Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-3110

Brad L. Berryman
Acting Vice President – Operations
Arkansas Nuclear One

1CAN111001

November 12, 2010

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Supplement to License Amendment Request Related to Changes to Technical Specification – Completion Times for One Inoperable RCS Cooling Loop
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

REFERENCES:
1. Entergy letter dated August 24, 2010, *License Amendment Request Changes to Technical Specification Related to Completion Times for One Inoperable RCS Cooling Loop* (1CAN081004)
2. NRC email dated October 13, 2010, *Changes to Technical Specification Related to Completion Times for One Inoperable RCS Cooling Loop – Request for Additional Information* (TAC No. ME4563)

Dear Sir or Madam:

In Reference 1, Entergy Operations, Inc. (Entergy) proposed a change to the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TS). Specifically, the change would revise several TSs to permit a greater time period for one of two required Reactor Coolant System (RCS) cooling loops to be inoperable. The affected TSs are applicable in lower Modes of Operation (Modes 4, 5, and 6). In Reference 2, the NRC requested additional information with regard to the Entergy request. The NRC requested additional information to be submitted within 30 days.

The attachment to this letter provides the requested information. Note that the responses to NRC questions summarize various procedural and administrative controls relating to RCS cooling loops and makeup sources. Copies of actual procedures and processes can be made available upon request.

There are no new commitments in this letter.

If you have any questions or require additional information, please contact Stephenie Pyle at 479-858-4704.

I declare under penalty of perjury that the foregoing is true and correct. Executed on November 12, 2010.

Sincerely,

Original signed by Brad L. Berryman

BLB/dbb

Attachment: Request for Additional Information – Completion Times for One Inoperable RCS Cooling Loop

cc: Mr. Elmo E. Collins
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
612 E. Lamar Blvd., Suite 400
Arlington, TX 76011-4125

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Mr. Kaly Kalyanam
MS O-8B1
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Mr. Bernard R. Bevill
Arkansas Department of Health
Radiation Control Section
4815 West Markham Street
Slot #30
Little Rock, AR 72205

Attachment to

1CAN111001

Request for Additional Information
Completion Times for One Inoperable RCS Cooling Loop

Request for Additional Information
Completion Times for One Inoperable RCS Cooling Loop

By letter dated August 24, 2010, Entergy Operations, Inc. (Entergy) made application to amend the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TSs).

The proposed amendment would revise several TSs: TS 3.4.6, "RCS Loops – Mode 4," TS 3.4.7, "RCS Loops – Mode 5, Loops Filled," TS 3.4.8, "RCS Loops – Mode 5, Loops Not Filled," and TS 3.9.5, "Decay Heat Removal (DHR) and Coolant Circulation – Low Water Level" to permit a greater time period for one of two required Reactor Coolant System (RCS) cooling loops to be inoperable. The affected TSs are applicable in lower Modes of Operation (Modes 4, 5, and 6).

The NRC Staff has reviewed the amendment request and determined that additional information is required to complete the review. A request for additional information (RAI) appears below. The Entergy response immediately follows each question.

1. *Discuss plant procedures and operator training programs to show that the in-service reactor coolant system (RCS) loop or decay heat removal (DHR) loop, as applicable, will not be adversely affected by outage activities and surveillance tests in Modes 4, 5, and 6.*

<u>Response</u>

TSs and many other regulatory documents require utilities to address plant shutdown conditions, focusing largely on the availability of RCS/DHR cooling loops and RCS inventory. ANO-1 maintains many procedures and administrative controls in this regard. These controls not only ensure TS requirements are maintained (including reference to applicable TSs and NRC commitments), but also provide a defense-in-depth approach to outage activities as they relate to these cooling loops or to RCS inventory control. The following provides an example of procedures and/or controls. Note that this is by no means a complete list of procedures nor a complete list of all controls contained in the example procedures provided below. Because requirements and controls are extremely robust, the below listing has been intentionally minimized. Actual procedures can be made available to the NRC upon request.

Note that the guidance illustrated below evaluates certain activities in light of the calculated time-to-boil (TTB), similar to that requested in this TS change request. Procedures related to this TS change request will be likewise updated in accordance with the Entergy TS implementation process upon NRC approval of this TS amendment.

OP 1015.002 DECAY HEAT REMOVAL AND LTOP SYSTEM CONTROL

This procedure provides DHR (RCS cooling loop) controls for operational Modes 4, 5, and 6. The individual TSs of concern are referenced throughout the procedure.

The procedure provides guidance for removal of equipment from service that could affect the ability to remove decay heat from the core or alter the Low Temperature Overpressurization (LTOP) system. Guidance is provided to maintain personnel awareness of the effects of a loss of DHR event. Guidance is also provided to track and implement containment closure. This procedure contains the administrative controls needed to ensure the DHR and LTOP systems are operated and maintained in a manner that maintains DHR capability. Also required is the periodic estimation of TTB and time-to-core uncovery (TTCU), which in part acts to maintain Operator awareness of the seriousness of a loss of DHR event.

Several factors affect the severity of the loss of DHR event, including the time since shutdown, available RCS inventory, initial RCS temperature, RCS integrity, RCS makeup capability, use of Steam Generator (SG) nozzle dams, and fuel loading.

As a general operating philosophy, containment breaches are not allowed. However, to provide flexibility during outages in support of necessary maintenance activities, additional measures may be taken that ensure containment closure can be established prior to TTB. When a breach is necessary, closure materials are prepared in advance and when possible, closure must be established from outside containment. During Lowered Inventory conditions, a containment breach via the Reactor Building (RB) Ventilation/Purge system is the only breach allowed without specific approval of the Operations Manager (or designee). Regardless, all containment breaches must have the capability to be closed within the estimated TTB.

In Modes 5 and 6 (TSs govern Mode 4), three power supplies are normally required with four required during Lowered Inventory conditions (i.e., combination of onsite and offsite power sources). Lowered Inventory is the condition of the RCS with fuel in the core such that water level is at or below the reactor vessel head flange (RCS level ≤ 376.5').

The following provides a limited number of requirements listed in this procedure:

- RCS level and Core Exit Thermocouple (CET) data recorded hourly per Cold Shutdown RCS Level Log (OPS-A19).

- Alarm setpoints (such as low RCS level, high CET temperature, and DHR vortex warning) must be established to provide a meaningful alarm to alert the Operator to a loss of DHR event.

- When either DHR system is not operable with the RCS closed, RCS integrity is maintained such that RCS pressure may be raised above the minimum conditions for Reactor Coolant Pump (RCP) operation within 30 minutes of a loss of DHR event and both SGs verified to contain ≥ 20 inches water level (capable of removing heat from the RCS). This requires both Service Water (SW) loops to be operable, and in Mode 4 and above, both Emergency Diesels Generators (EDGs) are required operable. Required support systems include power supply, cooling water to the pump, RCP oil systems, turbine bypass or atmospheric dump system, a means of providing feedwater to the steam generators.

- When the RCS is opened, DHR RCS suction valves CV-1050 and CV-1410 Auto Close Bypass switches are placed in the BYPASS position to prevent the inadvertent closure of either valve when the RCS is not capable of being pressurized.

- The Fuel Transfer Canal (FTC) volume may be determined as follows: - 401' 6" to 396' 6" = 11,070 gal/ft; 396' 6" to 377' 0" = 12,660 gal/ft

- Activities that may interfere with RB Sump recirculation, such as work inside the sump requiring screen removal from the sump Emergency Core Cooling System suction valves are only permissible provided a contingency plan to recover the sump is in place. These suction valves may not be danger tagged.

- With the DHR system in service and fuel in the core, two systems for RCS inventory makeup must be available. With the RCS intact (closed), two High Pressure Injection (HPI) makeup flow paths are required. With the RCS open, two RB Spray pumps may be used to satisfy the requirement for RCS inventory makeup.

- With the DHR system in service and fuel in the core, equipment listed in Attachment B (Decay Heat Removal Equipment List) must be operable/available. With any required Attachment B equipment inoperable/unavailable, a justification for continued operation with the equipment inoperable must be documented and/or additional compensatory measures must be established to ensure the operating DHR system is not interrupted (Form 1015.002A is used to document documentation and/or compensatory measures).

- In Mode 4, 5 or 6 with fuel in the core, a daily estimate of RCS TTB, TTCU, RCS heat-up rate, and required RCS makeup rate is performed (RCS temperature must be rounded up to the next highest temperature curve depicted on the associated graph). These estimates must be re-performed when plant conditions change that could significantly change the TTB. When an estimated TTB is significantly less than the previous TTB estimated while in Mode 5 or 6, containment closure estimates for all outstanding items on the Containment Closure Breach List must be re-evaluated.

ATTACHMENT A VERIFICATION OF DECAY HEAT REMOVAL AND LTOP SYSTEMS IN MODE 4, 5 OR 6

This checklist satisfies TS surveillance requirements (SRs) 3.4.6.1, 3.4.6.2, 3.4.7.1, 3.4.7.2, 3.4.7.3, 3.4.8.1, 3.4.8.2, 3.4.11.1, 3.4.11.2, 3.4.11.3, 3.4.11.4, 3.8.10.1, 3.9.4.1, 3.9.5.1, 3.9.5.2, and commitments made in response to NRC Generic Letter 88-17, Loss of Decay Heat Removal. This checklist satisfies the SR 3.8.1.1 part of SR 3.8.2.1. This attachment contains 12-hour TS surveillances and is required to be completed each shift between 07:30 - 10:30 and 19:30 - 22:30. The attachment lists TS requirements for the three individual modes and provides guidance to the Operator regarding what support features must be operable to meet the TS requirements. The “A” train DHR system listing is provided below as an example:

- DHR Pump Breaker available
- Bus A-3 and B-5 energized
- CV-1401 Low Pressure Injection (LPI) block valve
- CV-1428 "A" DHR Cooler outlet valve
- CV-1433 "A" DHR Cooler bypass either available or closed with SW throttled to the DHR Cooler
- CV-1050 DHR isolation valve
- SW Pump

- CV-3840 DHR Pump bearing cooler valve
- CV-3822 SW to "A" DHR Cooler valve
- EDG or Alternate AC Diesel Generator (AACDG) available to supply Bus A-3
- DHR flow within limits of OP 1104.004, Attachment B (Decay Heat Removal Operating Procedure).

The attachment includes other listings such as those components required for RCS cooling loop operability, SG operability, makeup pump and flow path availability, and power source availability. Alarm and alarm setpoints are also established by this attachment to ensure a loss of DHR or loss of RCS inventory is readily detected by Control Room Operators.

This attachment also provides the TTB/TTCU estimates, RCS heat-up rates, required RCS makeup rates based on initial conditions, and Spent Fuel Pool (SFP) TTB estimates. This information must be re-estimated when plant conditions have or may change that could significantly change the previous estimated values.

ATTACHMENT B DECAY HEAT REMOVAL EQUIPMENT LIST

The attachment provides a list intended to identify those components that could cause RCS perturbations and/or systems that are necessary to maintain the RCS in a stable and controlled condition with the DHR system in service. These systems include the DHR system, SW system, and instrumentation to monitor the RCS and DHR system. Maintenance or testing of the components listed may be permitted provided justification is documented and/or compensatory measures are taken to ensure that DHR will not be interrupted. The listing is approximately five pages and, therefore, is not listed in this RAI response.

Activities that could affect the DHR system are normally not permitted when the RCS is in a Lowered Inventory condition. However, if the activity cannot be delayed, additional measures such as failing valves in position, providing temporary instrumentation, and providing temporary power supplies may be taken to ensure DHR cooling is not interrupted. Enhanced monitoring requirements such as recording RCS level from the Tygon level instrument or stationing a dedicated operator to ensure timely response to a loss of DHR event may also be necessary.

ATTACHMENT C GRAPHS USED TO DETERMINE RCS TIME TO BOIL/CORE UNCOVERY ESTIMATES

This attachment is used in conjunction with the Calculation of RCS Time To Boil/Core Uncovery Estimate (Form 1015.002B) when required. Some assumptions used in developing the curves are as follows:

- Infinite time at 100% power
- All decay heat is transferred to the coolant or core components
- No heat loss from the system
- Pressuizer surge line volume is neglected

- No makeup from outside sources
- Correction is made for the fraction of spent fuel assemblies following refueling

Other graphs include RCS heat-up rate which considers initial RCS level and temperature, and graphs that show the required makeup rate based on time after shutdown and initial RCS pressure.

ATTACHMENT D GRAPHS TO ESTIMATE SPENT FUEL POOL TIME TO BOIL

This attachment provides graphs to estimate the TTB in the SFP, should all SFP cooling be lost. "Conservative fuel storage" is assumed and refers to an assumption that the SFP is completely full of fuel assemblies, ignoring any restrictions that would limit how fuel is stored (such as checker-boarding to meet criticality requirements, maximum heat load limits, or minimum time requirements for fuel movement). The graphs consider different configurations up to and including a full core offload condition.

ATTACHMENT F VERIFICATION OF DECAY HEAT SYSTEM ALIGNMENT

This checklist is performed once per day to verify DHR system alignment in Modes 5 and 6 with fuel in the core. The checklist provides administrative control to assure system misalignment will not prevent RCS DHR or cause the DHR system to be inoperable. DHR system alignment verification requires physical verification of valve positions. The valves are normally locked in their required position.

ATTACHMENT G CONTAINMENT CLOSURE DETERMINATION SHEET

This attachment is used to determine if a RB breach is permitted and, if permitted, to identify the affected penetration, method of closure, time required for closure, department responsible for closure, and department contact. This attachment is required to be completed and an entry made on the Containment Closure Breach List (1015.002D) for each Containment penetration that is impaired due to maintenance or any other activity.

ATTACHMENT J PROTECTED AREA AND INTERCONNECTING SYSTEM VALVE CONTROL

This checklist provides guidance for establishing restrictions surrounding protected areas or equipment to minimize the potential for loss of DHR or SFP cooling, and tagging interconnecting system valves to minimize the potential for inadvertent loss of inventory from the RCS. This attachment is implemented when the RCS is placed on the DHR system and remains in place until the system is secured during plant startup. This attachment remains applicable when the reactor is defueled. Items protected include power buses/panels, pumps, valves, heat exchangers, all other required support equipment, access to control panels, emergency/offsite power sources, and the AACDG. Following is a list of controls placed on protected equipment:

- Components are cordoned on all accessible sides where possible.
- Cabinets with controls on outside (e.g., electrical buses, battery chargers) are cordoned about a foot away from cabinet face controls, if practicable.
- Cordon may be hung directly on cabinets with doors (e.g., switchgear).
- Each group of cordoned components should have at least one sign.
- Signs should be about waist high and not obstruct other signs such as industrial safety and radiological postings.
- For areas needing repeated inspection (e.g., battery rooms), cordon should be installed so that door may be opened without violating the barrier.
- Stanchions should be stable enough to stand on their own and not be toppled by weight of cordon or minor contact.

ATTACHMENT M LOWERED INVENTORY CHECKLIST

This attachment is performed prior to entering Lowered Inventory conditions with fuel in the reactor vessel.

- TTB/TTCU is estimate using Form 1015.002B based on expected final RCS level after draining
- Form 1015.002D, “Containment Closure Breach List” and Attachment G, “Containment Closure Determination Sheet” must be reviewed and all estimated times of closure verified to be within the TTB calculated above
- Emergency Cooling Pond availability is verified as a SW suction source
- Verify RCS inventory makeup systems required per Verification of Decay Heat Removal and LTOP Systems in Mode 4, 5, or 6 (Attachment A) are verified available
- Appropriate protected areas have been cordoned off per Protected Area and Interconnecting System Valve Control (Attachment J)
- At least three of the following Offsite or Emergency Power sources are available (EDG-1, EDG-2, Startup Transformer (SU)-1, SU-2, AACDG)
- At least one EDG operable with automatic tie-on capability to the protected DHR train
- Switchyard posted as Operations Protected Area
- List breakers available to cross-tie buses
- At least two RCS water level indications are available
- Indication from two independent CETs verified available
- DHR trends established on the Safety Parameter Display System computer and Plant Monitoring System/Plant Data Server to allow monitoring during drain down and while in Lowered Inventory conditions
- DHR Impact Statement Log is reviewed to identify Work Request / Work Order (WR/WO) packages affected

- All WR/WO packages identified as having an impact on DHR have a completed Attachment G on file or stop work on those jobs
- Ensure equipment listed in Decay Heat Removal Equipment List (Attachment B) is operable/available or additional measures have been taken and documented in Additional Measures For DHR Maintenance (Form 1015.002A) to ensure DHR is not interrupted
- Prior to entering Lowered Inventory conditions, the following annunciators are flagged:

K09-A7 DECAY HEAT PUMP TRIP	K09-A8 DECAY HEAT FLOW HI/LO
K09-B7 CV-1050 AUTO CLOSE	K09-B8 CV-1410 AUTO CLOSE
K09-C7 TRAIN A RCS LEVEL LO	K09-C8 DH PUMP A/B SUCT TEMP HI
K09-D7 TRAIN B RCS LEVEL LO	K09-D8 DECAY HEAT VORTEX WARNING
K09-E7 LTOP TROUBLE	K09-E8 DH PUMP/MTR TEMP HI
K09-D6 TRAIN A CET TEMP HI	K09-E6 TRAIN B CET TEMP HI

- Perform Crew Brief of operational concerns for Lowered Inventory conditions

OP 1015.003A UNIT 1 OPERATIONS LOGS

This procedure provides a table of readings required by TSs, NRC requirements, or other license commitments or documents which are taken on the log sheets controlled by this procedure. Information is also included that describes the actions required for readings which are outside of specified ranges or limits to assure component/system inoperability is identified and documented. Most logs require review by the end of each shift by the Shift Manager and/or Control Room Supervisor. Individual log readings provide reference to the TS or other requirement in which the log reading relates to. The procedure also requires a set of logs to be recorded for the mode or condition that the plant will enter (where the log would differ from the current mode or condition), but before the mode or condition is entered. This ensures requirements are met prior to actual entry into a mode or condition. Some examples of procedure content are:

- Tygon tube (local RCS level) reading required every 4 hours when RCS level is < 390’
- With RCS level ≤ 375’, two independent CETs are required
- If a required RCS temperature or level instrument is out of service, the backup method utilized must be logged once every 15 minutes when in Lowered Inventory conditions

Many readings are required at least once per shift regardless of the plant mode or condition (such as fire detection/system status, source range indications, offsite and onsite power sources, boric acid makeup tank parameters, SFP parameters, SG parameters including feed source, RCS parameters including cooling loops available, etc.). Additional readings are required in Modes 5 and 6 (such as DHR parameters and equipment).

EN-OP-119 PROTECTED EQUIPMENT POSTINGS

This Procedure provides instruction and guidance for the administrative control of protected equipment postings to station personnel consistent with SOER 09-1, Recommendation 6.

OP 1015.048 SHUTDOWN OPERATIONS PROTECTION PLAN

This procedure provides minimal requirements for Mode 5, 6, and defueled operations whether the plant outage was planned or unplanned. This procedure was designed to maintain all Key Safety Functions in an N+1 condition where "N" is defined as the minimum number of trains or methods that are capable of satisfying those functions. An example of this would be the DHR system which consists of two 100% capacity trains of DHR equipment that are each capable of satisfying the DHR safety function independently. The Shutdown Operations Protection Plan (SOPP) will maintain both trains available during all shutdown conditions, except when the FTC is flooded, to maintain a "defense in depth" perspective. When the FTC is flooded, defense in depth is provided by the additional inventory above the fuel. The procedure covers six different conditions (related to RCS level, RCS open/closed configuration, and fuel locations or movement). The Key Safety Functions enveloped by this procedure include 1) DHR capability (includes SFP cooling), 2) RCS inventory control, 3) electrical power availability (includes both on-site and off-site power), 4) reactivity control, and 5) containment closure.

Safety assessments are performed with regard to each Key Safety Function. The results are represented by a color code. The overall outage safety status is based upon the most limiting Key Safety Function status color. The presence of a higher risk evolution activity will result in a 'non-green' color even if all the requirements for that safety function are satisfied. For example, an activity that has a potential for a loss of DHR event will be 'yellow' during its scheduled time span, even if N+1 exists.

Regardless of meeting N+1 criteria, the Outage Risk Assessment Team documents their review of risk significant items, such as work allowed during Lowered Inventory in the first part of an outage, maintenance or other activities performed when less than 30 minutes TTB exists, and single point vulnerabilities. Schedule changes that move an item in or out of a pre-determined window are also assessed.

The procedure requires avoidance of conditions that could upset SFP cooling systems and minimizes time in lowered inventory. Operator briefings are required for RCS or SFP inventory changes or activities that can affect RCS cooling loops. The procedure must be applied at least once per shift or anytime a new SOPP condition is to be entered. The procedure includes an attachment of contingency plans to implement when conditions of the SOPP are unexpectedly not met for a given configuration.

OP 1203.028 LOSS OF DECAY HEAT REMOVAL

This is an abnormal operating procedure used by Operators when conditions adversely affect DHR or RCS inventory. The procedure is designed to permit Operators to rapidly enter appropriate sections depending on the severity of the event. For example, the rate at which RCS inventory is being reduced will dictate what section of the procedure is to be entered, with the more severe criteria directing use of a section that would require rapid and more conservative response to the event.

Overall Discussion

Significant proceduralized administrative controls have been established and thoroughly engrained in the ANO-1 organization to place the appropriate focus on RCS cooling and inventory functions. In addition, Operators receive routine training, both classroom and in the dynamic simulator, related to standard outage controls and maneuvers. This training is generally performed in the training cycle just prior to an outage. Classroom training typically includes:

- Training on design change packages and procedure changes
- Outage overview
- TSs applicable in shutdown modes of operation
- SOPP and LTOP
- Shutdown/Startup activities
- Outage specific activities
- Human performance traps and tools (including operating experience)
- Outage preparation and evolutions review
- DHR

Dynamic simulator training typically includes:

- DHR operations and loss of DHR (includes loss of RCS inventory)
- Plant shutdown and cool down
- Reactor startup and power ascension

"Just-In-Time" training is also provided for specific infrequent evolutions or in relation to non-routine outage-related activities. Based on the above, sufficient training and numerous administrative controls are established to limit challenges to RCS cooling and inventory functions.

2. *Discuss alternate core cooling (ACC) methods that can be used for DHR and RCS inventory control during a total loss of the RCS loops and DHR loops event for the following applicable plant conditions: (1) the plant is in Mode 4 (TS 3.4.6 conditions); (2) the plant is in Mode 5 and the RCS loops are filled with water (TS 3.4.7 conditions); (3) the plant is in Mode 5 and the RCS loops are not filled with water (such as mid-loop operations - TS 3.4.8 conditions); and (4) the plant is in Mode 6 with the water level less than 23 feet above the irradiated fuel seated in the reactor pressure vessel (TS 3.9.5 conditions). The requested information should show that: (1) the ACC methods are effective to remove the decay heat and maintain the plant in safe and stable conditions for an extended period of time; (2) the associated operating procedures are available; and (3) the procedures are technically sound and provide clear guidance to the operator for applying the methods. In addition, provide a discussion of plant administration controls, programs or procedures to assure that the equipment (pumps, valves, and instrumentation) needed for the ACC methods is operable.*

Response

Based on the complexity of this question, the ACC methods are discussed separately in accordance with the four conditions depicted above. Significant procedural content is provided in response to Question 1 above; therefore, only reference to this content is provided in this response. Because Subpart (2) of this question, in reference to availability of procedures, Subpart (3) in reference to procedures being technically sound, and the additional subpart (in reference to a discussion of controls, procedures, etc.) are common to all three modes, the response to these subparts is as follows:

> As illustrated above, procedures and administrative controls provide significant guidance for protecting cooling and inventory makeup sources. Procedure numbers and titles are also provided in response to Question 1. Several others are noted in further response to this question below. The modes and conditions for which the procedures are applicable have also been provided. As stated previously, this listing is not all inclusive, but provides ample information related to available guidance to conclude sufficient controls have been established. Plant cool down and heat up procedures provide step-by-step instructions for transitioning to/from the desired core cooling methods, whether a result of normal plant maneuvering or when necessitated by unforeseen equipment loss. OP 1203.028 (Loss of Decay Heat Removal) also provides specific instruction and places required actions in an order of importance with regard to the recovery from a loss of DHR event or loss of RCS inventory event. As noted above, these and other procedures are available upon request.

Of special note is that many of the procedural requirements discussed previously are related directly or indirectly to NRC commitments. Many of these commitments are listed in the applicable procedures.

Mode 4

As discussed in the original submittal, more cooling methods are available during Mode 4 operations than any other mode. During plant cool down, both RCS cooling loops consisting of required RCPs and an operable SG are initially utilized. While the loss of all RCPs is possible should a loss of offsite power (LOOP) event occur in this mode, the loss of cooling capability via the SGs is unlikely. Only one SG need remain available following a LOOP to support natural circulation cooling. TS 3.7.5 requires the vital-powered Emergency Feedwater pump to be operable in this mode anytime the SG is relied upon for DHR. ANO-1 also has the AACDG power source in the event either or both EDGs are lost during a LOOP. Therefore, it is highly likely that at least one SG will remain available throughout this mode of operation.

As discussed in response to Question 1 above, the SOPP functions in an N+1 capacity, such that an additional cooling method is maintained available beyond that required by TSs. This is why procedures direct depressurizing the RCS and initiating the DHR system if all RCPs are lost. The same is true during initial plant heat up when the RCS is being cooled by the DHR system. The RCS must be maintained in a configuration where it can be pressurized to the point needed for RCP operation should a loss of both DHR systems occur. Procedures also ensure a cooling method via the SG will be available should the RCP cooling method become necessary.

Also as illustrated in the response to Question 1, required makeup sources are maintained for the various plant conditions. TS 3.5.3 requires two LPI makeup sources to be operable in Mode 4. Beyond this, station procedures require two HPI makeup sources to be available when the RCS is intact. TS 3.8.1.1 requires two offsite and two emergency (onsite) power sources to be operable in Mode 4. Although isolated for inventory control during plant cool down, the Core Flood Tanks remain capable of providing a makeup source to the RCS.

With regard to Subpart (1) of the question (in reference to the effectiveness of ACC methods), the normal and ACC methods are effective for removing decay heat and maintaining the plant in safe and stable condition for an extended period of time. With offsite power available and adequate RCS pressure, the use of one or more RCPs via a single SG provides all necessary long term core cooling. If offsite power is not available or when RCS pressure has been reduced to the necessary DHR system limit, a single DHR train is sufficient for providing long term core cooling. As discussed previously, the maintaining the capability to pressurize/depressurize the RCS is a procedural requirement in this mode. Natural circulation cooling can also be maintained over the long term should DHR trains or RCPs become unavailable, provided at least one SG remains available. The available methods provide sufficient defense-in-depth to preclude reliance on feed and bleed core cooling. As clearly illustrated in response to Question 1, substantial controls, including the control of maintenance and testing activities, have been established to minimize any condition or configuration that may lead to a loss of core cooling or RCS inventory event. Therefore, the proposed TS change will continue to provide a sufficient margin to safety with regard to RCS cooling source unavailability in Mode 4.

Mode 5 – RCS Filled

As discussed in the original submittal, the cooling methods available in Mode 5 are dependent on RCS level and whether the RCS is intact. With the RCS intact (closed), procedures require the ability to pressurize the RCS be maintained any time one of the two required DHR systems is inoperable. This includes maintaining the availability of at least one SG and RCP. In this respect, the available cooling methods and controls remain the same as those available in Mode 4 as depicted above (forced or natural circulation cooling remains available). In addition, procedures require two HPI makeup sources to be available while the RCS remains intact. OP 1103.011, Draining and N_2 Blanketing The RCS, provides further guidance, in addition to the procedures denoted in response to Question 1 above, with regard to depressurizing and opening the RCS prior to entering Lowered Inventory conditions.

With regard to Subpart (1) of the question (in reference to the effectiveness of ACC methods), the normal and ACC methods are effective for removing decay heat and maintaining the plant in safe and stable condition for an extended period of time while in Mode 5 with RCS loops filled (similar to that of Mode 4 above). The available methods provide sufficient defense-in-depth to preclude reliance on feed and bleed core cooling. As clearly illustrated in response to Question 1, substantial controls, including the control of maintenance and testing activities, have been established to minimize any condition or configuration that may lead to a loss of core cooling or RCS inventory event. Therefore, the proposed TS change will continue to provide a sufficient margin to safety with regard to RCS cooling source unavailability in Mode 5 when the RCS is filled.

Mode 5 – RCS Not Filled

When the RCS is drained to a predetermined level while in Mode 5, available cooling methods become more limited and, therefore, a heightened awareness is placed on the importance of all required cooling and makeup sources. If the steam bubble in the pressurizer has been collapsed and/or the RCS is open, RCS forced cooling via an RCP cannot be made readily available. The significance of an RCS draining evolution is amplified during the early stages of an outage where decay heat levels remain relatively high. Compliance not only with the applicable TSs related to cooling and makeup sources, but also with the aforementioned NRC GL 88-17 and with Institute of Nuclear Power Operations (INPO) Significant Operating Experience Report (SOER) 09-01, Shutdown Safety, is important. TS 3.4.8 permits one of the two DHR trains to be inoperable for up to 2 hours with the RCS not filled in Mode 5; however, TTB/TTCU estimates would severely limit activities permitted in this condition. As stated previously, justification and management approval is required for removing any equipment from service in this plant condition that could present a challenge to RCS cooling or makeup sources. Procedures permit consideration of removing equipment from service largely in support of unavoidable circumstances; notwithstanding such an event, management approval would not be received for cooling/makeup related equipment early in an outage when TTB/TTCU estimates are limiting.

Two makeup sources must be available at all times during draining evolutions or Lowered Inventory conditions. With the RCS open, the number of makeup sources available is increased. While HPI remains a preferred source, RCS makeup can also be achieved via RB Spray pumps or a DHR pump if necessary. OP 1203.028, Loss of Decay Heat Removal, alerts Operators to other makeup sources such as gravity feed from the Borated Water Storage Tank and the SFP cooling pump or Borated Water Recirculation pump (when the RCS is in thermal hydraulic communication with the refueling canal).

Because of the importance of RCS draining evolutions, several other controls are required to be in place such as independent CET and RCS level indications. DHR system flow is also closely controlled, especially when Lowered Inventory conditions are entered, in order to preclude pump vortexing. Alarms and their setpoints are specifically set to alert Operators of any potential malfunction during draining evolutions and throughout Lowered Inventory conditions. See the response to Question 1 above for further detail.

With regard to Subpart (1) of the question (in reference to the effectiveness of ACC methods), the normal and ACC methods are effective for removing decay heat and maintaining the plant in safe and stable condition for an extended period of time while in Mode 5 with RCS loops filled (similar to that of Mode 4 above). The available methods provide sufficient defense-in-depth to preclude reliance on feed and bleed core cooling. As clearly illustrated in response to Question 1, substantial controls, including the control of maintenance and testing activities, have been established to minimize any condition or configuration that may lead to a loss of core cooling or RCS inventory event. In addition, the proposed TS change would not support DHR pump or system testing early in the outage due to the limiting estimated TTB/TTCU results. Therefore, the proposed TS change will continue to provide a sufficient margin to safety with regard to RCS cooling source unavailability in Mode 5 when the RCS is not filled.

Mode 6 – Level < 23 Feet Above Fuel in the Core

TS 3.9.5 requires two operable DHR loops in Mode 6 when RCS inventory is < 23' above the fuel in the core. In Mode 6 with the FTC flooded, significant water volume is available above the core, in most cases even when level is < 23' (see response to Question 1 above). Some outage activities may require a relatively small reduction in level below 23' in the FTC, but well above Lowered Inventory conditions. In addition, core decay heat levels are significantly less by the time the reactor vessel head has been removed and the FTC flooded, than other drain down windows which may have occurred at early periods in the outage.

Note that the same requirements for cooling and makeup are required for this mode as is required for Mode 5 – RCS Not Filled (above) when entering Lowered Inventory conditions. As in Mode 5, the containment sump is also assured to provide a long term cooling recirculation path should gross failure of either the RCS or the FTC occur. The numerous items listed under "Attachment M" in response to Question 1 above provides significant detail regarding the defense-in-depth measures established anytime the RCS is placed in a Lowered Inventory condition. As discussed previously, the proposed TS change will limit challenges to RCS cooling or makeup sources in this Mode and condition by only permitting testing of the standby cooling source (i.e., the cooling source remains available although minor system realignments may be required) and only when the testing can be performed and the component restored within the estimated TTB. This is a significant restriction because the TTB far exceeds the TTCU in this mode and when considering the various RCS makeup sources available. The aforementioned procedural restrictions provide additional defense-in-depth during drain down operations. Therefore, the proposed TS change will continue to provide a sufficient margin to safety with regard to RCS cooling source unavailability in Mode 6 when the RCS level is < 23' above the fuel in the core.

3. *Discuss the method used for the time-to-boil calculations and address the acceptability of the method used. If the method used was previously approved by the NRC, address the compliance with the conditions and restrictions specified in the NRC safety evaluation report approving the method. The requested information should include the plant parameters considered in the calculations for Modes 4, 5 and 6 conditions, identify the major input initial conditions, discuss the bases used to select the numerical values of the input parameters and demonstrate that the numerical values (with consideration of the uncertainties and fluctuation around the nominal values) are conservative, resulting in a minimum time-to-boil. For TS 3.9.5 - Mode 6 conditions, specify and provide the bases for the amount of the water in the refueling pool cavity above the reactor vessel used in the time-to-boil calculation considering that the refueling cavity water may not be completely mixed. Also, provide the results of the calculated time-to-boil as a function of the key parameters that will have an effect on the calculated time-to-boil for use in implementation of the proposed changes to TSs 3.4.7, 3.4.8 and 3.9.5.*

Response

Estimating the time required to reach the boiling point of the reactor coolant is not complex. Initial RCS temperature, the heat input (decay heat) value, initial RCS level, and the status of the RCS (open to atmosphere or intact) all play a role in estimating the TTB. As discussed under "Attachment C" in response to Question 1 above, several conservatisms are incorporated in the TTB estimate such as an infinite power history assumption at 100% power, no ambient losses, not all available RCS volume is credited, and no makeup is assumed. Due to the many conservatisms, instrument uncertainty is not normally considered; however, Operator logs require instrument channel checks to verify instruments are tracking and within a pre-determined deviation from one another. With regard to RCS level, Tygon tube level indication can provide a mechanical means of observing RCS level for comparison with instrument channels. While the TTB estimation was not submitted to the NRC for approval, it has been in place for many years and reviewed during NRC inspection activities. Based on the above, the conservatisms included in the TTB (and TTCU) estimate provide a sufficient margin to safety.

The TTB estimate utilizes the aforementioned parameters and inputs in conjunction with several proceduralized graphs, including correction factors. A controlled computer-based program can also be used (incorporates the same method as the manual estimation). To discuss the significance (if any) of fluctuations in parameters, the following examples are provided using the TTB graphs for a given configuration:

1. A 1' change in level equates to anywhere from approximately a 0.1 to 2 minute change in TTB.

2. A 10° F change in temperature equates to approximately a 1 – 3 minute change in TTB.

3. Following shutdown, decay heat reduction continues to have a positive effect on TTB for the remainder of the outage. The TTB is also corrected for core offload and reload as necessary.

Note that the TTB and TTCU are two, normally significantly different values. Neither take into account makeup capability. However, the procedure, in addition to estimating TTB and TTCU, also estimates the RCS heat up rate (assuming cooling is lost) and the required RCS makeup rate to account for evaporative loss once boiling is reached (assuming all cooling is lost).

One of the first activities requiring significant draining of the RCS possibly early in an outage would be either the installation of SG nozzle dams (RCS level about 371.5') or removal of the reactor vessel head (occurs just below Lowered Inventory conditions at about 376'). Although decay heat input has significantly been reduced when these activities are permitted to occur, neither activity occurs at a time during the outage that would support testing of the standby RCS cooling loop while the RCS is drained. However, as core offload is commenced, sufficient TTB margin becomes available to eventually support testing of the standby cooling loop, in accordance with the proposed TS. Note that testing of the standby loop is normally scheduled in the latter half of an outage, when decay heat levels are low and sufficient RCS volume exists. This is not only due to TTB concerns, but also due to the testing usually being required after significant outage activities are completed (often to support post maintenance testing) in order to verify operability for the upcoming fuel cycle.

As plant cool down is commenced following shutdown, RCS boron concentration is gradually increased to ensure TS shutdown margin requirements are maintained (to counteract the reduction of RCS temperature which results in positive reactivity addition). When the shutdown is in support of a refueling outage, the boron concentration is increased during the cool down to meet TS 3.9.1 refueling boron concentration limits. The FTC is flooded (following reactor vessel head removal) using tank volumes having a boron concentration that will meet TS 3.9.1 requirements. Following flood-up of the FTC, OP 1103.011, Draining and N_2 Blanketing the RCS, requires additions to the RCS to be of equal or greater boron concentration than the

TS 3.9.1 required concentration. In addition, OP 1502.004, Control of Unit 1 Refueling, requires any path that could potentially dilute the FTC or SFP be isolated from these systems. This procedure also requires boron sampling of the FTC, DHR system, and SFP at least once daily, and provides actions should any unexpected drop in boron concentration be noted. Normal makeup to the SFP or to the RCS/FTC is not made directly to the pool, but via the RCS normal injection legs or via the SFP makeup/purification system. This provides a mixing evolution to occur during the actual makeup process. When needed, DHR system suction can also be aligned from the FTC, providing additional mixing of the pool. Based on the aforementioned restrictions and processes, pockets of water having a boron concentration of less than that required for refueling (Mode 6) are not likely to exist. Regardless, neutron flux count rate is available and monitored during any outage until all fuel has been removed from the core.

Based on the above, sufficient conservatisms are included in TTB/TTCU estimates and sufficient controls are in place to ensure required equipment is protected to minimize any challenge to the operating core cooling system or challenge to the maintenance of RCS inventory. The proposed TS change will provide an additional restriction, beyond the many currently addressed in TSs and station procedures, to ensure testing of the standby RCS cooling loop will not present a direct challenge to the operating cooling loop or significantly reduce the margin to safety, based on available makeup sources, protection of safety-significant equipment, and the capability to restore the standby loop to operation, if needed.