RAI Questions and Responses

This attachment provides responses to questions/requests transmitted in the NRC's Request for Additional Information (RAI) dated January 9, 2019, in regard to Ameren Missouri's License Amendment Request (LAR) described in the cover letter to this attachment.

It should be noted that introductory/background information was included in the RAI letter, some of which is repeated here. As an introduction to the NRC questions/requests contained in the RAI, Callaway licensing basis documents and references pertaining to the ultimate heat sink (UHS) in regard to its long-term heat removal capability and its function for supporting safe plant shutdown from postulated accidents and transients were identified. A reference to License Amendment 208 of the Callaway Operating License was included, by which revised UHS retention pond temperature and water level limits were approved, along with credited operator action to isolate one train of the essential service water (ESW) system within seven days after initiation of a large-break loss-of-coolant accident (assuming both ESW trains are running) to ensure the pond remains within its analyzed temperature and level.

Applicable regulatory basis requirements were also identified in the RAI letter, mainly in regard to the applicable General Design Criteria (GDCs) of 10 CFR 50 Appendix A, i.e., GDC 17, "Electrical power systems"; GDC 2, "Design bases for protection against natural phenomena;" and GDC 44, "Cooling water." 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," was also identified, particularly Section 50.46(b)(5), "Long-term cooling."

A "Background" section was included in the RAI letter in which background information pertinent to the RAI questions/requests was provided. That background information is repeated below and is followed by the NRC's RAI questions/requests themselves along with the associated responses for Callaway.

Background

Section 3.2, "Single Cooling Train Operation," of the LAR's Attachment 2, ADAMS Accession No. ML18068A688, references Callaway's GOTHIC calculation, "Callaway Control Building with Control Room Loss of Class 1E A/C GOTHIC Room Heat Up With Installed Fans and Louvers." This calculation evaluates the capability of one train of the Class 1E Electrical Equipment A/C System to supply adequate cooling for both trains of the Class 1E electrical equipment while one of the trains is inoperable.

The audit conducted at Callaway identified a supplemental calculation to the GOTHIC calculation above related to the electrical heat loads, titled, "Electrical Heat Loads in the Control Building During Normal and ESFAS Conditions," which was used to support the room heat-up calculation.

This electrical heat load calculation specifically identified the heat loads at time T = 0, T = 24 hours and T = 7 days. The NRC staff identified that there was a significant reduction in heat load at T = 7 days, and the licensee stated that one operating train of safety related systems is procedurally secured after 7 days into an event.

This supplemental electrical heat load calculation also revealed, in its detailed calculation of heat load section, that:

a) for conservatism, the voltages from electrical calculation, case LOCA No. 1, are used to calculate the maximum continuous breaker currents, and that

b) the power source for engineered safety feature (ESF) equipment is the Emergency Diesel Generator (NE01), via the 4.16-kV switchgear NB0111 breaker, with NE01 at a maximum test load of 6,201 kW @ 0.8 power factor.

The licensee is implementing plant modifications to maintain the environment for Operability of onsite and offsite power systems required for conformance with GDC 17. In the LAR, the licensee has discussed the proposed temperature range for the GDC 17 required power sources.

The LAR proposes a new TS 3.7.20 to allow 30-day operation with only one train of the HVAC system (i.e., Class 1E Electrical Equipment A/C system) operable for redundant electrical equipment. Shutting down a complete train of ESF equipment (after 7 days), with one HVAC train unavailable prior to (and during) an event, may complicate plant safety, considering the significant equipment in one train (with the inoperable HVAC) which may also not be available for an extended period.

The NRC staff is also reviewing the combinations of events and plant conditions that were considered for heat load calculations. The NRC staff is requesting the below additional information considering the actions to be taken to reduce heat loads following an event.

The staff is requesting additional information on events and accidents considered and equipment needed, during allowable ranges for room temperatures during normal operation, for anticipated operational occurrences and for accident conditions.

RAI Questions/Requests and Responses

NRC Staff Question No. 1

Please provide a tabulated listing (with descriptive names) of large loads, greater than 50 horsepower, that are operating at the onset of the event, including the nameplate rating, the brake horsepower used in the heat calculations, and the time that the load is disconnected. Please include discretional or procedure required loads that are manually started, and include the duration of operation for the large loads.

Callaway Response:

The tabulated listing with descriptive names of large loads, greater than 50 horsepower, that are operating at the onset of the event (as activated by the load sequencer) are provided in the table below. The duration of operation of each load is given for three time periods: 0 to 24 hours, 24 hours to 7 days, and 7 days to 30 days, as shown in the designated table columns.

Discretional or procedure-required loads that are manually started are those loads noted as being "load shed" or as a "standby load" or by "operating procedure setting" in the "Loading Basis" column of the table.

Class 1E Electrical Loading Greater Than 50 Horsepower Used in Heat Load Calculation

Component Number	Description	Nameplate Horsepower	Load Brake Horsepower	Loading Basis	Real Power	Reactive Power	Total Power	Operating Condition 0 to 24 hours	Operating Condition 24 hours to 7 days	Operating Condition 7 days to 30 days
ESF Train A										
480 V Bus Loads					KW	jKVAR	KVA			
NG01A	"A" Train Motor Control Center	NA	NA	LOCA composite load	103	94.1	139.5	Yes	Yes	Yes
NG01B	"A" Train Motor Control Center	NA	NA	LOCA composite load	77.3	138.3	158.4	Yes	Yes	Yes
DSGN01A	Containment Cooler A	75	46	maximum design operating point on slow speed	39.5	107.8	114.8	Yes	Yes	Yes
NK21	125 VDC Sep Group 1 Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
NK25	125 VDC Tain "A" Swing Battery Charger	NA	NA	standby load	1.5	0.7	1.7	Yes	Yes	Yes
PK21	125 VDC Non-Safety Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
PK23	125 VDC Non-Safety Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
DPEC01A	Fuel Pool Cooling Pump A"	150	124	maximum design operating point	100.1	47.7	110.9	Yes	Yes	Yes
SGK04A	Control Room Air Conditioner A	40/40	64.5/27.4	maximum design operating point	57.8	40.4	70.5	Yes	Yes	Yes
NG03C	"A" Train Motor Control Center	NA	NA	LOCA composite load	83.6	50.4	97.6	Yes	Yes	Yes
NG03D	"A" Train Motor Control Center	NA	NA	LOCA composite load	19.4	12.6	23.1	Yes	Yes	Yes
DSGN01C	Containment Cooler C	75	46	maximum design operating point on slow speed	39.1	87.5	95.8	Yes	Yes	Yes
NK23	125 VDC Sep Group 1 Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
DCKA01A	Non-Safety Air Compressor A	NA	NA	load shed	189.5	128.9	229.0	No	No	No
DCGM01A	EDG Room Cooling Fan A	100	83	maximum design operating point	70.1	84.2	109.6	Yes	Yes	Yes
SGS01A	CNMT Hydrogen Recombiner A	NA	NA	operating procedure setting	75.1	10.2	75.8	No	Yes	Yes
MCC NG05E	"A" Train Motor Control Center	NA	NA	LOCA composite load	18.3	21.8	28.5	Yes	Yes	Yes
DCEF01A	UHS Cooling Tower Fan A	50	50	maximum design operating point	40.2	56.3	69.2	Yes	Yes	Yes
DCEF01C	UHS Cooling Tower Fan A	50	50	maximum design operating point	40.2	56.3	69.2	Yes	Yes	Yes
NB01 4.16 kV										
PG21	"A" Train Backup Pressurizer Heaters	NA	NA	load shed	0	0	0.0	No	No	No
DPAL01A	Auxiliary Feed Water Pump A	800	660	maximum design flow (flow controlled)	527.3	301.7	607.5	Yes	Yes	Yes
DPBG05A	Centrifugal Charging Pump A	600	680	maximum design brake horsepower (near runout flow)	546	221	589.0	Yes	Yes	Yes
DPEF01A	Essential Service Water Pump A	1750	1500	maximum design operating point	1214.5	683.3	1393.5	Yes	Yes	Yes
DPEG01A	Component Cooling Water Pump A	700	640	maximum design operating point	508.3	377.4	633.1	Yes	Yes	Yes
DPEG01C	Component Cooling Water Pump C	700	640	standby load	508.3	377.4	633.1	No	No	No
DPEJ01A	Residual Heat Removal Pump A	500	545	maximum design brake horsepower (near runout flow)	433.4	186	471.6	Yes	Yes	Yes
DPEM01A	Safety Injection Pump A	450	460	maximum design brake horsepower (near runout flow)	370.1	176.1	409.9	Yes	Yes	Yes
DPEN01A	Containment Spray Pump A	500	495	maximum design operating point	396.2	170.4	431.3	Yes	Yes	Yes

Component Number	Description	Nameplate Horsepower	Load Brake Horsepower	Loading Basis	Real Power	Reactive Power	Total Power	Operating Condition 0 to 24 hours	Operating Condition 24 hours to 7 days	Operating Condition 7 days to 30 days
ESF Train B										
480 V Bus Loads					KW	jKVAR	KVA			
NG02A	"B" Train Motor Control Center	NA	NA	LOCA composite load	102	94.2	138.8	Yes	Yes	Yes
NG02B	"B" Train Motor Control Center	NA	NA	LOCA composite load	86.4	146.7	170.3	Yes	Yes	Yes
NG02T	"B" Containment Cooler B	75	46	maximum design operating point on slow speed	39.6	88	96.5	Yes	Yes	No
NK24	125 VDC Sep Group 1 Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
PJ31	250 VDC Non-Safety Battery Charger	NA	NA	load shed	0	0	0.0	No	No	No
DPEC01B	"B" Fuel Pool Cooling Pump B	150	124	maximum design operating point	100.1	47.7	111.0	No	No	No
SGK04B	"B" Control Room Air Conditioner B	40/40	64.5/27.4	maximum design operating point	57.8	40.4	71.0	No	No	No
NG04C	"B" Train Motor Control Center	NA	NA	LOCA composite load	70.6	43.5	82.9	Yes	Yes	Yes
NG04D	"B" Train Motor Control Center	NA	NA	LOCA composite load	19.4	12.6	23.1	Yes	Yes	Yes
NG04T	"D" Containment Cooler D	75	46	maximum design operating point on slow speed	45.5	107.1	116.4	Yes	Yes	No
NK22	125 VDC Sep Group 1 Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
NK26	125 VDC Tain "B" Swing Battery Charger	NA	NA	standby load	1.4	0.7	1.6	Yes	Yes	Yes
PK22	125 VDC Non-Safety Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
PK24	125 VDC Non-Safety Battery Charger	NA	NA	50% of charger 300 A rating	23	14.1	27.0	Yes	Yes	Yes
DCKA01B	Non-Safety Air Compressor B	NA	NA	100% load 100% of time	189.5	128.9	229.2	Yes	Yes	Yes
DCGM01B	EDG Room Cooling Fan B	100	83	maximum design operating point	69.9	84.1	109.4	Yes	Yes	Yes
SGS01B	CNMT Hydrogen Recombiner B	NA	NA	operating procedure setting	75.1	10.3	75.8		Yes	Yes
MCC NG06E	"B" Train Motor Control Center	NA	NA	LOCA composite load	18.3	21.8	28.5	Yes	Yes	No
DCEF01B	UHS Cooling Tower Fan B	50	50	maximum design operating point	40.2	56.3	69.2	Yes	Yes	No
DCEF01D	UHS Cooling Tower Fan D	50	50	maximum design operating point	40.2	56.3	69.2	Yes	Yes	No
NB02 4.16 kV										
PG22	"B" Train Backup Pressurizer Heaters	NA	NA	load shed	0	0	0.0	No	No	No
DPAL01B	Auxiliary Feed Water Pump B	800	660	maximum design flow (flow controlled)	527.3	301.7	607.5	Yes	Yes	No
DPBG05B	Centrifugal Charging Pump B	600	680	maximum design brake horsepower (near runout flow)	546.1	221	589.1	Yes	Yes	No
DPEF01B	Essential Service Water Pump B	1750	1500	maximum design operating point	1214.5	683.4	1393.6	Yes	Yes	No
DPEG01B	Component Cooling Water Pump B	700	640	maximum design operating point	508.4	377.5	633.2	Yes	Yes	No
DPEG01D	Component Cooling Water Pump D	700	640	standby load	508.4	377.5	633.2	No	No	No
DPEJ01B	Residual Heat Removal Pump B	500	545	maximum design brake horsepower (near runout flow)	433.4	186	471.6	Yes	Yes	No
DPEM01B	Safety Injection Pump B	450	460	maximum design brake horsepower (near runout flow)	370.2	176.1	410.0	Yes	Yes	No
DPEN01B	Containment Spray Pump B	500	495	maximum design operating point	396.2	170.4	431.3	Yes	No	No

NRC Staff Question No. 2

FSAR Section 15.0.1 describes four categories of plant conditions. Please provide a discussion explaining why loss of offsite power (LOOP) with a large break loss-of-coolant accident (LBLOCA) is the limiting case in the supplemental electrical head load calculations, considering heat contribution from electrical equipment during the 30-day post-accident period, with one Class 1E electrical equipment A/C train initially inoperable, while balancing ESF equipment operating in redundant trains at the onset of the event.

Callaway Response:

For responding to this NRC staff question, the rationale supporting Callaway's position that the LBLOCA is the bounding plant condition described in Callaway's current licensing basis, in regard to electrical heat loads in the Class 1E electrical equipment rooms, is provided below. Following that, a description is provided on how the electrical heat loads for the LBLOCA sequence were quantified to ensure that the values used in the room temperature analysis conservatively bound the heat loads that would be present during the LBLOCA sequence described in the Callaway FSAR.

Bounding DBA Scenario

When compared to the other accident sequences contained in the Callaway FSAR, the response to an LBLOCA results in the greatest usage of safety-grade systems and components that are supported by the Class 1E electrical equipment. For example, when operation of the emergency core cooling system (ECCS) pumps is evaluated, the LBLOCA results in the greatest demands on ECCS. Other accident sequences such as a steam generator tube rupture (SGTR) or main steam line break (MSLB) retain pressure in the reactor coolant system such that the low and intermediate head ECCS subsystems would be secured relatively early in the accident sequence. Given the complete depressurization of the reactor coolant system following an LBLOCA, all of the ECCS subsystems would be providing higher flows and therefore higher motor current demands, for the longest duration. An LBLOCA would also result in the longest duration of containment spray operation.

For small-break LOCA (SBLOCA) events, the RCS depressurizes much slower than an LBLOCA such that the ECCS injection time prior to cooling down to RHR entry conditions would be significantly longer than during a LBLOCA. However, the significantly reduced flowrates result in lower associated electrical heat loads. Ameren calculations demonstrate that the longest ECCS injection phase for an SBLOCA is 5 hours. During this injection phase the RCS would continue to cool down and depressurize via the SGs. However, some additional time would be required to complete the cooldown to RHR cut-in conditions. Although not explicitly quantified in the FSAR, this time would be significantly less than 24 hours.

Long-term decay heat removal via the RHR system is established for all non-LOCA events well before 24 hours is reached. Once RHR cooling is established, all other ECCS pumps are secured with the exception that for some period, charging pump operation may be required for boron addition or RCS makeup. For some events, such as an SGTR, the time to reach RHR conditions is as shown in the FSAR Chapter 15 Sequence of Events tables. Specifically, Table 15.6.1 shows RHR cut-in conditions reached at 21,800 seconds (6 hours). For other events, such as an MSLB or loss of AC power (LOAC), the core response analyses do not extend all the way to RHR cut-in. However, the radiological dose analysis applies a conservative assumption of 8 hours for the time to reach RHR cut-in conditions (FSAR 15.1.5.3, 15.2.6.3). This assumption would remain valid for FSAR Chapter 15 events not analyzed for dose consequences, such as a loss of normal feedwater (LONF) or main feedline break (FLB).

Bounding Electrical Heat Loads

In regard to the analysis of electrical heat loads during an LBLOCA sequence of events, the electrical heat load calculation used conservative assumptions to maximize the heat produced in the rooms. Low bounding voltages were used for the operating equipment to maximize the running current and thereby increase the I^2R heat losses from the current-carrying equipment (breakers, bus work transformers cables, etc.). The electrical loads are based on the worst loading for the driven load (i.e. maximum flow, maximum loading, runout, etc.) The bounding electrical heat load case is based on a LBLOCA with safety injection and containment spray actuation signals occurring. Assuming no loss of off-site power is conservative in this case.

The electrical heat loads used in the room temperature analysis were kept at their design maximum, even though loads/flows could decrease through the event. Electrical loads on the electrical distribution systems/equipment were turned on or off per the applicable emergency procedure. While non-safety related loads are designed to be shed from the safety busses with a safety injection signal, selected non-safety related loads were assumed to be added back in per the emergency procedures, at conservative load values. The electrical load profile was grouped into three time periods: time = 0 to 24 hours, 24 hours to 7 days, and 7 days to 30 days. Even though loads could be secured earlier by emergency procedure guidance and accident progression, for conservatism they were shown operating until the next time change. (For instance, a load may be turned off at 7 hours in the emergency procedure, but it was not turned off until 24 hours in the analysis.)

For additional conservatism, the battery chargers were assumed to be loaded at 50 percent of their rating even though the normal design load is much lower than this. For heat loss from cables, maximum design cable temperatures were assumed in order to maximize I^2R heat losses. Two non-safety related air compressors that are designed to be automatically shed were assumed to be re-loaded on to the safety busses and loaded to a conservative load of 50 percent with constant operation. In addition, the non-safety related 125-Vdc battery chargers also designed to be automatically shed were assumed to be re-loaded on the safety busses.

A table for the loads larger than 50 horsepower and with composite motor control center loading is provided in the response to NRC staff Question No. 2. Design break horsepower, loading basis, and the operating condition at event time of 0 seconds to 24 hours, 2 hours to 7 days, and 7 days to 30 days is provided for each load in the table.

Based on the above, it can be concluded that the LBLOCA represents the bounding accident sequence and that the electrical heat loads used in the room temperature analysis conservatively bound the electrical heat loads that would be present in the Class 1E electrical equipment rooms during the LBLOCA sequence described in the Callaway FSAR.

NRC Staff Question No 3

In the unlikely event of an external hazard (such as described in GDC-2) occurring with one Class 1E electrical equipment A/C train inoperable, and considering the post-event 30 day heat rejection time period for the UHS coupled with preplanned shutdown of one train of ESF equipment after 7 days, please provide a detailed discussion on ESF equipment that will be available for plant shutdown during the 30-day post-event period (with an inoperable Class 1E electrical equipment A/C train). If non-safety related systems such as offsite power are credited for restoration of systems, please provide a discussion on the capability to restore such sources following a GDC-2 event.

Callaway Response:

System functional response capability for the scenario involving a hazard with one Class 1E electrical equipment A/C train inoperable, including assumptions applicable to such an assessment, is addressed as part of the response for NRC Staff Question No. 5. However, additional points and details are provided as follows.

Assumptions applied in the design and analysis performed for hazard protection are given in the FSAR (Section 3.1.2 and Appendix 5.4A), as presented below.

From FSAR Appendix 3B.2 ANALYSIS ASSUMPTIONS:

> In the analysis of an event or hazard, it is assumed that the plant will be operated in accordance with the requirements of the Technical Specifications. Should the event result in a turbine or reactor trip, the plant will be placed in a hot standby condition. If required by a Limiting Condition of Operation or if recovery from the event will cause the plant to be shut down for an extended period of time, the plant will be taken to a cold shutdown condition. Safe shutdown is discussed in Appendix 5.4A
>
> During the hot standby condition, an adequate heat sink is provided to remove reactor core residual heat. Boration capability is provided to compensate for xenon decay and to

> maintain the required core shutdown margin. Boration is required within 25 hours after reactor shutdown to maintain the reactor in a hot standby condition.
>
> Redundancy or diversity of systems and components is provided to enable continued operation at hot standby or to cool the reactor to a cold shutdown condition. If required, it is assumed that temporary repairs can be made to circumvent damages resulting from the hazard. Loss of offsite power is not assumed, unless a trip of the turbine generator system or the reactor protection system is a direct consequence of the hazard. All available systems, including nonsafety-related systems and those systems requiring operator action, may be employed to mitigate the consequences of the hazard.
>
> In determining the availability of the systems required to mitigate the consequences of a hazard and those required to place the reactor in a safe condition, the direct consequences of the hazard are considered. The feasibility of carrying out operator actions are based on ample time and adequate access to the controls, motor control center, switchgear, etc., associated with the component required to accomplish the proposed action.
>
> When the postulated hazard occurs in and results in damage to one of two or more redundant or diverse trains, single failures of components in other trains (and associated supporting trains) are not assumed. The postulated hazard is precluded, by design, from affecting the opposite train or from resulting in a design basis accident. For the situation in which a hazard affects a safety-related component, the event and subsequent activities are governed by Technical Specification requirements in effect when that component is not functional.

For the given scenario in this NRC staff question, at least one train of ESF equipment would be expected to remain available for plant shutdown during the 30-day, post-event period. The action taken within 7 days (post-event) to shut down one train of ESF/ESW equipment (for supporting the UHS cooling pond function in accordance with provisions described in License Amendment 208) would be for the train associated with the initially inoperable Class 1E electrical equipment A/C train. Assuming no additional failures, the other ESF train would remain available to effect or maintain plant shutdown.

FSAR Section 3.1.3 addresses how SSCs important to safety, per the plant's design, comply with the GDCs of 10 CFR 50 Appendix 2, including GDC-2., "Design Bases for Protection Against Natural Phenomena." For GDC-2, the following is stated:

> The structures, systems, and components important to safety are designed either to withstand the effects of natural phenomena without loss of the capability to perform their safety functions, or to fail in a safe condition. Those structures, systems, and components vital to the shutdown capability of the reactor are designed to withstand the maximum probable natural phenomena at the site, determined from recorded data for the site vicinity, with appropriate margin to account for uncertainties in historical data.

> Appropriate combinations of structural loadings from normal, accident, and natural phenomena are considered in the plant design. The nature and magnitude of the natural phenomena considered in the design of this plant are discussed in Chapter 2.0. Chapter 3.0 discusses the design of the plant in relationship to natural events. Seismic and quality group classifications, as well as other pertinent standards and information, are given in the sections discussing individual structures and components.

Due to the nature of natural hazards, no deterministic, bounding detailed or analyzed sequence of events (like what is presented for design-basis accidents) is given in the FSAR for such an event (i.e., a tornado, for example), though design features or considerations for providing protection against such an event are included in the plant design, with bounding assumptions applied for that purpose (as noted above).

The criteria given in FSAR section 3.1.2 (as listed earlier) include consideration that the use of all available systems, including non-safety related systems and those systems requiring operator action, may be employed to mitigate the consequences of a hazard. Further, for the situation in which a hazard affects a safety-related component, the event and subsequent activities are recognized to be governed by Technical Specification requirements in effect when that component is not functional.

For beyond-design basis events or hazard effects not addressed in the FSAR, it can be assumed that actions would be taken to the fullest extent possible to bring the plant to a safe shutdown condition. Achieving hot shutdown is highly likely via the protected equipment within the power block. During the long-term post-event period, operator actions may be able to be taken and damaged equipment may be able to be repaired within a reasonable time to enable cold shutdown, in the long run.

For damage to the UHS from a hazard, FSAR Section 9.2.5.3 describes actions that could be taken to make up or compensate for lost pond inventory, but these are defense-in-depth measures only. Although they may be consistent with the types of actions described in FSAR Section 3.1.2 (noted above), the need for them would only be likely for a beyond-design basis event.

NRC Staff Question No. 4

Callaway's FSAR Section 9.2.1, "Station Service Water System," states that a method of adding makeup to the UHS is to use the Service Water System. During the audit, the licensee stated that although Callaway's FSAR discusses some defense-in-depth options for refilling the ESW pond post-accident, these options make use of non-safety related, non-seismic systems, structures and components (SSCs). Hence, SSCs that are not qualified to withstand such events may not be available. Additionally, use of these options would likely require local operator actions in areas that might be exposed to a postaccident, radioactive plume.

Considering the UHS 30-day heat rejection time period and the preplanned shutdown of one train of ESF equipment after 7 days, coupled with one HVAC train's unavailability (i.e., the unavailability of one train of the Class 1E Electrical Equipment A/C system), please provide a discussion on the ESF equipment that will be available for plant shutdown during the four categories of events discussed in FSAR Chapter 15.0.1.

Callaway Response:

Section 15.0.1 of the Callaway FSAR describes the classification of plant conditions (events) based on the American Nuclear Society (ANS) classification of plant conditions, which divides plant conditions into four categories in accordance with anticipated frequency of occurrence and potential radiological consequences to the public. (Reference: ANSI-N18.2, "Nuclear Safety Criteria for the Design of Stationary PWR Plants," 1973.) The four categories are as follows:

a. Condition I: Normal operation and operational transients
b. Condition II: Faults of moderate frequency
c. Condition III: Infrequent faults
d. Condition IV: Limiting faults

The basic principle applied in relating design requirements to each of the conditions is that the most probable occurrences should yield the least radiological risk to the public, and those extreme situations having the potential for the greatest risk to the public shall be those least likely to occur. Where applicable, reactor trip system and engineered safeguards functioning is assumed to the extent allowed by considerations, such as the single failure criterion, in fulfilling this principle. This means that seismic Category I, Class 1E, and IEEE qualified equipment, instrumentation, and components are used in the ultimate mitigation of the consequences of Conditions II, III, and IV events.

Each of these types of events is addressed as follows.

Condition I Events

With regards to Condition I events, a typical list is provided by the Callaway FSAR:

a. Steady state and shutdown operations[1]
   1. Power operation
   2. Startup
   3. Hot standby

[1] These listed conditions correspond to the MODES specified in the plant Technical Specifications, wherein MODE is defined in Section 1.1 (Definitions) and all of the MODES are listed in Table 1.1-1 of the Technical Specifications.

4. Hot shutdown
5. Cold shutdown
6. Refueling

b. Operation with permissible deviations

Various deviations from normal operation which may occur during continued operation as permitted by the Technical Specifications must be considered in conjunction with other operational modes. These include:

1. Operation with components or systems out of service
2. Leakage from fuel with limited clad defects
3. Excessive radioactivity in the reactor coolant
   (a) Fission products
   (b) Corrosion products
   (c) Tritium
4. Operation with steam generator leaks
5. Testing

c. Operational transients

1. Plant heatup and cooldown
2. Step load changes (up to ±10 percent)
3. Ramp load changes (up to 5 percent/minute)
4. Load rejection up to and including design basis 50% load rejection transient

The Condition I events do not result in the plant entering the Emergency Operating Procedure (EOP) network. Therefore, a discussion of the UHS 30-day heat rejection time period and the preplanned shutdown of one train of ESF equipment within 7 days following the initiation of a postulated accident sequence would not be applicable to Condition I events. With regards to availability of ESF equipment, the plant would be operated in accordance with the Technical Specifications, and the ESF equipment required by Technical Specifications for the applicable MODE corresponding to the Condition I event would be available.

Condition II Events

The Callaway FSAR provides the following list of Condition II Events:

a) Feedwater system malfunctions that result in a decrease in feedwater temperature.
b) Feedwater system malfunctions that result in an increase in feedwater flow.
c) Excessive increase in secondary steam flow.
d) Inadvertent opening of a steam generator relief or safety valve.
e) Loss of external electrical load.
f) Turbine trip.
g) Inadvertent closure of main steam isolation valves.

h) Loss of condenser vacuum and other events resulting in turbine trip.
i) Loss of nonemergency ac power to the station auxiliaries.
j) Loss of normal feedwater flow.
k) Partial loss of forced reactor coolant flow.
l) Uncontrolled rod cluster control assembly bank withdrawal from a subcritical or low power startup condition.
m) Uncontrolled rod cluster control assembly bank withdrawal at power.
n) Rod cluster control assembly misoperation (dropped full length assembly, dropped full length assembly bank, or statically misaligned full length assembly).
o) Startup of an inactive reactor coolant pump at an incorrect temperature.
p) Chemical and volume control system malfunction that results in a decrease in the boron concentration in the reactor coolant.
q) Inadvertent operation of the emergency core cooling system during power operation.
r) Chemical and volume control system malfunction that increases reactor coolant inventory.
s) Inadvertent opening of a pressurizer safety or relief valve.
t) Break in instrument line or other lines from reactor coolant pressure boundary that penetrate the containment.

Condition II events, at worst, result in a reactor trip and are not expected to result in fuel rod failures or reactor coolant system or secondary system over-pressurization. With respect to when these events may occur, the range of events extends from MODE 6 to MODE 1. (For example, some events could only occur during shutdown conditions; others could occur only during plant operation.) The ESF equipment available to mitigate the event would be dependent upon which MODE the event initiates from and the Technical Specifications applicable to the MODE of operation.

With regards to the UHS 30-day heat rejection time period and the preplanned shutdown of one train of ESF equipment within 7 days following the initiation of a postulated accident sequence, coupled with one HVAC train's unavailability, it should be noted that the supplemental cooling system would ensure that the remaining train of HVAC operating in conjunction with the supplemental cooling system would maintain both trains of Class 1E electrical equipment rooms within an acceptable temperature range such that both trains of ESF equipment would remain available to mitigate a Condition II event throughout a postulated 30-day mission time (assuming no additional failure).

Condition III Events

By definition, Condition III occurrences are faults which may occur very infrequently during the life of the plant. They will be accommodated with the failure of only a small fraction of the fuel rods, although sufficient fuel damage might occur to preclude resumption of operation for a considerable outage time. The release of radioactivity will not be sufficient to interrupt or restrict public use of those areas beyond the exclusion radius. A Condition III fault will not, by

itself, generate a Condition IV fault or result in a consequential loss of function of the reactor coolant system or containment barriers.

The Callaway FSAR provides the following list of Condition III events:

a) Steam system piping failure (minor).
b) Complete loss of forced reactor coolant flow.
c) Rod cluster control assembly misoperation (single rod cluster control assembly withdrawal at full power).
d) Inadvertent loading and operation of a fuel assembly in an improper position.
e) Loss-of-coolant accidents resulting from a spectrum of postulated piping breaks within the reactor coolant pressure boundary (small break).
f) Radioactive gas waste system leak or failure.
g) Radioactive liquid waste system leak or failure.
h) Postulated radioactive releases due to liquid tank failures.
i) Spent fuel cask drop accidents.

With regards to the Condition III events, it should be noted that events f, g, h, and i listed above would not result in the rejection of heat loads to the UHS and are of relatively short duration such that a discussion of the preplanned shutdown of one train of ESF equipment within 7 days following the initiation of a postulated accident sequence is not applicable to these events.

For the remaining Condition III events, with regards to the UHS 30-day heat rejection time period and the preplanned shutdown of one train of ESF equipment within 7 days, coupled with one HVAC train's unavailability, it should be noted that the supplemental cooling system would ensure that the remaining train of HVAC operating in conjunction with the supplemental cooling system would maintain both trains of Class 1E electrical equipment rooms within an acceptable temperature range such that both trains of ESF equipment would remain available to mitigate a Condition III event throughout a postulated 30-day mission time.

The preplanned shutdown of one train of ESF equipment within 7 days would not result in the unavailability of that train. Although operation of both trains is not required to mitigate any design basis event, the secured train would remain available for use and be supported by the supplemental cooling system during the remainder of a postulated 30-day accident mitigation mission time, if no additional failure is assumed. Additionally, it should be noted that per Section 3.1.2 of the Callaway FSAR, it is not necessary to postulate a hazard in conjunction with a Condition III event.

Condition IV Events

The Callaway FSAR provides the following list of Condition IV event:

a) Steam system pipe break.

b) Feedwater system pipe break.
c) Reactor coolant pump shaft seizure (locked rotor).
d) Reactor coolant pump shaft break.
e) Spectrum of rod cluster control assembly ejection accidents.
f) Steam generator tube rupture.
g) Loss-of-coolant accidents, resulting from a spectrum of postulated piping breaks within the reactor coolant pressure boundary (large break).
h) Design basis fuel handling accidents.

Condition IV occurrences are faults which are not expected to take place, but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material. They represent limiting design cases. Condition IV faults are not to cause fission product release to the environment resulting in an undue risk to public health and safety in excess of guideline values of 10 CFR 100. A single Condition IV fault is not to cause a consequential loss of required functions of systems needed to cope with the fault, including those of the emergency core cooling system and the containment.

With regards to item h listed above, the design basis fuel handling accident, it should be noted that this accident would not result in the rejection of heat loads to the UHS. Additionally, the design basis fuel handling accident is of relatively short duration such that a discussion of the preplanned shutdown of one train of ESF equipment within 7 days following the initiation of a postulated accident sequence is not applicable to the design basis fuel handling accident.

For the remainder of the Condition IV events listed in the Callaway FSAR, with regards to the UHS 30-day heat rejection time period and the preplanned shutdown of one train of ESF equipment within 7 days, coupled with one HVAC train's unavailability, it should be noted that the supplemental cooling system would ensure that the remaining train of HVAC operating in conjunction with the supplemental cooling system would maintain both trains of Class 1E electrical equipment rooms within an acceptable temperature range such that both trains of ESF equipment would remain available to mitigate a Condition IV event throughout a postulated 30-day mission time (assuming no additional failure).

The preplanned shutdown of one train of ESF equipment within 7 days would not result in the unavailability of that train. Although operation of both trains is not required to mitigate any design basis event, the secured train would remain available for use and be supported by the supplemental cooling system during the remainder of a postulated 30-day accident mitigation mission time, if no additional failure is assumed. Additionally, it should be noted that per Section 3.1.2 of the Callaway FSAR, it is not necessary to postulate a hazard in conjunction with a Condition IV event.

NRC Staff Question No. 5

With regard to Callaway's License Amendment 208 for the UHS, which addressed maintaining UHS operability and shutting down one train of ESWS after seven days, the premise for the amendment is that:

a. Both ESF trains of equipment are assumed to be operating for 7 days without a single failure and that

b. A design basis accident is in progress.

The proposed license amendment to add new TS 3.7.20 will have a Completion Time of 30 days for restoring an inoperable Class 1E electrical equipment A/C train to Operable status. In the event of an accident occurring with one Class 1E electrical equipment A/C train inoperable, the preplanned shutdown of one ESF train seven days after the accident would also have to be met. When discussing this scenario during the audit, the licensee stated that if equipment issues were to occur on the operating train, the train that was secured would remain available for possible restart.

Assuming that the ESF train with the associated inoperable Class 1E electrical equipment A/C train is secured after 7 days, in the event of equipment failure in the operating ESF train, please provide a discussion on how the train without an available Class 1E electrical equipment A/C train could be restarted to provide cooling for the ESF equipment required to support plant shutdown after a postulated event. Please include references to applicable plant procedures.

Callaway Response:

As described in the LAR and its supplement, upon implementation of plant modification MP 16-0024, two supplemental cooling trains, will be installed such that one train of supplemental cooling can be operated in conjunction with one Class 1E Electrical Equipment A/C Train, to cool both trains of Class 1E electrical equipment, in the event that one Class 1E Electrical Equipment A/C train is declared inoperable. For such a condition, redundancy at the supported system level is preserved, but not at the support system level. Without single-failure protection, it is appropriate that proposed Condition A and its Required Action be entered and tracked, and then only for a limited period of time (30 days) before plant shutdown is required.

Callaway's licensing basis is consistent with regulatory requirements in regard to how the plant's design and safety analyses include consideration of the capability to withstand a single additional failure without loss of safety functions(s). Assumptions regarding single-failure protection are addressed in Section 3.1.2 of the Callaway FSAR.

In general, the Limiting Conditions for Operation (LCOs) for systems and functions addressed by the Technical Specifications represent the minimum allowed functional capability or performance levels of equipment required for safe operation of the facility, as specified per 10

CFR 50.36 (c)(2). As further specified therein, when an LCO is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the Technical Specifications until the LCO is met.

For systems/functions having fully redundant and separate trains (in order to provide for single failure protection), compliance with the applicable TS LCO ensures the system/function can withstand a single failure and remain functional. With one train inoperable (i.e., with the LCO not met), a Condition and Required Action(s) must be entered, as appropriate, since such a condition is one in which single-failure protection is no longer assured. Generally, continued plant operation is allowed for only a limited period of time for such a condition, as the Completion Time for restoring the inoperable train to operable status imposes the time limit that must be met before entry into a Required Action for plant shutdown is required.

NRC Staff Question No. 5 describes a scenario in which an accident occurs with one Class 1E electrical equipment A/C train inoperable (i.e., as an initial condition). After the onset of the accident, the described scenario includes securing an ESF (ESW) train after 7 days (per the provisions described in License Amendment 208), which would be the train associated with the initially inoperable Class 1E A/C electrical equipment train. At that same time (7 days), an additional failure is assumed such that there is an equipment failure in the operating ESF train. The question requests discussion on how the train without an available Class 1E electrical equipment A/C train could be restarted to provide cooling for the ESF equipment needed to support plant shutdown after the accident.

What should first be noted about the given scenario is that it is one that is outside the plant's licensing basis. Since the scenario begins with an inoperable train (with a TS Required Action in effect) single-failure protection is not assured and is not expected to be assured for the time that the Required Action is in effect. While there is a risk associated with this condition (i.e., with the Required Action in effect), an accident occurring under such conditions can still be mitigated in accordance with the plant's licensing basis, assuming no additional failure.

With the introduction of the additional failure (at 7 days), loss of function(s) is likely as such a condition involves a level of inoperability (i.e., more than one failure) that is beyond the licensing basis of the facility. Per the plant's licensing basis, there is no requirement to ensure or demonstrate functional capability for such a scenario.

With the above basis acknowledged, the following three scenarios are summarily addressed:

1. The plant is operating with Condition "A" (i.e., Required Actions A.1, A.2 and A.3) of LCO 3.7.20 in effect (i.e., with one train of the Class 1E Electrical Equipment A/C system inoperable) and no accident or hazard exists or occurs (but plant shutdown may be needed).
2. The plant is operating with Condition "A" of LCO 3.7.20 in effect and an accident (DBA LOCA) occurs.
3. The plant is operating with Condition "A" of LCO 3.7.20 in effect and a hazard (such as a tornado) occurs.

Each of these is addressed summarily with "bullets" providing the key points and assumptions involved.

Plant is operating with Condition "A" of LCO 3.7.20 in effect:

- One SGK05A/B unit is inoperable, and one supplemental cooling train is in operation.
- Single-failure protection is not met. [Thus, the plant cannot (and is not expected to meet) its licensing basis in the event of another single failure.]
- Plant risk of being in Required Action A.3 for its 30-day Completion Time and the likelihood of an accident occurring during the time that the Required Action is in effect is considered as part of establishing the Required Action and Completion Time for the TS.
    - The 30-day Completion Time for Required Action "A.3" has no connection with the 30-day mission time ascribed to certain safety-related functions features (such as the UHS).
    - The 30-day Completion Time is risk-based (even if only based on "engineering judgment"), whereas the 30-day mission time is deterministically based (as required by regulatory guidance).
    - Plant may not (and is not required to) meet its licensing basis with the occurrence or assumption of another failure while Condition "A" is in effect.

Plant is operating with Condition "A" in effect and experiences an accident (e.g., DBA LOCA):

- A concurrent LOOP may be assumed, but with the Required Actions of Condition "A" in effect, no additional failure is required to be assumed (as single-failure protection is already not met, and it may be assumed that this was considered in assessing the risk associated with Required Action A.3 and its associated Completion Time).
- The safety train of equipment associated with the inoperable Class 1E electrical equipment A/C train is turned off at 7 days (i.e., major pumps and equipment are secured, but electrical safety bus/distribution remains energized) in order to preserve UHS function (as selected by the plant operators).
    - UHS mission time is 30 days.
    - EDG mission time is 7 days.
    - Offsite power restored in 7 days.
- Remaining train of safety-related equipment enables plant cool-down and long term core cooling.
- Class 1E electrical equipment for operating safety train is cooled by its Class 1E electrical equipment A/C train (with no supplemental cooling needed).

Plant is operating with Condition "A" in effect and experiences a hazard (natural event such as a tornado):

- A concurrent LOOP may be assumed, but no additional failure is required to be assumed.
- The safety train of equipment associated with the inoperable Class 1E electrical equipment A/C train is turned off at 7 days (i.e., major pumps and equipment are secured, but electrical safety bus/distribution remains energized) in order to preserve UHS function (as selected by the plant operators).
- Mission times are not specified for hazards.
    - UHS mission time is 30 days.
    - EDG mission time is not specified but may be assumed to be 7 days per Reference 1.
    - Offsite power restoration not addressed (but may be assumed to be restored in 7 days per Reference 1.
- Remaining train of safety-related equipment enables plant cool-down.
- Class 1E electrical equipment for operating safety train cooled by its Class 1E Electrical Equipment A/C train (with no supplemental cooling needed).
- Use of non-safety equipment, operator actions, and other provisions apply (as described in FSAR Section 3.1.2 and Appendix 3B).

With regards to the postulated post-accident scenario involving additional equipment failures after an ESF train has been secured within 7 days, procedural guidance for the restoration of safety functions is provided in the function restoration (FR) series of the Callaway EOP network. It should be acknowledged that such additional equipment failures would be beyond accident analysis assumptions described in the Callaway FSAR.

References

1. NRC letter, "Response to Task Interface Agreement 2014-10 Related to the Regulatory Position on Emergency Diesel Generator Mission Time for Operability Evaluations at Callaway Plant, Unit No. 1 (CAC No. MF5099, EPID L-2015-LRA-0001)," dated October 19, 2018.