding supporting evaluations of the safety-significant changes necessary to demonstrate the regulatory acceptability of the analysis for a GEH Boiling Water Reactor (BWR). The analysis utilized analytical models and methods, including computer codes, which GEH has developed, obtained NRC approval of, and applied to perform evaluations of Power Uprates for a GEH BWR. The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical

methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 17th day of September 2015.

James F. Harrison
Vice President, Fuel Licensing
Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
3901 Castle Hayne Road
Wilmington, NC 28401
James.Harrison@ge.com

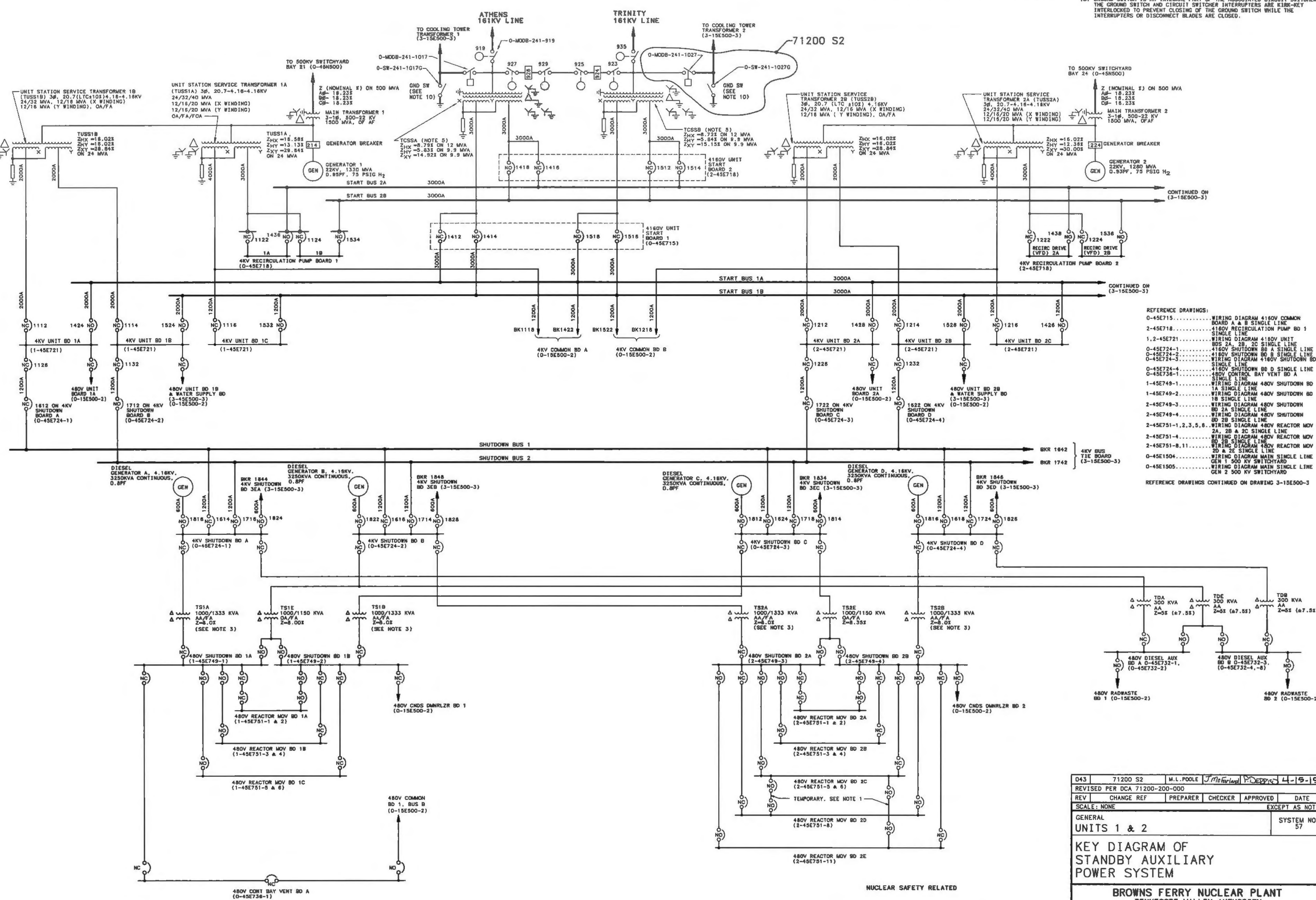
Enclosure 5

Single Line Diagrams Requested by EEEB-RAI 18

4kV SHUTDOWN BD A	(0-45E724-1)
4kV SHUTDOWN BD B	(0-45E724-2)
4kV SHUTDOWN BD C	(0-45E724-3)
4kV SHUTDOWN BD D	(0-45E724-4)
4kV SHUTDOWN BD 3EA	(3-45E724-6)
4kV SHUTDOWN BD 3EB	(3-45E724-7)
4kV SHUTDOWN BD 3EC	(3-45E724-8)
4kV SHUTDOWN BD 3ED	(3-45E724-9)
4kV UNIT BD 1A	(1-45E721)
4kV UNIT BD 1B	(1-45E721)
4kV UNIT BD 1C	(1-45E721)
4kV UNIT BD 2A	(2-45E721)
4kV UNIT BD 2B	(2-45E721)
4kV UNIT BD 2C	(2-45E721)
4kV UNIT BD 3A	(3-45E721)
4kV UNIT BD 3B	(3-45E721)
4kV UNIT BD 3C	(3-45E721)
4kV COMMON BD A	(0-15E500-2)
4kV COMMON BD B	(0-15E500-2)
Key Diagram of Standby Auxiliary Power System	(0-15E500-1)
Key Diagram of Normal & Standby Auxiliary Power System	(3-15E500-3)

NOTES:
1. THE TEMPORARY MAINTENANCE FEED FOR THE 2D & 2E 480V REACTOR MOV BOARDS MAY ONLY BE ENABLED AND USED DURING THE "COLD SHUTDOWN" REACTOR MODE AND MAY NOT BE USED DURING THE "POWER GENERATION" OR HOT STANDBY MODES (LICENSING REQUIREMENT).
2. DELETED
3. THE FORCED AIR COOLING FOR TS1A, TS1B, TS2A AND TS2B IS NOT 10CFR50.49 QUALIFIED, THEREFORE, THE 10CFR50.49 QUALIFIED RATING FOR THESE TRANSFORMERS IS AS DEFINED ON SINGLE LINE DRAWINGS 1-45E749-1, 1-45E749-2, 2-45E749-3 AND 2-45E749-4.
4. THE ALTERNATE FEEDS FOR 480V RMOV BD'S 1A, 1B, 1C, 2A, 2B AND 2C MAY BE USED DURING NORMAL OPERATION PROVIDED LIMITATIONS LISTED ON SINGLE-LINE DRAWING SERIES 1-45E751 AND 2-45E751 ARE FOLLOWED.

NOTES CONT'D:
5. FOR LIMITATIONS ON START BUS 1A AND 1B, FOLLOW THE LIMITATIONS LISTED ON SINGLE LINE DRAWINGS 0-45E715, 1-45E721, 2-45E721 AND 3-45E721.
6. 480 V RMOV BOARD 1D AND 1E ABANDONED IN PLACE VIA DCN 51216.
7. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNIDS.
8. THE ALTERNATE FEEDS FOR 480V SHUTDOWN BOARDS 1A,1B,2A AND 2B MAY BE USED DURING NORMAL OPERATION PROVIDED LIMITATIONS LISTED ON SINGLE LINE DRAWINGS 1-45E749-1, 1-45E749-2, 2-45E749-3 AND 2-45E749-4 ARE FOLLOWED.
9. BOTH START BUSES 1A,1B,2A AND 2B MAY BE ALIGNED TO ONE CSST PROVIDED LIMITATIONS LISTED ON DRAWINGS 0-45E715, 1-45E718 AND 2-45E718 ARE FOLLOWED.
10. GROUND SWITCH IS AN INTEGRAL PART OF THE ASSOCIATED CIRCUIT SWITCHER. THE GROUND SWITCH AND CIRCUIT SWITCHER INTERRUPTERS ARE KIRK-KEY INTERLOCKED TO PREVENT CLOSING OF THE GROUND SWITCH WHILE THE INTERRUPTERS OR DISCONNECT BLADES ARE CLOSED.



REFERENCE DRAWINGS:

0-45E715	WIRING DIAGRAM 4160V COMMON BOARD A & B SINGLE LINE
2-45E718	4160V RECIRCULATION PUMP BD 1 SINGLE LINE
1,2-45E721	WIRING DIAGRAM 4160V UNIT BDS 2A, 2B, 2C SINGLE LINE
0-45E724-1	4160V SHUTDOWN BD A SINGLE LINE
0-45E724-2	4160V SHUTDOWN BD B SINGLE LINE
0-45E724-3	WIRING DIAGRAM 4160V SHUTDOWN BD C SINGLE LINE
0-45E724-4	4160V SHUTDOWN BD D SINGLE LINE
0-45E736-1	480V CONTROL BAY VENT BD A SINGLE LINE
1-45E749-1	WIRING DIAGRAM 480V SHUTDOWN BD 1A SINGLE LINE
1-45E749-2	WIRING DIAGRAM 480V SHUTDOWN BD 1B SINGLE LINE
2-45E749-3	WIRING DIAGRAM 480V SHUTDOWN BD 2A SINGLE LINE
2-45E749-4	WIRING DIAGRAM 480V SHUTDOWN BD 2B SINGLE LINE
2-45E751-1,2,3,5,6	WIRING DIAGRAM 480V REACTOR MOV BD 2A, 2B & 2C SINGLE LINE
2-45E751-4	WIRING DIAGRAM 480V REACTOR MOV BD 2B SINGLE LINE
2-45E751-8,11	WIRING DIAGRAM 480V REACTOR MOV BD 2D & 2E SINGLE LINE
0-45E1504	WIRING DIAGRAM MAIN SINGLE LINE GEN 1 500 KV SWITCHYARD
0-45E1505	WIRING DIAGRAM MAIN SINGLE LINE GEN 2 500 KV SWITCHYARD

REFERENCE DRAWINGS CONTINUED ON DRAWING 3-15E500-3

NUCLEAR SAFETY RELATED

LEGEND

PERPENDICULAR LINE REPRESENTS UNIT 1/UNIT 2, AND UNIT 2/UNIT 3 BOUNDARY ISOLATION POINT. VALVES CLOSED FOR ISOLATION PURPOSES.

COMPANION DRAWINGS:
0-15E500-2
3-15E500-3
2-15E500-4

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: P.J. SPEIDEL / B.Y.

ALL A/D HISTORY RESEARCHED AT R012

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
043	71200 S2	M.L.POOLE	J McFarland	P. Dennis	4-15-15
REVISED PER DCA 71200-200-000					

SCALE: NONE EXCEPT AS NOTED

GENERAL
UNITS 1 & 2

SYSTEM NO. 57

KEY DIAGRAM OF STANDBY AUXILIARY POWER SYSTEM

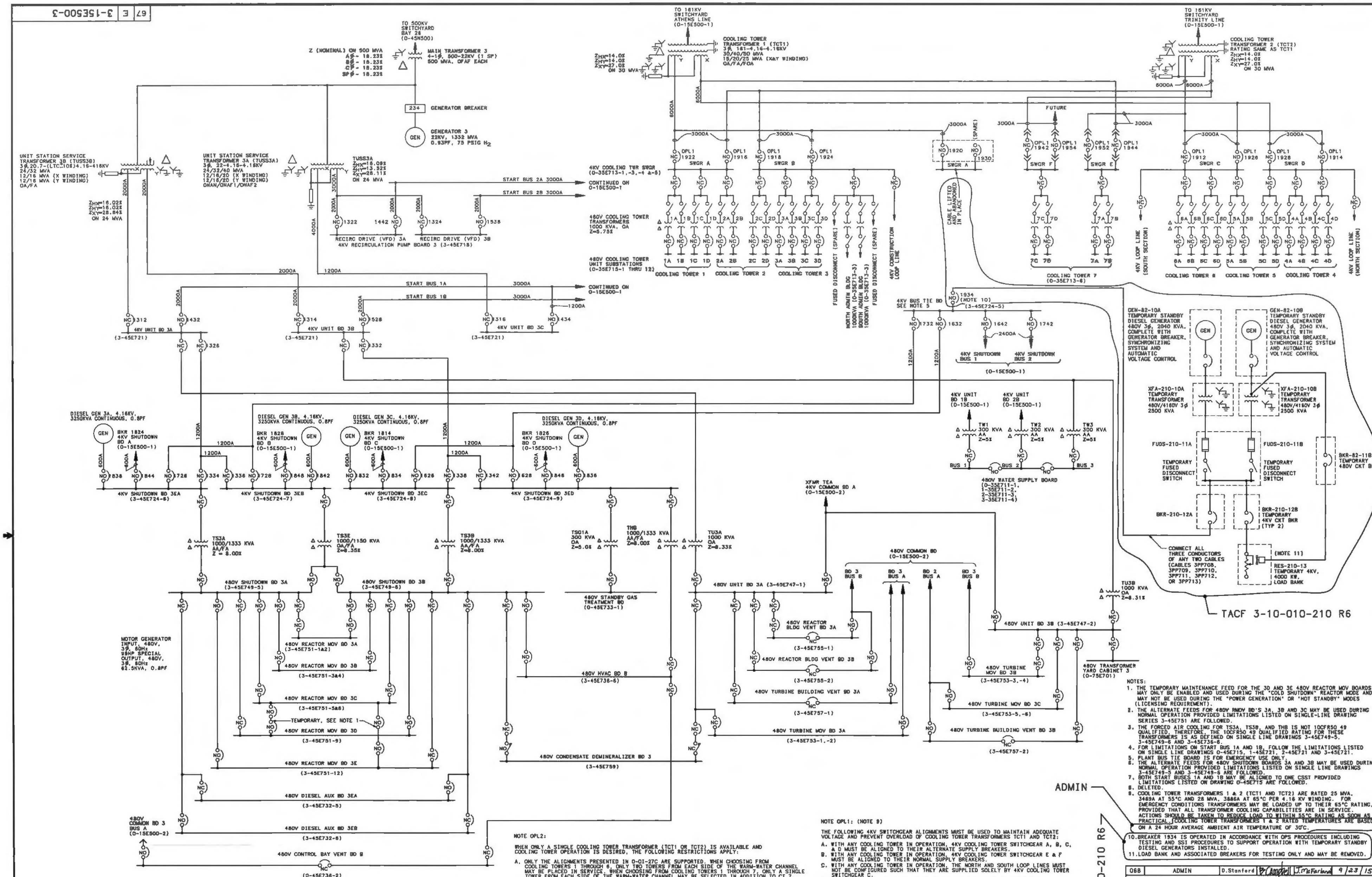
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		INITIAL ISSUE	ENGINEERING APPROVAL
DRAFTER: GS	CHECKER: JWC	R0 ISSUED PER EXCEPTION A CHANGE CONTROL. SUPERSEDES CCD DWG 4-15E500-1 REV 001, A/D 15W500-1 R10	1. L.L. ROWE
DESIGNER: JWC	REVIEWER: A. MENDIOLA		2. R.E. GALLAGHER
			3. A. MENDIOLA

DATE 2-12-88 | 67 | E | 0-15E500-1 | R043

CAD MAINTAINED DRAWING

CCD



NOTES:

1. THE TEMPORARY MAINTENANCE FEED FOR THE 3D AND 3E 480V REACTOR MOV BOARDS MAY ONLY BE ENABLED AND USED DURING THE "COLD SHUTDOWN" REACTOR MODE AND MAY NOT BE USED DURING THE "POWER GENERATION" OR "HOT STANDBY" MODES (LICENSING REQUIREMENT).
2. THE ALTERNATE FEEDS FOR 480V RMOV BD'S 3A, 3B AND 3C MAY BE USED DURING NORMAL OPERATION PROVIDED LIMITATIONS LISTED ON SINGLE-LINE DRAWING SERIES 3-45E751 ARE FOLLOWED.
3. THE FORCED AIR COOLING FOR TS3A, TS3B, AND THB IS NOT 10CFR50 49 QUALIFIED, THEREFORE, THE 10CFR50 49 QUALIFIED RATING FOR THESE TRANSFORMERS IS AS DEFINED ON SINGLE LINE DRAWINGS 3-45E749-5, 3-45E749-6 AND 3-45E736-6.
4. FOR LIMITATIONS ON START BUS 1A AND 1B, FOLLOW THE LIMITATIONS LISTED ON SINGLE LINE DRAWINGS 0-45E715, 1-45E721, 2-45E721 AND 3-45E721.
5. PLANT BUS TIE BOARD IS FOR EMERGENCY USE ONLY.
6. THE ALTERNATE FEEDS FOR 480V SHUTDOWN BOARDS 3A AND 3B MAY BE USED DURING NORMAL OPERATION PROVIDED LIMITATIONS LISTED ON SINGLE LINE DRAWINGS 3-45E749-5 AND 3-45E749-6 ARE FOLLOWED.
7. BOTH START BUSES 1A AND 1B MAY BE ALIGNED TO ONE CSST PROVIDED LIMITATIONS LISTED ON DRAWING 0-45E715 ARE FOLLOWED.
8. DELETED.
9. COOLING TOWER TRANSFORMERS 1 & 2 (TCT1 AND TCT2) ARE RATED 25 MVA, 3489A AT 55°C AND 28 MVA, 3886A AT 65°C PER 4.16 KV WINDING. FOR EMERGENCY CONDITIONS TRANSFORMERS MAY BE LOADED UP TO THEIR 65°C RATING, PROVIDED THAT ALL TRANSFORMER COOLING CAPABILITIES ARE IN SERVICE. ACTIONS SHOULD BE TAKEN TO REDUCE LOAD TO WITHIN 55°C RATING AS SOON AS PRACTICAL. COOLING TOWER TRANSFORMERS 1 & 2 RATED TEMPERATURES ARE BASED ON A 24 HOUR AVERAGE AMBIENT AIR TEMPERATURE OF 30°C.
10. BREAKER 1934 IS OPERATED IN ACCORDANCE WITH OPS PROCEDURES INCLUDING TESTING AND SSI PROCEDURES TO SUPPORT OPERATION WITH TEMPORARY STANDBY DIESEL GENERATORS INSTALLED.
11. LOAD BANK AND ASSOCIATED BREAKERS FOR TESTING ONLY AND MAY BE REMOVED.

ADMIN

TACF 3-10-010-210 R6

NOTE OPL2:

WHEN ONLY A SINGLE COOLING TOWER TRANSFORMER (TCT1 OR TCT2) IS AVAILABLE AND COOLING TOWER OPERATION IS DESIRED, THE FOLLOWING RESTRICTIONS APPLY:

A. ONLY THE ALIGNMENTS PRESENTED IN 0-OI-27C ARE SUPPORTED. WHEN CHOOSING FROM COOLING TOWERS 1 THROUGH 6, ONLY TWO TOWERS FROM EACH SIDE OF THE WARM-WATER CHANNEL MAY BE PLACED IN SERVICE. WHEN CHOOSING FROM COOLING TOWERS 1 THROUGH 7, ONLY A SINGLE TOWER FROM EACH SIDE OF THE WARM-WATER CHANNEL MAY BE SELECTED IN ADDITION TO CT 7.
B. WHEN OPERATING COOLING TOWERS FROM A SINGLE COOLING TOWER TRANSFORMER, TCT LOADING AND WINDING TEMPERATURE MUST BE MONITORED IN ORDER TO PREVENT OVERLOADING AND/OR OVERHEATING OF THE TCT.
C. THE ALIGNMENTS PRESENTED IN (A) ABOVE ARE CONSIDERED ABNORMAL OPERATING CONDITIONS. ADEQUATE VOLTAGE CANNOT BE GUARANTEED FOR MOTOR STARTING DUE TO VARIABILITY OF LOOP LINE LOADING. THEREFORE, IT IS RECOMMENDED THAT THE FAN STARTING SEQUENCE IN 0-OI-27C BE USED FOR EACH COOLING TOWER PLACED IN SERVICE.

NOTE OPL1: (NOTE 9)

THE FOLLOWING 4KV SWITCHGEAR ALIGNMENTS MUST BE USED TO MAINTAIN ADEQUATE VOLTAGE AND PREVENT OVERLOAD OF COOLING TOWER TRANSFORMERS TCT1 AND TCT2:

A. WITH ANY COOLING TOWER IN OPERATION, 4KV COOLING TOWER SWITCHGEAR A, B, C, & D MUST BE ALIGNED TO THEIR ALTERNATE SUPPLY BREAKERS.
B. WITH ANY COOLING TOWER IN OPERATION, 4KV COOLING TOWER SWITCHGEAR E & F MUST BE ALIGNED TO THEIR NORMAL SUPPLY BREAKERS.
C. WITH ANY COOLING TOWER IN OPERATION, THE NORTH AND SOUTH LOOP LINES MUST NOT BE CONFIGURED SUCH THAT THEY ARE SUPPLIED SOLELY BY 4KV COOLING TOWER SWITCHGEAR C.

ALL OTHER 4KV COOLING TOWER SWITCHGEAR ALIGNMENTS MUST BE APPROVED BY ENGINEERING WITH ANY COOLING TOWER IN OPERATION.

THE SWITCHGEAR BREAKER AUTO/MANUAL CONTROL SWITCH WILL BE CONTROLLED BY OPERATIONS (IN MANUAL MODE) VIA THE CLEARANCE AND PROCEDURE PROCESS.

THE LOAD CURRENT INCREASE EXPECTED FOR 1-3100 HP LIFT PUMP IS 430 AMPS. THE LOAD INCREASE FOR 1-250 HP FAN IS 31 AMPS. THE LOAD INCREASE EXPECTED FOR 1-200 HP FAN IS 25 AMPS.

REFERENCE DRAWINGS: (CONT FROM 0-15E500-1)

0-35E711-1..........WIRING DIAGRAM 480V WATER SUPPLY BD SINGLE LINE
1-35E711-2..........WIRING DIAGRAM 480V WATER SUPPLY BD BUS 1 SINGLE LINE
2-35E711-3..........WIRING DIAGRAM 480V WATER SUPPLY BD BUS 2 SINGLE LINE
3-35E711-4..........WIRING DIAGRAM 480V WATER SUPPLY BD BUS 3 SINGLE LINE
0-45E506............MAIN SINGLE LINE 161KV SWITCHYARD
0-45E1506...........MAIN SINGLE LINE 500KV SWITCHYARD
0-75E701............WIRING DIAGRAM 480V DISTRIBUTION CABINETS SINGLE LINE
0-35E715-1,-2.......WIRING DIAGRAM 480V COOLING TOWER 1 UNIT SUBSTATIONS SINGLE LINE
0-35E715-3,-4.......WIRING DIAGRAM 480V COOLING TOWER 2 UNIT SUBSTATIONS SINGLE LINE
0-35E715-5,-6.......WIRING DIAGRAM 480V COOLING TOWER 3 UNIT SUBSTATIONS SINGLE LINE
0-35E715-7,-8.......WIRING DIAGRAM 480V COOLING TOWER 4 UNIT SUBSTATIONS SINGLE LINE
0-35E715-9,-10......WIRING DIAGRAM 480V COOLING TOWER 5 UNIT SUBSTATIONS SINGLE LINE
0-35E715-11,-12.....WIRING DIAGRAM 480V COOLING TOWER 6 UNIT SUBSTATIONS SINGLE LINE
3-45E724-5..........WIRING DIAGRAM 4160V BUS TIE BOARD SINGLE LINE
3-45E747-1..........WIRING DIAGRAM 480V UNIT BD 3A SINGLE LINE
3-45E747-2..........WIRING DIAGRAM 480V UNIT BD 3B SINGLE LINE
3-45E753-1,-2.......WIRING DIAGRAM 480V TURBINE MOV BD 3A NV3 SINGLE LINE
3-45E753-3..........480V TURBINE MOV BD 3B SINGLE LINE
3-45E753-4..........WIRING DIAGRAM 480V TURBINE MOV BD 3B SINGLE LINE
3-45E753-5..........WIRING DIAGRAM 480V TURBINE MOV BD 3C SINGLE LINE
3-45E718............WIRING DIAGRAM 4160V RECIRCN PUMP BD 3 SINGLE LINE
0-45N500............WIRING DIAGRAM DEV SINGLE LINE
3-45E721............WIRING DIAGRAM 4160V UNIT BDS 3A, 3B, 3C SINGLE LINE
3-45E724-6,7,8,9....WIRING DIAGRAMS 4160V SHUTDOWN BD 3EA, 3EB, 3EC, 3ED SINGLE LINE
0-45E733-1..........480V STANDBY GAS TRTMT BD SINGLE LINE
3-45E759............WIRING DIAGRAM 480V CONDENSATE DEMINERALIZER BD 3 SINGLE LINE
3-45E751-2,-4.......WIRING DIAGRAM 480V REACTOR MOV BD 3A & 3B SINGLE LINE
3-45E753-6..........WIRING DIAGRAM 480V TURBINE MOV BD 3C SINGLE LINE
3-45E755-1..........WIRING DIAGRAM 480V REACTOR BLDG VENT BD 3A SINGLE LINE
3-45E755-2..........WIRING DIAGRAM 480V REACTOR BLDG VENT BD 3B SINGLE LINE
3-45E757-1..........WIRING DIAGRAM 480V TURBINE BLDG VENT BD 3A SINGLE LINE
3-45E757-2..........WIRING DIAGRAM 480V TURBINE BLDG VENT BD 3B SINGLE LINE
3-45E751-3,5,6,9,12.WIRING DIAGRAM 480V REACTOR MOV BDS 3B, 3C, 3D & 3E SINGLE LINE
3-45E732-5,-6.......WIRING DIAGRAM 480V DIESEL AUX BD 3EA, 3EB SINGLE LINE
0-45E736-2..........480V CONTROL BAY VENT BD B SINGLE LINE
0-35E713-1..........WIRING DIAGRAM 4160V COOLING TOWER SWGR A SINGLE LINE
0-35E713-3..........WIRING DIAGRAM 4160V COOLING TOWER SWGR B SINGLE LINE
0-35E713-4..........WIRING DIAGRAM 4160V COOLING TOWER SWGR C SINGLE LINE
0-35E713-5..........WIRING DIAGRAM 4160V COOLING TOWER SWGR D SINGLE LINE
0-45E729-2,3........WIRING DIAGRAM 480V COMMON BDS 2 & 3 SINGLE LINE

COMPANION DRAWINGS:
0-15E500-1
0-15E500-2

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
068	ADMIN	D.Stanford	B.Campbell	J.McFarland	9/23/15
	REVISED PER RIMS MEMO R14 150922 122 (REF: BFCR 1046047)				

SCALE: NONE — EXCEPT AS NOTED

GENERAL
UNIT 3

SYSTEM NO. 57-4, 57-5

KEY DIAGRAM OF NORMAL & STANDBY AUXILIARY POWER SYSTEM

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN ADS	CHECKED RAL	1 N/A	2 N/A	
DESIGNED D.F. LOVELESS	REVIEWED J.H. BOEHMS	3 N/A	4 N/A	F.W. CHANDLER
KNOXVILLE	DATE 10-15-79	67	E	3-15E500-3 R068

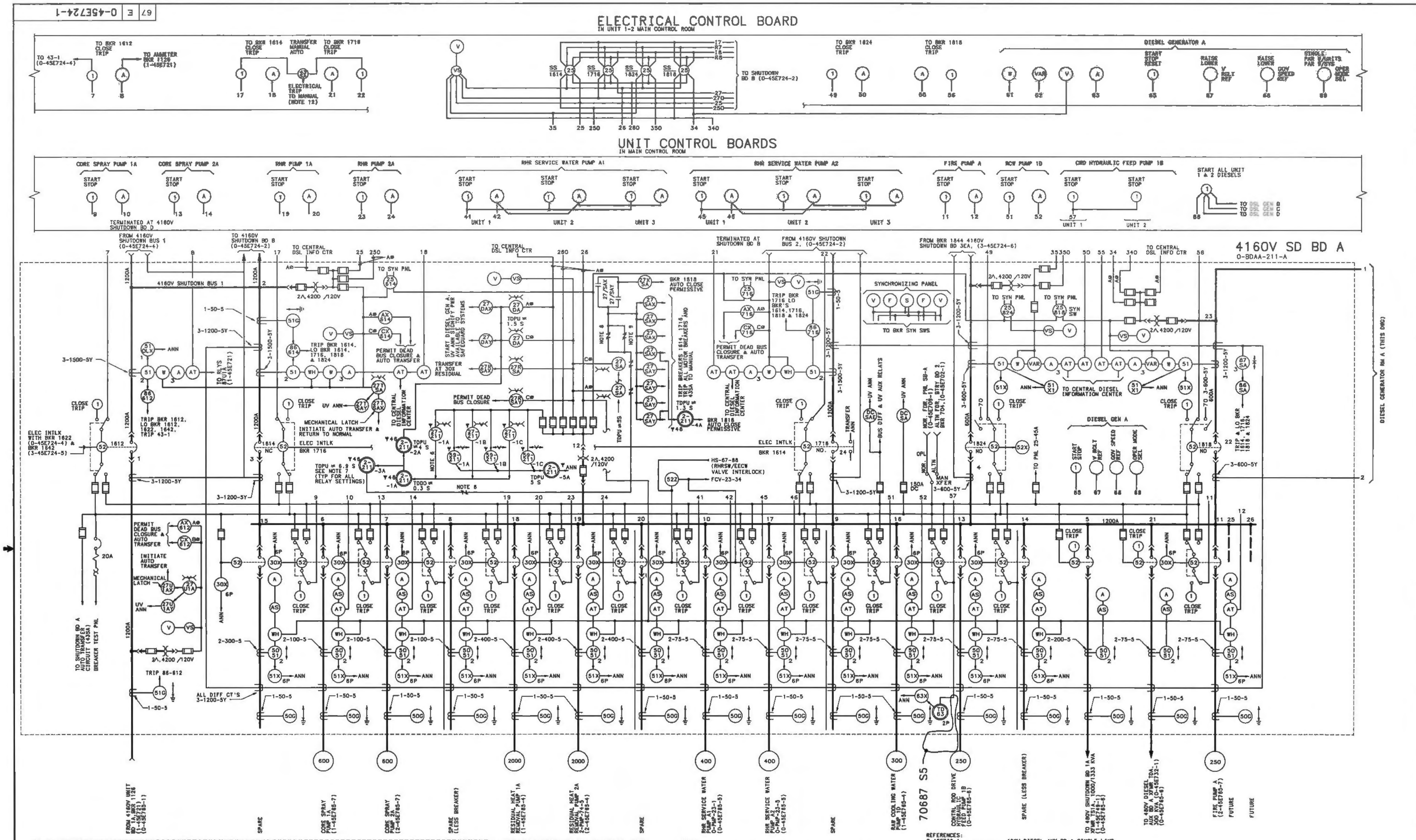
THIS DRAWING APPEARS IN THE FSAR

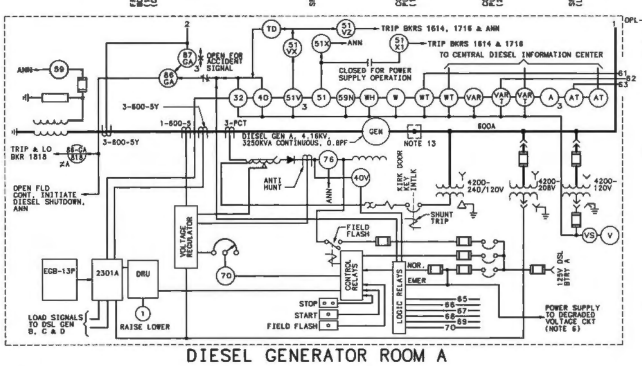
ISSUED BY: N/A

CAD MAINTAINED DRAWING

CCD

ALL A/D HISTORY RESEARCHED AT R019





OPL-WHEN 4KV SHUTDOWN BOARD A IS ALIGNED TO ITS ALTERNATE 250 V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 2), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG A AND 3D. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 11):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNIT 2. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNIT 2 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD A (250V DC DISTRIBUTION PANEL SHUTDOWN BATTERY-A) INOPERABLE AND ENTER LCO 3.8.7 BASED ON PLANT OPERATING CONDITIONS. THERE ARE NO RESTRICTIONS ON UNIT 1 AND 3 OPERATION EXCEPT AS NOTED BELOW

2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF SBGT TRAINS A AND C, INSTEAD OF JUST ONE SBGT TRAIN IF THE BOARDS WERE IN A NORMAL ALIGNMENT. UNITS 1, 2 AND 3 SHALL CONSIDER SBGT TRAIN A OR C INOPERABLE AND ENTER LCO 3.6.4.3 BASED ON PLANT OPERATING CONDITIONS.

3) A SINGLE FAILURE COULD RESULT IN THE LOSS OF THREE RHRSW/EECW SWING PUMPS THAT COULD BE ALIGNED FOR EECW INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT (C1 WILL NOT AUTO-START IF ALIGNED FOR EECW DUE TO THE DE-ENERGIZED VALVE INTERLOCK RELAY 0-RLY-67-48). IF TWO OR MORE OF THE A1, C1 OR D1 RHRSW/EECW PUMPS ARE ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER ONLY ONE OF THE PUMPS A1 C1 OR D1 AS OPERABLE, AND THE OTHER PUMPS ARE TO BE CONSIDERED INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

4) A SINGLE FAILURE COULD RESULT IN THE LOSS OF THREE PUMPS NORMALLY ALIGNED FOR RHRSW INSTEAD OF JUST TWO RHRSW PUMPS IF THE BOARDS WERE IN A NORMAL ALIGNMENT (MANUAL CONTROL OF C1 IS STILL AVAILABLE FOR RHRSW USE). UNITS 1, 2 AND 3 AND 3 SHALL CONSIDER EITHER THE A1 AND A2, OR THE D1 RHRSW PUMPS INOPERABLE AND ENTER LCO 3.7.1 AS REQUIRED FOR THE PLANT CONDITIONS.

NOTES:

1. ALL BREAKERS ARE RATED 1200 AMPERE CONTINUOUS, 250-MVA INTERRUPTING CLASS, 58,000-AMPERE CLOSE AND LATCH CAPABILITY.
2. WATTHOUR METERS FURNISHED FOR BREAKERS 1614, 1716, 1616, 1714, 1624, 1718, 1618, & 1724; FOR TWO RAW COOLING WATER PUMPS; FOR FOUR CORE SPRAY PUMPS; FOR FOUR RHR PUMPS; FOR FOUR RHR SERVICE WATER PUMPS; FOR ONE FIRE PUMP; FOR CRD HYDRAULIC FEED PUMP 1B AND FOR ALL DIESEL GENERATORS. WATTHOUR METER CASES ONLY ARE FURNISHED FOR REMAINING EQUIPMENT.
3. SHUTDOWN BOARD OVERCURRENT AND BUS DIFFERENTIAL RELAYS TRIP AND LOCK OUT SOURCE BREAKERS TO CLEAR A FAULTED BUS. AFTER A TIME DELAY THE BUS UNDERVOLTAGE RELAY TRIPS ALL MOTOR BREAKERS CONNECTED TO THE DEENERGIZED BUS.
4. OVERCURRENT RELAY INDUCTION DISC ELEMENTS ENERGIZE THE WHITE DISAGREEMENT LIGHT OF THE OVERLOADED MOTOR AND A LAMP ANNUNCIATOR COMMON TO ALL LARGE MOTORS. A HIGH DROPOUT INSTANTANEOUS UNIT WITH CONTACT IN SERIES WITH INDUCTION DISCONNECT CONTACT TRIPS MOTOR AT POINT OF INCIPIENT STALL. A NORMAL DROPOUT INSTANTANEOUS UNIT TRIPS MOTOR INSTANTANEOUSLY UNDER FAULT CONDITIONS.
5. IN THE LONG TERM FOLLOWING AN ACCIDENT OR AN INCIDENT, UNITS 1 & 2 DIESEL GENERATORS AND UNIT 3 DIESEL GENERATORS MAY BE PARALLELED IN SETS OF TWO (A-3A, B-3B, C-3C, D-3D) BY CLOSING TIE BREAKERS. SYNCHRONIZING EQUIPMENT IS AVAILABLE FOR THE EXISTING TIE BREAKERS IN THE UNITS 1 & 2 CONTROL ROOM AND PARALLELING WILL BE ACCOMPLISHED FROM THIS LOCATION.
6. EQUIPMENT DENOTED BY Ÿ IS FED FROM 125V DC DIESEL BATTERY CIRCUIT AT POINT INDICATED; THOSE SUFFIXED WITH 46 (EXAMPLE Ÿ 46) ARE LOCATED ON DIESEL LOGIC PANEL 25-46.
7. ALL RELAY SETTINGS ARE SHOWN FOR INFORMATION ONLY. THE APPROPRIATE RELAY SETTING SHEET AND MANUAL SHALL BE CONSULTED FOR THE ACTUAL SETTING VALUE AND CALCULATIONAL BASIS REFERENCE.
8. CONTACT OPENS WHEN DIESEL GENERATOR VOLTAGE IS AVAILABLE.
9. CONTACT OPENS ON ACCIDENT SIGNAL.
10. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNIDS. LEADING ZEROES SHOWN IN MEL AS PART OF THE UNID ARE NOT DEPICTED. REFER TO NEDP-4.

EXAMPLE:	MEL UNID	DRAWING UNID
	BFN-2-PMP-074-0005	2-PMP-74-5

11. REFERENCE CALCULATION ND-Q0999-940013.
12. MAINTAIN 43SA IN MANUAL POSITION.
13. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

REFERENCES:

0-45E732-1..............480V DIESEL AUX BD A SINGLE LINE
0-45N326................EQUIPMENT DIAGRAM
0-45N327................EQUIPMENT DIAGRAM
0-15E500-1..............KEY DIAGRAM OF AUXILIARY POWER SYSTEM
3-15E500-3..............KEY DIAGRAM OF AUXILIARY POWER SYSTEM
0-45E702-1..............BATTERY BD 2 PNL 1-7 SINGLE LINE
0-45E709-1..............SHUTDOWN BDS 250V BTRY & CHGR SINGLE LINE
0-45E710-1..............KEY DIAGRAM - I&C POWER
0-45W710-3..............KEY DIAGRAM - I&C POWER
1-45E721................4160V UNIT BDS SINGLE LINE DIAGRAM
0-45E724-2,-3,-4........4160V SHUTDOWN BDS SINGLE LINE DIAGRAM
3-45E724-5,-6,-7,-8,-9..4160 BUS TIE BDS SINGLE LINE DIAGRAM
3-45E764-4..............4160 BUS TIE BDS SCHEMATIC DIAGRAM
0-45E765-1,-5,-6........4160 SHUTDOWN AUXILIARY POWER SCHEMATIC DIAGRAM
2-45E765-4,-7...........4160 SHUTDOWN AUXILIARY POWER SCHEMATIC DIAGRAM
1-45E765-4,-7...........4160 SHUTDOWN AUXILIARY POWER SCHEMATIC DIAGRAM
0-45E766-23.............4160 SHUTDOWN AUXILIARY POWER SCHEMATIC DIAGRAM
3-45E766-22.............4160 SHUTDOWN AUXILIARY POWER SCHEMATIC DIAGRAM
1-45E749-1..............480 SHUTDOWN BD SINGLE LINE
2-45E749-3..............480 SHUTDOWN BD SINGLE LINE
3-45E768-2..............4160V SHUTDOWN BD A SINGLE LINE
CONTRACT 66-90744 & 66-91750 N1M 1.5-2, 3, B1
0-0106D8860.............CONNECTION DIAGRAM
0-0106D8861.............CONNECTION DIAGRAM
0-0106D8864.............CONNECTION DIAGRAM
0-0106D8865.............CONNECTION DIAGRAM
0122D6487...............CIRCUIT SCHEDULE (CONTRACT 69-64706)
3-0122D9380.............CONNECTION DIAGRAM
3-0122D9382.............CONNECTION DIAGRAM
3-0122D9384.............CONNECTION DIAGRAM
0184B1437...............CONNECTION DIAGRAM (CONTRACT 69-64706)
0-0223R0379.............CONNECTION DIAGRAM
0-0223R0394.............CONNECTION DIAGRAM
0-0223R0399.............CONNECTION DIAGRAM
0223R0428...............CONNECTION DIAGRAM
0223R0432...............CONNECTION DIAGRAM
3-0223R0811.............CONNECTION DIAGRAM
3-0223R0812.............CONNECTION DIAGRAM
0223R0813...............CONNECTION DIAGRAM
3-0223R0814.............CONNECTION DIAGRAM
0-0168R0216.............METAL CLAD SWITCHGEAR
0-0168R0219.............METAL CLAD SWITCHGEAR
0-0168R0228.............METAL CLAD SWITCHGEAR
0-0168R0230.............METAL CLAD SWITCHGEAR
0124B3306...............DEVICE & HARNESS IDENTIFICATION
0-0124B3333.............DEVICE & HARNESS IDENTIFICATION
0124B3378...............DEVICE & HARNESS IDENTIFICATION
0124B3388...............DEVICE & HARNESS IDENTIFICATION
1-791E5111-SERIES.......CENTRAL D.G. INFO CENTER (CONTRACT 69-64706)

SYMBOL:

≠A(B,C,D) COMPONENTS ON OTHER 4160V SHUTDOWN BOARD

COMPANION DRAWINGS:
0-45E724-2, -3, -4
3-45E724-5, -6, -7, -8, -9

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: N/A

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
039	70687 S5	M.L.POOLE	J McFarland	B Campbell	11-23-15
REVISED PER DCA 70687-5001-000					

SCALE: NONE EXCEPT AS NOTED

POWERHOUSE
UNITS 1, 2 & 3

SYSTEM NO. 57-5(211), 82

WIRING DIAGRAM 4160V SHUTDOWN BD A SINGLE LINE

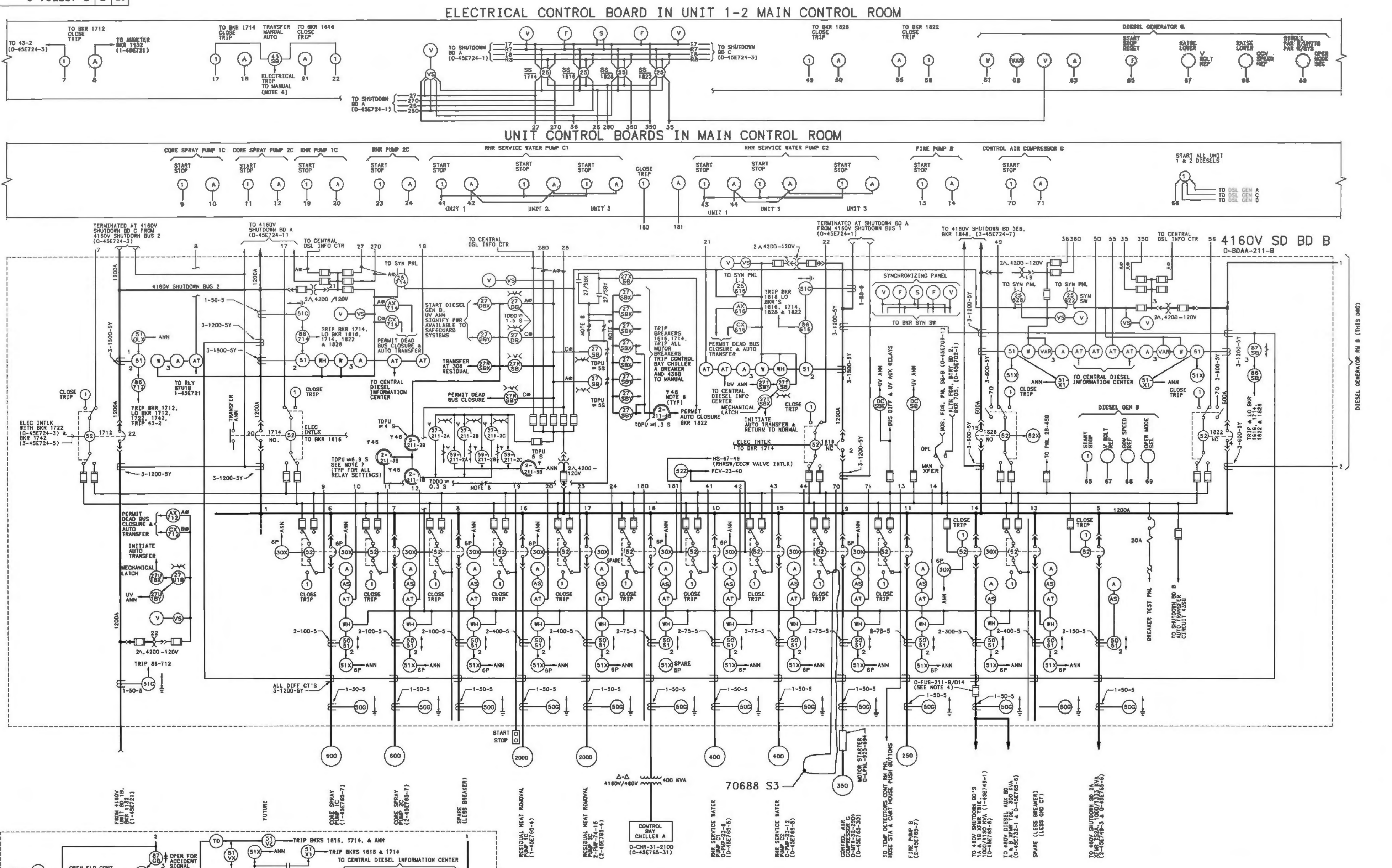
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

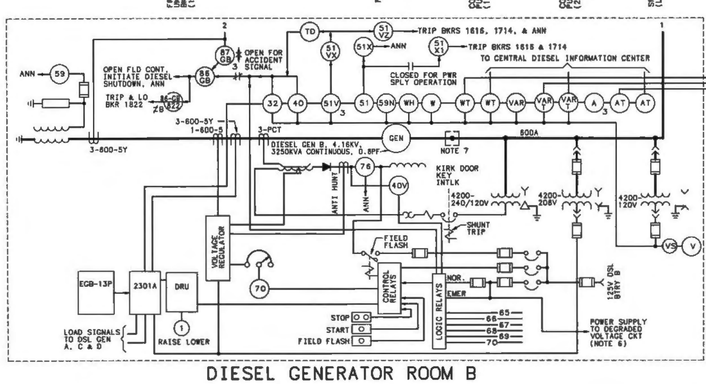
DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RWS	CHECKED JMF	1 N/A	2 N/A	C. McCORD
DESIGNED GWN	REVIEWED J.G. SAVERY	3 N/A	4 N/A	

KNOXVILLE | DATE 2-23-68 | 67 | E | 0-45E724-1 | R039

CAD MAINTAINED DRAWING | CCD

ALL A/D HISTORY RESEARCHED AT R010





WHEN 4KV SHUTDOWN BOARD B IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 2), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG B AND 3D. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 5):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNIT 2. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNIT 2 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD B (250V DC DISTRIBUTION PANEL SHUTDOWN BATTERY-B) INOPERABLE AND ENTER LCO 3.8.7 BASED ON PLANT OPERATING CONDITIONS. THERE ARE NO RESTRICTIONS ON UNIT 1 AND 3 OPERATION EXCEPT AS NOTED BELOW
2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF TWO RHRSW/EECW SWING PUMPS THAT COULD BE ALIGNED FOR EECW INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT. IF BOTH THE C1 AND D1 RHRSW/EECW PUMPS ARE ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE C1 OR THE D1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.
4) A SINGLE FAILURE COULD RESULT IN THE LOSS OF THREE PUMPS NORMALLY ALIGNED FOR RHRSW INSTEAD OF JUST TWO RHRSW PUMPS IF THE BOARDS WERE IN A NORMAL ALIGNMENT. UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE C1 AND C2, OR THE D1 RHRSW PUMPS INOPERABLE AND ENTER LCO 3.7.1 AS REQUIRED FOR THE PLANT CONDITIONS.
5) A SINGLE FAILURE COULD CAUSE THE LOSS OF BOTH REDUNDANT TRAINS OF UNIT 3 MAIN CONTROL ROOM AIR CONDITIONING (MCR AC) DUE TO THE LOSS OF ALL MCR AIR HANDLING UNITS (AHU). UNIT 3 SHALL CONSIDER EITHER THE MCR AC TRAIN A OR B INOPERABLE AND ENTER LCO 3.7.4 AS REQUIRED FOR THE PLANT CONDITIONS.

NOTES:
1. FOR GENERAL NOTES, SYMBOLS, AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS, REFER TO MEL FOR COMPLETE UNIDS.
3. DELETED
4. ALL THREE FUSES MUST BE REPLACED IF EVER SUBJECTED TO A FAULT CURRENT CAUSING BREAKER TO TRIP.
5. REFERENCE CALCULATION ND-Q0999-940013.
6. MAINTAIN 43SB IN MANUAL POSITION.
7. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

SYMBOLS:
ZA(B,C,D) - COMPONENTS ON OTHER 4160V SHUTDOWN BOARD

COMPANION DRAWINGS:
0-45E724-1,-3,A-4
3-45E724-5,-6,-7,-8,A-9

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
042	70688 S3	K KING	B Campbell	J McFarland	9-25-15
REVISED PER DCA 70688-3001-000					

SCALE: NONE EXCEPT AS NOTED

POWERHOUSE
UNITS 1, 2 & 3

SYSTEM NO. 57-5(211), 82

WIRING DIAGRAM 4160V SHUTDOWN BD B SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RWS	CHECKED JMF	1 N/A	2 N/A	C. McCORD
DESIGNED CWN	REVIEWED J.G. SAVERY	3 N/A	4 N/A	

THIS DRAWING APPEARS IN THE FSAR

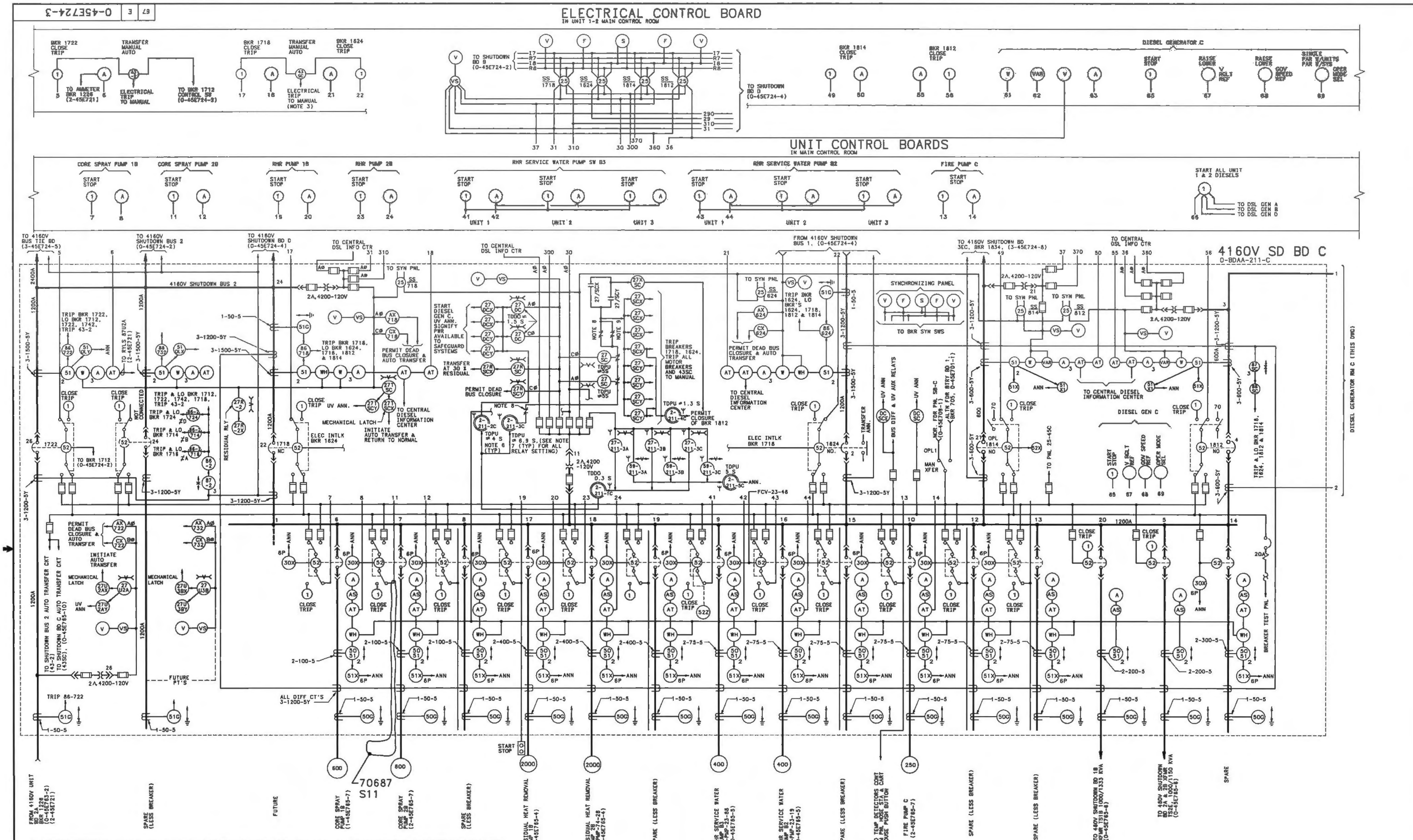
KNOXVILLE | DATE 2-23-68 | 67 | E | 0-45E724-2 | R042

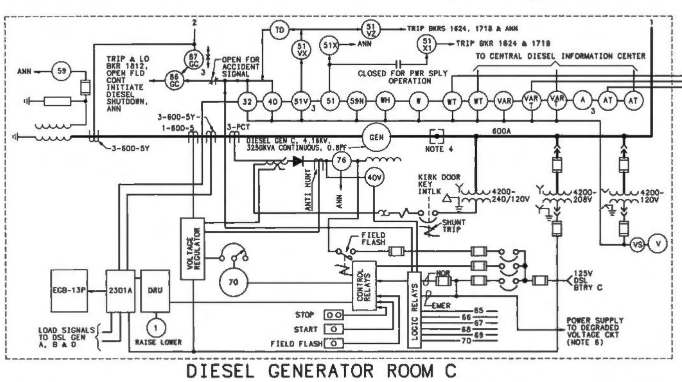
ISSUED BY: T.G. CHAPMAN/L

ALL A/D HISTORY RESEARCHED AT R011

CAD MAINTAINED DRAWING

CCD





NOTES:
1. FOR GENERAL NOTES, SYMBOLS, AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. REFERENCE CALCULATION ND-Q0999-940013.
3. MAINTAIN 43SC IN MANUAL POSITION.
4. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

REFERENCE DRAWINGS:
0-45E701-1.........WIRING DIAGRAM BATTERY BOARD 1, PANELS 1-7, SINGLE LINE
0-45E763-2.........WIRING DIAGRAM 4160V UNIT AUXILIARY POWER DC SCHEMATIC DIAGRAM

SYMBOLS:
ZA(B,C,D) - COMPONENTS ON OTHER 4160V SHUTDOWN BOARD

BREAKER SYMBOLS FOR UNIT 1, 2 & 3 OPERATION:

OPL -OPEN, ALLOWED TO BE CLOSED FOR LOAD NOT EXCEEDING 340 AMPS. MAY EXCEED 340 AMPS ONCE, FOR A MAXIMUM OF 100 HOURS.

OPL1 -A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG C AND 3A, AND TWO PUMPS NORMALLY ALIGNED FOR EECW (INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT). UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE A3 OR THE B3 EECW PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

COMPANION DRAWINGS:
0-45E724-1,2,4
3-45E724-SERIES

047	70687 S11	K KING	B Campbell	J McFarland	10-15-15
REVISED PER DCA 70687-11001-000					
REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
SCALE: NONE					EXCEPT AS NOTED

POWERHOUSE
UNITS 1, 2 & 3

SYSTEM NO. 57-5(211), 82

WIRING DIAGRAM
4160V SHUTDOWN BD C
SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RWS	CHECKED GWN	1 N/A	2 N/A	C. McCORD
DESIGNED GWN	REVIEWED J.G. SAVERY	3 N/A	4 N/A	

THIS DRAWING APPEARS IN THE FSAR

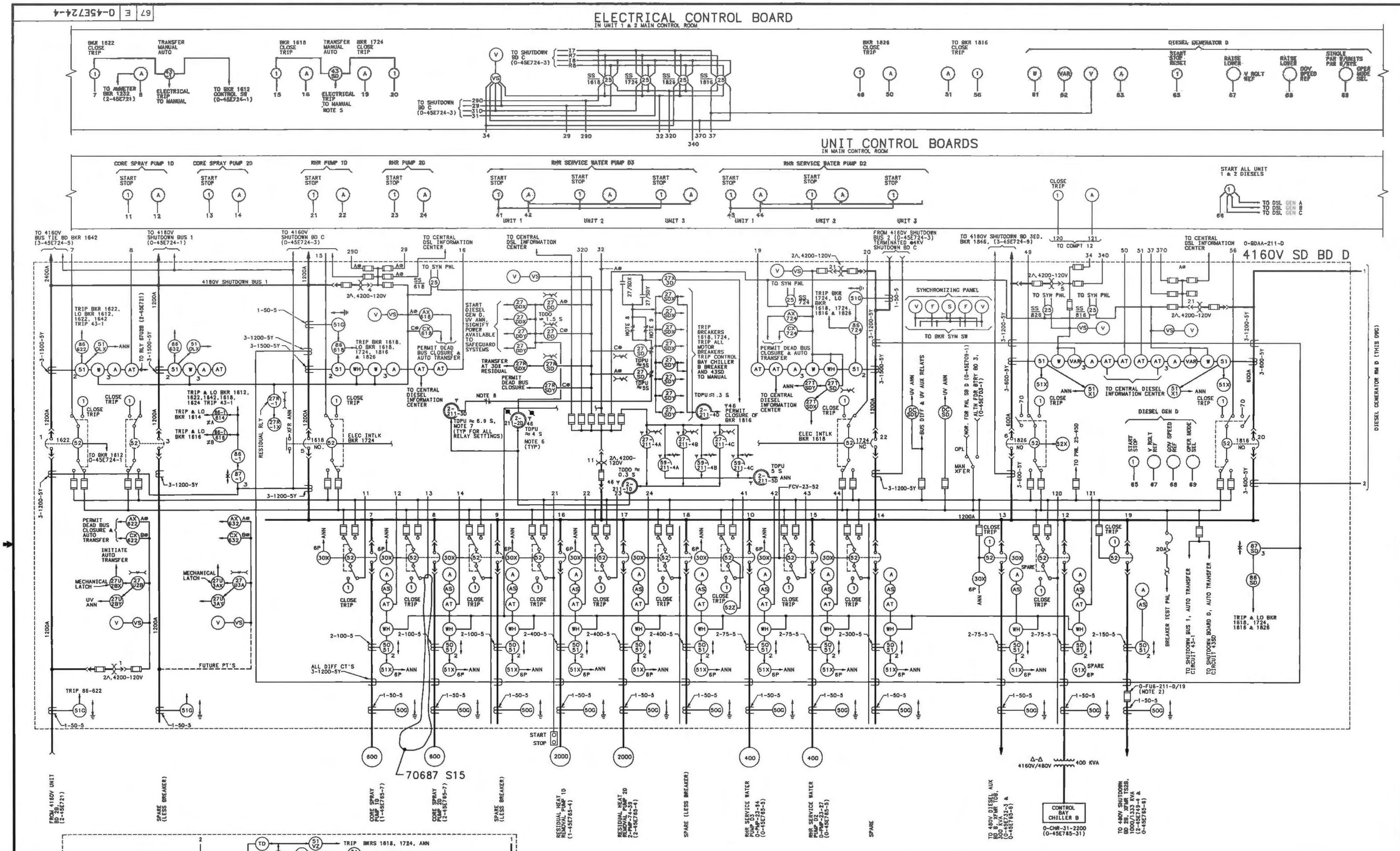
KNOXVILLE	DATE 2-23-68	67	E	0-45E724-3	R047

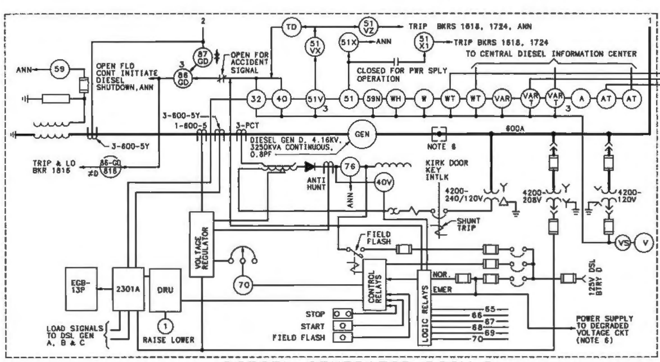
ISSUED BY:

CAD MAINTAINED DRAWING

CCD

ALL A/D HISTORY RESEARCHED AT R010





DIESEL GENERATOR ROOM D

NOTES:
1. FOR GENERAL NOTES, SYMBOLS, AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. ALL THREE FUSES MUST BE REPLACED IF EVER SUBJECTED TO A FAULT CURRENT CAUSING BREAKER TO TRIP.
3. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNID.
4. REFERENCE CALCULATION ND-Q0999-940013.
5. MAINTAIN 43SD IN MANUAL POSITION.
6. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

OPL-WHEN 4KV SHUTDOWN BOARD D IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 3), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG D AND 3C. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 4):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNITS 1 AND 2. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNITS 1 AND 2 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD D (250V DC DISTRIBUTION PANEL SHUTDOWN BATTERY-D) INOPERABLE AND ENTER LCO 3.8.7 IF OPERATING IN MODES 1, 2 OR 3. THERE ARE NO RESTRICTIONS ON UNIT 3 OPERATION EXCEPT AS NOTED BELOW.

2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF ONE PUMP NORMALLY ALIGNED FOR EECW AND TWO RHRSW/EECW SWING PUMP (INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT). BECAUSE THE D1 AND D3 PUMPS ARE IN THE SAME ROOM, BOTH CANNOT BE CREDITED FOR EECW AT THE SAME TIME. IF THE B1 PUMP IS ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE B1 OR THE D3 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS. IF THE B1 AND D1 PUMPS ARE ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE B1 OR THE D1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

SYMBOL:

≠A(B,C,D) COMPONENTS ON OTHER 4160V SHUTDOWN BOARD

COMPANION DRAWINGS:
0-45E724-1,-2,A-3
3-45E724-5,-6,-7,-8,A-9

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: T.G. CHAPMAN

ALL A/D HISTORY RESEARCHED AT R009

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
037	70687 S15	K KING	B Campbell	J McFarland	10-15-15
REVISED PER DCA 70687-15001-000					

SCALE: NONE — EXCEPT AS NOTED

POWERHOUSE UNITS 1, 2 & 3 — SYSTEM NO. 57-5(211),82

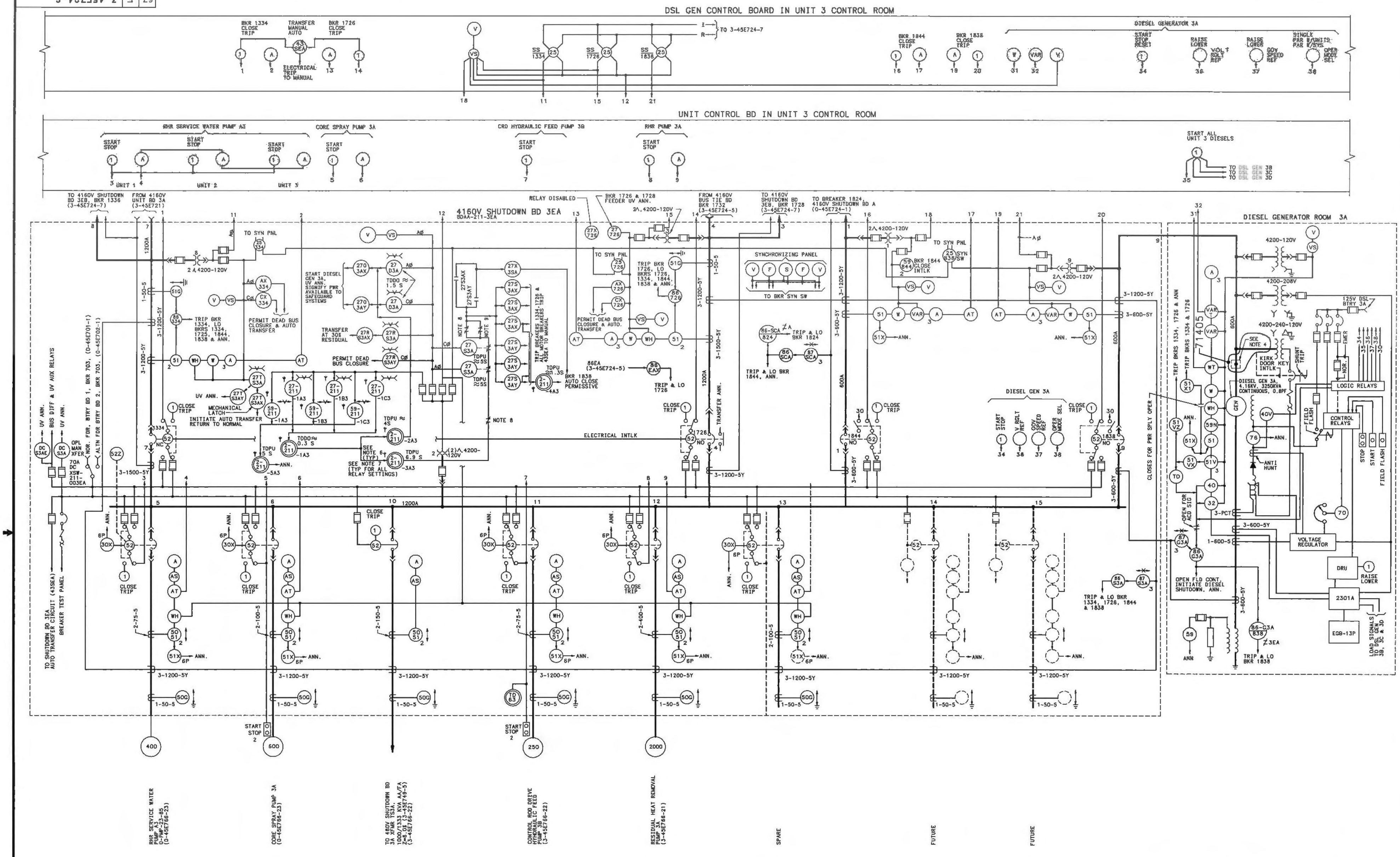
WIRING DIAGRAM 4160V SHUTDOWN BD D SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RWS	CHECKED GWN	1 N/A	2 N/A	C. McCORD
DESIGNED GWN	REVIEWED J.G. SAVERY	3 N/A	4 N/A	

KNOXVILLE | DATE 2-23-68 | 67 | E | 0-45E724-4 | R037

CAD MAINTAINED DRAWING | CCD



NOTES:

1. FOR GENERAL NOTES, SYMBOLS AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNIDS. ALL UNIDS ARE PREFIXED 'BFN-3' UNLESS OTHERWISE NOTED.
3. REFERENCE CALCULATION ND-Q0999-940013.
4. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

71405

OPL-WHEN 4KV SHUTDOWN BOARD 3EA IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 2), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG 3A AND 3D. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 3):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNIT 3. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNIT 3 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD 3EA (250V DC BATTERY BOARD-1) INOPERABLE AND ENTER LCO 3.8.7 IF OPERATING IN MODES 1,2 OR 3. THERE ARE NO RESTRICTIONS ON UNITS 1 AND 2 OPERATION EXCEPT AS NOTED BELOW.
2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF ONE EECW PUMP AND ONE RHRSW/EECW SWING PUMP THAT COULD BE ALIGNED FOR EECW (INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT). IF THE D1 PUMP IS ALIGNED FOR EECW, UNITS 1,2 AND 3 SHALL CONSIDER EITHER THE A3 OR THE D1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

REFERENCE DRAWINGS:
3-45E766-1,-2,-9,-10.....4160V SHUTDOWN AUX POWER SCHEMATIC DIAGRAMS
3-45E767-7,-8............DG SCHEMATIC DIAGRAMS

COMPANION DRAWINGS:
0-45E724-1,-2,-3,&-4
3-45E724-5,-7,-8,&-9

SYMBOLS:
Z3EA............LOCATED ON 4KV SHUTDOWN BD 3EA
ZA (B,C,D).......LOCATED ON OTHER 4160V SD BD

036	71405	D.Stanford	J.McFarland	B.Campbell	4-2-15
REVISED PER DCA 71405-015-000					
REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
SCALE: NONE				EXCEPT AS NOTED	

POWERHOUSE
UNIT 3

SYSTEM NO.
57-5(211)82

WIRING DIAGRAM 4160V SHUTDOWN BD 3EA SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RCS	CHECKED GRH	1 N/A	2 N/A	
DESIGNED GRH	REVIEWED R.W.CANTRELL	3 N/A	4 N/A	M.N. SPROUSE

THIS DRAWING APPEARS IN THE FSAR

KNOXVILLE | DATE 10-10-72 | 67 | E | 3-45E724-6 | R036

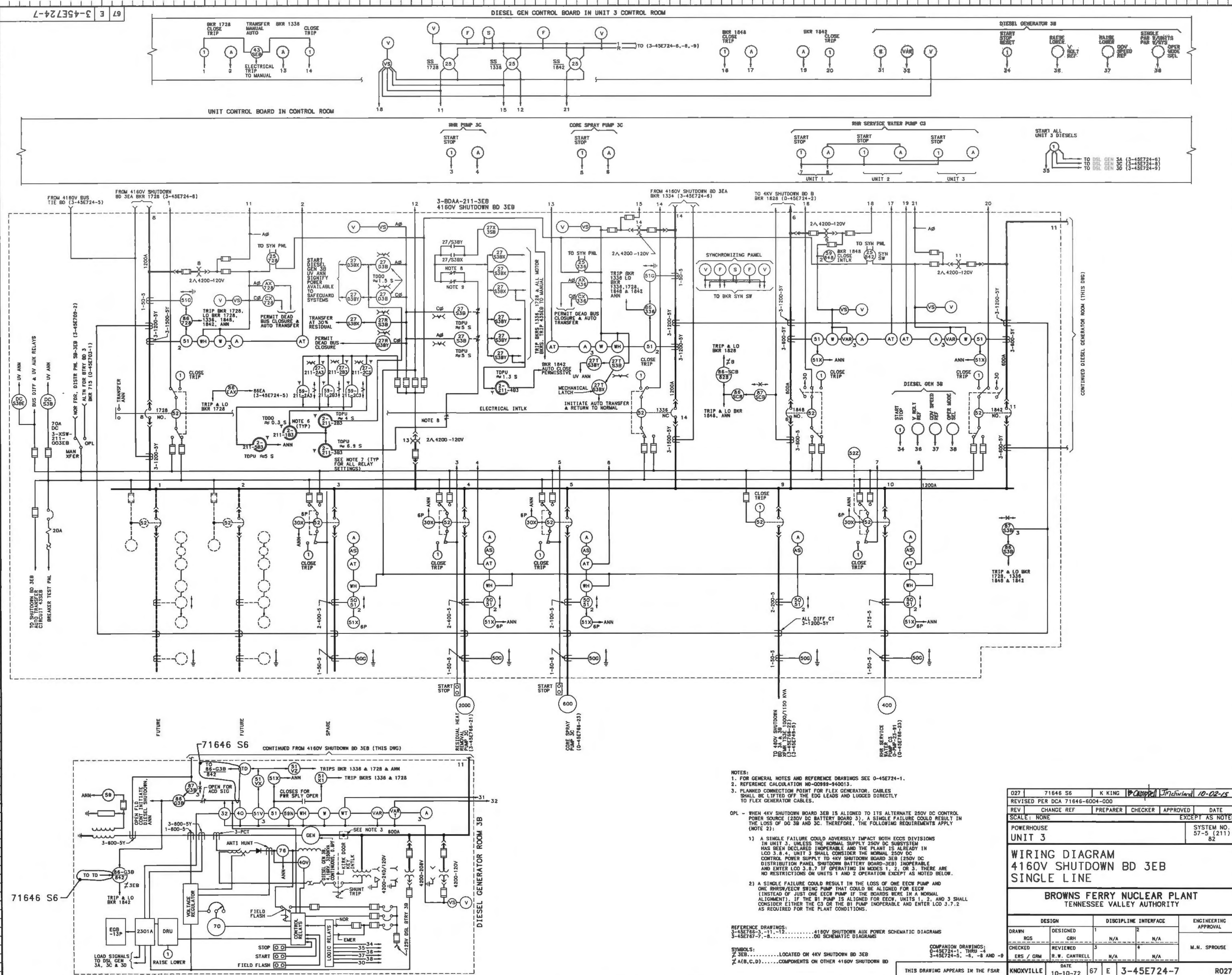
ISSUED BY: N/A

CAD MAINTAINED DRAWING

CCD

ALL A/D HISTORY RESEARCHED AT R012

67 E 3-45E724-6



NOTES:
1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. REFERENCE CALCULATION ND-Q0999-940013.
3. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

OPL - WHEN 4KV SHUTDOWN BOARD 3EB IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 3), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG 3B AND 3C. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 2):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNIT 3. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNIT 3 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD 3EB (250V DC DISTRIBUTION PANEL SHUTDOWN BATTERY BOARD-3EB) INOPERABLE AND ENTER LCO 3.8.7 IF OPERATING IN MODES 1, 2, OR 3. THERE ARE NO RESTRICTIONS ON UNITS 1 AND 2 OPERATION EXCEPT AS NOTED BELOW.

2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF ONE EECW PUMP AND ONE RHRSW/EECW SWING PUMP THAT COULD BE ALIGNED FOR EECW (INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT). IF THE B1 PUMP IS ALIGNED FOR EECW, UNITS 1, 2, AND 3 SHALL CONSIDER EITHER THE C3 OR THE B1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

REFERENCE DRAWINGS:
3-45E766-3,-11,-12..........4160V SHUTDOWN AUX POWER SCHEMATIC DIAGRAMS
3-45E767-7,-8..............DG SCHEMATIC DIAGRAMS

SYMBOLS:
3EB..........LOCATED ON 4KV SHUTDOWN BD 3EB
A(B,C,D).....COMPONENTS ON OTHER 4160V SHUTDOWN BD

COMPANION DRAWINGS:
0-45E724-1, THRU -4
3-45E724-5, -6, -8 AND -9

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: N/A

ALL A/D HISTORY RESEARCHED AT R008

027	71646 S6	K KING	B Campbell	J McFarland	10-02-15
REVISED PER DCA 71646-6004-000					
REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
SCALE: NONE				EXCEPT AS NOTED	

POWERHOUSE
UNIT 3

SYSTEM NO. 57-5 (211) 82

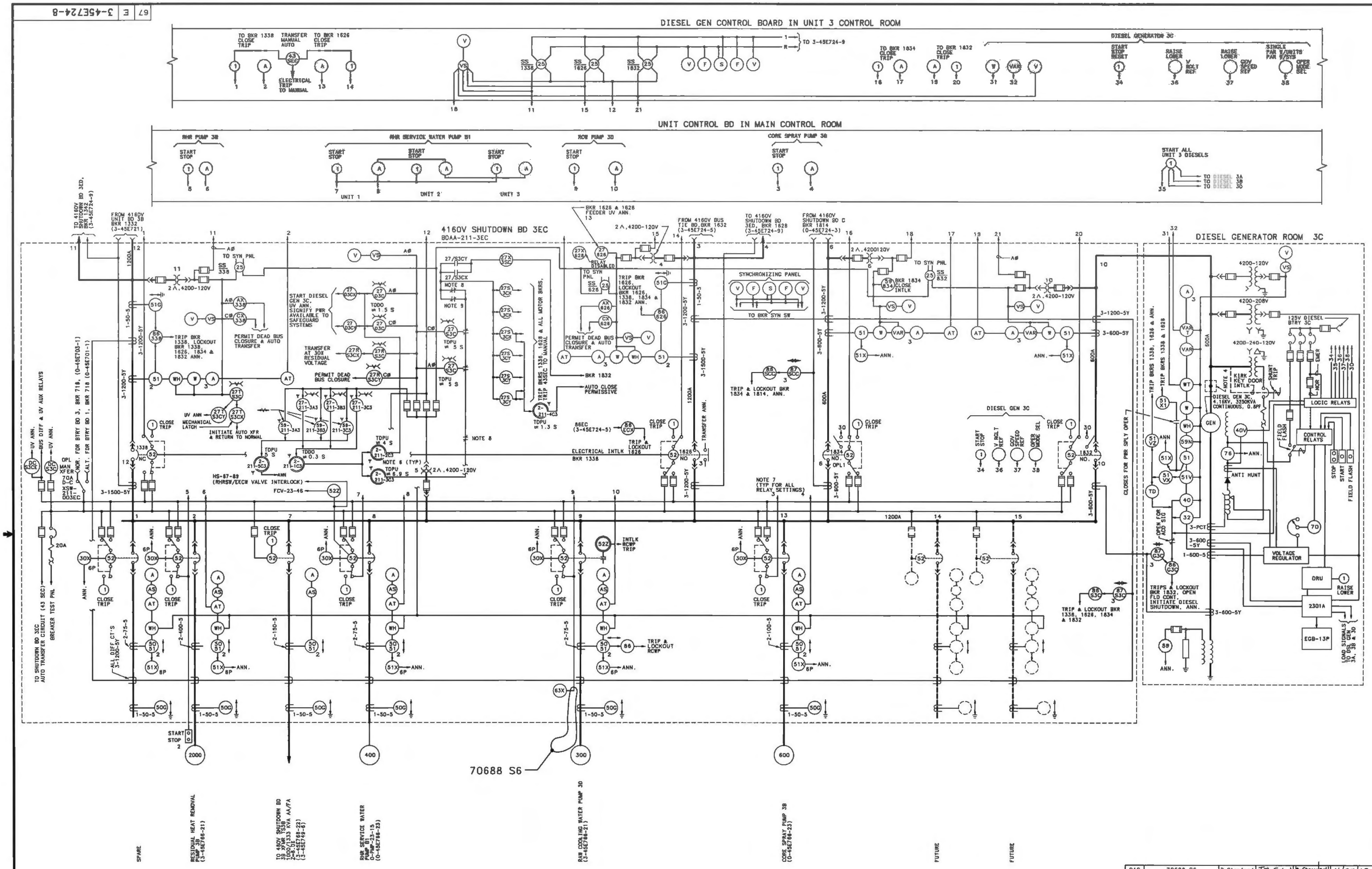
WIRING DIAGRAM 4160V SHUTDOWN BD 3EB SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RGS	DESIGNED GRH	1 N/A	2 N/A	
CHECKED ERS / GRM	REVIEWED R.W. CANTRELL	3 N/A	4 N/A	M.N. SPROUSE
KNOXVILLE	DATE 10-10-72	67	E	3-45E724-7	R027

CAD MAINTAINED DRAWING

CCD



BREAKER SYMBOLS FOR UNITS 1, 2 & 3 OPERATION:

OPL - WHEN 4KV SHUTDOWN BOARD 3EC IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 1), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG 3A AND 3C. THEREFORE, THE FOLLOWING REQUIREMENTS APPLY (NOTE 3):

1) A SINGLE FAILURE COULD ADVERSELY IMPACT BOTH ECCS DIVISIONS IN UNIT 3. UNLESS THE NORMAL SUPPLY 250V DC SUBSYSTEM HAS BEEN DECLARED INOPERABLE AND THE PLANT IS ALREADY IN LCO 3.8.4, UNIT 3 SHALL CONSIDER THE NORMAL 250V DC CONTROL POWER SUPPLY TO 4KV SHUTDOWN BOARD 3EC (250V DC BATTERY BOARD 3) INOPERABLE AND ENTER LCO 3.8.7 IF OPERATING IN MODES 1, 2 OR 3. THERE ARE NO RESTRICTIONS ON UNIT 1 OR 2 OPERATION EXCEPT AS NOTED BELOW.

2) A SINGLE FAILURE COULD RESULT IN THE LOSS OF ONE EECW PUMP AND ONE RHRSW/EECW SWING PUMP THAT COULD BE ALIGNED FOR EECW (INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT). IF THE B1 PUMP IS ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE A3 OR THE B1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS.

3) A SINGLE FAILURE COULD CAUSE THE LOSS OF BOTH REDUNDANT TRAINS OF AIR CONDITIONING (AC) FOR THE TWO UNIT 3 ELECTRIC BOARD ROOMS (EBR) ON ELEVATIONS 593' AND 621' OF THE REACTOR BUILDING. UNIT 3 SHALL CONSIDER EITHER THE EBR AC UNIT 3A OR 3B AC SYSTEM INOPERABLE AND ENTER TRM LCO 3.7.6 AS REQUIRED FOR THE PLANT CONDITIONS. THERE ARE NO RESTRICTIONS ON THE UNIT 1 OR 2 AIR CONDITIONING.

OPL1 - OPEN, ALLOWED TO BE CLOSED FOR LOAD NOT EXCEEDING 340 AMPS. MAY EXCEED 340 AMPS ONCE, FOR A MAXIMUM OF 100 HOURS.

NOTES:

1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. UNIDS ON DRAWINGS ARE FOR REFERENCE ONLY AND ARE TO BE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNIDS. ALL UNIDS ARE PREFIXED BFN-3 UNLESS OTHERWISE NOTED.
3. REFERENCE CALCULATION ND-Q0999-840013
4. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

REFERENCE DRAWINGS:
0-45E701-1..........WIRING DIAGRAM BATTERY BOARD 1 PANELS 1-7 SINGLE LINE
0-45E703-1..........WIRING DIAGRAM BATTERY BOARD 3 PANELS 1-7 SINGLE LINE
3-45E766-5,-6,-13,..4160V SHUTDOWN AUX POWER SCH DIAGRAMS
-14,-19,-27,-28
3-45E767-5,-7,-8....DIESEL GEN SCH DIAGRAMS

COMPANION DRAWINGS:
3-45E724-5,-6,-7,-9
0-45E724-1 THRU -4

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: N/A

ALL A/D HISTORY RESEARCHED AT R012

040	70688 S6	D.Stanford	J.McFarland	B.Campbell	4/28/15
REVISED PER DCA 70688-6001-000					
REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
SCALE: NONE				EXCEPT AS NOTED	

POWERHOUSE
UNIT 3

SYSTEM NO. 57-8(211),82

WIRING DIAGRAM 4160V SHUTDOWN BD 3EC SINGLE LINE

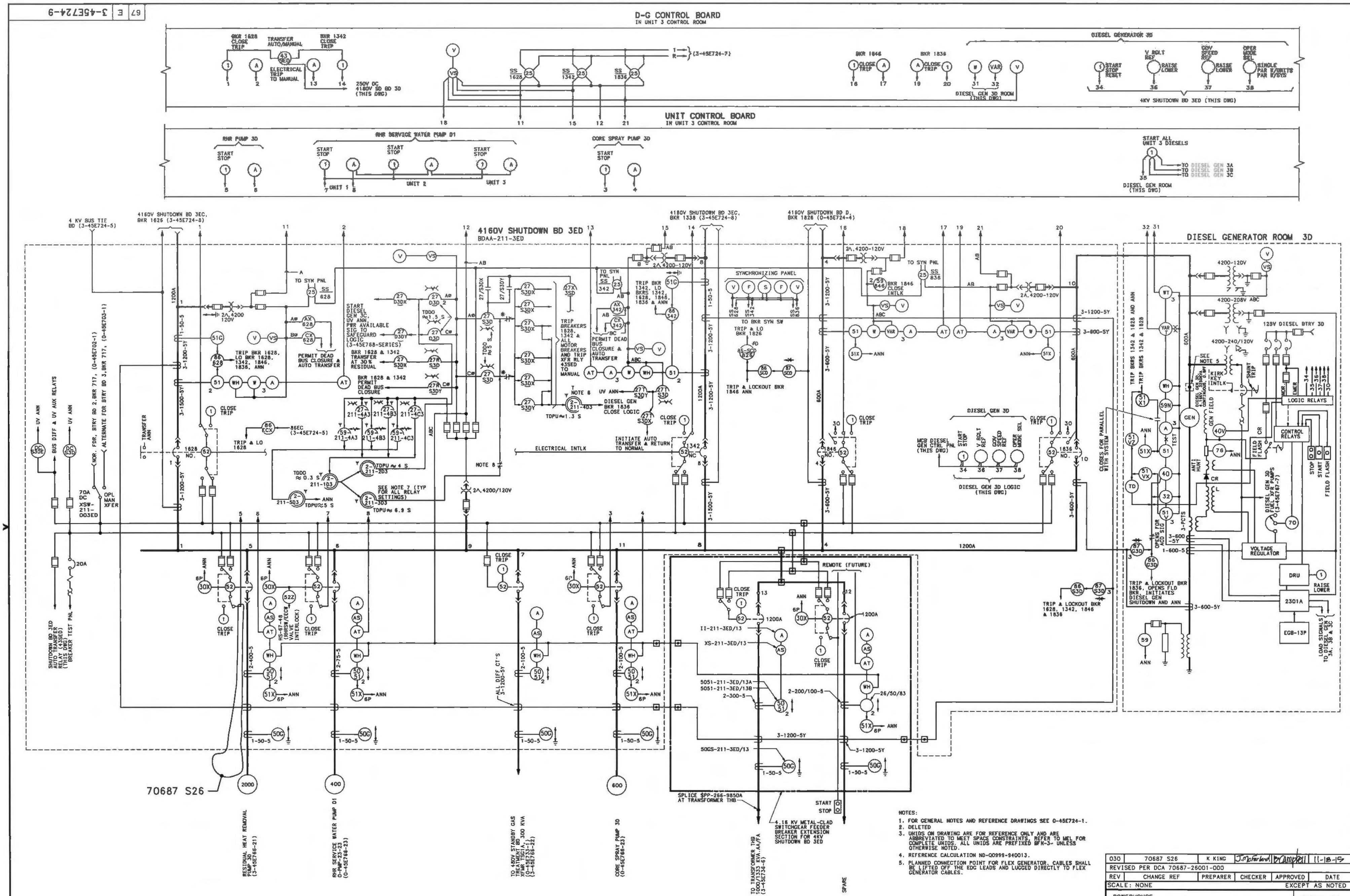
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RGS	CHECKED GRH	1 N/A	2 N/A	
DESIGNED GRH	REVIEWED R.W.CANTRELL	3 N/A	4 N/A	M.N. SPROUSE
KNOXVILLE	DATE 10-10-72	67	E	3-45E724-8 R040

CAD MAINTAINED DRAWING

CCD

67 E 3-45E724-8



NOTES:
1. FOR GENERAL NOTES AND REFERENCE DRAWINGS SEE 0-45E724-1.
2. DELETED
3. UNIDS ON DRAWING ARE FOR REFERENCE ONLY AND ARE ABBREVIATED TO MEET SPACE CONSTRAINTS. REFER TO MEL FOR COMPLETE UNIDS. ALL UNIDS ARE PREFIXED BFN-3- UNLESS OTHERWISE NOTED.
4. REFERENCE CALCULATION ND-Q0999-940013.
5. PLANNED CONNECTION POINT FOR FLEX GENERATOR. CABLES SHALL BE LIFTED OFF THE EDG LEADS AND LUGGED DIRECTLY TO FLEX GENERATOR CABLES.

OPL-WHEN 4KV SHUTDOWN BOARD 3ED IS ALIGNED TO ITS ALTERNATE 250V DC CONTROL POWER SOURCE (250V DC BATTERY BOARD 3), A SINGLE FAILURE COULD RESULT IN THE LOSS OF DG 3C AND 3D, AND TWO RHRSW/EECW SWING PUMPS THAT COULD BE ALIGNED FOR EECW INSTEAD OF JUST ONE EECW PUMP IF THE BOARDS WERE IN A NORMAL ALIGNMENT. IF BOTH THE B1 AND D1 RHRSW/EECW PUMPS ARE ALIGNED FOR EECW, UNITS 1, 2 AND 3 SHALL CONSIDER EITHER THE B1 OR THE D1 PUMP INOPERABLE AND ENTER LCO 3.7.2 AS REQUIRED FOR THE PLANT CONDITIONS (NOTE 4).

REFERENCE DRAWINGS:
3-45E768-7,-8,-15,-16,-20..........4160V SHUTDOWN AUX POWER SCHEMATIC DIAGRAMS
3-45E767-5,-7,-8..........DIESEL GENERATOR SCHEMATIC DIAGRAMS

COMPANION DRAWINGS:
0-45E724-1, -2, -3, -4
3-45E724-5, -6, -7, -8

SYMBOL
⊡ BUS OR WIRING CONNECTIONS FOR CUBICLES 12 AND 13 ROUTED THROUGH SEISMICALLY ISOLATED TRANSITION SECTION
* - CLOSED EXCEPT WHEN ACCIDENT AND DIESEL GENERATOR VOLTAGE AVAILABLE SIGNALS ARE BOTH PRESENT
#A(B,C,D) - COMPONENTS ON OTHER 4160V SHUTDOWN BOARD

R0 ISSUE FOR ECN W-92

THIS DRAWING APPEARS IN THE FSAR

ISSUED BY: N/A

ALL A/D HISTORY RESEARCHED AT R011

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
030	70687 S26	K KING	J.McFarland	[signature]	11-18-15
REVISED PER DCA 70687-26001-000					

SCALE: NONE — EXCEPT AS NOTED

POWERHOUSE UNIT 3 — SYSTEM NO. 57-5,82,211

WIRING DIAGRAM 4160V SHUTDOWN BD 3ED SINGLE LINE

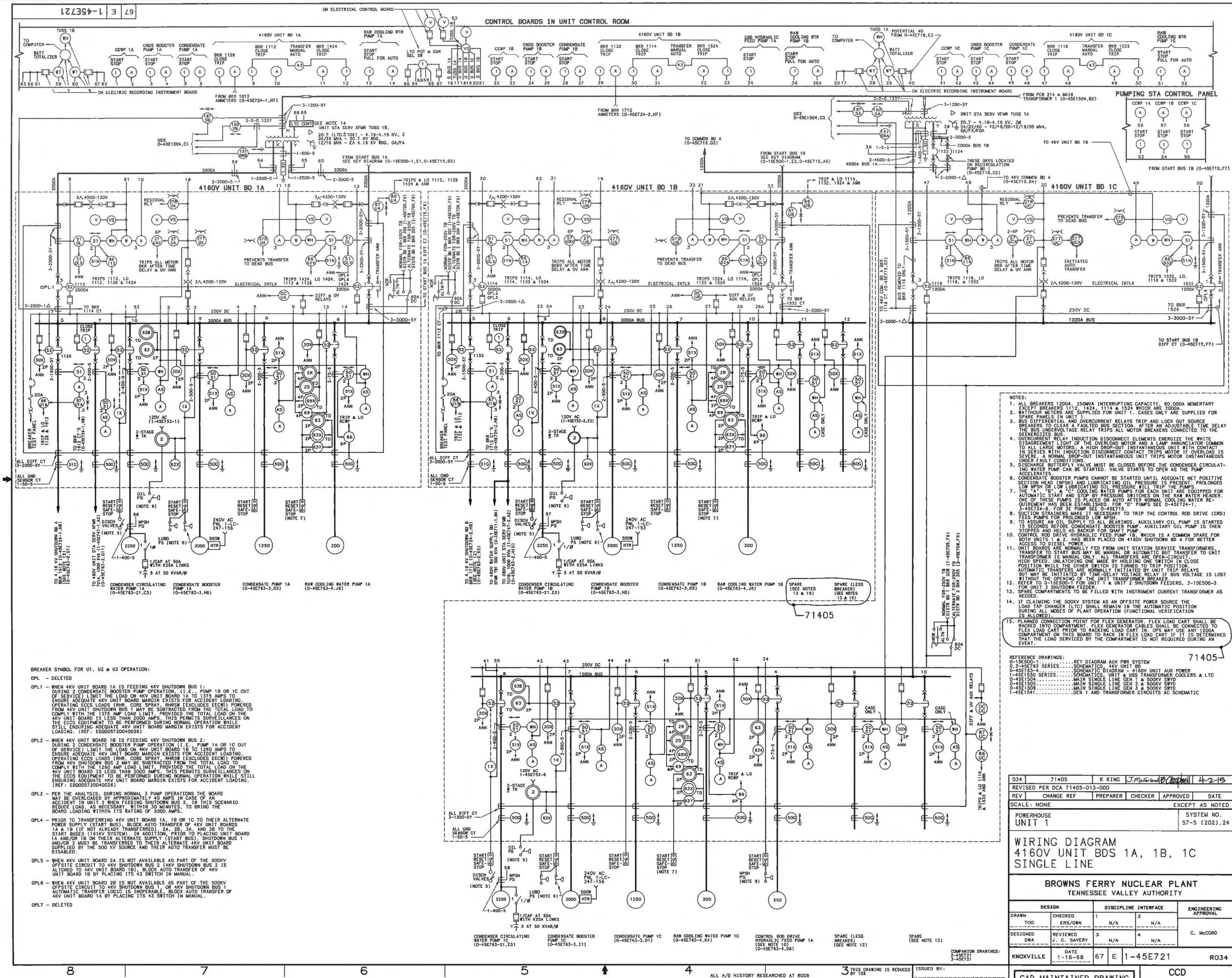
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN RGS	CHECKED ERS/GPH	1 N/A	2 N/A	
DESIGNED GRH	REVIEWED R.W. CANTRELL	3 N/A	4 N/A	M.N. SPROUSE

KNOXVILLE — DATE 10-10-72 — 67 E 3-45E724-9 R030

CCD

CAD MAINTAINED DRAWING



NOTES:

1. ALL BREAKERS 1200A, 250MVA INTERRUPTING CAPACITY, 60,000A MOMENTARY EXCEPT BREAKERS 1112, 1424, 1114 & 1524 WHICH ARE 2000A.
2. WATTHOUR METERS ARE SUPPLIED FOR UNIT 1. CASES ONLY ARE SUPPLIED FOR SPARE PANELS IN UNIT 1.
3. BUS DIFFERENTIAL AND OVERCURRENT RELAYS TRIP AND LOCK OUT SOURCE BREAKERS TO CLEAR A FAULTED BUS SECTION. AFTER AN ADJUSTABLE TIME DELAY THE BUS UNDERVOLTAGE RELAY TRIPS ALL MOTOR BREAKERS CONNECTED TO THE DEENERGIZED BUS.
4. OVERCURRENT RELAY INDUCTION DISCONNECT ELEMENTS ENERGIZE THE WHITE DISAGREEMENT LIGHT OF THE OVERLOAD MOTOR AND A LAMP ANNUNCIATOR COMMON TO ALL LARGE MOTORS. A HIGH DROP-OUT INSTANTANEOUS UNIT WITH CONTACT IN SERIES WITH INDUCTION DISCONNECT CONTACT TRIPS MOTOR IF OVERLOAD IS SEVERE. A NORMAL DROP-OUT INSTANTANEOUS UNIT TRIPS MOTOR INSTANTANEOUS UNDER FAULT CONDITIONS.
5. DISCHARGE BUTTERFLY VALVE MUST BE CLOSED BEFORE THE CONDENSER CIRCULATING WATER PUMP CAN BE STARTED. VALVE STARTS TO OPEN AS THE PUMP ACCELERATES.
6. CONDENSATE BOOSTER PUMPS CANNOT BE STARTED UNTIL ADEQUATE NET POSITIVE SECTION HEAD (NPSH) AND LUBRICATING OIL PRESSURE IS PRESENT. PROLONGED LOW NPSH OR LOW LUBRICATING OIL PRESSURE WILL TRIP THE PUMPS.
7. THE "A", "B", & "C" COOLING WATER PUMPS FOR EACH UNIT ARE EQUIPPED FOR AUTOMATIC START AND STOP BY PRESSURE SWITCHES ON THE RAW WATER HEADER. ONE OF THESE PUMPS IS PLACED ON AUTO AFTER NORMAL COOLING WATER REQUIREMENT HAS BEEN ESTABLISHED. FOR "D" PUMPS SEE 0-45E724-1, 3-45E724-8, FOR 3E PUMP SEE 0-45E715.
8. SUCTION STRAINERS MAKE IT NECESSARY TO TRIP THE CONTROL ROD DRIVE (CRD) FEED PUMPS FOR PROLONGED LOW NPSH.
9. TO ASSURE AN OIL SUPPLY TO ALL BEARINGS, AUXILIARY OIL PUMP IS STARTED 15 SECONDS BEFORE CONDENSATE BOOSTER PUMP. AUXILIARY OIL PUMP IS THEN STOPPED AND HELD AS BACKUP FOR SHAFT PUMP.
10. CONTROL ROD DRIVE HYDRAULIC FEED PUMP 1B, WHICH IS A COMMON SPARE FOR BOTH UNITS 1 & 2, HAS BEEN PLACED ON 4160V SHUTDOWN BD A FOR BETTER ACCESS TO DIESEL POWER.
11. UNIT BOARDS ARE NORMALLY FED FROM UNIT STATION SERVICE TRANSFORMERS. TRANSFER TO START BUS MAY BE MANUAL OR AUTOMATIC BUT TRANSFER TO UNIT TRANSFORMER IS MANUAL ONLY. ALL TRANSFERS ARE OPEN-CIRCUIT, HIGH SPEED. UNLATCHING ONE MADE BY HOLDING ONE SWITCH IN CLOSE POSITION WHILE THE OTHER SWITCH IS TURNED TO TRIP POSITION. AUTOMATIC TRANSFERS ARE NORMALLY INITIATED BY UNIT TRIP RELAYS BUT MAY BE INITIATED BY TIME-DELAY VOLTAGE RELAY IF BUS VOLTAGE IS LOST WITHOUT THE OPENING OF THE UNIT TRANSFORMER BREAKER.
12. REFER TO 0-15E500-1 FOR UNIT 1 & UNIT 2 SHUTDOWN FEEDERS, 3-15E500-3 FOR UNIT 3 SHUTDOWN FEEDER.
13. SPARE COMPARTMENTS TO BE FILLED WITH INSTRUMENT CURRENT TRANSFORMER AS NEEDED.
14. IF CLAIMING THE 500KV SYSTEM AS AN OFFSITE POWER SOURCE THE LOAD TAP CHANGER (LTC) SHALL REMAIN IN THE AUTOMATIC POSITION DURING ALL MODES OF PLANT OPERATION (FUNCTIONAL VERIFICATION IS ALLOWED).
15. PLANNED CONNECTION POINT FOR FLEX GENERATOR. FLEX LOAD CART SHALL BE RACKED INTO COMPARTMENT. FLEX GENERATOR CABLES SHALL BE CONNECTED TO FLEX LOAD CART PRIOR TO RACKING LOAD CART IN. OPS MAY USE ANY 1200A COMPARTMENT ON THIS BOARD TO RACK IN FLEX LOAD CART IF IT IS DETERMINED THAT THE LOAD SERVICED BY THE COMPARTMENT IS NOT REQUIRED DURING AN EVENT.

71405

REFERENCE DRAWINGS:

0-15E500-1	KEY DIAGRAM AUX PWR SYSTEM
0,2-45E763 SERIES	SCHEMATICS, 4KV UNIT BD
0-45E763-4	SCHEMATIC DIAGRAM - 4160V UNIT AUX POWER
1-45E1530 SERIES	SCHEMATICS, UNIT & USS TRANSFORMER COOLERS & LTC
0-45E1504	MAIN SINGLE LINE GEN 1 & 500KV SWYD
0-45E1505	MAIN SINGLE LINE GEN 2 & 500KV SWYD
0-45E1506	MAIN SINGLE LINE GEN 3 & 500KV SWYD
1-45E1541	GEN 1 AND TRANSFORMER CIRCUITS AC SCHEMATIC

BREAKER SYMBOL FOR U1, U2 & U3 OPERATION:

OPL - DELETED

OPL1 - WHEN 4KV UNIT BOARD 1A IS FEEDING 4KV SHUTDOWN BUS 1: DURING 2 CONDENSATE BOOSTER PUMP OPERATION, (I.E., PUMP 1B OR 1C OUT OF SERVICE) LIMIT THE LOAD ON 4KV UNIT BOARD 1A TO 1375 AMPS TO ENSURE ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. OPERATING ECCS LOADS (RHR, CORE SPRAY, RHRSW [EXCLUDES EECW]) POWERED FROM 4KV UNIT SHUTDOWN BUS 1 MAY BE SUBTRACTED FROM THE TOTAL LOAD TO COMPLY WITH THE 1375 AMP LOAD LIMIT, PROVIDED THE TOTAL LOAD ON THE 4KV UNIT BOARD IS LESS THAN 2000 AMPS. THIS PERMITS SURVEILLANCES ON THE ECCS EQUIPMENT TO BE PERFORMED DURING NORMAL OPERATION WHILE STILL ENSURING ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. (REF: EDQ005720040026)

OPL2 - WHEN 4KV UNIT BOARD 1B IS FEEDING 4KV SHUTDOWN BUS 2: DURING 2 CONDENSATE BOOSTER PUMP OPERATION (I.E., PUMP 1A OR 1C OUT OF SERVICE) LIMIT THE LOAD ON 4KV UNIT BOARD 1B TO 1260 AMPS TO ENSURE ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. OPERATING ECCS LOADS (RHR, CORE SPRAY, RHRSW [EXCLUDES EECW]) POWERED FROM 4KV SHUTDOWN BUS 2 MAY BE SUBTRACTED FROM THE TOTAL LOAD TO COMPLY WITH THE 1260 AMP LOAD LIMIT, PROVIDED THE TOTAL LOAD ON THE 4KV UNIT BOARD IS LESS THAN 2000 AMPS. THIS PERMITS SURVEILLANCES ON THE ECCS EQUIPMENT TO BE PERFORMED DURING NORMAL OPERATION WHILE STILL ENSURING ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. (REF: EDQ005720040026)

OPL3 - PER THE ANALYSIS, DURING NORMAL 3 PUMP OPERATIONS THE BOARD MAY BE OVERLOADED BY APPROXIMATELY 40 AMPS IN CASE OF AN ACCIDENT IN UNIT 2 WHEN FEEDING SHUTDOWN BUS 2. IN THIS SCENARIO REDUCE LOAD, AS NECESSARY, WITHIN 30 MINUTES, TO BRING THE BOARD LOADING WITHIN ITS RATING OF 2000 AMPS.

OPL4 - PRIOR TO TRANSFERRING 4KV UNIT BOARD 1A, 1B OR 1C TO THEIR ALTERNATE POWER SUPPLY (START BUS), BLOCK AUTO TRANSFER OF 4KV UNIT BOARDS 1A & 1B (IF NOT ALREADY TRANSFERRED), 2A, 2B, 3A, AND 3B TO THE START BUSES (161KV SYSTEM). IN ADDITION, PRIOR TO PLACING UNIT BOARD 1A AND/OR 1B ON THEIR ALTERNATE SUPPLY (START BUS), SHUTDOWN BUS 1 AND/OR 2 MUST BE TRANSFERRED TO THEIR ALTERNATE 4KV UNIT BOARD SUPPLIED BY THE 500 KV SOURCE AND THEIR AUTO TRANSFER MUST BE DISABLED.

OPL5 - WHEN 4KV UNIT BOARD 2A IS NOT AVAILABLE AS PART OF THE 500KV OFFSITE CIRCUIT TO 4KV SHUTDOWN BUS 2 (4KV SHUTDOWN BUS 2 IS ALIGNED TO 4KV UNIT BOARD 1B), BLOCK AUTO TRANSFER OF 4KV UNIT BOARD 1B BY PLACING ITS 43 SWITCH IN MANUAL.

OPL6 - WHEN 4KV UNIT BOARD 2B IS NOT AVAILABLE AS PART OF THE 500KV OFFSITE CIRCUIT TO 4KV SHUTDOWN BUS 1, OR 4KV SHUTDOWN BUS 1 AUTOMATIC TRANSFER LOGIC IS INOPERABLE, BLOCK AUTO TRANSFER OF 4KV UNIT BOARD 1A BY PLACING ITS 43 SWITCH IN MANUAL.

OPL7 - DELETED

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
034	71405 REVISED PER DCA 71405-013-000	K KING	J. McFarland	B Campbell	4-2-15

SCALE: NONE EXCEPT AS NOTED

POWERHOUSE UNIT 1 — SYSTEM NO. 57-5 (202),24

WIRING DIAGRAM 4160V UNIT BDS 1A, 1B, 1C SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DRAWN TOG	CHECKED ERS/GWN	1 N/A	2 N/A	C. McCORD
DESIGNED DWA	REVIEWED J. G. SAVERY	3 N/A	4 N/A	

KNOXVILLE | DATE 1-16-68 | 67 | E | 1-45E721 | R034

COMPANION DRAWINGS: 2-45E721 3-45E721

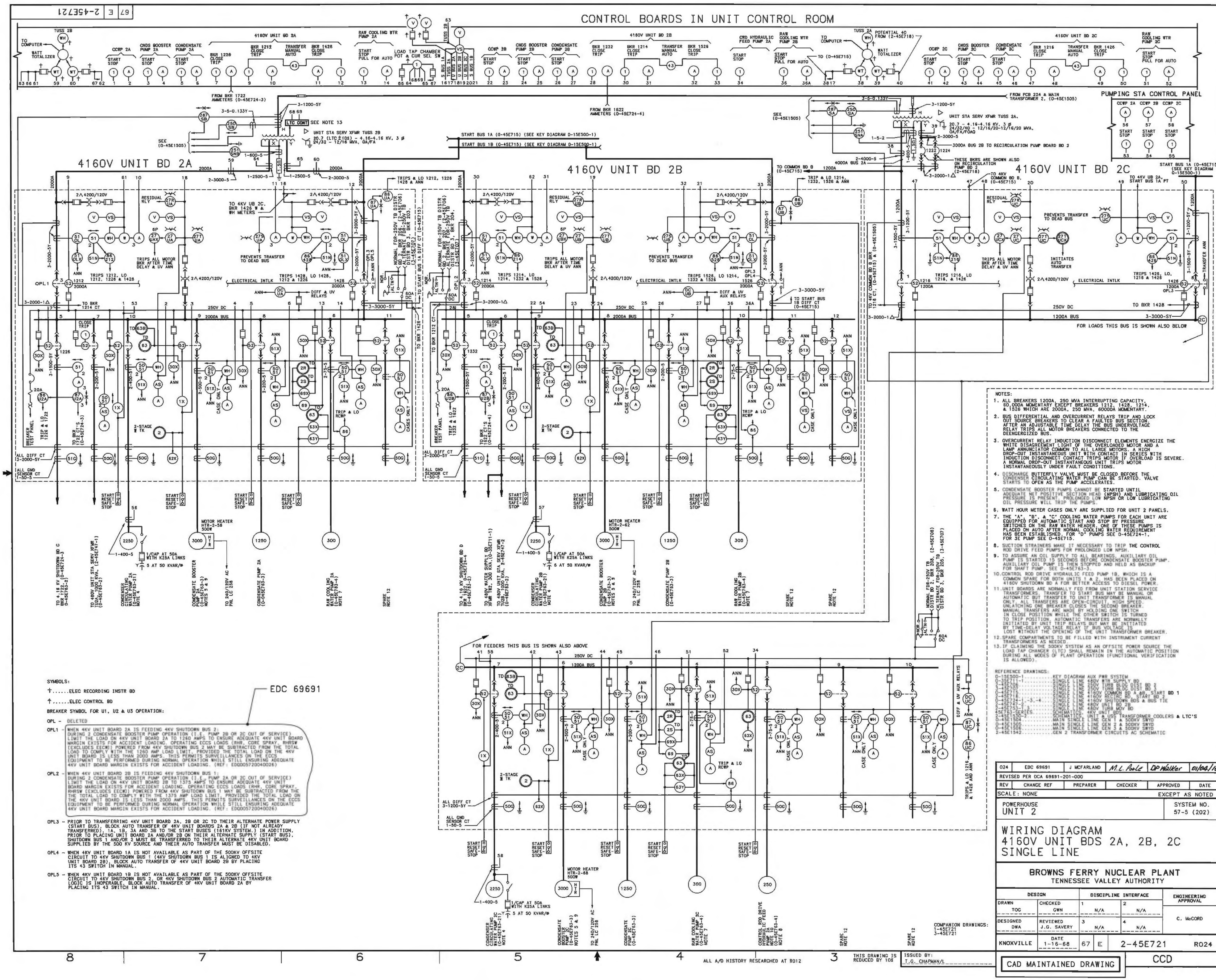
ISSUED BY:

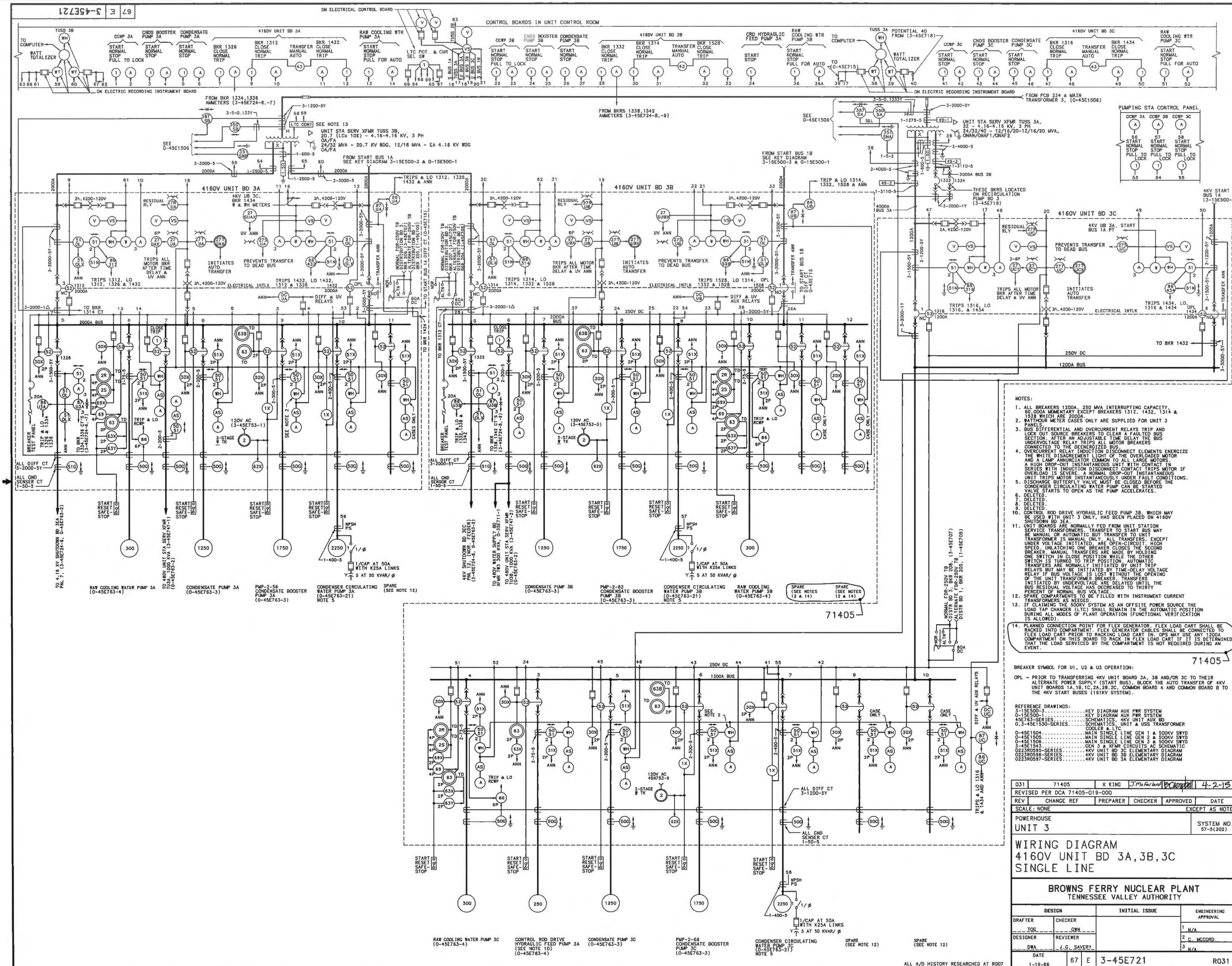
CAD MAINTAINED DRAWING — CCD

THIS DRAWING IS REDUCED BY 10%

ALL A/D HISTORY RESEARCHED AT R009

67 E 1-45E721


CONTROL BOARDS IN UNIT CONTROL ROOM
PUMPING STA CONTROL PANEL
4160V UNIT BD 2A
4160V UNIT BD 2B
4160V UNIT BD 2C
NOTES:
1. ALL BREAKERS 1200A, 250 MVA INTERRUPTING CAPACITY, 60,000A MOMENTARY EXCEPT BREAKERS 1212, 1428, 1214, & 1526 WHICH ARE 2000A, 250 MVA, 60000A MOMENTARY.
2. BUS DIFFERENTIAL AND OVERCURRENT RELAYS TRIP AND LOCK OUT SOURCE BREAKERS TO CLEAR A FAULTED BUS SECTION. AFTER AN ADJUSTABLE TIME DELAY THE BUS UNDERVOLTAGE RELAY TRIPS ALL MOTOR BREAKERS CONNECTED TO THE DEENERGIZED BUS.
3. OVERCURRENT RELAY INDUCTION DISCONNECT ELEMENTS ENERGIZE THE WHITE DISAGREEMENT LIGHT OF THE OVERLOADED MOTOR AND A LAMP ANNUNCIATOR COMMON TO ALL LARGE MOTORS. A HIGH DROP-OUT INSTANTANEOUS UNIT WITH CONTACT IN SERIES WITH INDUCTION DISCONNECT CONTACT TRIPS MOTOR IF OVERLOAD IS SEVERE. A NORMAL DROP-OUT INSTANTANEOUS UNIT TRIPS MOTOR INSTANTANEOUSLY UNDER FAULT CONDITIONS.
4. DISCHARGE BUTTERFLY VALVE MUST BE CLOSED BEFORE THE CONDENSER CIRCULATING WATER PUMP CAN BE STARTED. VALVE STARTS TO OPEN AS THE PUMP ACCELERATES.
5. CONDENSATE BOOSTER PUMPS CANNOT BE STARTED UNTIL ADEQUATE NET POSITIVE SECTION HEAD (NPSH) AND LUBRICATING OIL PRESSURE IS PRESENT. PROLONGED LOW NPSH OR LOW LUBRICATING OIL PRESSURE WILL TRIP THE PUMPS.
6. WATT HOUR METER CASES ONLY ARE SUPPLIED FOR UNIT 2 PANELS.
7. THE "A", "B", & "C" COOLING WATER PUMPS FOR EACH UNIT ARE EQUIPPED FOR AUTOMATIC START AND STOP BY PRESSURE SWITCHES ON THE RAW WATER HEADER. ONE OF THESE PUMPS IS PLACED ON AUTO AFTER NORMAL COOLING WATER REQUIREMENT HAS BEEN ESTABLISHED. FOR "D" PUMPS SEE 0-45E724-1. FOR 3E PUMP SEE 0-45E715.
8. SUCTION STRAINERS MAKE IT NECESSARY TO TRIP THE CONTROL ROD DRIVE FEED PUMPS FOR PROLONGED LOW NPSH.
9. TO ASSURE AN OIL SUPPLY TO ALL BEARINGS, AUXILIARY OIL PUMP IS STARTED 15 SECONDS BEFORE CONDENSATE BOOSTER PUMP. AUXILIARY OIL PUMP IS THEN STOPPED AND HELD AS BACKUP FOR SHAFT PUMP. SEE 0-45E763-3.
10. CONTROL ROD DRIVE HYDRAULIC FEED PUMP 1B, WHICH IS A COMMON SPARE FOR BOTH UNITS 1 & 2, HAS BEEN PLACED ON 4160V SHUTDOWN BD A FOR BETTER ACCESS TO DIESEL POWER.
11. UNIT BOARDS ARE NORMALLY FED FROM UNIT STATION SERVICE TRANSFORMERS. TRANSFER TO START BUS MAY BE MANUAL OR AUTOMATIC BUT TRANSFER TO UNIT TRANSFORMER IS MANUAL ONLY. ALL TRANSFERS ARE OPEN-CIRCUIT, HIGH SPEED. UNLATCHING ONE BREAKER CLOSES THE SECOND BREAKER. MANUAL TRANSFERS ARE MADE BY HOLDING ONE SWITCH IN CLOSE POSITION WHILE THE OTHER SWITCH IS TURNED TO TRIP POSITION. AUTOMATIC TRANSFERS ARE NORMALLY INITIATED BY UNIT TRIP RELAYS BUT MAY BE INITIATED BY TIME-DELAY VOLTAGE RELAY IF BUS VOLTAGE IS LOST WITHOUT THE OPENING OF THE UNIT TRANSFORMER BREAKER.
12. SPARE COMPARTMENTS TO BE FILLED WITH INSTRUMENT CURRENT TRANSFORMERS AS NEEDED.
13. IF CLAIMING THE 500KV SYSTEM AS AN OFFSITE POWER SOURCE THE LOAD TAP CHANGER (LTC) SHALL REMAIN IN THE AUTOMATIC POSITION DURING ALL MODES OF PLANT OPERATION (FUNCTIONAL VERIFICATION IS ALLOWED).
REFERENCE DRAWINGS:
0-15E500-1..........KEY DIAGRAM AUX PWR SYSTEM
0-35E711-1..........SINGLE LINE 480V WTR SUPPLY BD
2-45E706..........SINGLE LINE 250V TURB BLDG DIST BD 2
3-45E707..........SINGLE LINE 250V TURB BLDG DIST BD 3
0-45E715..........SINGLE LINE 4160V COMMON BD A &B, START BD 1
2-45E718..........SINGLE LINE 4160V RECIRC BD, START BD 2
0-45E724-1,-3,-4..........SINGLE LINE 4160V SHUTDOWN BDS & BUS TIE
2-45E747-2..........SINGLE LINE 480V UNIT BD 2B
2-45E753-1,3..........SINGLE LINE 480V TURB MOV BD
45E763-SERIES..........SCHEMATICS, 4KV UNIT BDS
2-45E1530-2..........SCHEMATICS, UNIT & USS TRANSFORMER COOLERS & LTC'S
0-45E1504..........MAIN SINGLE LINE GEN 1 & 500KV SWYD
0-45E1505..........MAIN SINGLE LINE GEN 2 & 500KV SWYD
0-45E1506..........MAIN SINGLE LINE GEN 3 & 500KV SWYD
2-45E1542..........GEN 2 TRANSFORMER CIRCUITS AC SCHEMATIC
SYMBOLS:
†......ELEC RECORDING INSTR BD
†......ELEC CONTROL BD
BREAKER SYMBOL FOR U1, U2 & U3 OPERATION:
OPL - DELETED
EDC 69691
OPL1 - WHEN 4KV UNIT BOARD 2A IS FEEDING 4KV SHUTDOWN BUS 2: DURING 2 CONDENSATE BOOSTER PUMP OPERATION (I.E. PUMP 2B OR 2C OUT OF SERVICE) LIMIT THE LOAD ON 4KV UNIT BOARD 2A TO 1260 AMPS TO ENSURE ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. OPERATING ECCS LOADS (RHR, CORE SPRAY, RHRSW [EXCLUDES EECW]) POWERED FROM 4KV SHUTDOWN BUS 2 MAY BE SUBTRACTED FROM THE TOTAL LOAD TO COMPLY WITH THE 1260 AMP LOAD LIMIT, PROVIDED THE TOTAL LOAD ON THE 4KV UNIT BOARD IS LESS THAN 2000 AMPS. THIS PERMITS SURVEILLANCES ON THE ECCS EQUIPMENT TO BE PERFORMED DURING NORMAL OPERATION WHILE STILL ENSURING ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. (REF: EDQ005720040026)
OPL2 - WHEN 4KV UNIT BOARD 2B IS FEEDING 4KV SHUTDOWN BUS 1: DURING 2 CONDENSATE BOOSTER PUMP OPERATION (I.E. PUMP 2A OR 2C OUT OF SERVICE) LIMIT THE LOAD ON 4KV UNIT BOARD 2B TO 1375 AMPS TO ENSURE ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. OPERATING ECCS LOADS (RHR, CORE SPRAY, RHRSW [EXCLUDES EECW]) POWERED FROM 4KV SHUTDOWN BUS 1 MAY BE SUBTRACTED FROM THE THE TOTAL LOAD TO COMPLY WITH THE 1375 AMP LOAD LIMIT, PROVIDED THE TOTAL LOAD ON THE 4KV UNIT BOARD IS LESS THAN 2000 AMPS. THIS PERMITS SURVEILLANCES ON THE ECCS EQUIPMENT TO BE PERFORMED DURING NORMAL OPERATION WHILE STILL ENSURING ADEQUATE 4KV UNIT BOARD MARGIN EXISTS FOR ACCIDENT LOADING. (REF: EDQ005720040026)
OPL3 - PRIOR TO TRANSFERRING 4KV UNIT BOARD 2A, 2B OR 2C TO THEIR ALTERNATE POWER SUPPLY (START BUS), BLOCK AUTO TRANSFER OF 4KV UNIT BOARDS 2A & 2B (IF NOT ALREADY TRANSFERRED), 1A, 1B, 3A AND 3B TO THE START BUSES (161KV SYSTEM.) IN ADDITION, PRIOR TO PLACING UNIT BOARD 2A AND/OR 2B ON THEIR ALTERNATE SUPPLY (START BUS), SHUTDOWN BUS 1 AND/OR 2 MUST BE TRANSFERRED TO THEIR ALTERNATE 4KV UNIT BOARD SUPPLIED BY THE 500 KV SOURCE AND THEIR AUTO TRANSFER MUST BE DISABLED.
OPL4 - WHEN 4KV UNIT BOARD 1A IS NOT AVAILABLE AS PART OF THE 500KV OFFSITE CIRCUIT TO 4KV SHUTDOWN BUS 1 (4KV SHUTDOWN BUS 1 IS ALIGNED TO 4KV UNIT BOARD 2B), BLOCK AUTO TRANSFER OF 4KV UNIT BOARD 2B BY PLACING ITS 43 SWITCH IN MANUAL.
OPL5 - WHEN 4KV UNIT BOARD 1B IS NOT AVAILABLE AS PART OF THE 500KV OFFSITE CIRCUIT TO 4KV SHUTDOWN BUS 2, OR 4KV SHUTDOWN BUS 2 AUTOMATIC TRANSFER LOGIC IS INOPERABLE, BLOCK AUTO TRANSFER OF 4KV UNIT BOARD 2A BY PLACING ITS 43 SWITCH IN MANUAL.
024 | EDC 69691 | J MCFARLAND | M.L. Poole | DP Walker | 01/04/10
REVISED PER DCA 69691-201-000
REV | CHANGE REF | PREPARER | CHECKER | APPROVED | DATE
SCALE: NONE
EXCEPT AS NOTED
POWERHOUSE UNIT 2
SYSTEM NO. 57-5 (202)
WIRING DIAGRAM
4160V UNIT BDS 2A, 2B, 2C
SINGLE LINE
BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY
DESIGN | DISCIPLINE INTERFACE | ENGINEERING APPROVAL
DRAWN TOC | CHECKED GWN | 1 N/A | 2 N/A
DESIGNED DWA | REVIEWED J.G. SAVERY | 3 N/A | 4 N/A | C. McCORD
KNOXVILLE | DATE 1-16-68 | 67 | E | 2-45E721 | R024
COMPANION DRAWINGS: 1-45E721 3-45E721
THIS DRAWING IS REDUCED BY 10%
ISSUED BY: T.G. CHAPMAN/S
CCD
CAD MAINTAINED DRAWING
ALL A/D HISTORY RESEARCHED AT R012
67 | E | 2-45E721



NOTES:

1. ALL BREAKERS 1200A, 250 MVA INTERRUPTING CAPACITY, 60,000A MOMENTARY EXCEPT BREAKERS 1312, 1432, 1314 & 1528 WHICH ARE 2000A.
2. WATTHOUR METER CASES ONLY ARE SUPPLIED FOR UNIT 3 PANELS.
3. BUS DIFFERENTIAL AND OVERCURRENT RELAYS TRIP AND LOCK OUT SOURCE BREAKERS TO CLEAR A FAULTED BUS SECTION. AFTER AN ADJUSTABLE TIME DELAY THE BUS UNDERVOLTAGE RELAY TRIPS ALL MOTOR BREAKERS CONNECTED TO THE DEENERGIZED BUS.
4. OVERCURRENT RELAY INDUCTION DISCONNECT ELEMENTS ENERGIZE THE WHITE DISAGREEMENT LIGHT OF THE OVERLOADED MOTOR AND A LAMP ANNUNCIATOR COMMON TO ALL LARGE MOTORS. A HIGH DROP-OUT INSTANTANEOUS UNIT WITH CONTACT IN SERIES WITH INDUCTION DISCONNECT CONTACT TRIPS MOTOR IF OVERLOAD IS SEVERE. A NORMAL DROP-OUT INSTANTANEOUS UNIT TRIPS MOTOR INSTANTANEOUSLY UNDER FAULT CONDITIONS.
5. DISCHARGE BUTTERFLY VALVE MUST BE CLOSED BEFORE THE CONDENSER CIRCULATING WATER PUMP CAN BE STARTED VALVE STARTS TO OPEN AS THE PUMP ACCELERATES.
6. DELETED.
7. DELETED.
8. DELETED.
9. DELETED.
10. CONTROL ROD DRIVE HYDRAULIC FEED PUMP 3B, WHICH MAY BE USED WITH UNIT 3 ONLY, HAS BEEN PLACED ON 4160V SHUTDOWN BD 3EA.
11. UNIT BOARDS ARE NORMALLY FED FROM UNIT STATION SERVICE TRANSFORMERS. TRANSFER TO START BUS MAY BE MANUAL OR AUTOMATIC BUT TRANSFER TO UNIT TRANSFORMER IS MANUAL ONLY. ALL TRANSFERS, EXCEPT UNDER VOLTAGE INITIATED, ARE OPEN-CIRCUIT, HIGH SPEED. UNLATCHING ONE BREAKER CLOSES THE SECOND BREAKER. MANUAL TRANSFERS ARE MADE BY HOLDING ONE SWITCH IN CLOSE POSITION WHILE THE OTHER SWITCH IS TURNED TO TRIP POSITION. AUTOMATIC TRANSFERS ARE NORMALLY INITIATED BY UNIT TRIP RELAYS BUT MAY BE INITIATED BY TIME-DELAY VOLTAGE RELAY IF BUS VOLTAGE IS LOST WITHOUT THE OPENING OF THE UNIT TRANSFORMER BREAKER. TRANSFERS INITIATED BY UNDERVOLTAGE ARE DELAYED UNTIL THE BUS RESIDUAL VOLTAGE HAS DECREASED TO THIRTY PERCENT OF NORMAL BUS VOLTAGE.
12. SPARE COMPARTMENTS TO BE FILLED WITH INSTRUMENT CURRENT TRANSFORMERS AS NEEDED.
13. IF CLAIMING THE 500KV SYSTEM AS AN OFFSITE POWER SOURCE THE LOAD TAP CHANGER (LTC) SHALL REMAIN IN THE AUTOMATIC POSITION DURING ALL MODES OF PLANT OPERATION (FUNCTIONAL VERIFICATION IS ALLOWED).
14. PLANNED CONNECTION POINT FOR FLEX GENERATOR. FLEX LOAD CART SHALL BE RACKED INTO COMPARTMENT. FLEX GENERATOR CABLES SHALL BE CONNECTED TO FLEX LOAD CART PRIOR TO RACKING LOAD CART IN. OPS MAY USE ANY 1200A COMPARTMENT ON THIS BOARD TO RACK IN FLEX LOAD CART IF IT IS DETERMINED THAT THE LOAD SERVICED BY THE COMPARTMENT IS NOT REQUIRED DURING AN EVENT.

71405

BREAKER SYMBOL FOR U1, U2 & U3 OPERATION:

OPL - PRIOR TO TRANSFERRING 4KV UNIT BOARD 3A, 3B AND/OR 3C TO THEIR ALTERNATE POWER SUPPLY (START BUS), BLOCK THE AUTO TRANSFER OF 4KV UNIT BOARDS 1A,1B,1C,2A,2B,2C, COMMON BOARD A AND COMMON BOARD B TO THE 4KV START BUSES (161KV SYSTEM).

REFERENCE DRAWINGS:
3-15E500-3..............KEY DIAGRAM AUX PWR SYSTEM
0-15E500-1..............KEY DIAGRAM AUX PWR SYSTEM
45E763-SERIES...........SCHEMATICS, 4KV UNIT AUX BD
0,3-45E1530-SERIES......SCHEMATICS, UNIT & USS TRANSFORMER COOLER & LTC
0-45E1504...............MAIN SINGLE LINE GEN 1 & 500KV SWYD
0-45E1505...............MAIN SINGLE LINE GEN 2 & 500KV SWYD
0-45E1506...............MAIN SINGLE LINE GEN 3 & 500KV SWYD
3-45E1543...............GEN 3 & XFMR CIRCUITS AC SCHEMATIC
0223R0595-SERIES........4KV UNIT BD 3C ELEMENTARY DIAGRAM
0223R0596-SERIES........4KV UNIT BD 3B ELEMENTARY DIAGRAM
0223R0597-SERIES........4KV UNIT BD 3A ELEMENTARY DIAGRAM

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
031	71405	K KING	J. McFarland	B Campbell	4-2-15
	REVISED PER DCA 71405-019-000				

SCALE: NONE — EXCEPT AS NOTED

POWERHOUSE
UNIT 3

SYSTEM NO. 57-5(202)

WIRING DIAGRAM
4160V UNIT BD 3A,3B,3C
SINGLE LINE

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		INITIAL ISSUE	ENGINEERING APPROVAL
DRAFTER TCC	CHECKER CWN		1 N/A
DESIGNER DWA	REVIEWER J.G. SAVERY		2 C. MCCORD
DATE 1-18-68	67 E 3-45E721		3 N/A R031

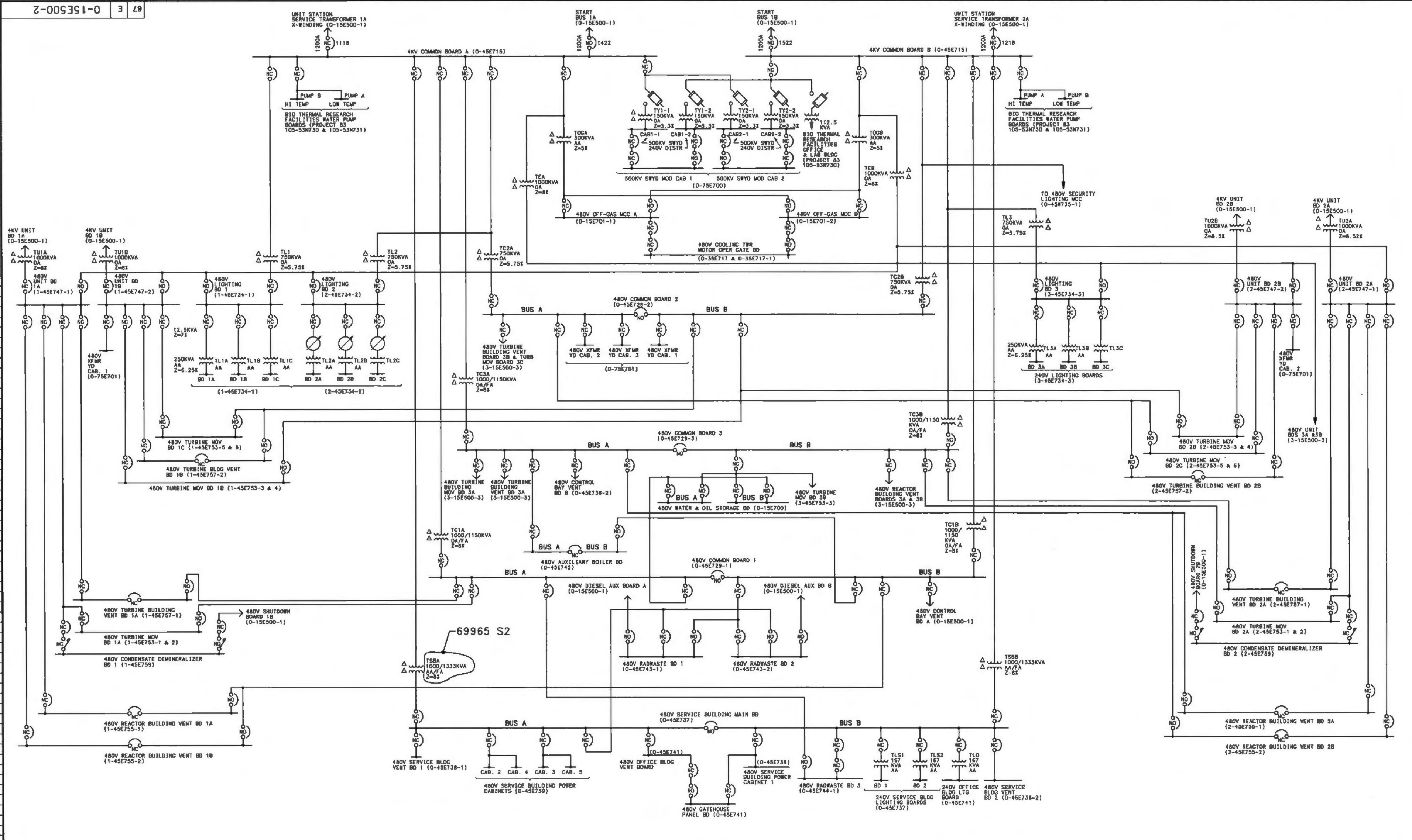
ALL A/D HISTORY RESEARCHED AT R007

ISSUED BY: T.G. CHAPMAN/L

CAD MAINTAINED DRAWING

CCD

67 E 3-45E721



027	69965 S2	B CAMPBELL	M.L. Poole	DP Walker	8/25/11
REVISED PER DCA 69965-220-000					
REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE

SCALE: NONE — EXCEPT AS NOTED

GENERAL
UNITS 1 & 2 — SYSTEM NO. 57-4/57-5

KEY DIAGRAM OF NORMAL AUXILIARY POWER SYSTEM

BROWNS FERRY NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		INITIAL ISSUE	ENGINEERING APPROVAL
DRAFTER RWS/CWT	CHECKER GWN		N/A
DESIGNER JHM	REVIEWER J.G. SAVERY		N/A
			N/A

THIS DRAWING APPEARS IN THE FSAR — ISSUED BY: J. R. PARRISH

DATE 1-24-1991 | 67 | E | 0-15E500-2 | R027

CAD MAINTAINED DRAWING — CCD

ALL A/D HISTORY RESEARCHED AT ROOT