UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 27, 2019

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 4A
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3; SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2; WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 309, 332, 292, 345, 339, 128, AND 31 REGARDING UNBALANCED VOLTAGE PROTECTION (EPID L-2017-LLA-0391)

Dear Mr. Shea:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed amendments:

1. Amendment Nos. 309, 332, and 292 to Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68 for the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (Browns Ferry), respectively

2. Amendment Nos. 345 and 339 to Renewed Facility Operating License Nos. DPR-77 and DPR-79 for Sequoyah Nuclear Plant, Units 1 and 2 (Sequoyah), respectively

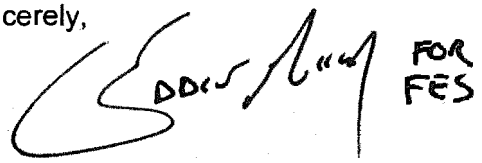
3. Amendment Nos. 128 and 31 to Facility Operating License Nos. NPF-90 and NPF-96 for the Watts Bar Nuclear Plant, Units 1 and 2 (Watts Bar), respectively

These amendments are in response to Tennessee Valley Authority's request dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019. The amendments add a new level of protection regarding "unbalanced voltage" to the Browns Ferry, Sequoyah, and Watts Bar Technical Specifications (TSs) for the loss of power instrumentation.

Implementation of these amendments provides for equipment protection from the effects of an unbalanced voltage in a similar fashion to the existing degraded and loss of voltage protection schemes. Specifically, the amendments add a new condition to TS 3.3.8.1 and revise TS Table 3.3.8.1-1 for Browns Ferry, and add a new condition to TS 3.3.5 and revise TS Table 3.3.5-1 for Sequoyah and Watts Bar to reflect the implementation of the Class 1E "unbalanced voltage" relays.

A copy of the related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,



Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, 50-296,
50-327, 50-328,
50-390, and 50-391

Enclosures:
1. Amendment No. 309 to DPR-33 (Browns Ferry, Unit 1)
2. Amendment No. 332 to DPR-52 (Browns Ferry, Unit 2)
3. Amendment No. 292 to DPR-68 (Browns Ferry, Unit 3)
4. Amendment No. 345 to DPR-77 (Sequoyah, Unit 1)
5. Amendment No. 339 to DPR-79 (Sequoyah, Unit 2)
6. Amendment No. 128 to NPF-90 (Watts Bar, Unit 1)
7. Amendment No. 31 to NPF-96 (Watts Bar, Unit 2)
8. Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-259

BROWNS FERRY NUCLEAR PLANT, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 309
Renewed License No. DPR-33

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-33 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 309, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 309

BROWNS FERRY NUCLEAR PLANT, UNIT 1

RENEWED FACILITY OPERATING LICENSE NO. DPR-33

DOCKET NO. 50-259

Replace the following page of Renewed Facility Operating License No. DPR-33 with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

REMOVE	INSERT
3	3

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3.3-72	3.3-72
3.3-74	3.3-74

(3) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use at any time any byproduct, source, and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3952 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 309, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 234 to Facility Operating License DPR-33, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 234. For SRs that existed prior to Amendment 234, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 234.

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. Two or more degraded voltage relay channels or one or more associated timers inoperable on one shutdown board. AND The loss of voltage relay channel(s) inoperable on the same shutdown board.	D.1	Verify by administrative means that the other shutdown boards and undervoltage relay channels and associated timers are OPERABLE.	Immediately
	AND		
	D.2	Place the inoperable channels in trip.	5 days
E. One or more unbalanced voltage relays inoperable on one shutdown board.	E.1	Verify by administrative means that the other shutdown boards and unbalanced voltage relays are OPERABLE.	Immediately
	AND		
	E.2	Place the inoperable channels in trip.	5 days
F. Required Action and associated Completion Time not met.	F.1	Declare associated diesel generator (DG) inoperable.	Immediately

Table 3.3.8.1-1 (page 1 of 1)
Loss of Power Instrumentation

FUNCTION	REQUIRED CHANNELS PER BOARD	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. 4.16 kV Shutdown Board Undervoltage (Loss of Voltage)			
a. Board Undervoltage	2	SR 3.3.8.1.2 SR 3.3.8.1.3	Reset at ≥ 2813 V and ≤ 2927 V
b. Diesel Start Initiation Time Delay	2	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 1.4 seconds and ≤ 1.6 seconds
2. 4.16 kV Shutdown Board Undervoltage (Degraded Voltage)			
a. Board Undervoltage	3	SR 3.3.8.1.1 SR 3.3.8.1.3	≥ 3900 V and ≤ 3940 V
b.1 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.2 seconds and ≤ 0.4 seconds
b.2 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 3 seconds and ≤ 5 seconds
b.3 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 5.15 seconds and ≤ 8.65 seconds
b.4 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.9 seconds and ≤ 1.7 seconds
3. 4.16 kV Shutdown Board Undervoltage (Unbalanced Voltage Relay)	3	SR 3.3.8.1.2 SR 3.3.8.1.3	≤ 1.5V at 3 seconds (Permissive Alarm) ≤ 3.4V at 8.65 seconds (Lo) ≤ 20V at 3.5 seconds (High)

UNITED STATES
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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-260

BROWNS FERRY NUCLEAR PLANT, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 332
Renewed License No. DPR-52

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-52 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 332, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days of the issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 332

BROWNS FERRY NUCLEAR PLANT, UNIT 2

RENEWED FACILITY OPERATING LICENSE NO. DPR-52

DOCKET NO. 50-260

Replace the following page of Renewed Facility Operating License No. DPR-52 with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

REMOVE	INSERT
3	3

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3.3-73	3.3-73
3.3-75	3.3-75

sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3952 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 332, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 253 to Facility Operating License DPR-52, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 253. For SRs that existed prior to Amendment 253, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 253.

3) The licensee is authorized to relocate certain requirements included in Appendix A and the former Appendix B to licensee-controlled documents. Implementation of this amendment shall include the relocation of these requirements to the appropriate documents, as described in the licensee's

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. Two or more degraded voltage relay channels or one or more associated timers inoperable on one shutdown board. AND The loss of voltage relay channel(s) inoperable on the same shutdown board.	D.1	Verify by administrative means that the other shutdown boards and undervoltage relay channels and associated timers are OPERABLE. AND	Immediately
	D.2	Place the inoperable channels in trip.	5 days
E. One or more unbalanced voltage relays inoperable on one shutdown board.	E.1	Verify by administrative means that the other shutdown boards and unbalanced voltage relays are OPERABLE. AND	Immediately
	E.2	Place the inoperable channels in trip.	5 days
F. Required Action and associated Completion Time not met.	F.1	Declare associated diesel generator (DG) inoperable.	Immediately

Table 3.3.8.1-1 (page 1 of 1)
Loss of Power Instrumentation

FUNCTION	REQUIRED CHANNELS PER BOARD	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. 4.16 kV Shutdown Board Undervoltage (Loss of Voltage)			
a. Board Undervoltage	2	SR 3.3.8.1.2 SR 3.3.8.1.3	Reset at ≥ 2813 V and ≤ 2927 V
b. Diesel Start Initiation Time Delay	2	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 1.4 seconds and ≤ 1.6 seconds
2. 4.16 kV Shutdown Board Undervoltage (Degraded Voltage)			
a. Board Undervoltage	3	SR 3.3.8.1.1 SR 3.3.8.1.3	≥ 3900 V and ≤ 3940 V
b.1 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.2 seconds and ≤ 0.4 seconds
b.2 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 3 seconds and ≤ 5 seconds
b.3 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 5.15 seconds and ≤ 8.65 seconds
b.4 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.9 seconds and ≤ 1.7 seconds
3. 4.16 kV Shutdown Board Undervoltage (Unbalanced Voltage Relay)	3	SR 3.3.8.1.2 SR 3.3.8.1.3	≤ 1.5V at 3 seconds (Permissive Alarm) ≤ 3.4V at 8.65 seconds (Lo) ≤ 20V at 3.5 seconds (High)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-296

BROWNS FERRY NUCLEAR PLANT, UNIT 3

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 292
Renewed License No. DPR-68

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letters dated November 19, 2018 and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-68 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 292, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days of the issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 292

BROWNS FERRY NUCLEAR PLANT, UNIT 3

RENEWED FACILITY OPERATING LICENSE NO. DPR-68

DOCKET NO. 50-296

Replace the following page of Renewed Facility Operating License No. DPR-68 with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

REMOVE	INSERT
3	3

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3.3-73	3.3-73
3.3-75	3.3-75

(3) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use at any time any byproduct, source, and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40, and 70, to receive, possess, and use in amounts as required any byproduct, source, or special nuclear material without restriction to chemical or physical form for sample analysis or equipment and instrument calibration or associated with radioactive apparatus or components;

(5) Pursuant to the Act and 10 CFR Parts 30 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This renewed operating license shall be deemed to contain and is subject to the conditions specified in the following Commission regulations in 10 CFR Chapter I: Part 20, Section 30.34 of Part 30, Section 40.41 of Part 40, Sections 50.54 and 50.59 of Part 50, and Section 70.32 of Part 70; is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 3952 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 292, are hereby incorporated in the renewed operating license. The licensee shall operate the facility in accordance with the Technical Specifications.

For Surveillance Requirements (SRs) that are new in Amendment 212 to Facility Operating License DPR-68, the first performance is due at the end of the first surveillance interval that begins at implementation of the Amendment 212. For SRs that existed prior to Amendment 212, including SRs with modified acceptance criteria and SRs whose frequency of performance is being extended, the first performance is due at the end of the first surveillance interval that begins on the date the surveillance was last performed prior to implementation of Amendment 212.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Two or more degraded voltage relay channels or one or more associated timers inoperable on one shutdown board. AND The loss of voltage relay channel(s) inoperable on the same shutdown board.	D.1 Verify by administrative means that the other shutdown boards and undervoltage relay channels and associated timers are OPERABLE. AND D.2 Place the inoperable channels in trip.	Immediately 5 days
E. One or more unbalanced voltage relays inoperable on one shutdown board.	E.1 Verify by administrative means that the other shutdown boards and unbalanced voltage relays are OPERABLE. AND E.2 Place the inoperable channels in trip.	Immediately 5 days
F. Required Action and associated Completion Time not met.	F.1 Declare associated diesel generator (DG) inoperable.	Immediately

Table 3.3.8.1-1 (page 1 of 1)
Loss of Power Instrumentation

FUNCTION	REQUIRED CHANNELS PER BOARD	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. 4.16 kV Shutdown Board Undervoltage (Loss of Voltage)			
a. Board Undervoltage	2	SR 3.3.8.1.2 SR 3.3.8.1.3	Reset at ≥ 2813 V and ≤ 2927 V
b. Diesel Start Initiation Time Delay	2	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 1.4 seconds and ≤ 1.6 seconds
2. 4.16 kV Shutdown Board Undervoltage (Degraded Voltage)			
a. Board Undervoltage	3	SR 3.3.8.1.1 SR 3.3.8.1.3	≥ 3900 V and ≤ 3940 V
b.1 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.2 seconds and ≤ 0.4 seconds
b.2 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 3 seconds and ≤ 5 seconds
b.3 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 5.15 seconds and ≤ 8.65 seconds
b.4 Time Delay	1	SR 3.3.8.1.2 SR 3.3.8.1.3	≥ 0.9 seconds and ≤ 1.7 seconds
3. 4.16 kV Shutdown Board Undervoltage (Unbalanced Voltage Relay)	3	SR 3.3.8.1.2 SR 3.3.8.1.3	≤ 1.5V at 3 seconds (Permissive Alarm) ≤ 3.4V at 8.65 seconds (Lo) ≤ 20V at 3.5 seconds (High)

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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-327

SEQUOYAH NUCLEAR PLANT, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 345
Renewed License No. DPR-77

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, as amended; the provisions of the Act; and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-77 is hereby amended to read as follows:

   (2) Technical Specifications

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 345 are hereby incorporated into this renewed license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days of the issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 345

TO RENEWED FACILITY OPERATING LICENSE NO. DPR-77

SEQUOYAH NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-327

Replace page 3 of Renewed Facility Operating License No. DPR-77 with the attached revised page 3. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3.3.5-1	3.3.5-1
3.3.5-2	3.3.5-2
3.3.5-3	3.3.5-3

(3) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the Sequoyah and Watts Bar Unit 1 Nuclear Plants.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The Tennessee Valley Authority is authorized to operate the facility at reactor core power levels not in excess of 3455 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 345 are hereby incorporated into the renewed license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Initial Test Program

The Tennessee Valley Authority shall conduct the post-fuel-loading initial test program (set forth in Section 14 of Tennessee Valley Authority's Final Safety Analysis Report, as amended), without making any major modifications of this program unless modifications have been identified and have received prior NRC approval. Major modifications are defined as:

a. Elimination of any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;

b. Modification of test objectives, methods, or acceptance criteria for any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;

3.3 INSTRUMENTATION

3.3.5 Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

LCO 3.3.5 The LOP DG start instrumentation for each Function in Table 3.3.5-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.5-1.

ACTIONS

---NOTE---

Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Functions with one voltage sensor channel inoperable.	A.1 Restore the inoperable channel to OPERABLE status.	6 hours
B. One or more Functions with two or more voltage sensor channels inoperable. OR One or more Functions with one required timer inoperable.	B.1.1 Restore all but one voltage sensor channel to OPERABLE status. AND B.1.2 Restore required timer to OPERABLE status.	1 hour 1 hour
C. One or more unbalanced voltage relays inoperable.	C.1 Restore unbalanced voltage relays to OPERABLE status.	1 hour

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Required Action and associated Completion Time not met.	D.1 Enter applicable Condition(s) and Required Action(s) for the associated DG made inoperable by LOP DG start instrumentation.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.5-1 to determine which SRs apply for each LOP DG Start Instrumentation Function.

SURVEILLANCE		FREQUENCY
SR 3.3.5.1	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	In accordance with the Surveillance Frequency Control Program
SR 3.3.5.2	Perform CHANNEL CALIBRATION.	In accordance with the Surveillance Frequency Control Program

Table 3.3.5-1 (page 1 of 1)
Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE	NOMINAL TRIP SETPOINT
1. 6.9 kV Shutdown Board – Loss of Voltage					
a. Voltage Sensors	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≥ 5331 V and ≤ 5688 V	5520 V
b. Diesel Generator Start and Load Shed Timer	1,2,3,4, (a)	1 per Shutdown Board	SR 3.3.5.2	≥ 1.00 sec and ≤ 1.50 sec	1.25 sec
2. 6.9 kV Shutdown Board – Degraded Voltage					
a. Voltage Sensors	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≥ 6403.5 V and ≤ 6522.5 V	6456 V
b. Diesel Generator Start and Load Shed Timer	1,2,3,4, (a)	1 per Shutdown Board	SR 3.3.5.2	≥ 218.6 sec and ≤ 370 sec	300 sec
c. SI/Degraded Voltage Logic Enable Timer	1,2,3,4	1 per Shutdown Board	SR 3.3.5.2	≥ 7.5 sec and ≤ 11.5 sec	9.5 sec
3. 6.9 kV Shutdown Board – Unbalanced Voltage Relay	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.3 V at 10 sec (Low) ≤ 20.0 V at 4 sec (High)	1.30 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Low) 18.13 V at 3.95 sec (High)

(a) When the associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources – Shutdown."

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-328

SEQUOYAH NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 339
Renewed License No. DPR-79

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, as amended; the provisions of the Act; and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. DPR-79 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 339 are hereby incorporated into this renewed license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days of the issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Renewed Facility Operating
License and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO LICENSE AMENDMENT NO. 339

TO RENEWED FACILITY OPERATING LICENSE NO. DPR-79

SEQUOYAH NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-328

Replace page 3 of Renewed Facility Operating License No. DPR-79 with the attached revised page 3. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

REMOVE	INSERT
3.3.5-1	3.3.5-1
3.3.5-2	3.3.5-2
3.3.5-3	3.3.5-3

(3) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;

(4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and

(5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the Sequoyah and Watts Bar Unit 1 Nuclear Plants.

C. This renewed license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The Tennessee Valley Authority is authorized to operate the facility at reactor core power levels not in excess of 3455 megawatts thermal.

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 339 are hereby incorporated into the renewed license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Initial Test Program

The Tennessee Valley Authority shall conduct the post-fuel-loading initial test program (set forth in Section 14 of Tennessee Valley Authority's Final Safety Analysis Report, as amended), without making any major modifications of this program unless modifications have been identified and have received prior NRC approval. Major modifications are defined as:

a. Elimination of any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;

3.3 INSTRUMENTATION

3.3.5 Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

LCO 3.3.5 The LOP DG start instrumentation for each Function in Table 3.3.5-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.5-1.

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more Functions with one voltage sensor channel inoperable.	A.1 Restore the inoperable channel to OPERABLE status.	6 hours
B. One or more Functions with two or more voltage sensor channels inoperable. OR One or more Functions with one required timer inoperable.	B.1.1 Restore all but one voltage sensor channel to OPERABLE status. AND B.1.2 Restore required timer to OPERABLE status.	1 hour 1 hour
C. One or more unbalanced voltage relays inoperable.	C.1 Restore unbalanced voltage relays to OPERABLE status.	1 hour

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Required Action and associated Completion Time not met.	D.1 Enter applicable Condition(s) and Required Action(s) for the associated DG made inoperable by LOP DG start instrumentation.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.5-1 to determine which SRs apply for each LOP DG Start Instrumentation Function.

SURVEILLANCE		FREQUENCY
SR 3.3.5.1	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	In accordance with the Surveillance Frequency Control Program
SR 3.3.5.2	Perform CHANNEL CALIBRATION.	In accordance with the Surveillance Frequency Control Program

Table 3.3.5-1 (page 1 of 1)
Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE	NOMINAL TRIP SETPOINT
1. 6.9 kV Shutdown Board – Loss of Voltage					
a. Voltage Sensors	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≥ 5331 V and ≤ 5688 V	5520 V
b. Diesel Generator Start and Load Shed Timer	1,2,3,4, (a)	1 per Shutdown Board	SR 3.3.5.2	≥ 1.00 sec and ≤ 1.50 sec	1.25 sec
2. 6.9 kV Shutdown Board – Degraded Voltage					
a. Voltage Sensors	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≥ 6403.5 V and ≤ 6522.5 V	6456 V
b. Diesel Generator Start and Load Shed Timer	1,2,3,4, (a)	1 per Shutdown Board	SR 3.3.5.2	≥ 218.6 sec and ≤ 370 sec	300 sec
c. SI/Degraded Voltage Logic Enable Timer	1,2,3,4	1 per Shutdown Board	SR 3.3.5.2	≥ 7.5 sec and ≤ 11.5 sec	9.5 sec
3. 6.9 kV Shutdown Board – Unbalanced Voltage Relay	1,2,3,4, (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.3 V at 10 sec (Low) ≤ 20.0 V at 4 sec (High)	1.30 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Low) 18.13 V at 3.95 sec (High)

(a) When the associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources – Shutdown."

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

WATTS BAR NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 128
License No. NPF-90

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (TVA, the licensee) dated November 17, 2017, as supplemented by letter dated June 18, 2018, and as subsequently revised by letter dated November 19, 2018, and supplemented by letter dated January 25, 2019, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

ATTACHMENT TO AMENDMENT NO. 128

WATTS BAR NUCLEAR PLANT, UNIT 1

FACILITY OPERATING LICENSE NO. NPF-90

DOCKET NO. 50-390

Replace the following page of Facility Operating License No. NPF-90 with the attached page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
3	3

Replace the following pages of the Appendix A Technical Specifications with the attached pages. The pages are identified by amendment number and contain vertical lines indicating the areas of change.

Remove Page	Insert Page
3.3-49	3.3-49
3.3-50	3.3-50
3.3-51	3.3-51
3.3-51a	3.3-51a

(4) TVA, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required, any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis, instrument calibration, or other activity associated with radioactive apparatus or components; and

(5) TVA, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified or incorporated below.

(1) Maximum Power Level

TVA is authorized to operate the facility at reactor core power levels not in excess of 3459 megawatts thermal.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A as revised through Amendment No. 128 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Safety Parameter Display System (SPDS) (Section 18.2 of SER Supplements 5 and 15)

Prior to startup following the first refueling outage, TVA shall accomplish the necessary activities, provide acceptable responses, and implement all proposed corrective actions related to having the Watts Bar Unit 1 SPDS operational.

(4) Vehicle Bomb Control Program (Section 13.6.9 of SSER 20)

During the period of the exemption granted in paragraph 2.D.(3) of this license, in implementing the power ascension phase of the approved initial test program, TVA shall not exceed 50% power until the requirements of 10 CFR 73.55(c)(7) and (8) are fully implemented. TVA shall submit a letter under oath or affirmation when the requirements of 73.55(c)(7) and (8) have been fully implemented.

3.3 INSTRUMENTATION

3.3.5 Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

LCO 3.3.5 The LOP DG Start Instrumentation for each Function in Table 3.3.5-1 shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4,
When associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources-Shutdown."

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
----------NOTE---------- Not applicable to Function 5 ---------- A. One or more Functions with one channel per bus inoperable.	----------NOTE---------- Enter applicable Conditions and Required Actions of LCO 3.3.2, "ESFAS Instrumentation," for Auxiliary Feedwater Start Instrumentation made inoperable by LOP DG Start Instrumentation. ---------- A.1 Restore channel to OPERABLE status.	6 hours
----------NOTE---------- Not applicable to Function 5 ---------- B. One or more Functions with two or more channels per bus inoperable.	B.1 Restore all but one channel to OPERABLE status.	1 hour

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
----------NOTE---------- Only applicable to Function 5 ----------		
C. One or more Functions with one channel per bus inoperable.	C.1 Restore channel to OPERABLE status.	1 hour
D. Required Action and associated Completion Time not met.	D.1 Enter applicable Condition(s) and Required Action(s) for the associated DG made inoperable by LOP DG start instrumentation.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.5-1 to determine which SRs apply for each LOP Function.

SURVEILLANCE		FREQUENCY
SR 3.3.5.1	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	92 days
SR 3.3.5.2	Perform CHANNEL CALIBRATION.	6 months
SR 3.3.5.3	Perform CHANNEL CALIBRATION.	18 months

Table 3.3.5-1 (page 1 of 2)
LOP DG Start Instrumentation

	FUNCTION	REQUIRED CHANNELS PER BUS	SURVEILLANCE REQUIREMENTS	TRIP SETPOINT	ALLOWABLE VALUE
1.	6.9 kV Emergency Bus Undervoltage (Loss of Voltage)				
	a. Bus Undervoltage	3	SR 3.3.5.1 SR 3.3.5.2	≥ 5994 V and ≤ 6006 V	≥ 5967.6 V
	b. Time Delay	2	SR 3.3.5.3	≥ 0.73 sec and ≤ 0.77 sec	≥ 0.58 sec and ≤ 0.94 sec
2.	6.9 kV Emergency Bus Undervoltage (Degraded Voltage)				
	a. Bus Undervoltage	3	SR 3.3.5.1 SR 3.3.5.2	≥ 6593.4 V and ≤ 6606.6 V	≥ 6570 V
	b. Time Delay	2	SR 3.3.5.3	≥ 9.73 sec and ≤ 10.27 sec	≥ 9.42 sec and ≤ 10.49 sec
3.	Diesel Generator Start	2	SR 3.3.5.1 SR 3.3.5.2	≥ 4733.4 V and ≤ 4926.6 V with an internal time delay of ≥ 0.46 sec and ≤ 0.54 sec	≥ 2295.6 V with an internal time delay of 0.56 sec at zero volts.
4.	Load Shed	4	SR 3.3.5.1 SR 3.3.5.2	≥ 4733.4 V and ≤ 4926.6 V with an internal time delay of ≥ 2.79 sec and ≤ 3.21 sec	≥ 2295.6 V with an internal time delay of ≤ 3.3 sec at zero volts.

Table 3.3.5-1 (page 2 of 2)
LOP DG Start Instrumentation

	FUNCTION	REQUIRED CHANNELS PER BUS	SURVEILLANCE REQUIREMENTS	TRIP SETPOINT	ALLOWABLE VALUE
5.	6.9 kV Emergency Bus Undervoltage (Unbalanced Voltage)	3	SR 3.3.5.1 SR 3.3.5.2 SR 3.3.5.3	1.30 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Lo) 18.13 V at 3.95 sec (High)	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.35 V at 10 sec (Lo) ≤ 20.0 V at 4 sec (High)

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-90 is hereby amended to read as follows:

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A as revised through Amendment No. 31 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 120 days of the issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Undine Shoop, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Facility Operating License
and Technical Specifications

Date of Issuance: August 27, 2019

ATTACHMENT TO AMENDMENT NO. 31

WATTS BAR NUCLEAR PLANT, UNIT 2

FACILITY OPERATING LICENSE NO. NPF-96

DOCKET NO. 50-391

Replace the following page of Facility Operating License No. NPF-96 with the attached page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove Page	Insert Page
3	3

Replace the following pages of the Appendix A Technical Specifications with the attached pages. The pages are identified by amendment number and contain vertical lines indicating the areas of change.

Remove Page	Insert Page
3.3-51	3.3-51
3.3-52	3.3-52
3.3-52a	3.3-52a
3.3-53	3.3-53

C. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act, and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified or incorporated below.

(1) Maximum Power Level

TVA is authorized to operate the facility at reactor core power levels not in excess of 3411 megawatts thermal.

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A as revised through Amendment No. 31 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) TVA shall implement permanent modifications to prevent overtopping of the embankments of the Fort Loudon Dam due to the Probable Maximum Flood by June 30, 2018.

(4) PAD4TCD may be used to establish core operating limits until the WBN Unit 2 steam generators are replaced with steam generators equivalent to the existing steam generators at WBN Unit 1.

(5) By December 31, 2019, the licensee shall report to the NRC that the actions to resolve the issues identified in Bulletin 2012-01, "Design Vulnerability in Electrical Power System," have been implemented.

(6) The licensee shall maintain in effect the provisions of the physical security plan, security personnel training and qualification plan, and safeguards contingency plan, and all amendments made pursuant to the authority of 10 CFR 50.90 and 50.54(p).

(7) TVA shall fully implement and maintain in effect all provisions of the Commission approved cyber security plan (CSP), including changes made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p). The TVA approved CSP was discussed in NUREG-0847, Supplement 28, as amended by changes approved in License Amendment No. 7.

(8) TVA shall implement and maintain in effect all provisions of the approved fire protection program as described in the Fire Protection Report for the facility, as described in NUREG-0847, Supplement 29, subject to the following provision:

3.3 INSTRUMENTATION

3.3.5 Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation

LCO 3.3.5 The LOP DG Start Instrumentation for each Function in Table 3.3.5-1 shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4,
When associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources-Shutdown."

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each Function.

CONDITION	REQUIRED ACTION	COMPLETION TIME
----------NOTE---------- Not applicable to Function 5 ---------- A. One or more Functions with one channel per bus inoperable.	----------NOTE---------- Enter applicable Conditions and Required Actions of LCO 3.3.2, "ESFAS Instrumentation," for Auxiliary Feedwater Start Instrumentation made inoperable by LOP DG Start Instrumentation. ---------- A.1 Restore channel to OPERABLE status.	6 hours

(continued)

ACTIONS continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
----------NOTE---------- Not applicable to Function 5 ----------			
B. One or more Functions with two or more channels per bus inoperable.	B.1	Restore all but one channel to OPERABLE status.	1 hour
----------NOTE---------- Only applicable to Function 5 ----------			
C. One or more Functions with one channel per bus inoperable.	C.1	Restore channel to OPERABLE status.	1 hour
D. Required Action and associated Completion Time not met.	D.1	Enter applicable Condition(s) and Required Action(s) for the associated DG made inoperable by LOP DG start instrumentation.	Immediately

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.5-1 to determine which SRs apply for each LOP Function.

	SURVEILLANCE	FREQUENCY
SR 3.3.5.1	----------NOTE---------- Verification of relay setpoints not required. --- Perform TADOT.	92 days
SR 3.3.5.2	Perform CHANNEL CALIBRATION.	6 months
SR 3.3.5.3	Perform CHANNEL CALIBRATION.	18 months

Table 3.3.5-1 (page 1 of 1)
LOP DG Start Instrumentation

	FUNCTION	REQUIRED CHANNELS PER BUS	SURVEILLANCE REQUIREMENTS	TRIP SETPOINT	ALLOWABLE VALUE
1.	6.9 kV Emergency Bus Undervoltage (Loss of Voltage)				
a.	Bus Undervoltage	3	SR 3.3.5.1 SR 3.3.5.2	≥ 5994 V and ≤ 6006 V	≥ 5967.6 V
b.	Time Delay	2	SR 3.3.5.3	≥ 0.73 sec and ≤ 0.77 sec	≥ 0.58 sec and ≤ 0.94 sec
2.	6.9 kV Emergency Bus Undervoltage (Degraded Voltage)				
a.	Bus Undervoltage	3	SR 3.3.5.1 SR 3.3.5.2	≥ 6593.4 V and ≤ 6606.6 V	≥ 6570 V
b.	Time Delay	2	SR 3.3.5.3	≥ 9.73 sec and ≤ 10.27 sec	≥ 9.42 sec and ≤ 10.49 sec
3.	Diesel Generator Start	2	SR 3.3.5.1 SR 3.3.5.2	≥ 4733.4 V and ≤ 4926.6 V with an internal time delay of ≥ 0.46 sec and ≤ 0.54 sec	≥ 2295.6 V with an internal time delay of 0.56 sec at zero volts
4.	Load Shed	4	SR 3.3.5.1 SR 3.3.5.2	≥ 4733.4 V and ≤ 4926.6 V with an internal time delay of ≥ 2.79 sec and ≤ 3.21 sec	≥ 2295.6 V with an internal time delay of ≤ 3.3 sec at zero volts.
5.	6.9 kV Emergency Bus Undervoltage (Unbalanced Voltage)	3	SR 3.3.5.1 SR 3.3.5.2 SR 3.3.5.3	1.30 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Lo) 18.13 V at 3.95 sec (High)	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.35 V at 10 sec (Lo) ≤ 20.0 V at 4 sec (High)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

AMENDMENT NO. 309 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-33

AMENDMENT NO. 332 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-52

AMENDMENT NO. 292 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-68

AMENDMENT NO. 345 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-77

AMENDMENT NO. 339 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-79

AMENDMENT NO. 128 TO FACILITY OPERATING LICENSE NO. NPF-90

AMENDMENT NO. 31 TO FACILITY OPERATING LICENSE NO. NPF-96

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-259, 50-260, 50-296, 50-327, 50-328, 50-390, AND 50-391

TENNESSEE VALLEY AUTHORITY

1.0 INTRODUCTION

By application dated November 17, 2017 (Reference 1), as supplemented by letter dated June 18, 2018 (Reference 2), and subsequently revised by letter dated November 19, 2018 (Reference 3), and supplemented by letter dated January 25, 2019 (Reference 4), Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) to Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68 for the Browns Ferry Nuclear Plant (Browns Ferry), Units 1, 2, and 3; Renewed Facility Operating License Nos. DPR-77 and DPR-79 for the Sequoyah Nuclear Plant (Sequoyah), Units 1 and 2; and Facility Operating License Nos. NPF 90 and NPF-96 for the Watts Bar Nuclear Plant (Watts Bar), Units 1 and 2.

The amendments would add a new condition to Technical Specification (TS) 3.3.8.1 and revise TS Table 3.3.8.1-1 for Browns Ferry, and add a new condition to TS 3.3.5 and revise TS Table 3.3.5-1 for Sequoyah and Watts Bar to reflect the implementation of the Class 1E "unbalanced voltage" relays for Browns Ferry, Sequoyah, and Watts Bar.

The supplemental letter dated June 18, 2018, provided additional information that clarified the application. By letter dated November 19, 2018, TVA revised the LAR dated November 17, 2017, in its entirety to remove extraneous information and requested additional time to implement the proposed plant modifications for unbalanced voltage relays (UVRs). The supplemental letter dated January 25, 2019, confirmed that the November 19, 2018, supplement superseded the November 17, 2017, LAR, and clarified that the May 21, 2018, and June 18, 2018, RAI responses were still applicable. The supplemental letters did not expand the scope of the application as originally noticed and did not change the U.S. Nuclear Regulatory Commission (NRC, the Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on January 16, 2018 (83 FR 2231).

2.0 REGULATORY EVALUATION

TVA, in the revised LAR, proposed TS changes that support installation of Class 1E UVRs on the medium voltage shutdown buses at Browns Ferry, Sequoyah, and Watts Bar to address potential concerns with consequences of unbalanced voltage conditions on operating equipment. Currently, the Browns Ferry, Sequoyah, and Watts Bar TSs contain provisions for loss of voltage and degraded voltage conditions. These provisions are included in the limiting conditions for operations (LCOs) in loss of power (LOP) instrumentation TSs, which state:

Browns Ferry, Units 1 and 2, TS 3.3.8.1

> LCO 3.3.8.1 The LOP instrumentation for each Table 3.3.8.1-1 Function on 4 kV shutdown boards A, B, C, and D shall be OPERABLE.

Browns Ferry, Unit 3

> LCO 3.3.8.1 The LOP instrumentation for each Table 3.3.8.1-1 Function on 4 kV shutdown boards 3EA, 3EB, 3EC, and 3ED shall be OPERABLE.

Browns Ferry TS Table 3.3.8.1-1, "Loss of Power Instrumentation," provides details on function of the instrumentation, required number of minimum channels, surveillance requirements (SRs), and allowable setpoint values for loss of voltage and degraded voltage relays installed on 4 kilovolt (kV) shutdown boards.

Sequoyah, Units 1 and 2, and Watts Bar, Units 1 and 2

> LCO 3.3.5 The LOP DG start instrumentation for each Function in Table 3.3.5-1 shall be OPERABLE.

The corresponding TS requirements for the Sequoyah and Watts Bar units are identified in Table 3.3.5-1, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," for each plant. Table 3.3.5-1 identifies the number of required channels, SRs, allowable values (AVs), and trip setpoints for loss of voltage and degraded voltage relays.

In the LAR, the licensee requested NRC approval to add a new condition to TS 3.3.8.1 and revise Table 3.3.8.1-1 for Browns Ferry, and add a new condition to TS 3.3.5 and revise Table 3.3.5-1 for Sequoyah and Watts Bar to reflect the implementation of Class 1E "unbalanced voltage" relays for Browns Ferry, Sequoyah, and Watts Bar TSs LOP

instrumentation. These UVRs are being added to the 4.16 kV bus medium voltage shutdown boards at Browns Ferry and to the 6.9 kV medium voltage shutdown boards at Sequoyah and Watts Bar.

TVA, in the revised LAR dated November 19, 2018 (Reference 3), referenced NRC Bulletin 2012-01, "Design Vulnerability in Electrical Power System," dated July 27, 2012 (Reference 5). The bulletin identified a weakness in the design of offsite and onsite power systems whereby an open phase condition (OPC) in the offsite power system precluded both the offsite and onsite electric systems from performing their intended safety functions and also resulted in unbalanced voltage conditions on plant buses. In Section 2.1 of the LAR, "Reason for the Proposed Change," the licensee stated, "For this fleet submittal, the reason for the proposed change is to provide equipment protection from the effects of an unbalanced voltage in a similar fashion to the existing degraded and loss of voltage protection schemes." In Section 3.3 of the LAR, "Unbalanced Voltage as a Level of Undervoltage Protection," TVA stated, "The UVR scheme is not intended to ensure operability of the offsite power supply, but rather to ensure that the safety-related loads have adequate voltage to perform their intended safety function when connected to offsite power."

The NRC staff reviewed the capability of proposed unbalanced voltage relays to protect safety-related equipment from effects of unbalanced voltage conditions in the onsite power systems. TVA specifically requested approval of the UVR setpoints and setpoint methodology contained in the proposed LAR and corresponding TS changes. As discussed in Section 3.1, although the licensee may cite this change as a component of meeting NRC Bulletin 2012-01 in the future, this review does not evaluate the adequacy of the licensee's response to the bulletin.

2.1 System Descriptions

The electric power systems of the Browns Ferry, Sequoyah, and Watts Bar plants contain the main generators, the main step-up transformers, the unit station service transformers (USSTs), the common station service transformers (CSSTs), the batteries, and associated equipment. In the emergency power system of the three TVA sites, each unit has the engineered safety features (ESF) buses or the shutdown boards.

The existing LOP instrumentation at the three TVA sites consists of loss of voltage relays (LVRs) and degraded voltage relays (DVRs) located at 4.16 kV (Browns Ferry) and 6.9 kV (Sequoyah and Watts Bar) buses. The preferred source of power for these shutdown boards is offsite power. The LOP instrumentation monitors the voltages of these boards, and whenever the monitoring instrumentation determines that the power source is either unavailable or degraded to a level where it is not able to support safe shutdown of the unit, the undervoltage protection scheme on the shutdown boards will generate a LOP signal. The LOP signal actuates breakers that separate the degraded power source from the shutdown boards and connects the onsite DGs to these buses.

2.1.1 Browns Ferry Electrical System Design and Operation

At Browns Ferry, offsite power for the three units is delivered to the site via seven 500 kV and two 161kV transmission lines; these lines feed a 500 kV switchyard and a 161 kV switchyard. During normal operation, station auxiliary power is taken from the main generator through the USSTs. During startup and shutdown, auxiliary power is supplied from the 500 kV system through the main transformers to the USST with the main generators isolated by the main generator breakers. The ESF buses are normally powered from the main generator through the

USSTs. Auxiliary power is also available through the two CSSTs, which are fed from the 161 volts (V) system.

The standby alternating current (AC) supply and distribution system for Browns Ferry, Units 1 and 2, includes four DGs (A, B, C, and D), and Unit 3 includes four DGs (3A, 3B, 3C, and 3D). The standby AC supply and distribution systems are connected so that they supply unitized power to the Units 1, 2, and 3 electrical loads. Each of the DGs is assigned to one 4.16 kV shutdown board. For Units 1 and 2, the Updated Final Safety Analysis Report (UFSAR) (Reference 6) states that it is possible through breaker ties to make any DG available to any 4.16 kV shutdown board.

The standby AC supply and distribution system for Unit 3 is separate from that of Units 1 and 2. It consists of four DGs (3A, 3B, 3C, and 3D) that can be connected to four 4.16 kV shutdown boards. For flexibility of operation, provisions have been made using manually controlled circuit breakers for the interconnection of 4.16 kV shutdown board A (Units 1 and 2) with 4.16 kV shutdown board 3EA (Unit 3). Similar interconnections have been provided between boards B and 3EB, C and 3EC, and D and 3ED. Therefore, the DGs can be manually aligned to support a unit that may be in a station blackout condition. The DGs start automatically on receipt of an accident signal, loss of voltage, or degraded voltage on the associated shutdown board.

2.1.2 Sequoyah Electrical System Design and Operation

As described in the Sequoyah UFSAR (Reference 7), Section 8.2.1.1, the offsite or the preferred power system (PPS) consists of two physically and functionally independent circuits for energizing safety-related load groups. The station has a 500 kV switchyard and a 161 kV switchyard. Unit 1 of the two nuclear units is connected to the 500 kV transmission system and Unit 2 is connected to the 161 kV transmission system. The PPS consists of two main bank transformers; six 24 kV isolated phase buses; four 24/6.9 kV USSTs; four 6.9 kV USST buses; three 161/6.9 kV CSSTs (A and C, energized spare B); a 6.9 kV start board; four 6.9 kV start buses; eight 6.9 kV Unit boards; four 6.9 kV shutdown boards; and the associated interconnecting conductors. The PPS can power the plant safety buses from the 161 kV or 500 kV switchyard. During normal operations, the auxiliary system is typically supplied by unit power through the USSTs. During startup and shutdown, the auxiliary power is typically supplied by the 500 kV system through the main bank and USSTs for Unit 1 and the 161 kV system through the main bank and USSTs for Unit 2. During startup, shutdown, and normal operations, auxiliary power may be supplied by the 161 kV system through the CSSTs. The standby onsite power is supplied by four DGs. The power to the 6.9 kV common boards is supplied by the 161 kV system through the CSSTs. During normal plant operation the ESF buses are powered from the CSSTs.

For Sequoyah, Units 1 and 2, power supply to the 6.9 kV shutdown boards is provided through the main generator breakers. When the main generator is not operating, USSTs function as stepdown transformers and supply electrical power from the offsite sources to the shutdown boards.

The standby onsite power at Sequoyah is supplied by four DGs. The LOP relays monitor the voltage on the ESF buses (shutdown boards). In the event of LOP or degraded voltage conditions, the LOP relays actuate to start the DGs and supply power to the safety-related loads.

2.1.3 Watts Bar Electrical System Design and Operation

As described in the Watts Bar UFSAR (Reference 8), Section 8.2, the preferred offsite power for Watts Bar is supplied from TVA's 161 kV transmission grid at the Watts Bar Hydro Plant switchyard over two separate transmission lines, each connecting to two 161/6.9 kV CSSTs (C and D). CSST C provides offsite power from the secondary Y winding to the 6.9 kV shutdown board 1A-A and from the secondary X winding to the 6.9 kV shutdown board 2A-A. In addition, this transformer provides alternate (offsite) power from the secondary X winding to 6.9 kV shutdown board 1B-B and from the secondary Y winding to 6.9 kV shutdown board 2B-B. CSST C is normally aligned to power 6.9 kV shutdown boards 1A-A (Unit 1) and 2A-A (Unit 2). CSST D provides offsite power from the secondary X winding to 6.9 kV shutdown board 1B-B and from the secondary Y winding to 6.9 kV shutdown board 2B-B. In addition, this transformer provides alternate (offsite) power from the secondary Y winding to 6.9 kV shutdown board 1A-A from the secondary X winding to 6.9 kV shutdown board 2A-A. CSST D is normally aligned to power 6.9 kV shutdown boards 1B-B (Unit 1) and 2B-B (Unit 2). The four 6.9 kV shutdown boards are arranged electrically into four power trains (two per unit) with two boards associated with each load group in each unit. The balance of the Class 1E auxiliary power system is normally aligned to the respective 6.9 kV shutdown bus load group. During normal plant operation, the ESF buses are powered from the CSSTs.

For flexibility, there is also a maintenance feed available from CSSTs A and B to the Class 1E power systems. During normal plant operation, CSSTs A and B supply the 6.9 kV common unit and reactor coolant pump boards via the 6.9 kV start boards.

The standby onsite power at Watts Bar is supplied by four DGs. The LOP relays monitor the voltage on the ESF buses (shutdown boards). In the event of LOP or degraded voltage conditions, the LOP relays actuate to start the DGs and supply power to the safety-related loads.

2.2 Description of Proposed Changes

2.2.1 Hardware Changes

In electrical power systems, an unbalanced voltage condition may be caused by several factors. As discussed in NRC Bulletin 2012-01 (Reference 5), an open circuit in a three-phase power system results in an unbalanced voltage condition on plant buses. The unbalanced voltage condition results in unbalanced current flow that produces negative and zero sequence current that can be detrimental to operating equipment. TVA is installing UVRs to protect safety-related electrical equipment from the deleterious effects of negative sequence current.

Based on industry operating experience, TVA performed vulnerability studies for the three nuclear plants to determine the effects of unbalanced voltage conditions on the Class 1E power system and structures, systems, and components (SSCs). The results of the vulnerability studies indicated that there were cases where the unbalanced voltages could not be detected with existing protection schemes and due to the potential consequences, TVA concluded that additional protective measures were needed. As a result, the licensee proposed to install an additional Class 1E 4.16 kV/6.9 kV protective relaying scheme on the three TVA sites. The new protection scheme utilizes existing undervoltage protection sensing circuits (bus potential transformers) and tripping circuits to directly disconnect the respective 4.16 kV or 6.9 kV ESF buses from the offsite power source when unbalanced voltages exceed an allowable limit. Based on experience with similar relays, TVA utilized Type 60Q phase voltage unbalance relays

that measure negative sequence overvoltage. These relays are manufactured by Asea Brown Boveri (ABB), have been qualified for Class 1E applications, and have similarities with the DVRs used at the TVA plants.

The proposed unbalanced voltage function is monitored by three new UVRs for each shutdown board at each unit. The actuation logic scheme is set up with a permissive one-out-of-two logic configuration. The permissive one-out-of-two trip logic is defined as a trip of the "Alarm" relay and either the "High" or "Low" relay. This permissive interlock prevents a spurious trip. Therefore, with the proposed UVRs and existing relays (LVRs and DVRs), the voltage of each shutdown board would be monitored at three levels, which is considered as three different undervoltage functions: (1) loss of voltage, (2) degraded voltage, and (3) unbalanced voltage. The existing loss of voltage and degraded voltage actuations are based on two-out-of-three logics, but the new UVR actuation logic is based on one-out-of-two actuations with alarm relay acting as a permissive to the actuation logic.

2.2.2 Revised Technical Specifications

The licensee requested NRC approval for the TS revisions as the result of the installation of the Class 1E ABB Type 60Q phase unbalanced voltage relays in the unbalanced voltage protection of the 4.16 kV/6.9 kV ESF buses. In its letter dated November 1, 2018 (Reference 3), TVA proposed to add operability requirements, required actions, instrument settings, and SRs to the TSs for the installation of an unbalanced voltage protection function associated with the specified unbalanced voltage protection from the proposed UVRs for Browns Ferry Units 1, 2, and 3; Sequoyah, Units 1 and 2, and Watts Bar, Units 1 and 2.

Proposed TS Change for Browns Ferry Units 1, 2, and 3

The LAR proposed changes to add the unbalanced voltage function to Browns Ferry TS 3.3.8.1 as follows:

- A new Condition E and its required actions are added to TS 3.3.8.1 that apply when one or more UVRs are inoperable on one shutdown board.
- A new Function 3 is added to Table 3.3.8.1-1 to include "unbalanced voltage."
- Existing Condition E and its associated Required Action E.1 are renamed as Condition F and Required Action F.1.

The licensee proposed to insert Item 3 in TS Table 3.3.8.1-1, "Loss of Power Instrumentation," as shown below.

Function	Required Channels Per Board	Surveillance Requirements	Allowable Value
3. 4.16 kV Shutdown Board Undervoltage (Unbalanced Voltage Relay)	3	SR 3.3.8.1.2 SR 3.3.8.1.3	≤ 1.5 V at 3 seconds (Permissive Alarm) ≤ 3. 4 V at 8.65 sec (Lo) ≤ 20 V at 3.5 sec (High)

In the original LAR dated November 17, 2017 (Reference 1), and subsequent revised LAR dated November 19, 2018 (Reference 3), the licensee did not provide the nominal trip setpoints for the proposed UVR changes in Browns Ferry TS Table 3.3.8-1. In response to the NRC staff's request for additional information (RAI) identified as EICB RAI-1, the licensee, in its letter dated June 18, 2018 (Reference 2), provided a summary of nominal setpoints for the Browns Ferry units.

The summary of the Browns Ferry nominal setpoints for the proposed UVR relays is shown below.

	Voltage Setpoint	Time Delay Setpoint
Permissive Alarm	1.34 volts (V)	2.60 seconds
Low	3.23 V	7.86 seconds
High	19.50 V	3.18 seconds

Proposed Change for Sequoyah, Units 1 and 2

The LAR proposed changes to add the unbalanced voltage function to Sequoyah TS 3.3.5 as follows:

- A new Condition C and its required actions are added to TS 3.3.5 that apply when one or more UVRs are inoperable.
- A new Function 3 is added to Table 3.3.5-1 to include "unbalanced voltage."
- Existing Condition C and its associated Required Action C.1 are renamed as Condition D and Required Action D.1.

The licensee proposed to insert Item 3 in TS Table 3.3.5-1, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," as shown below.

Function	Applicable Modes or Other Specified Conditions	Required Channels	Surveillance Requirements	Allowable Value	Nominal Trip Setpoint
3. 6.9 kV Shutdown Board – Unbalanced Voltage Relay	1, 2, 3, 4 (a)	3 per Shutdown Board	SR 3.3.5.1 SR 3.3.5.2	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.3 V at 10 sec (Lo) ≤ 20 V at 4 sec (High)	1.30 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Lo) 18.13 V at 3.95 sec (High)

Existing Note (a): When the associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources – Shutdown."

Proposed Change for Watts Bar, Units 1 and 2

The LAR proposed changes to add the unbalanced voltage function to TS 3.3.5 as follows:

- A new Condition C and its required actions are added to TS 3.3.5 that apply when one or more functions with one channel per bus are inoperable. A new note is added to Condition C stating that Condition C is only applicable to Function 5.
- A new note is added to both Condition A and Condition B stating that those conditions are not applicable to the new Function 5.
- A new Function 5 is added to Table 3.3.5-1 to include "unbalanced voltage."
- Existing Condition C and its associated Required Action C.1 are renamed as Condition D and Required Action D.1.

Revised TS Table 3.3.5-1 of Watts Bar, Units 1 and 2

The licensee proposed to insert Item 5 in TS Table 3.3.5-1, "LOP DG Start Instrumentation," as shown below.

Function	Required Channels Per Bus	Surveillance Requirements	Trip Setpoint	Allowable Value
5. 6.9 kV Emergency Bus Undervoltage (Unbalanced Voltage)	3	SR 3.3.5.1 SR 3.3.5.2 SR 3.3.5.3	1.3 V at 2.95 sec (Permissive Alarm) 2.96 V at 9.95 sec (Lo) 18.13 V at 3.95 sec (High)	≤ 1.5 V at 3 sec (Permissive Alarm) ≤ 3.3 V at 10 sec (Lo) ≤ 20 V at 4 sec (High)

Note: Applicable modes of this LOP function:

MODES 1, 2, 3, and 4, when the associated DG is required to be OPERABLE by LCO 3.8.2, "AC Sources - Shutdown."

2.3 Applicable Regulatory Requirements

2.3.1 Requirements

The staff applied the following NRC regulations to evaluate the LAR for Browns Ferry, Units 1, 2, and 3; Sequoyah, Units 1 and 2; and Watts Bar, Units 1 and 2.

- Under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 34, an application for a construction permit must include the principal design criteria for a proposed facility. The principal design criteria establish the necessary design, fabrication, construction, testing, and performance requirements for SSCs important to safety; that is, SSCs that provide reasonable assurance that the facility can be operated without undue risk

to the health and safety of the public. The General Design Criteria (GDC) in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission.

- Browns Ferry, Units 1, 2, and 3, were not licensed to the 10 CFR Part 50, Appendix A, GDC. The UFSAR, Appendix A, "Conformance to AEC [Atomic Energy Commission] Proposed General Design Criteria," provides an assessment against the draft GDC published in November 1965 (Units 1 and 2) and July 1967 (Unit 3). This appendix presents the interpretations, discussions, and conclusions on how the design of Browns Ferry conformed to the AEC proposed GDC of 27 draft criteria and 70 draft criteria current at the time of the plant design. For Browns Ferry, the licensee also performed a review of plant-specific requirements and concluded that the AEC criteria are sufficiently similar to Appendix A GDC 17. Section 8.4.6, "Safety Evaluation," of the UFSAR discusses conformance to 10 CFR Part 50, Appendix A, GDC 17, and concludes that the Browns Ferry units are in conformance with the requirements of GDC 17.

- Appendix A, GDC 17, "Electric Power Systems," of 10 CFR Part 50 states, in part, that an onsite electric power system and an offsite electric power system shall be provided to permit functioning of SSCs important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled, and containment integrity and other vital functions are maintained in the event of postulated accidents. The onsite system is required to have sufficient independence, redundancy, and testability to perform its safety function, assuming a single failure. The offsite power system is required to be supplied by two physically independent circuits that are designed and located to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. GDC 17 ensures that the electric power system provides: (1) capacity and capability to permit functioning of SSCs important to safety; (2) independence, redundancy, and availability; and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the LOP generated by the nuclear power unit, the LOP from the transmission network, or the LOP from the onsite electric power supplies.

- For the Browns Ferry units, AEC Criterion 39, "Emergency Power for Engineered Safety Features," states:

> Alternate power systems shall be provided and designed with adequate independency, redundancy, capacity, and testability to permit the functioning required of the engineered safety features. As a minimum, the onsite power system and the offsite power system shall each, independently, provide this capacity assuming a failure of a single active component in each power system.

- Appendix A, GDC 13, "Instrumentation and control," of 10 CFR Part 50 applies to Sequoyah and Watts Bar only. This criterion states, in part:

> Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

- For the Browns Ferry units, AEC Criterion 12, "Instrumentation and Control System (Category B)," states, "Instrumentation and controls shall be provided as required to monitor and maintain variables within prescribed operating ranges."

(Note: In view of the similarity between AEC Criterion 39 and Browns Ferry conformance to GDC 17, and the similarity between AEC Criterion 12 and GDC 13, the discussion in this evaluation references the general requirements in GDC 17 and GDC 13 for all TVA plants.)

- 10 CFR 50.36(a)(1) "Technical specifications," states, in part, "each applicant for a license authorizing operation of a production or utilization facility shall include in his application proposed technical specifications (TSs) in accordance with the requirements of this section."

- 10 CFR 50.36(c) requires that TSs include items in five specific categories related to station operation. These categories are: (1) safety limits, limiting safety system settings, and limiting control settings; (2) LCOs; (3) SRs; (4) design features; and (5) administrative controls. The proposed changes to TSs, discussed in this safety evaluation (SE), are within the LCOs and the SRs categories.

- 10 CFR 50.36(c)(1)(ii)(A) states, in part:

> Limiting safety system settings for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting (LSSS) is specified for a variable on which a safety limit has been placed, the setting must be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. If, during operation, it is determined that the automatic safety system does not function as required, the licensee shall take appropriate action, which may include shutting down the reactor.

  This section also requires, among other things, that the licensee notify the NRC if the licensee determines that an automatic safety system does not function as required. The licensee is required to then review the matter and record the results of the review.

- 10 CFR 50.36(c)(2) provides the requirement for the establishment of TS LCOs. Specifically, 10 CFR 50.36(c)(2)(ii) requires that a TS LCO of a nuclear reactor must be established for each item meeting one or more of the criteria listed. For the TVA plants, the following criterion applies:

> Criterion 3 - A Structure, System, or Component (SSC) that is part of the primary success path and which functions or actuates to mitigate a DBA [Design-Basis Accident] or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

- 10 CFR 50.36(c)(3), "Surveillance requirements," states:

> Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met.

- 10 CFR 50.55a(h)(2), "Protection systems," states:

> For nuclear power plants with construction permits issued after January 1, 1971, but before May 13, 1999, protection systems must meet the requirements stated in either Electrical and Electronic Engineers (IEEE) Std. 279, 'Criteria for Protection Systems for Nuclear Power Generating Stations,' or in IEEE Std. 603 1991, 'Criteria for Safety Systems for Nuclear Power Generating Stations,' and the correction sheet dated January 30, 1995. For nuclear power plants with construction permits issued before January 1, 1971, protection systems must be consistent with their licensing basis or may meet the requirements of IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.

- 10 CFR 50.57(a)(3), "Issuance of operating license," states that the Commission may issue an operating license upon finding, in, part:

> There is reasonable assurance (i) that the activities authorized by the operating license can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the regulations in this chapter.

2.3.2 Applicable Guidance and Industry Documents

At the time of licensing the TVA plants, the regulations promulgated in 10 CFR Part 50 and NRC regulatory guides did not consider the consequences of unbalanced voltage conditions on safety-related equipment. In order to develop an understanding of the technical issues related to unbalanced voltage conditions in power systems, the NRC staff used publicly available industry standards and associated RGs. Some of these documents may not be part of the licensing basis of the TVA plants, but provide technical information related to unbalanced voltages and the impact on safety-related motors:

- The American National Standard for Electric Power Systems and Equipment, American National Standards Institute [ANSI] C84.1 (Reference 10), recommends that "electric supply systems should be designed and operated to limit the maximum voltage unbalance to 3 percent when measured at the electric-utility revenue meter under no-load conditions."

- The LAR references National Electrical Manufacturers Association (NEMA) MG-1-1987, "Motors and Generators" (Reference 11), as a guidance document for evaluating the

allowable unbalanced voltages in power systems. This guidance document is generally invoked for purchase of rotating equipment such as motors and generators by all industries. The commercial nuclear industry has also adopted NEMA MG-1 for procurement of motors in safety-related applications. The standard requires motors to produce rated output for 1 percent of voltage unbalance. By limiting voltage unbalance to 1 percent, this guidance is more stringent than either ANSI C84.1 or utility guidelines. NEMA MG-1 states that 1 percent of voltage unbalance can create 6-10 percent current unbalance.

- IEEE Standard 308-1974, "Standard Criteria for Class IE Power Systems for Nuclear Power Generating Stations" (Reference 12). This standard has been adopted by TVA plants and provides guidance for the design of Class 1E power systems. The purpose of this standard is to provide:

  1. The principal design criteria and the design features of the Class IE electric systems that enable the systems to meet their functional requirement under the conditions produced by the design-basis events. The standard states, in part, that as a minimum the design-basis shall include the acceptable ranges for transient and steady-state conditions of both the energy supply and environment (e.g., voltage, frequency, humidity, temperature, pressure, vibration, etc.) during normal, abnormal, and accident circumstances throughout which the equipment must perform.

  2. The minimum operational conditions of the Class 1E electric systems under which the station will be permitted to operate.

  3. The SRs of the Class 1E electric systems.

  The NRC staff reviewed pertinent sections of the standard that relate to offsite power requirements and SRs proposed for the UVRs.

- IEEE 603-1991 (Reference 13), "Standard Criteria for Safety Systems for Nuclear Power Generating Stations," contains criteria to establish minimum functional and design requirements for the power, instrumentation, and control portions of safety systems for nuclear power generating stations.

- IEEE Standard 3004.8-2016, "IEEE Recommended Practice for Motor Protection in Industrial and Commercial Power Systems" (Reference 14), provides an approximate relationship between voltage unbalance and negative sequence current magnitude that can degrade motor insulation. This standard also provides information on protective relays that can be used to protect motors from abnormal power supply conditions including detection of unbalanced voltages, negative sequence voltages, and negative sequence currents.

- IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" (Reference 15),

- RG 1.93, Revision 1, "Availability of Electric Power Sources," issued March 2012 (Reference 16). This guide describes guidelines that the NRC staff considers acceptable when the number of available electric power sources is less than the number of sources required by the LCOs for a facility. This RG applies to single- and multiple-unit plants and is consistent with the improved standard technical specifications.

- RG 1.105, Revision 3, "Setpoints for Safety-Related Instrumentation," dated December 1999 (Reference 9), describes a method acceptable to the NRC staff for complying with the NRC's regulations for ensuring that setpoints for safety-related instrumentation are initially within and remain within the TS limits. RG 1.105 endorses Part I of Instrument Society of America (ISA) Standard 67.04-01-1994, "Setpoints for Nuclear Safety-Related Instrumentation." The staff used the principles of this guide to establish the adequacy of the licensee's setpoint calculation methodologies and the related plant surveillance procedures.

- International Society of Automation (ISA) document ISA-S67.04 Section 4.3, "LSSS," "Setpoints for Nuclear Safety-Related Instrumentation"(Reference 17), which was endorsed by RG 1.105, states, in part, that, "The LSSS is derived from the analytical limit in a manner determined by the setpoint calculation methodology. Depending on the methodology, the LSSS may be the allowable value, the trip setpoints, or both."

- IEEE Std. 714-1997 (R2002), "IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations" (Reference 18).

- Section 4.3, "LSSS," of ISA-S67.04, which was endorsed by Regulatory Guide (RG) 1.105 (Reference 9), states, in part, that, "The LSSS is derived from the analytical limit in a manner determined by the setpoint calculation methodology. Depending on the methodology, the LSSS may be the allowable value, the trip setpoints, or both."

3.0 NRC STAFF TECHNICAL EVALUATION

3.1 Scope

TVA, in the revised LAR dated November 19, 2018 (Reference 3), proposed adding a new level of protection, "unbalanced voltage," to the TSs for the LOP instrumentation. In Section 2.1, "Reason for the Proposed Change," of Enclosure 1 to the LAR, the licensee stated, "For this fleet submittal, the reason for the proposed change is to provide equipment protection from the effects of an unbalanced voltage in a similar fashion to the existing degraded and loss of voltage protection schemes. The identification of the vulnerability was based on industry operating experience."

TVA, in the revised LAR, referenced NRC Bulletin 2012-01, "Design Vulnerability in Electrical Power System," dated July 27, 2012 (Reference 5). The bulletin identified a weakness in the design of offsite and onsite power systems whereby an open phase condition (OPC) in the offsite power system precluded both the offsite and onsite electric systems from performing their intended safety functions.

TVA, in its revised LAR, stated that the scope of the proposed amendments are limited to UVR setpoints and setpoint methodology. In Section 3.3, "Unbalanced Voltage as a Level of Undervoltage Protection," of the LAR, TVA stated, "The UVR scheme is not intended to ensure operability of the offsite power supply, but rather to ensure that the safety-related loads have adequate voltage to perform their intended safety function when connected to offsite power."

Therefore, the NRC staff reviewed the capability of the proposed unbalanced voltage relays to protect safety-related equipment from the effects of unbalanced voltage conditions. Specifically, the NRC staff's review was focused on the evaluation of the UVR setpoints and setpoint

methodology, and on the consequences of unbalanced voltage conditions on operating safety-related equipment.

The scope of NRC review of the LAR is limited to protection of safety-related equipment from effects of unbalanced voltage conditions originating in the offsite or onsite power systems. TVA is specifically requesting approval of the UVR setpoints and setpoint methodology contained in the proposed LAR. Therefore, the staff's review of this LAR does not include the adequacy of the proposed changes to address the design vulnerability described in NRC Bulletin 2012-01 "Design Vulnerability in Electric Power System," dated July 27, 2012 (Reference 5), which was referenced in the revised LAR. The staff did not evaluate the adequacy of the proposed changes to mitigate the consequences of events described in the NRC Bulletin 2012-01 that can degrade the capacity, capability, and operability of offsite power systems at the TVA plants.

3.2 NRC Staff's Technical Evaluation of Proposed Changes

An open circuit in one phase of a three-phase power system results in an unbalanced voltage condition on plant buses. The unbalanced voltage condition results in unbalanced current flow that produces negative and zero sequence current. Due to the relative low impedance of motors for negative sequence current, high negative sequence currents can flow during low unbalanced voltage conditions, resulting in overheating of motors in a short time.

TVA performed vulnerability studies for the three nuclear plants to determine the effects of OPC on the Class 1E power system and SSCs. Based on the current licensing basis, 10 CFR Part 50, Appendix A, GDC 17 requirements and the issuance of NRC Bulletin 2012-01, the licensee determined that the existing protection circuitry of the three TVA sites may not detect consequential unbalanced voltage conditions initiated by a degraded power source. The results of this design vulnerability indicated that the affected offsite power source would not be able to supply adequate power to the safety system loads and potentially degrade and/or cause operating equipment to trip due to unbalanced voltage conditions. TVA concluded that existing LOP relays could not detect unbalanced voltage conditions, and additional protective measures were needed.

TVA decided to implement plant modifications for Browns Ferry, Sequoyah, and Watts Bar to install three UVRs (on each of the three phases) on each shutdown board (ESF buses) at each plant for detecting a sustained unbalanced voltage condition. TVA stated that it will install three ABB Type 60Q phase unbalance relays (negative sequence overvoltage) on the 4.16 kV shutdown buses at Browns Ferry and 6.9 kV shutdown buses at Sequoyah and Watts Bar. The relays are combined in a permissive one-out-of-two logic configuration to actuate an annunciator in the main control room (MCR) and initiate a supply breaker trip if sustained unbalanced voltage conditions exceeding a pre-established magnitude and duration are detected. The supply breaker trip results in LOP on the safety-related buses that actuates loss of voltage relays and initiates the start signal for the related onsite power sources. The licensee stated in its letter dated November 19, 2018 (Reference 3), that the hardware modifications have already been installed on all 16 shutdown boards in the TVA fleet. The installed hardware is currently only performing a monitoring function, and upon NRC approval of this LAR, the trip/alarm function will be enabled.

As noted in Section 3.2, "TVA Design Description," of Enclosure 1 to the LAR, and related industry standards referenced in Section 2.3.2 of this SE, voltage unbalance causes additional heating in the connected loads due to the "negative sequence" phase currents. If the voltage unbalance is high, the resulting current unbalance can cause protective devices to trip and

isolate safety-related loads, thereby adversely impacting safe shutdown capability of the plant. At lower levels of voltage unbalance, the higher heating effects experienced during prolonged operation can reduce the qualified life of the equipment resulting in premature failure. The protective relay setpoints have to preclude spurious trips due to short duration unbalanced conditions and extended low level unbalanced voltages within the design margin of the equipment, while actuating for unacceptable unbalanced conditions that can degrade safety-related equipment.

The NRC staff reviewed input assumptions, plant configurations, and licensing basis of the TVA plants and applicable industry standards referenced above and in the LAR to evaluate the adequacy of the proposed setpoints for protection of safety-related equipment from the effects of unbalanced voltage.

3.2.1 Protection Features

The NRC staff reviewed the combined LAR for Browns Ferry, Sequoyah, and Watts Bar to evaluate the proposed changes in electrical design to meet the intent of GDC 17 requirements for onsite and offsite power systems. Specifically, the NRC staff evaluated the capability of the proposed changes to satisfy the GDC 17 requirement for functioning of SSCs important to safety and provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the LOP from the transmission network. The staff noted that the Browns Ferry units are licensed in accordance with the requirements of AEC Criterion 39, which has a similar intent.

An OPC in the offsite power system results in an unbalanced voltage condition in the plant distribution system (Reference 5). In Section 3, "Technical Evaluation," of Enclosure 1 to the LAR, the licensee stated that the new Class 1E UVRs will automatically transfer the medium voltage shutdown boards to the DGs in the event that magnitude of unbalanced voltage levels exceeds a threshold above which any connected Class 1E equipment may be adversely impacted. The Class 1E unbalanced voltage protective function is designed to protect the functionality of the Class 1E equipment from unbalanced voltage. For these facilities, TVA utilized ABB Type 60Q phase unbalance relay (negative sequence overvoltage) because these relays were already qualified for Class 1E applications and can detect unbalanced conditions for varying load conditions. Section 3 of Enclosure 1 provides an overview of the LOP protective schemes and states that the existing loss of voltage and degraded voltage relay schemes remain in place with no changes to their setpoints or time delays.

In Section 3 of Enclosure 1 to the LAR, the licensee also stated that TVA's new Class 1E unbalanced voltage protection scheme provides a means to detect and automatically respond to events that could cause an unbalanced voltage and potentially prevent the connected safety equipment from performing its intended safety function. The licensee further stated:

> The intent of this installation is to provide a Class 1E protection scheme consistent with Browns Ferry, Sequoyah, and Watts Bar's current licensing basis and GDC 17 requirements. The existing protective circuitry is sufficiently sensitive to detect design basis conditions such as a loss of voltage condition or a sustained balanced degraded voltage condition and would separate the Class 1E buses from a connected balanced failed source. The new circuitry is sufficiently sensitive to detect the new design basis condition, unbalanced voltage, and would separate the Class 1E buses from a connected unbalanced failed source.

TVA performed vulnerability studies to determine the effects of open-phase faults that cause unbalanced voltages on the Class 1E power system and SSCs. The NRC staff did not review the TVA vulnerability studies. The licensee evaluated bounding conditions to evaluate unbalanced voltages and UVR setpoints that envelop all events that result in unbalanced voltage conditions, including OPCs on the high voltage and low voltage side of transformers and interconnecting onsite auxiliary power circuits. Since the licensee evaluated bounding conditions, the NRC staff reviewed the LAR and the supplemental information to determine if the licensee's proposed UVRs protect the safety-related equipment from any adverse impact of negative sequence currents resulting from unbalanced voltage conditions.

By letter dated May 18, 2018 (Reference 19), the NRC staff issued a request for additional information (RAI) related to the methodology and analyses performed to establish the proposed UVR setpoints. In the supplement dated June 18, 2018 (Reference 2), the licensee stated that the installed unbalanced voltage detection scheme has the capability to annunciate in the MCR if an unbalanced voltage condition lasting more than 3 seconds is detected by the UVR relays. The licensee has proposed a setpoint of less than or equal to (≤) 1.5 V as measured by the sensing potential transformers. Industry guidance documents identified in Section 2.3.2 of this SE provide guidance on harmful effects of unbalanced voltage conditions in terms of percentage of the unbalance that can occur on plant buses. In EEOB-RAI-1, the NRC staff requested the licensee to provide the corresponding magnitude of the unbalanced voltage on the associated safety bus. In addition, the staff requested the licensee to explain how percentage voltage imbalance is calculated based on negative sequence voltage and whether other sequence components such as zero and positive sequence components were considered in determining the power system unbalance. The staff also requested information on proposed operator actions. In its letter dated June 18, 2018, the licensee stated:

> The alarm relay setpoint alerts the main control room (MCR) operators of an abnormal voltage unbalance and can be used to protect against unacceptable loss of life or long-term motor degradation for the connected Class 1E loads. A maximum voltage unbalance of 2.3 [percent] was used to prevent an unacceptable reduction of service life from the additional heating caused by the voltage unbalance. This setpoint was determined by ensuring the additional heating does not outpace that accounted for in traditional overload protection settings, which only consider balanced conditions.

IEEE Standard 308 -1974 (Reference 12) states:

1) Power Quality: The variations of voltage and frequency in the Class 1E power systems during any design basis event shall not degrade the performance of any load to the extent of causing significant damage to the fuel or to the reactor coolant system.

2) Protective devices: Protective devices shall be provided to limit the degradation of the Class 1E power systems. Sufficient indication shall be provided to identify the actuation of a protective device.

As indicated in Section 2.3.2 of this SE, the LAR references NEMA MG-1-1987 as a guidance document for evaluating the allowable unbalanced voltages in power systems. This standard states that the current at normal operating speed with unbalanced voltages will be greatly unbalanced in the order of approximately 6 to 10 times the voltage unbalance. The increased

current yields additional heating effect in the motor windings. The licensee used motor starting current (5 to 7 times full load current) to evaluate the heating effect in the motors. A conservative motor with locked rotor currency equal to 3.75 times the nominal full load current was considered for 2.3 percent for the alarm setpoint. Using the approximation, temperature rise percent equals 2 times (voltage imbalance percent squared) x 100, indicates that a 2.3 percent voltage unbalance can result in an increase of approximately 11 percent temperature rise in the operating motors. In Section 3.4, "Analytical Limits and UVR Nominal Setpoints," of Enclosure 1 to the LAR, the licensee stated the UVR alarm and trip setpoints ensure that the heating effect from unbalanced voltage conditions does not outpace the heating effect considered for traditional overload protection such as heating from locked rotor current during motor starts. Since the UVR setpoints will ensure that heating from unbalanced voltage conditions is less than the rate of heating expected during normal motor starts, the NRC staff finds the use of the motor starting current in support of determining the heating effect reasonable and acceptable. In accordance with guidance provided in IEEE Standard 308-1974, the licensee is implementing unbalanced voltage relays that will protect the equipment required for reactor core cooling and limiting the potential degradation of motors related to heating effects. The alarm function will identify the actuation of a protective device.

The LAR proposed the following low trip setpoints:

- ≤ 3.4 V unbalance for an allowable duration of 8.65 sec for Browns Ferry units,
- ≤ 3.3 V for an allowable duration of 10 sec for Sequoyah units, and
- ≤ 3.3 V for an allowable duration of 10 sec for Watts Bar units.

In EEOB-RAI-1, the NRC staff also requested information on percentage of voltage unbalance with respect to proposed trip setpoints. In its letter dated June 18, 2018 (Reference 2), the licensee stated:

> The low trip relay setpoint protects the point at which the required safety loads must perform their safety function during a voltage unbalance for all anticipated transients, operational occurrences, and design basis events. The industry standard, National Electrical Manufacturers Association (NEMA) MG-1, "Motors and Generators," recommends not exceeding 5% voltage unbalance for motor operation. Therefore, a maximum voltage unbalance of 5% was used to determine the time delay that is no greater than the safety analysis time allowed for the emergency DGs (EDGs) to come up to rated speed and voltage and be ready to accept load."

Section 3.2, "TVA Design Description," of Enclosure 1 to the revised LAR (Reference 3) states:

> The "low trip" setpoint protects against loss of safety function on offsite power (i.e., ensures "everything works") by ensuring no motors trip on current for running or starting and no motors fail to start including during LOCA [loss-of-coolant accident] sequencing. The associated time delay is based on the safety analysis limit for the DG start time.

The purpose of phase unbalanced voltage protection is to prevent motor overheating damage. A small voltage unbalance produces a large negative sequence current flow in induction motors. IEEE Standard 3004.8-2016, "IEEE Recommended Practice for Motor Protection in Industrial

and Commercial Power Systems" (Reference 14), provides an approximate relationship between voltage unbalance and negative sequence current magnitude that can degrade motor insulation. The IEEE standard states, in part:

> The per-unit negative sequence impedance of a motor is approximately equal to the reciprocal of the rated voltage per-unit locked rotor current. When, for example, a motor has a locked rotor current equal to six times rated current, the motor has a negative sequence impedance of approximately 0.167 per unit (16.7 percent) on the motor rated input kilovolt ampere base. When voltages having a 0.05 per-unit negative sequence component are applied to the motor, negative sequence currents of 0.30 per unit flow in the windings. Thus, a 5 percent approximate in voltage unbalance produces a stator negative sequence current equal to 30 percent of full load current. This situation can lead to a 40 percent to 50 percent increase in temperature rise.

As discussed in Section 2.3.2 of this SE, NEMA MG-1 is a widely used guidance document for purchase of motors. The NRC staff noted that NEMA MG-1 indicates that a 5 percent unbalanced voltage can result in excessive heating in motors, the locked-rotor torque and breakdown torque are decreased when the voltage is unbalanced, and if the voltage unbalance is extremely severe, the torques might not be adequate for the application. The full-load speed is reduced slightly when the motor operates with unbalanced voltages. The low trip point of the UVRs is set below the maximum allowable 5 percent magnitude of allowable unbalanced voltage discussed in NEMA MG-1 and IEEE Standard 3004.8-2016. The actuation time delay for UVRs is below the time allowed for onsite power systems to start and accept loads. This will ensure that the safety-related loads that may be operating during sustained unbalanced voltage conditions emanating from the offsite power source are separated in a timely manner. The time delay will also preclude spurious actuations during transient voltage conditions resulting from system perturbations. Therefore, the NRC staff finds the proposed trip setpoints (low) and associated time delays for the three plants to be acceptable.

The LAR proposed the following high trip setpoints:

- ≤ 20.0 V unbalance for an allowable duration of 3.5 seconds for Browns Ferry units,
- ≤ 20.0 V for an allowable duration of 4 seconds for Sequoyah units, and
- ≤ 20.0 V for an allowable duration of 4 seconds for Watts Bar units.

The licensee, in its letter dated November 19, 2018 (Reference 3), Section 3.2, stated:

> Utilizing the setpoint methodology, alarm, low trip, and high trip setpoints were determined. The "alarm" setpoint protects against long term motor degradation or "loss of life" and is based on ANSI allowable values. The associated time delay allows for clearing anticipated ground faults. The "low trip" setpoint protects against loss of safety function on offsite power (i.e., ensures "everything works") by ensuring no motors trip on current for running or starting and no motors fail to start including during LOCA sequencing. The associated time delay is based on the safety analysis limit for the DG start time. The "high trip" setpoint protects the ability to survive the unbalance and transfer required safety loads to the DGs by ensuring no motors trip on current for running or starting.

> The associated time delay is based on survival time at 100% voltage unbalance. Setpoint determination is not scenario driven making them independent of grid operation, transformer configuration, generation conditions, loading conditions, or anything outside the Class 1E boundary. The setpoints are determined for equipment protection to ensure Class 1E equipment will operate within their capability limits, irrespective of upstream conditions and connections.

The licensee also stated that the upper time delay limit for the high trip setpoints is less than the minimum design time allowed for motor starting, adjusting for additional current created by unbalanced voltages, and less than the tripping time of overcurrent protective devices during unbalanced voltage conditions. The licensee stated (Reference 2) in response to EEOB-RAI-1 that, "The high trip relay setpoint provides faster tripping time for high-level voltage unbalances, where catastrophic load failure may occur within a few seconds. Using a bounding analytical method, a maximum voltage unbalance of 100 percent was used to determine the time delay prior to catastrophic failure."

In response to the NRC staff's request for percentage magnitude of unbalanced voltage conditions evaluated, in its letter dated June 18, 2018 (Reference 2), the licensee provided additional details on the allowable magnitude of the unbalanced voltage. The licensee stated:

> This analytical technique utilizes the assumption of a 100 [percent] unbalanced voltage condition, which bounds all resulting unbalanced voltage values that could occur from an OPC in the offsite power source. The results show that for the highest magnitude of consequential unbalanced voltage condition resulting from any event, the shutdown board would be disconnected from offsite power after the high trip relay time delay and subsequently loaded to the EDG. This is consistent for all three sites.

Since the existing overload protection allows adequate time delay for motor starting current, and the UVR trip time delay is less than the overload protection time delay, the staff concludes that safety-related motors will not trip and lock out during unbalanced voltage conditions. In response to EEOB-RAI-4, the licensee also stated:

> The high trip setpoint is established to ensure all Class 1E loads required for postulated design basis accidents would successfully auto-transfer to the onsite power supply if the UVR monitored bus experiences high magnitude unbalanced voltage conditions.

Based on the information provided by the licensee, the staff concludes that the upper high trip setpoints will adequately protect the motors from heating effects resulting from maximum postulated unbalanced voltage conditions, and the Class 1E motors will be available for mitigating the consequences of postulated events after UVRs actuate and the degraded power source is isolated. This will maintain conformance with the GDC 17 requirement for assuring that safety-related equipment is available for performing its intended functions.

3.2.2 Reliability and Functional Capability of Protection Schemes

In Section 2.1, "Reason for the Proposed Change," of Enclosure 1 of its letter dated November 19, 2018 (Reference 3), the licensee stated:

For this fleet submittal, the reason for the proposed change is to provide equipment protection from the effects of an unbalanced voltage in a similar fashion to the existing degraded and loss of voltage protection schemes. The identification of the vulnerability was based on industry operating experience.

GDC 17 requires the offsite and onsite power sources to be able to perform the required safety functions assuming either source is not available. The licensee described accident analyses for each nuclear plant and provided information on the response time for equipment required to safely shut down the plant in the event of postulated accidents and anticipated operational occurrences. The NRC staff questioned whether the UVR relays were capable of detecting and initiating protective actions during condition(s) when the plant buses are lightly loaded and the magnetization effects in transformer windings may mask an unbalanced voltage caused by an open phase that is not a visually observable condition. The licensee's response to EEOB-RAI-2 (June 18, 2018, supplement (Reference 2)), includes the following salient points:

- Long-term low levels of voltage unbalanced conditions are normally present in the power systems and do not adversely impact the operating equipment.

- The alarm setpoint alerts operators when the magnitude of unbalanced conditions on the safety buses reaches a threshold that can result in unacceptable "loss of life" or long-term motor degradation for the connected Class 1E loads.

- Any open phase that is not visually observable and does not produce measurable effects that establish the existence of a degraded condition (i.e., relay actuation), is an acceptable configuration that will not adversely affect the function of any of the connected Class 1E equipment.

  The trip setpoints were selected to ensure that if the offsite power system is incapable of performing its design function with respect to unbalanced voltage, the relays actuate to transfer from the offsite power system to the onsite power system.

The licensee also stated that, "The UVR alarm relay setpoints do not protect against a loss of safety function (e.g., offsite power system capability) referred to in GDC 17," and concluded, "if the unbalanced voltage condition does not reach the trip setpoints, there is no effect on equipment function and no protection is needed."

Based on the licensee's assertion that operating equipment can tolerate a long-term low level of unbalanced voltage conditions, the NRC staff concludes that the proposed setpoints for the UVRs provide adequate protection over the range of postulated unbalanced voltage conditions and, if during open phase conditions the magnetizing effects in large transformers result in balanced voltages within the allowable tolerances, then the UVRs do not actuate. The staff noted that the UVRs do not detect or afford protection for a loss of safety function (i.e., capacity and capability of the GDC 17 related offsite power system when open phase conditions or unbalanced voltages exist during light load conditions).

The NRC staff requested a description of the sequence of events for the Browns Ferry, Sequoyah, and Watts Bar units when emergency loads need to start during postulated accident conditions and anticipated operational occurrences, in the event that an unbalanced voltage condition was present and not detected. In response to EEOB-RAI-3, the licensee indicated (Reference 2) that at Browns Ferry, the auxiliaries of each unit are connected to an offsite

source via the main transformer, and the generator has an output breaker that opens on a unit trip. For normal operation with the unit online, the licensee stated:

- A unit trip can result in an automatic unbalanced voltage alarm with no automatic protective action (i.e., shutdown board transfer) required, because the unbalanced voltage level would be below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds after the unit trip.

- With the initiation of an accident signal, a loading change from "normal" to "design basis accident" loading would result in no automatic alarm or trip associated with the UVRs, because the unbalanced voltage level would be below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged.

- Initiation of an accident signal and a subsequent unit trip can produce an unbalanced voltage alarm, but would not produce automatic protective actions, because the unbalanced voltage level would be below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds after the unit trip.

When a Browns Ferry unit is offline, an undetected unbalanced voltage condition exists and the auxiliaries are supplied through the main transformer. The licensee stated:

> An accident signal changes the loading from "refuel" to "design basis accident" loading and results in no automatic alarm or trip associated with the UVRs. No detection is required because the unbalanced voltage level is below all setpoints. Equipment functionality and life expectancy are not challenged.

In the event that a Browns Ferry unit is offline and powered from either CSST, then an accident signal changes the loading from "refuel" to "design basis accident" loading and results in no automatic alarm or trip associated with the UVRs. The licensee stated that detection is not required because the unbalanced voltage level is below all setpoints, and equipment functionality and life expectancy are not challenged.

For the Browns Ferry units, the licensee concluded that any unbalanced voltage condition, including a condition resulting from an OPC that is not detected because of light load conditions, will not result in bus transfer to the onsite source when the load changes due to an accident signal. Based on the information provided in response to EEOB-RAI-3, the NRC staff accepts the licensee's clarification that the response time of equipment required for mitigating the consequences of postulated events at the Browns Ferry units is not adversely impacted by the installation of UVRs.

For the Sequoyah units, the auxiliaries of each unit are connected to an offsite source via the main transformer, and the generator has an output breaker that opens on unit trip. For the normal operation with a unit online, the licensee, in its response to NRC staff RAIs dated June 18, 2018 (Reference 2), stated:

- A unit trip can result in an automatic unbalance voltage alarm with no automatic protective action (i.e., shutdown board transfer) required, because the unbalanced voltage level is below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds after unit trip.

- With the initiation of an accident signal, a loading change from "normal" to "design basis accident" loading would result in no automatic alarm or trip associated with the UVRs, because the unbalanced voltage level would be below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged.

- Initiation of an accident signal and a subsequent unit trip can produce an unbalanced voltage alarm, but would not produce automatic protective actions, because the unbalanced voltage level would be below the UVR trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds after the unit trip.

Similar to the Browns Ferry units, when a Sequoyah unit is offline, an undetected unbalanced voltage condition exists (with or without an OPC), and the auxiliaries are supplied through the main transformer. The licensee stated in its letter dated June 18, 2018 (Reference 2), that:

> An accident signal changes the loading from "refuel" to "design basis accident" loading and results in no automatic alarm or trip associated with the UVRs. No detection is required because the unbalanced voltage level is below all setpoints. Equipment functionality and life expectancy are not challenged.

When the Sequoyah buses are supplied through CSSTs, the licensee provided the following details:

- Starting from refuel conditions bounds starting from normal operation.

- In the event that the maximum grid unbalanced voltage cannot be detected by the UVRs on the medium voltage shutdown board with refuel conditions, then an accident signal changes the loading from "refuel" to "design basis accident" loading and results in no automatic alarm or trip associated with the UVRs. No detection is required, because the unbalanced voltage level is below all setpoints. Equipment functionality and life expectancy are not challenged.

- An OPC cannot remain undetected by connected UVRs on the medium voltage shutdown board under refuel conditions. The licensee did not identify a loading case that cannot be detected by the UVRs.

Similar to the Browns Ferry units, for the Sequoyah units, the licensee concluded that any unbalanced voltage condition, including a condition resulting from an OPC that is not detected because of light load conditions, will not result in bus transfer to the onsite source when the load changes due to an accident signal. Based on the assumptions that the station auxiliary system is connected to the offsite power source through the main transformers, that a unit trip maintains

the same connection, and that the unbalance in the power system remains within the allowable threshold, the NRC staff concludes that the response time of equipment required for mitigating the consequences of postulated events at the Sequoyah units should not be adversely impacted by the installation of UVRs.

As shown in the Watts Bar electrical distribution system diagram in Attachment 4.1 of the November 19, 2018 (Reference 3), supplement, the Watts Bar units do not have generator circuit breakers, and the Watts Bar design and licensing basis requires that the Class 1E loads remain connected to the grid through CSSTs C and D. However, the NRC staff noted that in the supplement dated June 18, 2018 (Reference 2), the licensee describes the potential connection through CSSTs A and B, which provide bounding conditions after considering the unbalanced voltage conditions by using the lightest loading (refueling) and heaviest loading (accident) for any anticipated operational event. The licensee's response to the RAI (Reference 2) details two scenarios:

1. Maximum grid unbalance that cannot be seen by the connected unbalanced alarm relay on the medium voltage shutdown board with refuel conditions. For this scenario, the licensee stated, "An accident signal changes the loading from "refuel" to "design basis accident" loading and results in an automatic unbalance voltage alarm with no automatic protective action (i.e., shutdown board transfer), because the unbalanced voltage level is below the trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds."

2. Open phase that cannot be seen by the connected unbalanced alarm relay on the medium voltage shutdown board under refuel conditions. For this scenario, the licensee stated that, "An accident signal changes the loading from 'refuel' to 'design basis accident' loading and results in an automatic unbalanced voltage alarm with no automatic protective action (i.e., shutdown board transfer), because the unbalanced voltage level is below the trip setpoints. Equipment functionality and life expectancy are not challenged. When the automatic alarm setpoint is met, the MCR alarm will occur in approximately three seconds."

The licensee concluded that no instance at Watts Bar was identified where an existing unbalanced voltage condition that could not be detected for an extended duration would result in an automatic transfer to the onsite power source for any anticipated operational occurrence. Based on the information provided in response (Reference 2) to EEOB-RAI-3, the NRC staff finds the licensee's statement that the response time of equipment required for mitigating the consequences of postulated events at the Watts Bar units is not adversely impacted by the installation of UVRs acceptable.

In the supplemental response dated June 18, 2018 (Reference 2), the licensee stated:

> The sequence of events for the TVA fleet does not change from current design and licensing basis during the period of operation when an unbalanced voltage is not detected coincident with a subsequent event. Additionally, the response times for emergency loads in both accident and non-accident conditions for the GDC 17 offsite power circuit that is designed to be available within a few seconds following a loss-of-coolant accident remains unchanged.

The response further states that in the event that the UVRs at the Browns Ferry, Sequoyah, and Watts Bar units do not detect unbalanced voltage conditions due to low load or light load conditions, the response time of safety-related equipment is not impacted. Based on the details

provided in the plant-specific evaluation of light load conditions discussed above, the NRC staff concludes that the response time of equipment, as assumed in the plant-specific accident analysis required for mitigating the consequences of postulated events at the TVA fleet is not adversely impacted by the installation of UVRs.

Industry standards such as IEEE 603-1991 (Reference 13) recommend coincidence logic for measurement channels and protective channels used at nuclear plants. In general, the intent of coincidence logic is to preclude inadvertent operation of a logic scheme to actuate protective actions based on (spurious) operation or detection by a single element. Coincidence logic used in LOV relay schemes precludes spurious trips of the offsite power source. This requirement is translated into design by using several sensing elements and combining the output from at least two elements (coincident logic) measuring similar parameters to actuate required actions. This method provides reasonable assurance that the sensing elements have independently detected a valid abnormality. The licensee, in its letter dated November 19, 2018 (Reference 3), stated that at each of the units at Browns Ferry, Sequoyah, and Watts Bar, the unbalanced voltage function is monitored by three UVRs for each SBDB. To improve the reliability and security of the UVR scheme, detection outputs of the relays are arranged in a permissive one-out-of-two logic configuration. Therefore, if one of the UVRs were to spuriously actuate with no unbalanced conditions present, the remaining relays on the bus would not actuate, and the permissive one-out-of-two logic would not be satisfied, precluding an inadvertent separation of offsite power.

In EEOB-RAI-5 (Reference 19), the NRC staff questioned the margin between the UVR setpoints and normal unbalances in the power systems that frequently occur in the interconnected power systems. In the supplement response dated June 18, 2018 (Reference 2), the licensee stated:

> There have been 176 data points captured as of April 15, 2018, that document transitory and anticipated operational occurrences that produce unbalanced voltages at the Class 1E boundary. Significant margin (typically > 1000 [percent]) to the final low and high trip setpoints was experienced for transient events in the fleet during the monitoring phase.

The licensee concluded that:

> In addition to the insight provided by data point triggers, the lack of data points for events such as lightning strikes, board transfers, main generator power level changes, outage activities, transfer from 161 kV to 500 kV switchyards, hot functional testing, loss of phase not directly connected to safety bus, and spurious SI signal, validates that there are no negative unbalanced voltage effects for these types of events.

In EEOB-RAI-6 (Reference 19), the NRC staff questioned the independence of each UVR sensing circuit channel to evaluate the consequences of failure modes of the components in the sensing circuits. In the supplement dated June 18, 2018 (Reference 2), the licensee stated:

> Channel independence requirements (i.e., between the two separate onsite power sources) is carried throughout the standby power system in accordance with the TVA licensing basis. Independence and separation, from sensor through the devices actuation the protective function are in conformance with the licensing basis of the TVA plants for the standby power system.

The licensee's UVR design is in conformance with the licensing basis of the TVA plants as follows:

- A separate UVR protection scheme is installed for each shutdown board/EDG.

- Each new UVR scheme utilizes the existing sensor as input to the UVRs and the existing logic and actuating device for the action, as the undervoltage protection schemes (e.g., loss of voltage and degraded voltage), without modification.

- There is no connection/communication between separate UVR installations associated with separate shutdown boards, consistent with the existing undervoltage protection schemes.

The licensee stated that there is significant margin (typically > 1000 [percent]) between the normal unbalanced voltage conditions and relay setpoints. The licensee also stated that the UVR configuration is similar to the existing configuration of the LOP relays with adequate electrical separation between each sensing scheme. Based on these statements, the NRC staff concludes that the design of UVRs at the TVA plants will not spuriously actuate in the event of a single relay failure or momentary transient in the power system. Therefore, the NRC staff finds there is reasonable assurance that the UVRs will not spuriously actuate to separate the Class 1E buses from the offsite power source due to transient unbalanced voltages or single relay failure.

3.3 NRC Staff Evaluation of Licensee Unbalanced Voltage Setpoint Methodology

Using the regulatory requirements and guidance shown in Section 2.0 of this SE, the NRC staff reviewed the LAR to verify the adequacy of the setpoint values to assure, with a high confidence level, that the required protective actions are initiated before the associated plant process parameter exceeds its analytical limit.

The NRC staff reviewed TVA's design information and the corresponding TS proposed changes to evaluate the adequacy of the setpoints.

Unbalanced Voltage Setpoint Methodology

The revised LAR dated November 19, 2018 (Reference 3), states that the UVR setpoint methodology is based on the design requirements of the connected Class 1E loads and allowable duration of unbalanced voltage conditions for safety-related equipment. The licensee used accepted industry standards for establishing AVs.

The degraded voltage and unbalanced voltage relays protect functionality of Class 1E equipment from degraded voltage sources. They provide equivalent protection from a voltage degradation perspective, that is, the DVR protects plant equipment during three phase balanced low voltage conditions, and the UVR protects plant equipment during phase unbalance conditions. Since both sets of relays use common sensing circuits, the tolerances are identical for the common part of the circuits.

The licensee, in its letter dated June 18, 2018 (Reference 2), provided responses to NRC RAIs related to the LAR. In response to EEOB-RAI-1, the licensee stated that the magnitude of

unbalanced voltage considered on each bus was from zero to 100 percent. The NRC staff relied on industry accepted guidance documents, such as NEMA MG-1, to evaluate the adequacy of the proposed UVR setpoints. The NRC staff also used IEEE 741-1997, which refers to the ANSI/ISA S67.04 Part I – 1994, "Setpoints for Nuclear Safety-Related Instrumentation" (Reference 17), which in turn describes technical issues that are related to the establishment of the AV and trip setpoints for nuclear safety-related instrumentation.

Proposed TVA Analytical Limit from the NEMA Standard MG-1 Recommendation

NEMA MG-1 (Reference 11), Section 14.36, "Effects of Unbalanced Voltages on the Performance of Polyphase Induction Motors," states, in part, that, "When the line voltages applied to a polyphase induction motor are not equal, unbalanced currents in the stator windings will result. A small percentage voltage unbalance will result in a much larger percentage current unbalance." That is because the motor will create additional heating that is detrimental to its operation.

In Figure 14.1, "Medium Motor Derating Factor Due to Unbalanced Voltage," of NEMA MG-1, the derating curve shows when voltages are unbalanced, the rated horsepower of the motor should be multiplied by the factor to reduce the possibility of damage to the motor, as shown in Figure 3.3-1 below.

Figure 3.3-1: Figure 14.1 of the NEMA-MG1

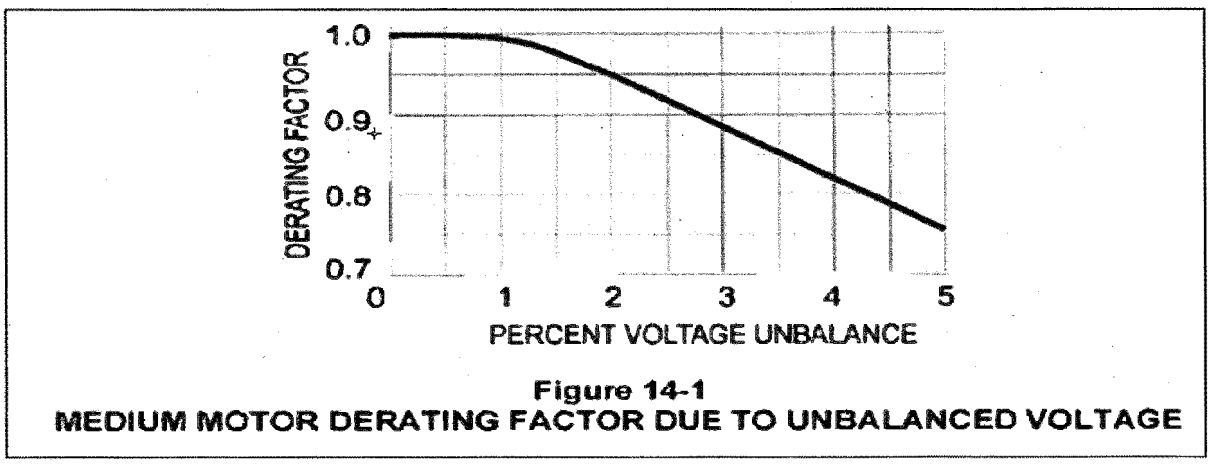


Figure 14-1
MEDIUM MOTOR DERATING FACTOR DUE TO UNBALANCED VOLTAGE

NEMA MG-1 states, in part, that, "Operation of the motor above a 5-percent unbalance voltage condition is not recommended."

In Section 3.2 of the LAR, the licensee referred to this recommendation. Additionally, in Section 3.4 of the LAR, "Analytical Limits and UVR Nominal Setpoints," the licensee stated, in part, that, "In order to determine the analytical limits for the unbalanced voltage relays, a supporting analysis is done based on load requirements, and independent of characteristics of the incoming power source." The underlying basis behind these allowable limits for unbalanced voltage and associated time delays is accepted industry standards.

In Section 3.2 of ISA-67.04.01-1994, which is endorsed within NRC RG 1.105, the definition of analytical limit (AL) is: "Limit of a measured or calculated variable established by the safety analysis to ensure that a safety limit is not exceeded."

Based on the requirements of 10 CFR 50.36(c)(1)(ii)(A), 10 CFR 50.57(a)(3), and the AL definition above, the NRC staff used the industry standard NEMA MG-1 recommendation to determine the acceptability of "5 percent of operating voltage" as the AL for the proposed UVR.

The licensee proposed an AL of 5 percent of unbalanced voltage, which is consistent with the industry standard recommendation. The UVR operates on 120 V sensing circuits. The shutdown boards have potential transformers that convert the shutdown board nominal voltage (6.9 kV or 4.16 kV) to 120 V for the sensing circuits. A 5 percent unbalance correlates to 6V in the sensing circuit.

The UVR setpoints should ensure that voltage unbalances higher than 6 V are detected with minimum delay time. The proposed setting of the new UVR is described in Figure 3.2, "TVA UVR Allowable Value and Trip Setpoints Relationships," below. The licensee has proposed maximum short time high unbalance AV of 20 V, which is based on factors such as maximum limit of voltage unbalance to prevent motor stalling and preclude unnecessary bus power source trips. This relay provides a faster tripping time for high-level unbalances to protect against catastrophic load failures.

Therefore, to protect the motors from overheating due to unbalanced currents, the NRC staff accepts the industry standard recommendation of 5 percent unbalanced voltage for calculating the setpoints.

UVR Logic Configuration

The proposed UVR of the three TVA sites would be configured in a permissive one-out-of-two logic based on the voltage monitoring between phases A-B, A-C, and B-C of ESF buses. This logic will generate a supply breaker trip.

Unbalanced Voltage Trip Setpoints

The NRC staff followed the guidance in RG 1.105, Revision 3, to independently confirm whether there are adequate margins for instrument channel performance uncertainty between the AL to nominal trip setpoint and associated AV to satisfy the requirements of 10 CFR 50.57(a)(3) and 10 CFR 50.36(c)(1)(ii)(A).

Based on Section 3 (Definitions) and Section 4 (Establishment of Setpoints) of (ANSI)/ ISA 67.04.01-1994 (Reference 17), the total loop uncertainty, AV margin, and ABB instrument errors (IEs) are defined below.

> Nominal Trip Setpoint (NTSP) is a predetermined value for actuation of the final actuation device to initiate protection action.
>
> Total Loop Uncertainty (TLU) is total amount by which an instrument channel's output is in doubt (or the allowance made for such doubt) due to possible errors, either random or systematic. The uncertainty is generally identified within a probability and confidence level. Random error is described as a variable whose value at a particular future instant cannot be predicted exactly but can only be estimated by a probability distribution function. Bias is an uncertainty component that consistently has the same algebraic sign and is expressed as an estimated limit of error.

Allowable Value (AV) is a limiting value that the trip setpoint may have when tested periodically, beyond which appropriate action shall be taken.

AV Margin is an allowance provided between the Maximum AV and the AL, which is dependent on the process measurement uncertainties, the instrument accuracies and the calibration errors, but does not include error due to instrument drift;

ABB Instrument Errors

In the ABB instruction manual (Reference 20), Section 4.3.1, "Trip Setpoint," the repeatability tolerances of relays are plus or minus (±) 0.25 percent typical (in the operating voltage variation of ± 10 percent of control voltage (108 V -132 V)) and ± 5.00 percent typical (over the temperature range of -20 to +55 degrees C). These tolerances and instrument errors are included in the list of the "not-all inclusive" uncertainties of Section 4.3.1, "Trip Setpoint," of ISA-S67.04.

The TLU, on an increasing process, and the AV and NTSP margins would be calculated by the following equations:

TLU (A)	=	AL – Low NTSP
IE UVR Voltage (B)	=	± (0.25% + 5%) typical
	=	± 5.25% typical
Maximum Low NTSP	=	Low NTSP + B
Minimum Low NTSP	=	Low NTSP - B
Margin AV (C)	=	AL – Max AV
Margin C %	=	(C / A) x 100%

Not detectable is less than (<) 1.2 V (1 percent of 120V): Figure 14-1 of NEMA MG-1, as shown above, the derating factor of 0 percent to 1 percent unbalanced voltage is 1 (i.e., no derating applies for up to 1 percent unbalanced voltage). Therefore, the motor can withstand 1 percent (1.2 V) of the unbalanced voltage and the error in the ABB relay is acceptable.

NRC Staff Evaluation of Setpoints

- Section 4.3.2 of ISA-S67.04 states, "A channel whose trip setpoint as-found condition exceeds the AV should be evaluated for operability, considering the setpoint calculation methodology."

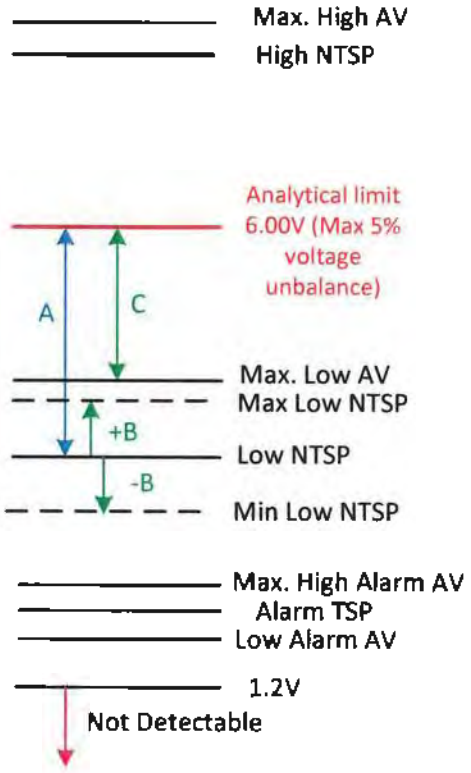
- As shown in Figure 3.3-2, "TVA UVR AV and Trip Setpoints Relationships," below, the upper analytical limit of UVR time delay that is typically only a few seconds (around 3 to 4 seconds) and the lower analytical limit of UVR time delay (equal or less than (≤) 10 seconds) are consistent with the inverse time relationship between unbalanced voltage and motor thermal damage discussed in NEMA MG-1.

The NRC staff evaluated the maximum low AV and low NTSP of the proposed UVR of the three TVA sites to determine if these setpoints for loss-of-voltage safety-related instrumentation are established and maintained within the AL limits. The NRC staff illustrated the relationship between the AV and NTSP settings for the new UVR (no scale) for all three sites in Figure 3.3-2. To protect the motors from overheating due to unbalanced currents, the NRC staff used the industry standard recommendation of 5 percent unbalanced voltage for calculating the setpoints.

IEEE Standard 3004.8-2016 (Reference 14) recommends a time delay for relay operation when using negative sequence current detection relays or unbalanced voltage relays. The time delay should be long enough to preclude spurious trips and short enough (2 to 3 seconds) for voltage unbalances greater than 5 percent to preclude insulation damage.

Figure 3.3-2: TVA UVR Allowable Value and Trip Setpoints Relationships

TVA UVR Allowable Value & Trip Setpoints Relationships



Plant		Allowable Value (AV)	Nominal Trip Setpoint (NTSP)
BFN (4.16 kV)	High / Time	≤ 20V@ 3.5 sec	19.5V @ 3.18 sec
	Low / Time	≤ 3.4V @ 8.65 sec	3.23V @ 7.86 sec
	Alarm / Time	≤ 1.5V @ 3 sec	1.34V @ 2.60 sec
SQN (6.9 kV)	High / Time	≤ 20V @ 4 sec	18.13V @ 3.95 sec
	Low / Time	≤ 3.3V @ 10 sec	2.96V @ 9.95 sec
	Alarm / Time	≤ 1.5V @ 3 sec	1.3V @ 2.95 sec
WBN (6.9 kV)	High / Time	≤ 20V @ 4 sec	18.13V @ 3.95 sec
	Low / Time	≤ 3.3V @ 10 sec	2.96V @ 9.95 sec
	Alarm / Time	≤ 1.5V @ 3 sec	1.3V @ 2.95 sec

A: Total Allowance; B: Setting Tolerance; C: Max Low AV Margin

Based on its review of the licensee's application and supplements, the NRC staff finds that the proposed settings provide automatic protective action that will correct the abnormal situation before a safety limit is exceeded. Therefore, the changes provide reasonable assurance that the licensee will comply with the regulations in 10 CFR 50.57(a) and that the health and safety of the public will not be endangered. The NRC staff's evaluation is based on applicable regulatory requirements identified in Section 2.3.1 of this SE (i.e.,10 CFR 50.36(c)(1)(ii)(A), Criterion 3 of 10 CFR 50.36(c)(2), 10 CFR 50.57(a), GDC 13, and AEC Criterion 12). On this

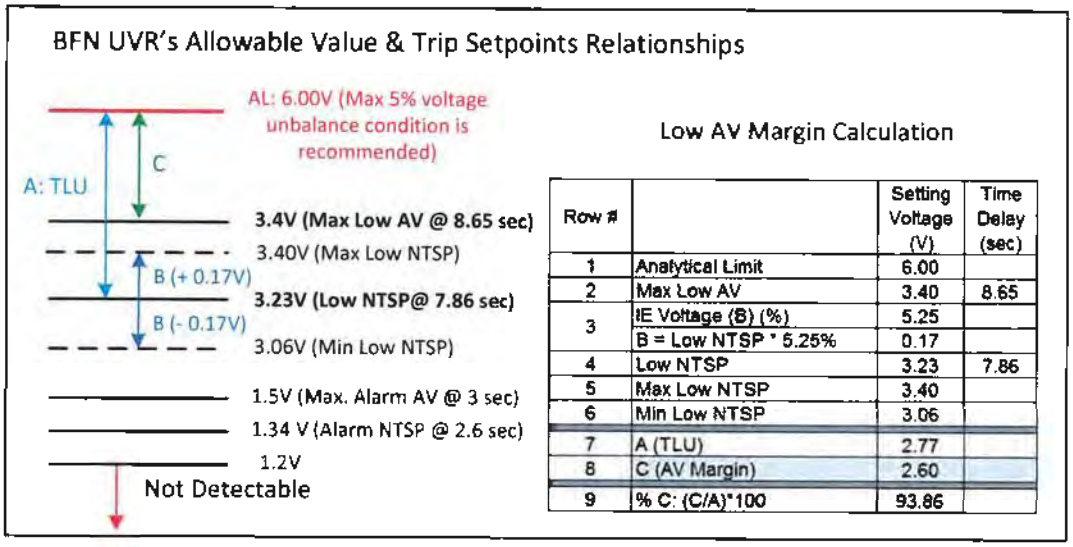
basis, the NRC staff determines that the proposed TS changes discussed in this section are acceptable.

3.3.1 Browns Ferry Unbalanced Voltage Setpoints Evaluation

The NRC staff evaluated the licensee's proposed AV and NTSP and their associated time delay for the 4.16 kV undervoltage (unbalanced voltage) of the Browns Ferry shutdown board.

The relationship between the low AV and NTSP of the Browns Ferry UVR is illustrated in Figure 3.3-3, "NRC Margin Calculation for Browns Ferry," below.

Figure 3.3-3: NRC Margin Calculation for Browns Ferry



Low AV Margin Calculation

Row #		Setting Voltage (V)	Time Delay (sec)
1	Analytical Limit	6.00	
2	Max Low AV	3.40	8.65
3	IE Voltage (B) (%)	5.25	
	B = Low NTSP * 5.25%	0.17	
4	Low NTSP	3.23	7.86
5	Max Low NTSP	3.40	
6	Min Low NTSP	3.06	
7	A (TLU)	2.77	
8	C (AV Margin)	2.60	
9	% C: (C/A)*100	93.86	

The NRC staff used the equations in Section 3.3 of this SE to independently calculate the margins from AL to max AV and max low NTSP. The NRC staff verified that:

- The UVR value of maximum (Max) low NTSP voltage remains less than the max AV voltage.
- The UVR value of minimum (Min) low NTSP voltage is higher than the max alarm AV.
- The margins as indicated (Row 9) in Figure 3.3-3 above are adequate at a value greater than 93 percent to assure that a trip or safety actuation will occur automatically and significantly before the measured process reaches the AL level.

Based on the reviews and evaluation above, the NRC staff finds that the 4.16 kV bus unbalanced voltage setpoints and their associated time delays for the new Browns Ferry UVR are acceptable. The proposed settings have been chosen so that automatic protective action will correct the abnormal situation before a safety limit is exceeded. These proposed settings are consistent with RG 1.105 and satisfy the requirements of 10 CFR 50.36(c)(1)(ii)(A) and 10 CFR 50.57(a)(3).

Therefore, the NRC staff has determined that the undervoltage setpoints for Browns Ferry's UVR provide reasonable assurance that the licensee will comply with the regulations in this

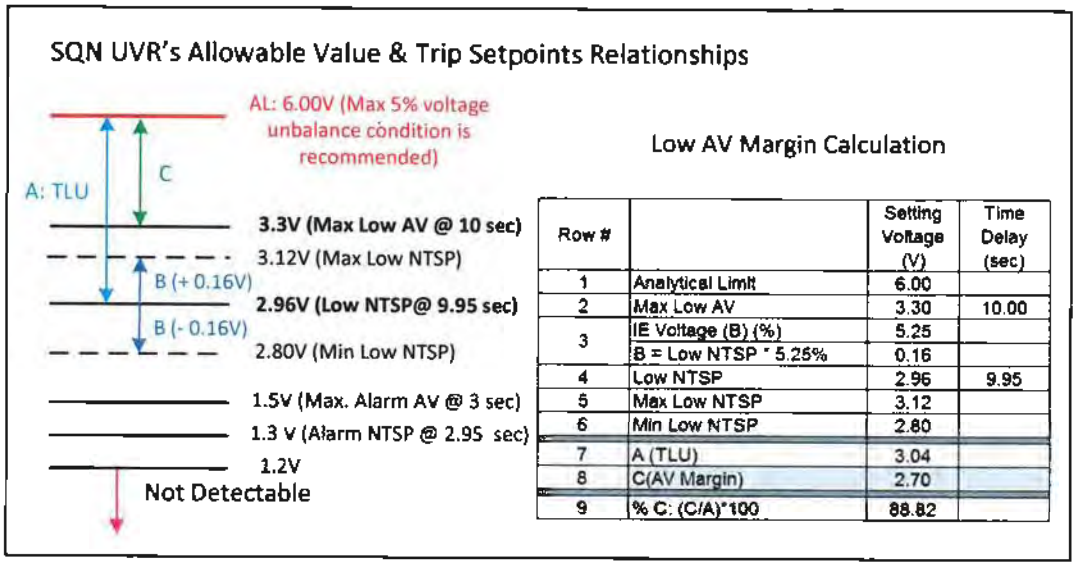
chapter and that the health and safety of the public will not be endangered, and therefore, are acceptable for inclusion into the Browns Ferry TSs.

3.3.2 Sequoyah Unbalanced Voltage Setpoints Evaluation

The NRC staff evaluated the licensee's proposed low AV and NTSP and their associated time delays for the 6.9 kV undervoltage (unbalanced voltage) of the Sequoyah shutdown board.

The relationship between the AV and NTSP of the Sequoyah UVR is illustrated in Figure 3.3-4, "NRC Margin Calculation for Sequoyah," below.

Figure 3.3-4: NRC Margin Calculation for Sequoyah



Low AV Margin Calculation

Row #		Setting Voltage (V)	Time Delay (sec)
1	Analytical Limit	6.00	
2	Max Low AV	3.30	10.00
3	IE Voltage (B) (%)	5.25	
	B = Low NTSP * 5.25%	0.16	
4	Low NTSP	2.96	9.95
5	Max Low NTSP	3.12	
6	Min Low NTSP	2.80	
7	A (TLU)	3.04	
8	C(AV Margin)	2.70	
9	% C: (C/A)*100	88.82	

The NRC staff used the equations in Section 3.3 of this SE to independently calculate the margins from AL to max AV and max low NTSP. The NRC staff verified that:

- The UVR value of maximum (max) low NTSP voltage remains less than the max AV voltage.
- The UVR value of minimum (min) low NTSP voltage is higher than the max alarm AV.
- The margins (as indicated (row 9) in Figure 3.3-4 above) are adequate at a value greater than 88 percent to assure that a trip or safety actuation will occur automatically and significantly before the measured process reaches the AL level.

Based on the reviews and evaluation above, the NRC staff finds that the 6.9 kV unbalanced voltage setpoints and their associated time delays for the new UVR of Sequoyah are acceptable. The proposed settings have been chosen so that automatic protective action will correct the abnormal situation before a safety limit is exceeded. These proposed settings satisfy the requirements of 10 CFR 50.36(c)(1)(ii)(A).

Therefore, the NRC staff has determined that the undervoltage setpoints for Sequoyah's UVR provide reasonable assurance that the licensee will comply with the regulations in this chapter

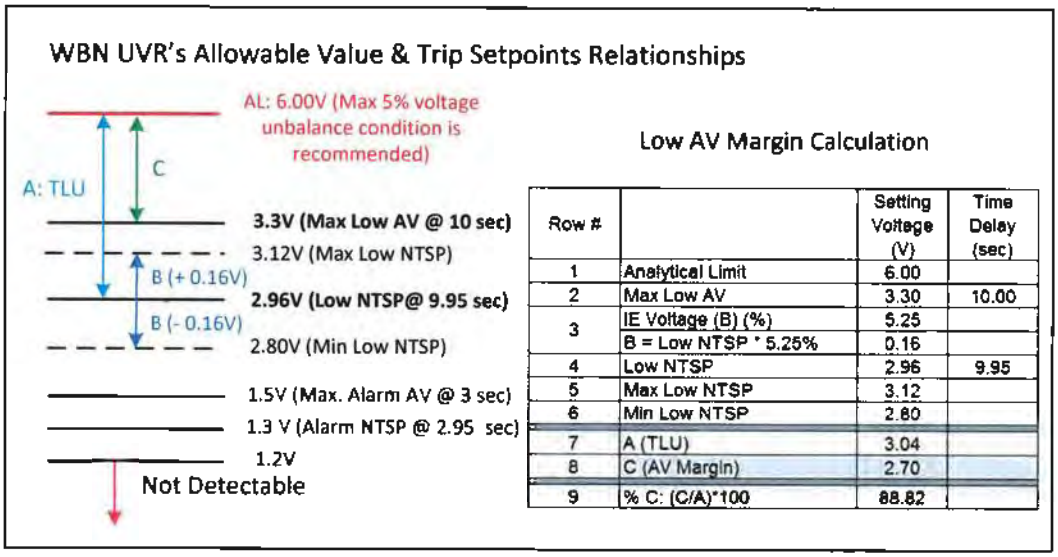
and that the health and safety of the public will not be endangered, and therefore, are acceptable for inclusion into the Sequoyah TSs.

3.3.3 Watts Bar Unbalanced Voltage Setpoints Evaluation

The NRC staff evaluated the licensee's proposed low AV and NTSP and their associated time delay for the 6.9 kV undervoltage (unbalanced voltage) of the Watts Bar shutdown board.

The relationship between the AV and NTSP of the Watts Bar UVR is illustrated in Figure 3.3-5, "NRC Margin Calculation for Watts Bar," below.

Figure 3.3-5: NRC Margin Calculation for Watts Bar



Low AV Margin Calculation

Row #		Setting Voltage (V)	Time Delay (sec)
1	Analytical Limit	6.00	
2	Max Low AV	3.30	10.00
3	IE Voltage (B) (%)	5.25	
	B = Low NTSP * 5.25%	0.16	
4	Low NTSP	2.96	9.95
5	Max Low NTSP	3.12	
6	Min Low NTSP	2.80	
7	A (TLU)	3.04	
8	C (AV Margin)	2.70	
9	% C: (C/A)*100	88.82	

The NRC staff used the equations in Section 3.2 of this SE to independently calculate the margins from AL to max AV and max low NTSP. The NRC staff verified that:

- The UVR value of maximum (max) Low NTSP voltage remains less than the max AV voltage.
- The UVR value of minimum (min) low NTSP voltage is higher than the max alarm AV.
- The margins (as indicated (row 9) in Figure 3.3-5 above) are adequate at a value greater than 88 percent to assure that a trip or safety actuation will occur automatically and significantly before the measured process reaches the AL level.

Based on the reviews and evaluation above, the NRC staff finds that the 6.9 kV unbalanced voltage setpoints and their associated time delays for the new Watts Bar UVR are acceptable. The proposed settings have been chosen so that automatic protective action will correct the abnormal situation before a safety limit is exceeded. These proposed settings are consistent with RG 1.105 and satisfy the requirements of 10 CFR 50.36(c)(1)(ii)(A) and 10 CFR 50.57(a)(3).

Therefore, the NRC staff has determined that the undervoltage setpoints for Watts Bar's UVR provide reasonable assurance that the licensee will comply with the regulations in this chapter and that the health and safety of the public will not be endangered, and therefore, are acceptable for inclusion into the Watts Bar TSs.

3.3.4 Time Delays

As shown in Figure 3.3-2 of this SE, the proposed time delays associated with the AV of 6 V of unbalanced voltage for the new UVRs: (1) are less than or equal 10 seconds, (2) typically vary from 2.6 seconds to 4 seconds at the permissive alarm and high setting levels, and (3) vary from 7.86 seconds to 10 seconds at the low setting level. The time delay for the AVs is longer than the NTSP (of all high, low, or alarm levels).

The NRC staff verified that the time delay settings for the new UVR are consistent with NEMA-MG1. When the proposed UVR is at the high setting level, the time delay settings are within a few seconds (≤ 4 seconds and ≥ 2.6 seconds). The low delay time setting minimizes the heating effects that can degrade motor insulation. The time delays associated with the AVs are longer than the time delays of the NTSP (of all high, low, or alarm levels) and are consistent with the analyses of Section A.4 and the relay timing period in Figure A.1 of IEEE Standard 741-1997 (Reference 18). These time delay settings are also consistent with the recommendations of IEEE Standard 3004.8-2016 (Reference 14).

Based on the above discussion, the NRC staff finds the proposed time delay settings for the UVRs at the three TVA plants provide reasonable assurance that a trip or safety actuation will occur within the allowable time to protect safety-related equipment. Hence, an automatic protective action will correct the abnormal situation to satisfy the requirements of 10 CFR 50.36(c)(1)(ii)(A) and 10 CFR 50.57(a)(3) and are consistent with RG 1.105.

Therefore, the NRC staff has determined that these time delay settings provide reasonable assurance that the licensee will comply with the regulations in 10 CFR 50.57(a), that the health and safety of the public will not be endangered, and therefore, are acceptable.

3.3.5 Conclusion for NRC Staff Evaluation of Setpoint Methodology

Based on the above evaluations, the NRC staff finds that the proposed revisions of the TSs to incorporate UVR setpoints for the three TVA plants is acceptable. The staff has concluded that the methodology, analysis, and assumptions used in this application are consistent with the industry standards and the requirements identified in Section 2.0 of this SE. Therefore, the Browns Ferry, Sequoyah, and Watts Bar units will continue to comply with applicable NRC regulatory requirements.

3.4 NRC Staff Evaluation of Proposed Technical Specification Changes

3.4.1 Proposed Browns Ferry Technical Specification Changes

Attachment 2.2, "Proposed TS Changes (Mark-Ups) for Browns Ferry, Units 1, 2, and 3," of the TVA letter dated November 19, 2018 (Reference 3), identifies the proposed TS changes. Since each Browns Ferry unit has a unique TS, the licensee has provided detailed marked-up copies of the TSs for each unit. The following discussion is related to TS changes for Browns Ferry, Unit 1. As Units 2 and 3 have similar changes, the evaluation is applicable to all three units.

The proposed changes to Browns Ferry TS 3.3.8.1 "LOP Instrumentation," can be summarized as follows:

- New Function 3, "4.16 kV Shutdown Board Undervoltage (Unbalanced Voltage Relay)," with Required Channels Per Board, "3," Surveillance Requirements, "SR 3.3.8.1.2, SR 3.3.8.1.3," and AV, "≤ 1.5V at 3 seconds (Permissive Alarm), ≤ 3.4V at 8.65 seconds (Lo), ≤ 20V at 3.5 seconds (High)," is added to Table 3.3.8.1-1.

- New Condition E for, "One or more unbalanced voltage relays inoperable on one shutdown board," with corresponding Required Action E.1 that requires verification by administrative means that the other shutdown boards and unbalanced voltage relays are 'operable' and additional Required Action E.2 that requires placing the inoperable channels in trip mode is added to the Actions table.

- Existing Condition E, "Required Action and associated Completion Time not met," will become Condition F, with corresponding Required Action E.1 becoming "F.1."

Required Action E.1 must be completed immediately upon discovery. Required Action E.2 has a 5-day completion time.

Condition E applies to the LOP EDG start functions with one unbalanced voltage channel per bus inoperable. If one channel is inoperable, Required Action E.1 requires verification of UVR channels associated with other boards, and Required Action E.2 requires that channel to be placed in trip within 5 days. The unbalanced voltage function is monitored by three UVRs for each shutdown board, and the outputs are arranged in a permissive one-out-of-two logic configuration. With a channel in trip, the LOP DG start instrumentation channels are configured to provide a one-out-of-one logic to initiate a trip of the incoming offsite power to protect safety-related equipment from potential degradation from negative sequence currents. Electric power from the transmission network to the onsite electric distribution system is to be supplied by two physically independent circuits designed and located to minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. It is, therefore, unlikely that unacceptable unbalanced voltage conditions resulting from an event such as an OPC will impact both sources simultaneously. RG 1.93 describes operating procedures and restrictions that should be implemented if the available electric power sources are less than the LCO. The NRC staff reviewed the guidance provided for plant operation when a GDC 17 related power source may be degraded or unavailable. A failure of UVR relays can impact the automatic actuation of onsite power systems and not isolate the degraded source.

The NRC staff concluded that the specified completion time of 5 days for restoration of a failed sensor circuit is reasonable considering the low probability of an OPC event occurring during this period. The proposed Condition E and associated actions are consistent with similar conditions and actions for LOP channels that receive actuation signals. The NRC staff finds the proposed changes to be acceptable.

The revised LAR (Reference 3) states that the UVR setpoints are proposed for inclusion in Section 3.3, "Instrumentation," of the TSs, specifically, in the "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation." The requirements for LOP DG start instrumentation indicate that where an LSSS is specified for a variable on which a safety limit has been placed, the setting must be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. The licensee stated, in the supplement dated June 18, 2018

(Reference 2), that UVR design shares similar features as the degraded voltage relays (included in the same TSs for LOP instrumentation) for protection of onsite safety-related equipment from adverse conditions resulting from a degraded grid. In the case of the UVRs, the degradation in the power system is related to unbalanced voltage conditions, whereas the degraded voltage relays consider a balanced three phase system. The UVRs are intended to actuate when the unbalanced conditions exceed the magnitude and duration of thresholds established for the setpoints to disconnect the shutdown board from the offsite power source and connect to the onsite power source. The abnormal condition in this case is that the offsite power source is not providing acceptable power from an unbalanced voltage consideration. The licensee further stated:

> The UVR settings are chosen such that the abnormal condition is corrected before any safety limit is exceeded by initiating a transfer to the EDG associated with the affected shutdown board and part of the onsite standby power system. The setpoint methodology considers uncertainty allowances and setpoint discrepancies to ensure that the equipment operates to protect the safety function, as discussed in Regulatory Guide 1.105, "Setpoints for Safety-Related Instrumentation." Analytical limits (ALs) were determined for each setpoint at each plant to protect equipment function from an unacceptable unbalanced voltage condition. Suitable margin was then determined to calculate individual AVs (AVs), which are contained in the TS, to ensure that the health and safety of the public is maintained.

Section 3.3 of this evaluation discusses the adequacy of the proposed setpoints in the TSs. The evaluation concluded that the alarm and trip setpoints and the corresponding time delays are in conformance with paragraph (c)(1)(ii)(A) of 10 CFR 50.36 because they have significant safety functions. The settings as specified will provide automatic protective action to correct the abnormal situation to protect equipment that functions to mitigate an accident or transient that presents a challenge to a fission product barrier. The test intervals for LOP relays are decided using a combination of deterministic and risk-based methods. Testing frequency is determined by factors such as regulatory requirements, safety significance, impact on plant safety, degradation of equipment caused by testing, historical experience with usage of similar equipment, critical failure modes, mechanisms of failure, etc. The regulatory requirements for the UVRs, as with other LOP relays, are related to conformance with GDC 17. The reliability and failure modes of the ABB Type 60Q phase unbalanced voltage relays that will be used at the TVA plants are expected to be similar to electronic relays used in Class 1E protection schemes. The impact on plant safety is similar to the impact on plant safety when considering other LOP relays. The TS required trip actuating device operational test and channel calibration SRs will ensure that the necessary quality of the UVRs and LOP instrumentation is maintained. The revised LAR proposed SRs that are commensurate with the existing LOP relays. Since the UVR relays have similar functions and design requirements compared to degraded voltage relays that receive actuation signals, the NRC staff finds the proposed setpoints and SR frequencies for UVRs acceptable.

3.4.2 Proposed Sequoyah Technical Specification Changes

Attachment 3.2 to the LAR identifies proposed TS changes for Sequoyah. For the Sequoyah units, in TS 3.3.5, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," the following changes were proposed:

- New Function 3, "6.9kV Shutdown Board – Unbalanced Voltage Relay," is added with an applicability of Modes 1 through 4 and when the associated DG is required to be operable by LCO 3.8.2, Required Channels, SRs, Allowable Values, and Nominal Trip Setpoints for the proposed unbalanced voltage relays.

- New Condition C, "One or more unbalanced voltage relays inoperable," is added with corresponding Required Action C.1 stating, "Restore unbalanced voltage relays to OPERABLE status," with a Completion Time of 1 hour.

- Existing Condition C, "Required Action and associated Completion Time not met," will become Condition D with corresponding Required Action C.1 becoming, "D.1."

3.4.3 Proposed Watts Bar Technical Specification Changes

The changes proposed to the Watts Bar TSs are identified in Attachment 4.2 to the LAR. For the Watts Bar units the proposed TS changes in Table 3.3.5-1 "LOP DG Start Instrumentation" include addition of new Function 5, "6.9 kV Emergency Bus Undervoltage (Unbalanced Voltage)," which provides unit specific SRs, trip setpoints and AVs for the proposed unbalanced voltage relays. TS 3.3.5, "Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation," with the addition of proposed Condition C, has the corresponding Conditions, Required Actions and associated Completion Times for Function 5. Corresponding Required Action C.1 states "Restore channel to OPERABLE status," with a Completion time of 1 hour. Existing Condition C and Required Action C.1 are renamed Condition D and required Action D.1. A Note clarifying that Condition C is applicable only to Function 5 is being added. The LAR also proposed clarifying notes before each Condition A and Condition B stating that those conditions are, "Not applicable to Function 5." Actions are not applicable to Conditions A and B for other LOP relays in Table 3.3.5.

3.4.4 NRC Staff Evaluation Summary of TS Changes

The adequacy of proposed TS changes for Browns Ferry, Sequoyah, and Watts Bar is discussed in Section 3.4. The TS surveillances, completion times, and related actions for the Browns Ferry units are commensurate with corresponding surveillances, completion times, and actions for the existing LOP relays. The NRC staff concluded that the alarm, trip, and allowable parameters for the unbalanced voltage relays at the TVA plants provide reasonable assurance that the safety-related equipment will be protected from adverse effects of unbalanced voltages. The staff determined that the LAR, including the collective TS changes discussed above, appropriately identify the lowest performance level for the UVRs required for safe operation and will ensure the functionality of the GDC 17 required power sources to support safe shutdown of the TVA plants. In addition, the NRC staff found that the proposed changes are consistent in structure and form to those developed by the staff as Standard Technical Specifications for plants of a similar design. Since the LOP relays in Table 3.3.5 perform similar functions, the NRC staff finds the proposed TS changes to be acceptable.

3.5 Changes to Licensing Basis Documents

Excerpts from UFSAR sections for Browns Ferry, Sequoyah, and Watts Bar pertinent to the electrical system design and operation were provided in attachments to Enclosure 1 of the original LAR (Reference 1). These excerpts include information about current design of offsite power systems and degraded voltage protection that is referenced as part of the unbalanced voltage protection scheme. In EEOB-RAI-8, the staff requested information on proposed

changes to UFSAR sections with regard to installation of UVRs. The licensee responded, in its supplement dated June 18, 2018 (Reference 2), with an overview of the typical changes under consideration. The licensee intends to update the UFSAR for each unit after implementation of the modifications is completed.

3.6 NRC Staff Technical Evaluation Conclusion

The NRC staff determines that the proposed UVR protection schemes will provide reasonable assurance that the safety-related equipment will be adequately protected from the consequences of negative sequence currents resulting from unbalanced voltage conditions. The UVR protection will be part of the primary success path that functions or actuates to mitigate a design-basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier and, therefore, will meet Criterion 3 of 10 CFR 50.36(c)(2)(ii) for inclusion into the TSs. The NRC staff concludes that the implementation of the UVR protection schemes will provide reasonable assurance that GDC 17 (AEC Criterion 39 for the Browns Ferry units) required onsite electric power system will be available to permit functioning of SSCs important to safety following a detectable degradation related to unbalanced voltages in the offsite power system. The staff also concludes that after final implementation of the UVR detection scheme setpoints in the TSs at the TVA plants, each of the Browns Ferry, Sequoyah and Watts Bar, unit LCOs will maintain compliance with the intent of 10 CFR 50.36(c)(2) since the LCOs and associated tables for the LOP instrumentation will include the UVRs limits and setpoints, and the proposed SRs will maintain compliance with the intent of 10 CFR 50.36(c)(3).

Based on a review of the licensee's application and supplements, the NRC staff finds that the proposed changes provide reasonable assurance of adequate protection of public health, safety, and security. The NRC staff's evaluation, as described in this SE, applies current and applicable regulatory requirements identified in Section 2.0 of this SE. On this basis, the NRC staff determines that the proposed TS changes discussed in Sections 3.1 through 3.5 of this SE will provide reasonable assurance that the TVA plants will comply with the regulations contained in 10 CFR 50.36(c)(2) and (3) and that the health and safety of the public will be maintained, and therefore, are acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Alabama State and Tennessee State officials were notified of the proposed issuance of the amendments on October 10, 2018. The State officials had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change requirements with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes SRs. The NRC staff has determined that the amendments involve no significant increase in the amounts and no significant change in the types of any effluents that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding published in the *Federal Register* on January 16, 2018 (83 FR 2231). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9).

Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1 TVA letter to the U.S. NRC, "Application to Modify Technical Specification for Browns Ferry, Sequoyah, and Watts Bar Nuclear Plants to resolve Open Phase Issue Identified in BL 2012-01, 'Design Vulnerability in Electircal Power System'," dated November 17, 2017 (Agencywide Douments Access and Manangement System (ADAMS) Accession No. ML17324A349).

2 TVA letter to U.S. NRC, "Response to Browns Ferry, Sequoyah, and Watts Bar - Request for Additional Information Related to License Amendment Request to Incorporate New Technical Specification for Unblanced Voltage Relays," dated June 18, 2018 (ADAMS Accession No. ML18169A404).

3 TVA Letter to U.S. NRC, "Revised Application to Modify the Technical Specifications for the Browns Ferry, Units 1, 2, and 3; Sequoyah, Units 1 and 2; Watts Bar, Units 1 and 2 to Incorporate New Technical Specification for Unbalance Voltage Relays," dated November 19, 2018 (ADAMS Accession No. ML18324A609).

4 TVA letter to U.S. NRC, "Supplement to Application to Modify the Technical Specifications for the Browns Ferry Nuclear Plant (TS-512), Sequoyah Nuclear Plant (TS-17-03) and Watts Bar Nuclear Plant (TS-17-20) to Incorporate New Technical Specification for Unbalanced Voltage Relays," dated January 25, 2019 (ADAMS Accession No. ML19025A210).

5 U.S. NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System," dated July 27, 2012 (ADAMS Accession No. ML12074A115).

6 TVA letter to U.S. NRC, "Browns Ferry Nuclear Plant - Updated Final Safety Analysis Report, Amendment 27," dated October 5, 2017 (ADAMS Accession No. ML17286A079).

7 TVA letter to U.S. NRC, "SQN, Units 1 and 2 Updated Final Safety Analysis Report Amendment 27," dated November 28, 2017 (ADAMS Accession No. ML18017A446).

8 TVA letter to U.S. NRC, "Watts Bar Nuclear Plant (WBN) - Dual Unit Updated Final Safety Analysis Report (UFSAR) Amendment 1," dated November 2, 2017 (ADAMS Accession No. ML17334A177).

9 ANSI C84.1-2016, "American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60 Hz)," dated October 28, 2016.

10 National Electrical Manufacturers Association (NEMA) MG 1-1987, "Motor and Generators."

11 Institute of Electrical and Electronic Engineers (IEEE) Standard 308-1974, "Standard Criteria for Class IE Power Systems for Nuclear Power Generating Stations," 1974.

12 IEEE 603-1991, "Standard Criteria for Safety Systems for Nuclear Power Generating

Stations," 1991.

13 IEEE Standard 3004.8, "IEEE Recommended Practice for Motor Protection in Industrial and Commercial Power Systems," 2016.

14 IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," 1971.

15 RG 1.93, Revision 1, "Availability of Electric Power Sources," dated March 2012 (ADAMS Accession No. ML101870610).

16 RG 1.105, Revision 3, "Setpoints for Safety-Related Instrumentation," dated December 1999 (ADAMS Accession No. ML993560062).

17 ANSI/ISA S67.04, "Setpoints for Nuclear Safety-Related Instrumentation," Instrument Society of America document, dated 1994.

18 IEEE Std 714-1997, R2002, "IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations,".

19 U.S. NRC letter to TVA, "Request for Additional Information Related to License Amendment Request To Incorporate New Technical Specification for Unbalanced Voltage Relays (EPID L 2017 LLA 0030)," dated May 21, 2018 (ADAMS Accession No. ML18115A379).

20 IB 7.4.1.7-3, "ABB Instructions for Phase Unbalance Relay," Issue C.

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Date: August 27, 2019

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3; SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2; WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – ISSUANCE OF AMENDMENT NOS. 309, 332, 292, 345, 339, 128, AND 31 REGARDING UNBALANCED VOLTAGE PROTECTION (EPID L-2017-LLA-0391) DATED AUGUST 27, 2019

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