DUKE POWER COMPANY

OCONEE NUCLEAR STATION

ATTACHMENT 1

TECHNICAL SPECIFICATIONS

| Remove Page | Insert Page |
|---|---|
| 3.4.3-3 | 3.4.3-3 |
| 3.4.3-4 | 3.4.3-4 |
| 3.4.3-5 | 3.4.3-5 |
| 3.4.3-6 | 3.4.3-6 |
| 3.4.3-7 | 3.4.3-7 |
| 3.4.3-8 | 3.4.3-8 |
| 3.4.3-9 | 3.4.3-9 |
| 3.4.3-10 | 3.4.3-10 |
| 3.4.3-11 | 3.4.3-11 |
| 3.4.3-12 | 3.4.3-12 |
| 3.4.3-13 | 3.4.3-13 |
| 3.4.12-1 | 3.4.12-1 |
| 3.4.12-2 | 3.4.12-2 |
| B 3.4.3-1 | B 3.4.3-1 |
| B 3.4.3-2 | B 3.4.3-2 |
| B 3.4.3-3 | B 3.4.3-3 |
| B 3.4.3-4 | B 3.4.3-4 |
| B 3.4.3-5 | B 3.4.3-5 |
| B 3.4.3-6 | B 3.4.3-6 |
| B 3.4.3-7 | B 3.4.3-7 |
| B 3.4.3-8 | B 3.4.3-8 |
| B 3.4.3-9 | B 3.4.3-9 |
| B 3.4.12-5 | B 3.4.12-5 |
| B 3.4.12-7 | B 3.4.12-7 |
| B 3.4.12-8 | B 3.4.12-8 |
| B 3.4.12-11 | B 3.4.12-11 |

Table 3.4.3-1 (page 1 of 1)
Operational Requirements for Unit Heatup

| CONSTRAINT | RC TEMPERATURE[a] | MAXIMUM HEATUP RATE | ALLOWED PUMP COMBINATION |
|---|---|---|---|
| RC Temperature[a] | T < 280°F<br>T ≥ 280°F | 50°F/hr<br>100°F/hr | NA<br>NA |
| RC Pumps | T < 250°F<br>T ≥ 250°F | NA<br>NA | ≤ two pumps<br>Any |

(a) RC Temperature is cold leg temperature if one or more RC pumps are in operation; otherwise it is the LPI cooler outlet temperature.

Table 3.4.3-2 (page 1 of 1)
Operational Requirements for Unit Cooldown

| CONSTRAINT | RC TEMPERATURE[a] | MAXIMUM COOLDOWN RATE[b] | ALLOWED PUMP COMBINATION |
|---|---|---|---|
| RC Temperature[a] | T ≥ 280°F | ≤ 50°F in any 1/2 hour period | NA |
| | 150°F ≤ T < 280°F | ≤ 25°F in any 1/2 hour period | NA |
| | T< 150°F | ≤ 10°F in any one hour period | NA |
| | RCS depressurized[c] | ≤ 50°F in any one hour period | NA |
| RC Pumps | T ≥ 250°F | NA | Any |
| | T < 250°F | NA | ≤ two pumps |

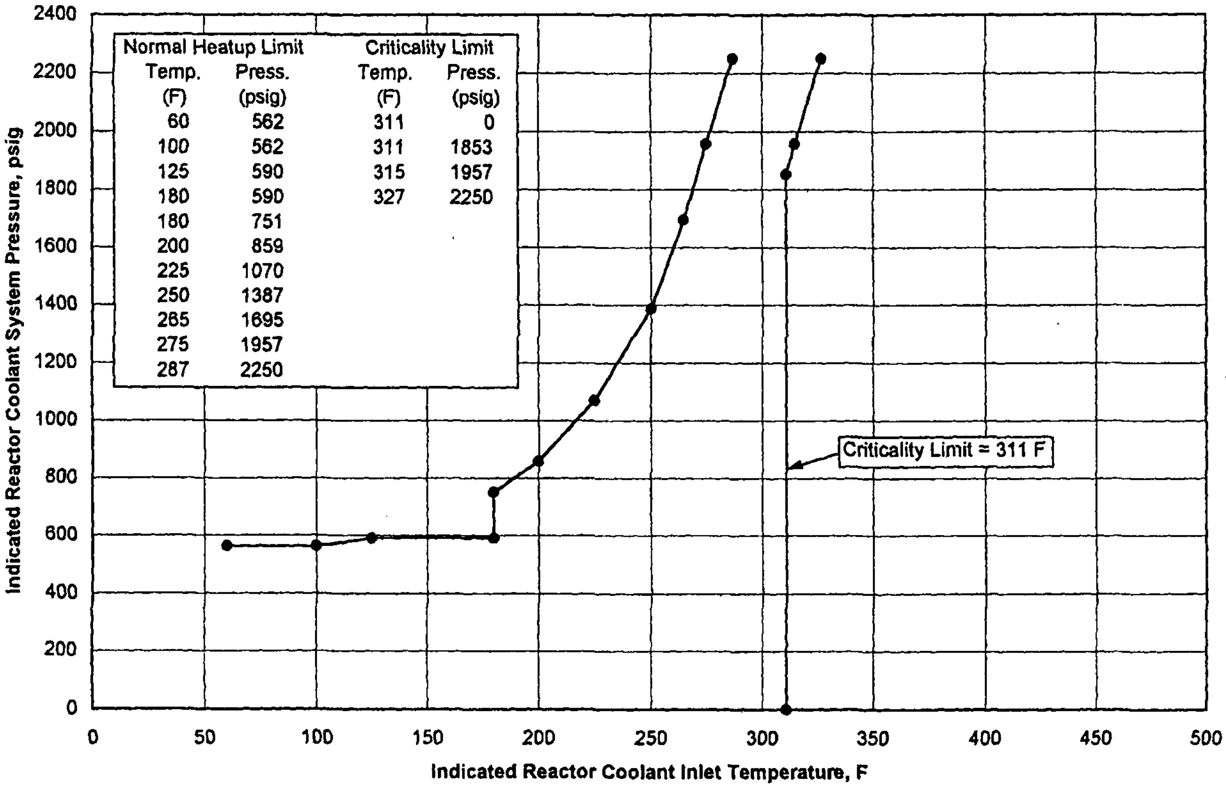
(a) RC Temperature is cold leg temperature if one or more RC pumps are in operation or if on natural circulation cooldown; otherwise it is the LPI cooler outlet temperature.

(b) These rate limits must be applied to the change in temperature indication from cold leg temperature to LPI cooler outlet temperature per Note (a).

(c) When the RCS is depressurized such that all three of the following conditions exist:

a) RCS temperature < 200°F,
b) RCS pressure < 50 psig,
c) All RC Pumps off,

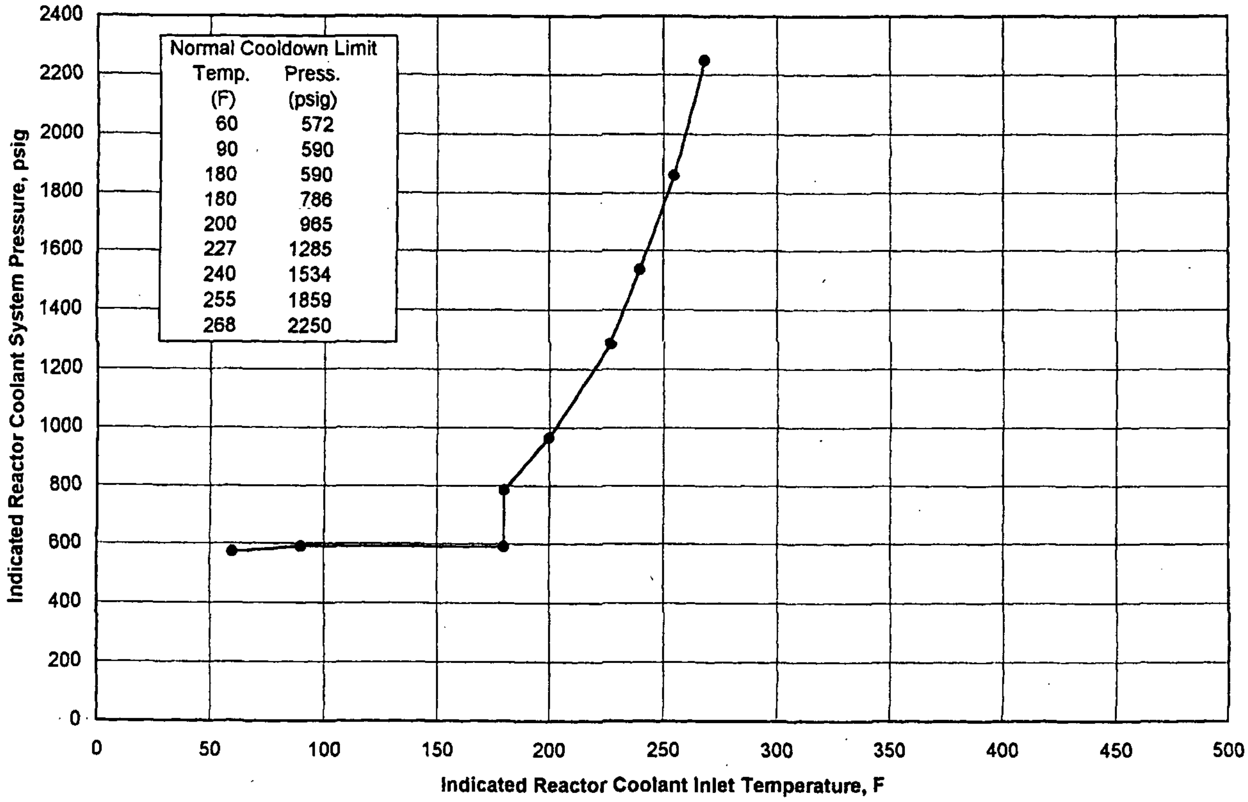
the maximum cooldown rate shall be relaxed to ≤ 50°F in any 1 hour period.




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. <u>Margins for instrument error are not included</u>.

<u>NOTE</u>: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

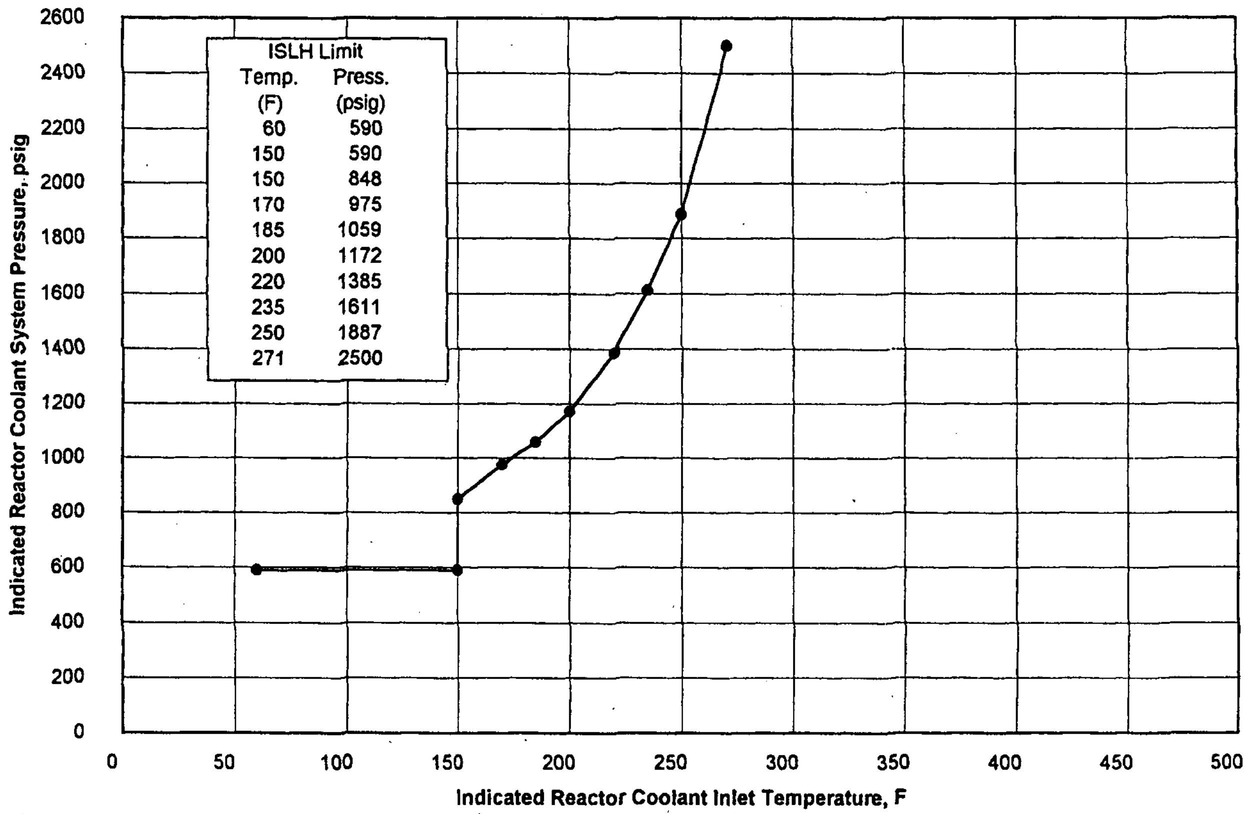
Figure 3.4.3-1 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 1




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

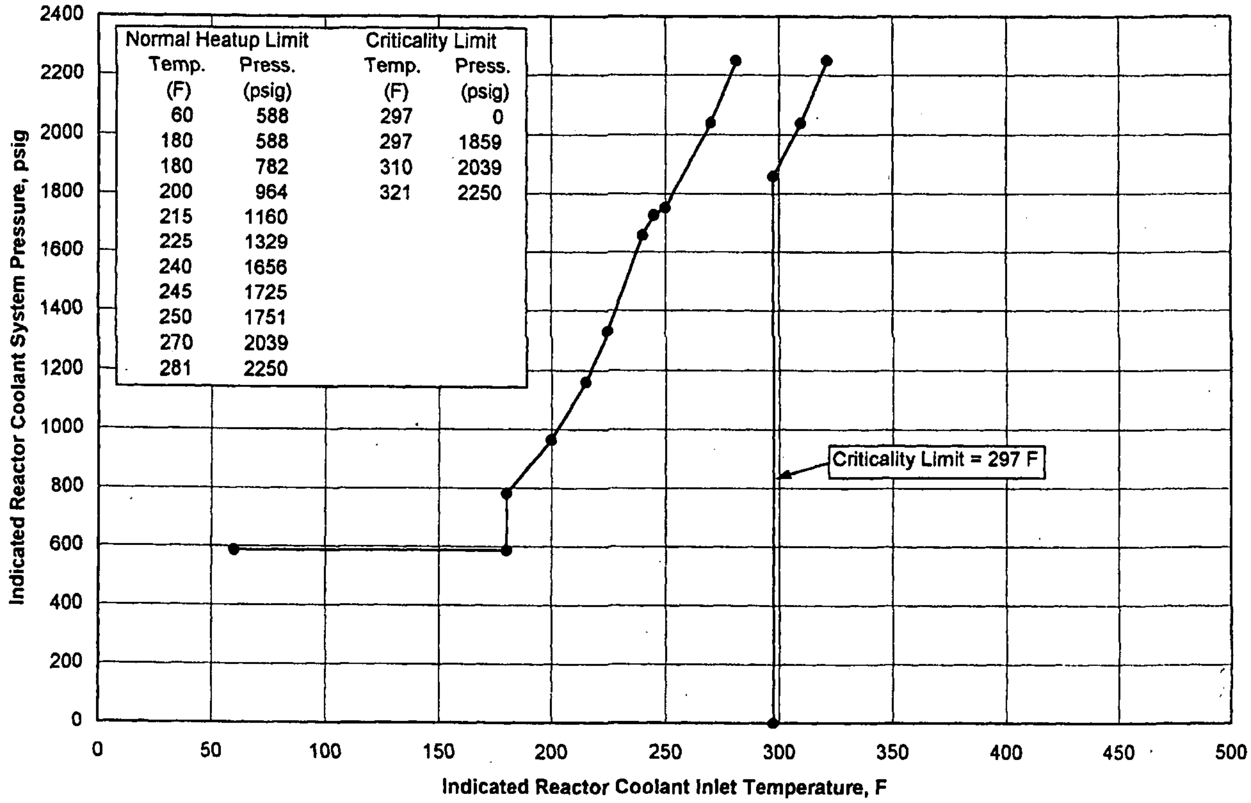
Figure 3.4.3-2 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 1




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

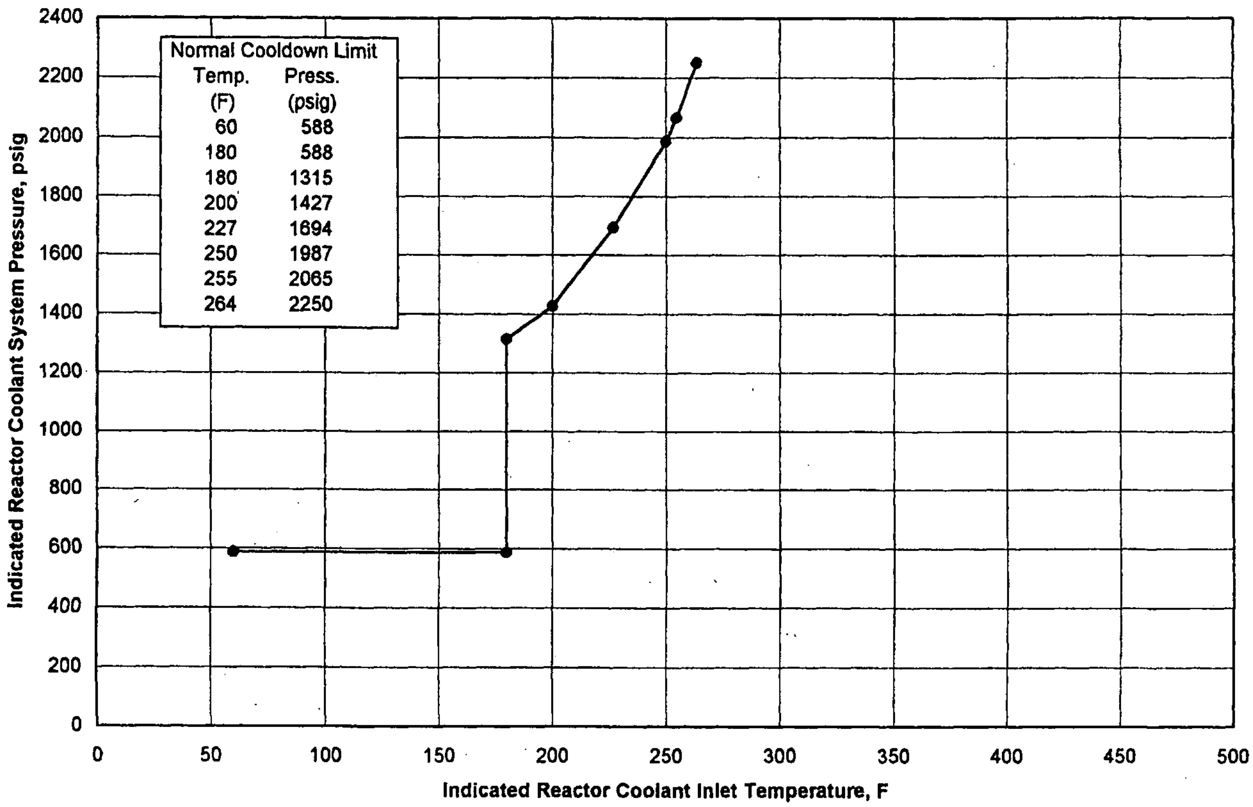
Figure 3.4.3-3 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 1




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and cooldown rate restrictions and Reactor coolant pump combination restrictions during Heatup and cooldown are required, as identified in text.

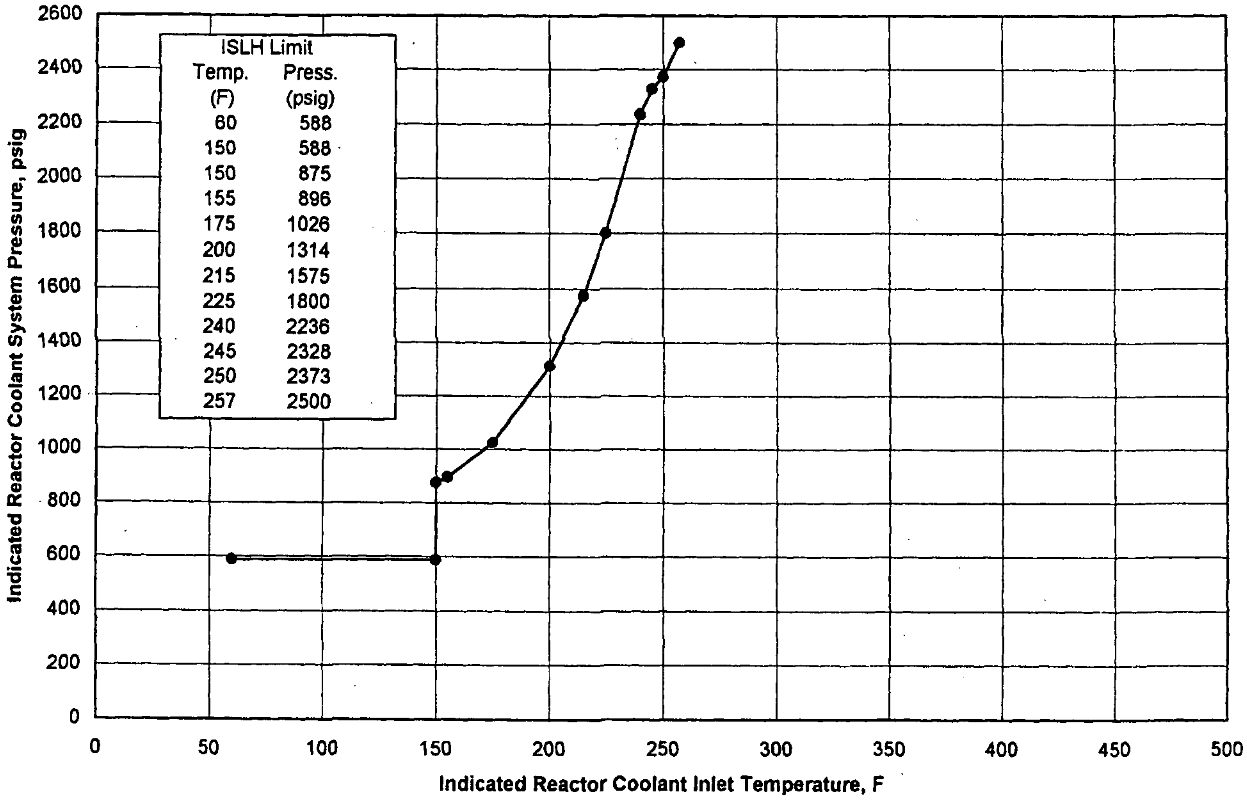
Figure 3.4.3-4 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 2




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

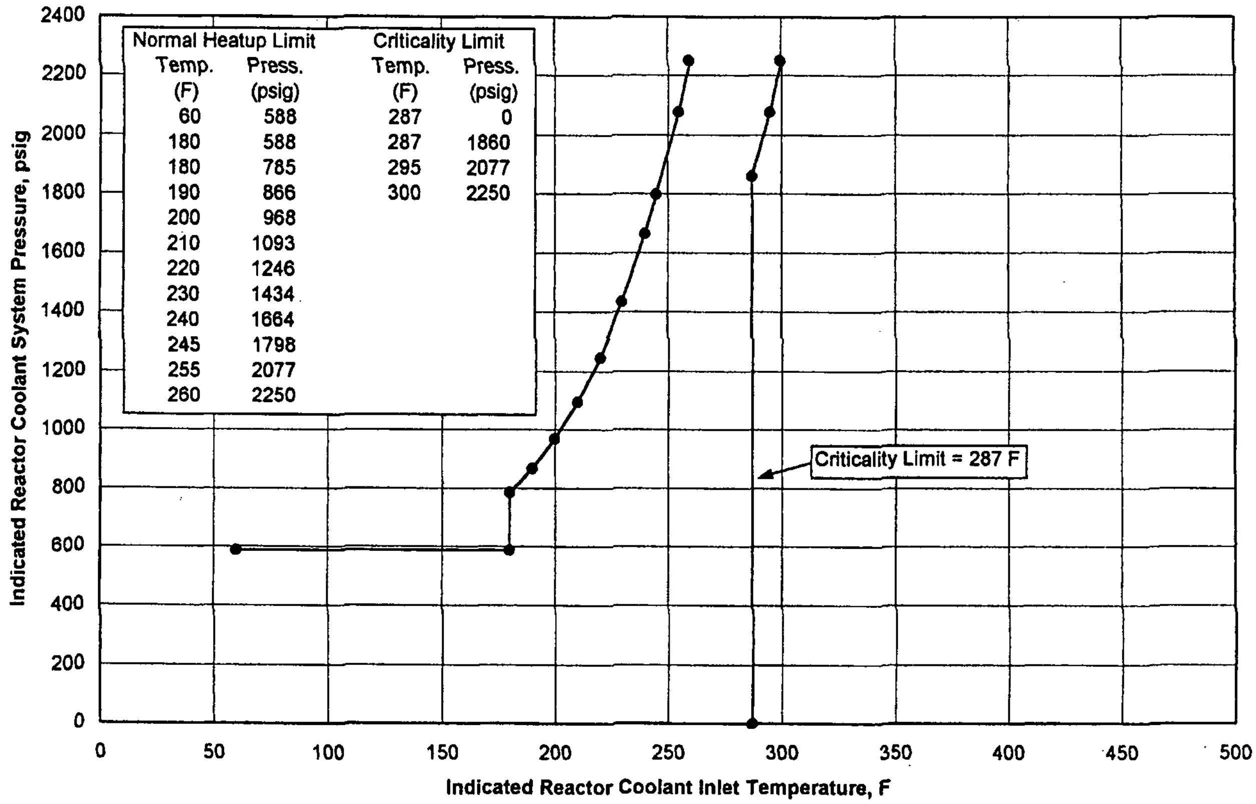
Figure 3.4.3-5 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 2




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. <u>Margins for instrument error are not included</u>.

<u>NOTE</u>: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

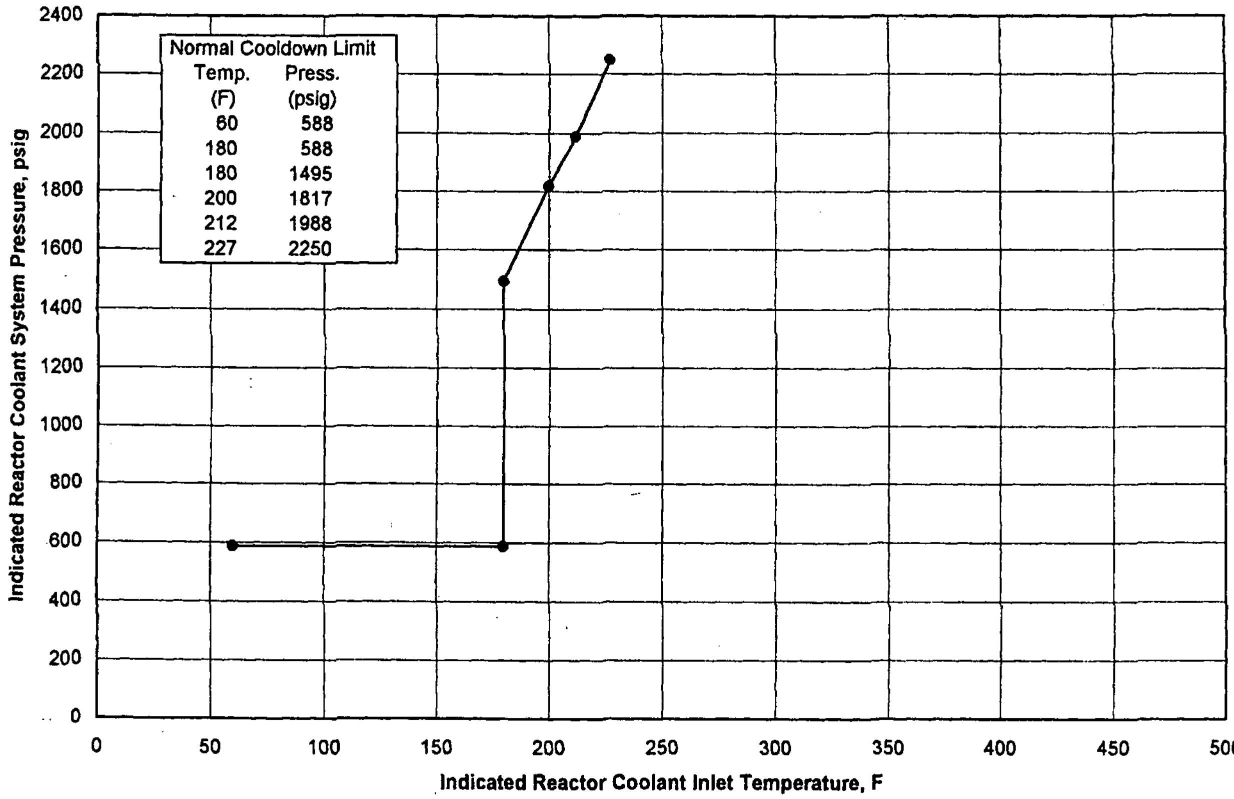
Figure 3.4.3-6 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 2




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. <u>Margins for instrument error are not included</u>.

<u>NOTE</u>: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

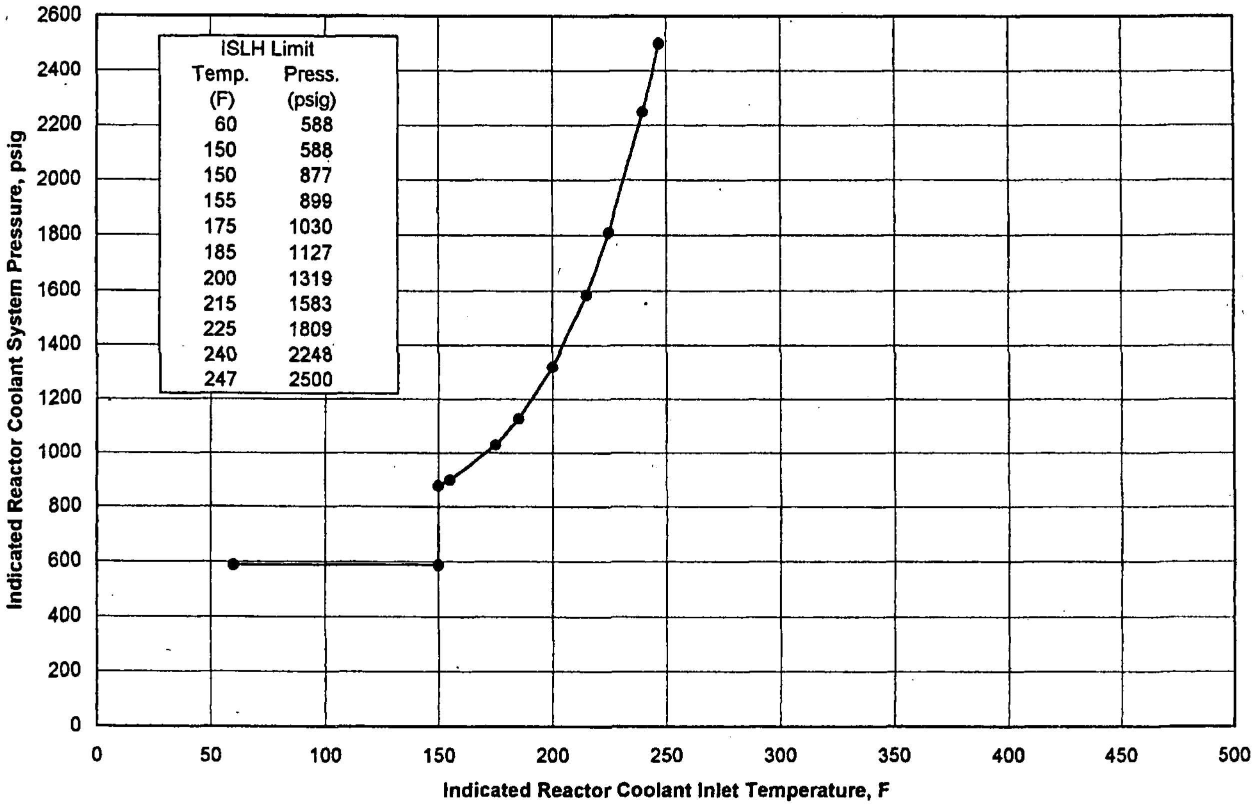
Figure 3.4.3-7 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 3




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

Figure 3.4.3-8 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 3




The regions of acceptable operation are below and to the right of the limit curves. Margins are included for the pressure differential between point of system pressure measurement and the pressure on the reactor vessel region controlling the limit curve. Margins for instrument error are not included.

NOTE: Heatup and Cooldown rate restrictions and Reactor Coolant Pump combination restrictions during Heatup and Cooldown are required, as identified in text.

Figure 3.4.3-9 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First 33 EFPY - Oconee Nuclear Station Unit 3

## 3.4 REACTOR COOLANT SYSTEM (RCS)

### 3.4.12 Low Temperature Overpressure Protection (LTOP) System

LCO 3.4.12 An LTOP System shall be OPERABLE with high pressure injection (HPI) deactivated, and the core flood tanks (CFTs) isolated and:

a. An OPERABLE power operated relief valve (PORV) with a lift setpoint of ≤ 535 psig; and

b. Administrative controls implemented that assure ≥ 10 minutes are available for operator action to mitigate an LTOP event.

APPLICABILITY: MODE 3 when any RCS cold leg temperature is ≤ 325°F, MODES 4, 5, and 6 when an RCS vent path capable of mitigating the most limiting LTOP event is not open.

---------------------------NOTES---------------------------

1. CFT isolation is only required when CFT pressure is greater than or equal to the maximum RCS pressure for the existing RCS temperature allowed by the pressure and temperature limit curves provided in Specification 3.4.3.

2. The PORV is not required to be OPERABLE when no HPI pumps are running and RCS pressure < 100 psig.

------------------------------------------------------------

ACTIONS

| CONDITION | REQUIRED ACTION | | COMPLETION TIME |
|---|---|---|---|
| A. HPI activated. | A.1 | Initiate action to deactivate HPI. | Immediately |
| B. A CFT not isolated when CFT pressure is greater than or equal to the maximum RCS pressure for existing temperature allowed by Specification 3.4.3. | B.1 | Isolate affected CFT. | 1 hour |
| C. Required Action and associated Completion Time of Condition B not met. | C.1 | Be in MODE 4 with RCS temperature > 200°F. | 12 hours |
| | <u>OR</u> | | |
| | C.2 | Depressurize affected CFT to < 373 psig. | 12 hours |
| D. PORV inoperable. | D.1 | Restore PORV to OPERABLE status. | 1 hour |
| E. Required Action and associated Completion Time of Condition D not met. | E.1 | Be in MODE 3 with RCS average temperature > 325°F. | 23 hours |
| | <u>OR</u> | | |
| | E.2 | Depressurize RCS to < 100 psig. | 35 hours |

(continued)

# B 3.4 REACTOR COOLANT SYSTEM (RCS)

## B 3.4.3 RCS Pressure and Temperature (P/T) Limits

BASES

BACKGROUND

All components of the RCS are designed to withstand effects of cyclic loads due to system pressure and temperature changes. These loads are introduced by startup (heatup) and shutdown (cooldown) operations, power transients, and reactor trips. This LCO limits the pressure and temperature changes during RCS heatup and cooldown, within the design assumptions and the stress limits for cyclic operation.

Figures 3.4.3-1 through 3.4.3-9 contain P/T limit curves for heatup, cooldown, and leak and hydrostatic (LH) testing. Tables 3.4.3-1 and 3.4.3-2 contain data for the maximum rate of change of reactor coolant temperature. The minimum temperature indicated in the P/T limit curves and tables of 60°F is the lowest unirradiated nil ductility reference temperature ($RT_{ndt}$) of all materials in the reactor vessel. This temperature (60°F) is the minimum allowable reactor pressure vessel temperature if any head closure stud is not fully detensioned.

Figures 3.4.3-1, 3.4.3-2, 3.4.3-4, 3.4.3-5, 3.4.3-7 and 3.4.3-8 define an acceptable region for normal operation. The usual use of the curves is operational guidance during heatup or cooldown maneuvering, when pressure and temperature indications are monitored and compared to the applicable curve to determine that operation is within the allowable region.

The LCO establishes operating limits that provide a margin to brittle failure of the reactor vessel and piping of the reactor coolant pressure boundary (RCPB). The vessel is the component most subject to brittle failure, and the LCO limits apply mainly to the vessel. The limits do not apply to the pressurizer, which has different design characteristics and operating functions.

10 CFR 50, Appendix G (Ref. 1), requires the establishment of P/T limits for material fracture toughness requirements of the RCPB materials. Reference 1 requires an adequate margin to brittle failure during normal operation, anticipated operational occurrences, and system hydrostatic tests. It mandates the use of the American Society of

(continued)

BASES

BACKGROUND (continued)

Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section III, Appendix G (Ref. 2).

Linear elastic fracture mechanics (LEFM) methodology is used to determine the stresses and material toughness at locations within the RCPB. The LEFM methodology follows the guidance given by 10 CFR 50, Appendix G; ASME Code, Section III, Appendix G; and Regulatory Guide 1.99 (Ref. 3).

Material toughness properties of the ferritic materials of the reactor vessel are determined in accordance with ASTM E 185 (Ref. 4), and additional reactor vessel requirements. These properties are then evaluated in accordance with Reference 2.

The actual shift in the nil ductility reference temperature ($RT_{NDT}$) of the vessel material will be established periodically by evaluating the irradiated reactor vessel material specimens, in accordance with ASTM E 185 (Ref. 5) and Appendix H of 10 CFR 50 (Ref. 5). The operating P/T limit curves will be adjusted, as necessary, based on the evaluation findings and the recommendations of Reference 2.

The P/T limit curves are composite curves established by superimposing limits derived from stress analyses of those portions of the reactor vessel and head that are the most restrictive. At any specific pressure, temperature, and temperature rate of change, one location within the reactor vessel will dictate the most restrictive limit. Across the span of the P/T limit curves, different locations are more restrictive, and, thus, the curves are composites of the most restrictive regions.

The heatup curve represents a different set of restrictions than the cooldown curve because the directions of the thermal gradients through the vessel wall are reversed. The thermal gradient reversal alters the location of the tensile stress between the outer and inner walls.

The calculation to generate the LH testing curve uses different safety factors (per Ref. 2) than the heatup and cooldown curves.

The P/T limit curves and associated temperature rate of change limits are developed in conjunction with stress analyses for large numbers of operating cycles and provide conservative margins to nonductile failure. Although

(continued)

BASES

BACKGROUND (continued)

created to provide limits for these specific normal operations, the curves also can be used to determine if an evaluation is necessary for an abnormal transient.

The criticality limit curve includes the Reference 1 requirement that it be 40°F above the heatup curve or the cooldown curve, and not less than the minimum permissible temperature for LH testing. However, the criticality curve is not operationally limiting; a more restrictive limit exists in LCO 3.4.2, "RCS Minimum Temperature for Criticality."

The consequence of violating the LCO limits is that the RCS has been operated under conditions that can result in brittle failure of the RCPB, possibly leading to a nonisolable leak or loss of coolant accident. In the event these limits are exceeded, an evaluation must be performed to determine the effect on the structural integrity of the RCPB components. The ASME Code, Section XI, Appendix E (Ref. 6) provides a recommended methodology for evaluating an operating event that causes an excursion outside the limits.

APPLICABLE SAFETY ANALYSES

The P/T limits are not derived from accident analyses. They are prescribed during normal operation to avoid encountering pressure, temperature, and temperature rate of change conditions that might cause undetected flaws to propagate and cause nonductile failure of the RCPB, an unanalyzed condition. Reference 1 establishes the methodology for determining the P/T limits. Since the P/T limits are not derived from any accident analysis, there are no acceptance limits related to the P/T limits. Rather, the P/T limits are acceptance limits themselves since they preclude operation in an unanalyzed condition.

RCS P/T limits satisfy Criterion 2 of 10 CFR 50.36 (Ref. 7).

LCO

The three elements of this LCO are:

a. The limit curves for heatup and cooldown,

b. Limits on the rate of change of temperature, and

(continued)

BASES

LCO (continued)

c. Allowable RC pump combinations.

The LCO is modified by three Notes. Note 1 states that for leak tests of the RCS and leak tests of connected systems where RCS pressure and temperature are controlling, the RCS may be pressurized to the limits of the specified figures. Note 2 states that for thermal steady state hydro tests required by ASME Section XI RCS may be pressurized to the limits Specification 2.1.2 and the specified figures. The limits on the rate of change of reactor coolant temperature RCS P/T Limits are the same ones used for normal heatup and cooldown operations. Note 3 states the RCS P/T limits are not applicable to the pressurizer.

The LCO limits apply to all components of the RCS, except the pressurizer. These limits define allowable operating regions and permit a large number of operating cycles while providing a wide margin to nonductile failure.

Table 3.4.3-1 includes temperature rate of change limits with allowable pump combinations for RCS heatup while Table 3.4.3-2 includes temperature rate of change limits with allowable pump combinations for RCS cooldown. The breakpoints between temperature rate of change limits in these two tables are selected to limit reactor vessel thermal gradients to acceptable limits. The breakpoint between allowable pump combinations was selected based on operational requirements and are used to determine the change of RCS pressure associated with the change in number of operating reactor coolant pumps.

The limits for the rate of change of temperature control the thermal gradient through the vessel wall and are used as inputs for calculating the heatup, cooldown, and LH P/T limit curves. Thus, the LCO for the rate of change of temperature restricts stresses caused by thermal gradients and also ensures the validity of the P/T limit curves.

The limits on allowable RC pump combinations controls the pressure differential between the vessel wall and the pressure measurement point and are used as inputs for calculating the heatup, cooldown and LH P/T limit curves. Thus, the LCO for the allowable RC pump combinations restricts the pressure at the vessel wall and ensures the validity of the P/T limit curves.

(continued)

BASES

LCO (continued)

Violating the LCO limits places the reactor vessel outside of the bounds of the stress analyses and can increase stresses in other RCPB components. The consequences depend on several factors, as follows:

a. The severity of the departure from the allowable operating P/T regime or the severity of the rate of change of temperature;

b. The length of time the limits were violated (longer violations allow the temperature gradient in the thick vessel walls to become more pronounced); and

c. The existences, sizes, and orientations of flaws in the vessel material.

APPLICABILITY

The RCS P/T limits Specification provides a definition of acceptable operation for prevention of nonductile failure in accordance with 10 CFR 50, Appendix G (Ref. 1). Although the P/T limits were developed to provide guidance for operation during heatup or cooldown (MODES 3, 4, and 5) or LH testing, their applicability is at all times in keeping with the concern for nonductile failure. The limits do not apply to the pressurizer.

During MODES 1 and 2, other Technical Specifications provide limits for operation that can be more restrictive than or can supplement these P/T limits. LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits"; LCO 3.4.2, "RCS Minimum Temperature for Criticality"; and Safety Limit (SL) 2.1, "SLs," also provide operational restrictions for pressure and temperature and maximum pressure. MODES 1 and 2 are above the temperature range of concern for nonductile failure, and stress analyses have been performed for normal maneuvering profiles, such as power ascension or descent.

ACTIONS

A.1 and A.2

Operation outside the P/T limits during MODE 1, 2, 3, or 4 must be corrected so that the RCPB is returned to a condition that has been verified by stress analyses.

(continued)

BASES

ACTIONS

A.1 and A.2 (continued)

The 30 minute Completion Time reflects the urgency of restoring the parameters to within the analyzed range. Most violations will not be severe, and the activity can be accomplished in this time in a controlled manner.

Besides restoring operation to within limits, an evaluation is required to determine if RCS operation can continue. The evaluation must verify the RCPB integrity remains acceptable and must be completed before continuing operation. Several methods may be used, including comparison with pre-analyzed transients in the stress analyses, new analyses, or inspection of the components. The evaluation must be completed, documented, and approved in accordance with established plant procedures and administrative controls.

ASME Code, Section XI, Appendix E (Ref. 6) may be used to support the evaluation. However, its use is restricted to evaluation of the vessel beltline. The evaluation must extend to all components of the RCPB.

The 72 hour Completion Time is reasonable to accomplish the evaluation. The evaluation for a mild violation is possible within this time, but more severe violations may require special, event specific stress analyses or inspections. A favorable evaluation must be completed before continuing to operate.

Condition A is modified by a Note requiring Required Action A.2 to be completed whenever the Condition is entered. The Note emphasizes the need to perform the evaluation of the effects of the excursion outside the allowable limits. Restoration alone per Required Action A.1 is insufficient because higher than analyzed stresses may have occurred and may have affected the RCPB integrity.

B.1 and B.2

If a Required Action and associated Completion Time of Condition A are not met, the unit must be brought to a lower MODE because: (a) the RCS remained in an unacceptable pressure and temperature region for an extended period of increased stress, or (b) a sufficiently severe event caused entry into an unacceptable region. Either possibility indicates a need for more careful examination of the event,

(continued)

BASES

ACTIONS

B.1 and B.2 (continued)

best accomplished with the RCS at reduced pressure and temperature. With reduced pressure and temperature conditions, the possibility of propagation of undetected flaws is decreased.

If the required restoration activity cannot be accomplished within 30 minutes, Required Action B.1 and Required Action B.2 must be implemented to reduce pressure and temperature.

If the required evaluation for continued operation cannot be accomplished within 72 hours, or the results are indeterminate or unfavorable, action must proceed to reduce pressure and temperature as specified in Required Actions B.1 and B.2. A favorable evaluation must be completed and documented before returning to operating pressure and temperature conditions. However, if the favorable evaluation is accomplished while reducing pressure and temperature conditions, a return to power operation may be considered without completing Required Action B.2.

Pressure and temperature are reduced by bringing the unit to MODE 3 within 12 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required MODE from full power conditions in an orderly manner and without challenging unit systems.

C.1 and C.2

Actions must be initiated immediately to correct operation outside of the P/T limits at times other than MODE 1, 2, 3, or 4, so that the RCPB is returned to a condition that has been verified acceptable by stress analysis.

The immediate Completion Time reflects the urgency of initiating action to restore the parameters to within the analyzed range. Most violations will not be severe, and the activity can be accomplished within this time in a controlled manner.

(continued)

BASES

ACTIONS

C.1 and C.2 (continued)

In addition to restoring operation to within limits, an evaluation is required to determine if RCS operation can continue. The evaluation must verify that the RCPB integrity remains acceptable and must be completed prior to entry into MODE 4. Several methods may be used, including comparison with pre-analyzed transients in the stress analysis, or inspection of the components.

ASME Code, Section XI, Appendix E (Ref. 6), may also be used to support the evaluation. However, its use is restricted to evaluation of the vessel beltline.

Condition C is modified by a Note requiring Required Action C.2 to be completed whenever the Condition is entered. The Note emphasizes the need to perform the evaluation of the effects of the excursion outside the allowable limits. Restoration alone, per Required Action C.1, is insufficient because higher than analyzed stresses may have occurred and may have affected RCPB integrity.

SURVEILLANCE REQUIREMENTS

SR 3.4.3.1

Verification that operation is within limits is required every 30 minutes when RCS pressure or temperature conditions are undergoing planned changes.

This Frequency is considered reasonable in view of the control room indication available to monitor RCS status. Thirty minutes permits assessment and correction for minor deviations within a reasonable time.

Surveillance for heatup, cooldown, or LH testing may be discontinued when the definition given in the relevant plant procedure for ending the activity is satisfied.

This SR is modified by a Note that requires this SR to be performed only during system heatup, cooldown, and LH testing.

(continued)

BASES (continued)

REFERENCES

1. 10 CFR 50, Appendix G.
2. ASME, Boiler and Pressure Vessel Code, Section III, Appendix G.
3. Regulatory Guide 1.99, Revision 2, May 1988.
4. ASTM E 185-82, July 1982.
5. 10 CFR 50, Appendix H.
6. ASME, Boiler and Pressure Vessel Code, Section XI, Appendix E.
7. 10 CFR 50.36.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The Reference 3 analyses demonstrate the PORV can maintain RCS pressure below limits when both makeup flow capability and the number of available pressurizer heater banks is restricted. Consequently, the administrative controls require makeup flow capability and the number of available pressurizer heater banks to be limited in the LTOP MODES.

Since the PORV cannot protect the reactor vessel for engineered safeguards actuation of one or more HPI pumps, or discharging the CFTs, the LCO also requires the HPI-ES actuation circuits be deactivated and the CFTs isolated. The isolated CFTs must have their discharge valves closed and the valve power breakers fixed in their open positions.

Fracture mechanics analyses established the temperature of LTOP Applicability at 325°F. Above this temperature, the pressurizer safety valves provide the reactor vessel pressure protection. The vessel materials were assumed to have a neutron irradiation accumulation equal to 33 effective full power years (EFPYs) of operation for Units 1, 2, and 3.

This LCO will deactivate the HPI-ES actuation when the RCS temperature is ≤ 325°F.

Reference 3 contains the acceptance limits that satisfy the LTOP requirements. Any change to the RCS must be evaluated against these analyses to determine the impact of the change on the LTOP acceptance limits.

PORV Performance

The fracture mechanics analyses show that the vessel is protected when the PORV is set to open at ≤ 535 psig. The setpoint is derived by modeling the performance of the LTOP system for different LTOP events. The PORV setpoint at or below the derived limit ensures the Reference 1 limits will be met.

The PORV setpoint is re-evaluated for compliance when the revised P/T limits conflict with the LTOP analysis limits. The P/T limits are periodically modified as the reactor vessel material toughness decreases due to embrittlement

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

The RCS vent size will also be re-evaluated for compliance each time P/T limit curves are revised based on the results of the vessel material surveillance.

These vents are passive and not subject to active failure.

The LTOP System satisfies Criterion 2 and Criterion 3 of 10 CFR 50.36 (Ref.6).

LCO

The LCO requires an LTOP System OPERABLE with a limited coolant input capability and a pressure relief capability. The LCO requires HPI to be deactivated and the CFTs to be isolated. For pressure relief, it requires the pressurizer coolant at or below a maximum level and the PORV OPERABLE with a lift setting ≤ the LTOP limit.

The PORV is OPERABLE when its block valve is open, its lift setpoint is set at ≤ 535 psig and testing has proven its ability to open at that setpoint, and power is available to the two valves and their control circuits.

An RCS vent path capable of mitigating the most limiting LTOP event (except for HPI-ES actuation or CFT discharge) has a minimum equivalent diameter of 1-3/32 inches, which is equal to the inner throat diameter of the PORV.

Implementation of the following administrative controls assure that ≥ 10 minutes are available for operator action to mitigate an LTOP event:

1. RCS pressure:

   < 375 psig when RCS temperature ≤ 220°F

   < 525 psig when RCS temperature > 220°F and ≤ 325°F

2. Pressurizer level is maintained within the following limits:

   a. RCS pressure is > 100 psig:

      ≤ 220 inches when RCS temperature ≤ 325°F

(continued)

BASES

LCO
(continued)

b. RCS pressure is ≤ 100 psig:

≤ 310 inches when RCS temperature ≤ 220°F.

≤ 380 inches while filling or draining the RCS when RCS temperature ≤ 160°F and no HPI pumps are running.

When the RCS pressure is ≤ 100 psig, pressurizer level is normally maintained ≤ 220 inches except for certain RCS evolutions. The specified pressurizer level limits provide assurance that at least 10 minutes is available for operator action during those evolutions. The temperature limits are based on operational limits for the evolutions and are used in the analyses to determine allowable pressurizer levels.

3. Makeup flow is restricted with the HP-120 (makeup control valve) travel stop set to ≤ 98.0 gpm for all three units.

4. Three audible pressurizer level alarms at ≤ 225 inches, ≤ 260 inches, and ≤ 315 inches from the temperature compensated pressurizer level indication.

5. Two audible RCS pressure alarms at 375 psig and 525 psig.

6. High pressure nitrogen system is administratively controlled to prevent inadvertent pressurization of the RCS.

7. Core Flood Tank(s) are isolated as required by the LCO by closing the appropriate isolation valve(s) (either CF-1 and/or CF-2), tagging open the valve breaker(s), and tagging the valve(s) in the closed position.

8. The HPI safety injection flowpaths must be deactivated.

(continued)

BASES

ACTIONS (continued)

B.1, C.1, and C.2

An unisolated CFT requires isolation within 1 hour only when the CFT pressure is at or more than the maximum RCS pressure for the existing temperature allowed in LCO 3.4.3.

If isolation is needed and cannot be accomplished in 1 hour, Required Action C.1 and Required Action C.2 provide two options, either of which must be performed in 12 hours. By placing the unit in MODE 4 with the RCS temperature > 200°F, the CFT pressure of 650 psig cannot exceed the LTOP limits if both tanks are fully injected. Depressurizing the CFTs below the LTOP limit of 373 psig also prevents exceeding the LTOP limits in the same event.

The Completion Times are based on operating experience that these activities can be accomplished in these time periods and on engineering judgement indicating that a limiting LTOP event is not likely in the allowed times.

D.1, E.1, and E.2

With the PORV inoperable, overpressure relieving capability is lost, and restoration of the PORV within 1 hour is required.

If restoration cannot be completed within 1 hour, either Required Action E.1 or Required Action E.2 must be performed. Required Action E.1 requires increasing RCS temperature within 23 hours to exit the Applicability of the specification. With RCS temperature > 325°F, the CFTs are not required to be isolated. Required Action E.2 requires the RCS be depressurized to less than 100 psig within 35 hours. With reactor pressure < 100 psig more time is available for operator action to mitigate an LTOP event.

These Completion Times also consider these activities can be accomplished in these time periods. A limiting LTOP event is not likely in these times.

(continued)

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

ATTACHMENT 2

TECHNICAL SPECIFICATIONS

MARKED UP PAGES

Table 3.4.3-2 (page 1 of 1)
Operational Requirements for Unit Cooldown

| CONSTRAINT | RC TEMPERATURE[a] | MAXIMUM COOLDOWN RATE[b] | ALLOWED PUMP COMBINATION |
|---|---|---|---|
| RC Temperature[a] | T > [≥] 280°F | ≤ 50°F in any 1/2 hour period | NA |
| | 150°F < [≤] T ≤ [<] 280°F | ≤ 25°F in any 1/2 hour period | NA |
| | T ≤ [<] 150°F | ≤ 10°F in any one hour period | NA |
| | RCS depressurized[c] | ≤ 50°F in any one hour period | NA |
| RC Pumps | T > 270°F [≥250] | NA | Any |
| | ~~200°F < T ≤ 270°F~~ | ~~NA~~ | ~~≤ one pump/loop~~ |
| | T ~~≤ 200~~ °F [<250] | NA | ≤ ~~one pump~~ TWO PUMPS |

(a) RC Temperature is cold leg temperature if one or more RC pumps are in operation or if on natural circulation cooldown; otherwise it is the LPI cooler outlet temperature.

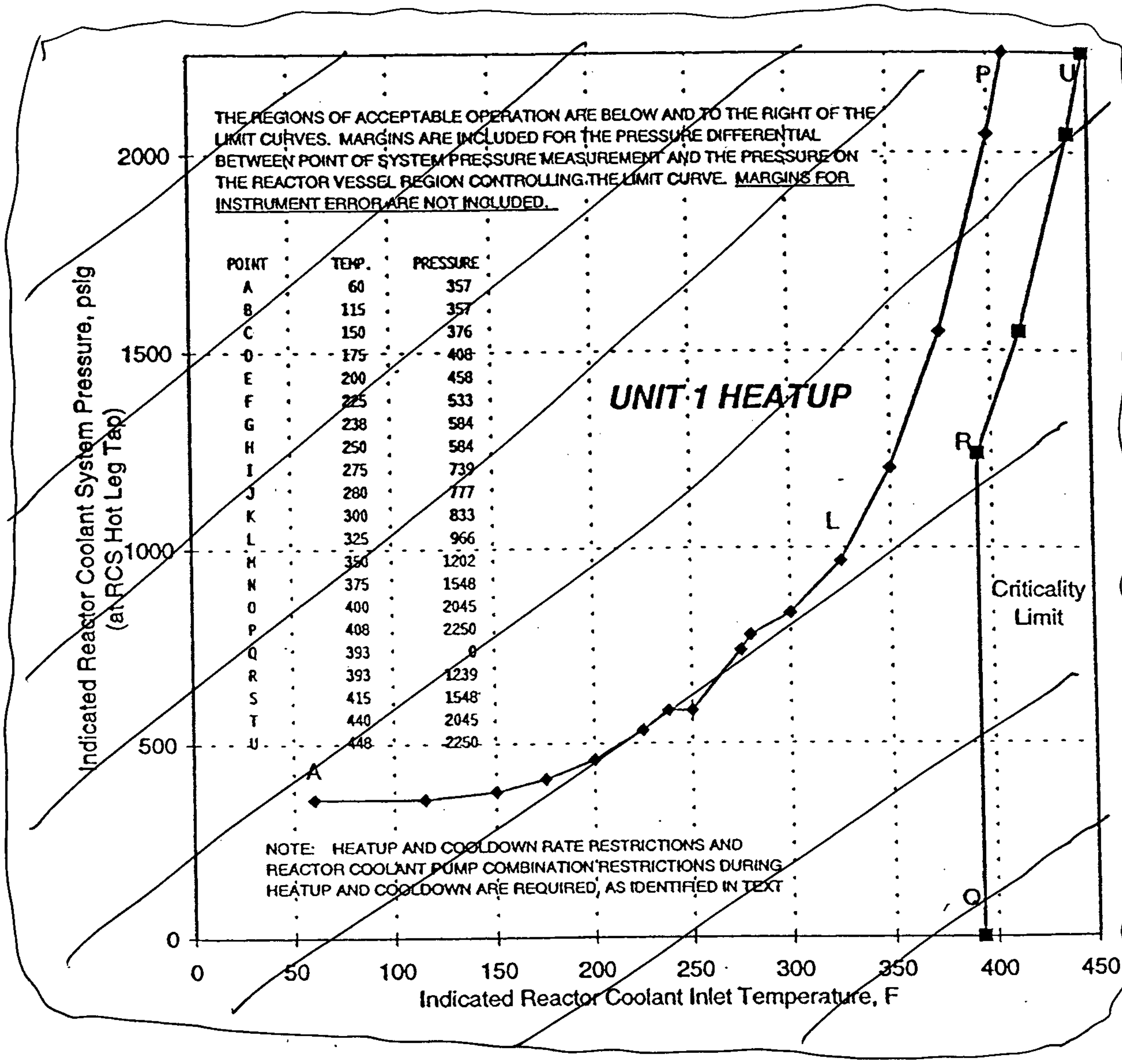
(b) These rate limits must be applied to the change in temperature indication from cold leg temperature to LPI cooler outlet temperature per Note (a).

(c) When the RCS is depressurized such that all three of the following conditions exist:

a) RCS temperature < 200°F,
b) RCS pressure < 50 psig,
c) All RC Pumps off,

the maximum cooldown rate shall be relaxed to ≤ 50°F in any 1 hour period.

SEE NEW FIGURE




| POINT | TEMP. | PRESSURE |
|---|---|---|
| A | 60 | 357 |
| B | 115 | 357 |
| C | 150 | 376 |
| D | 175 | 408 |
| E | 200 | 458 |
| F | 225 | 533 |
| G | 238 | 584 |
| H | 250 | 584 |
| I | 275 | 739 |
| J | 280 | 777 |
| K | 300 | 833 |
| L | 325 | 966 |
| M | 350 | 1202 |
| N | 375 | 1548 |
| O | 400 | 2045 |
| P | 408 | 2250 |
| Q | 393 | 0 |
| R | 393 | 1239 |
| S | 415 | 1548 |
| T | 440 | 2045 |
| U | 448 | 2250 |

Figure 3.4.3-1 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First 26 EFPY - Oconee Nuclear Station Unit 1

33

SEE NEW FIGURE

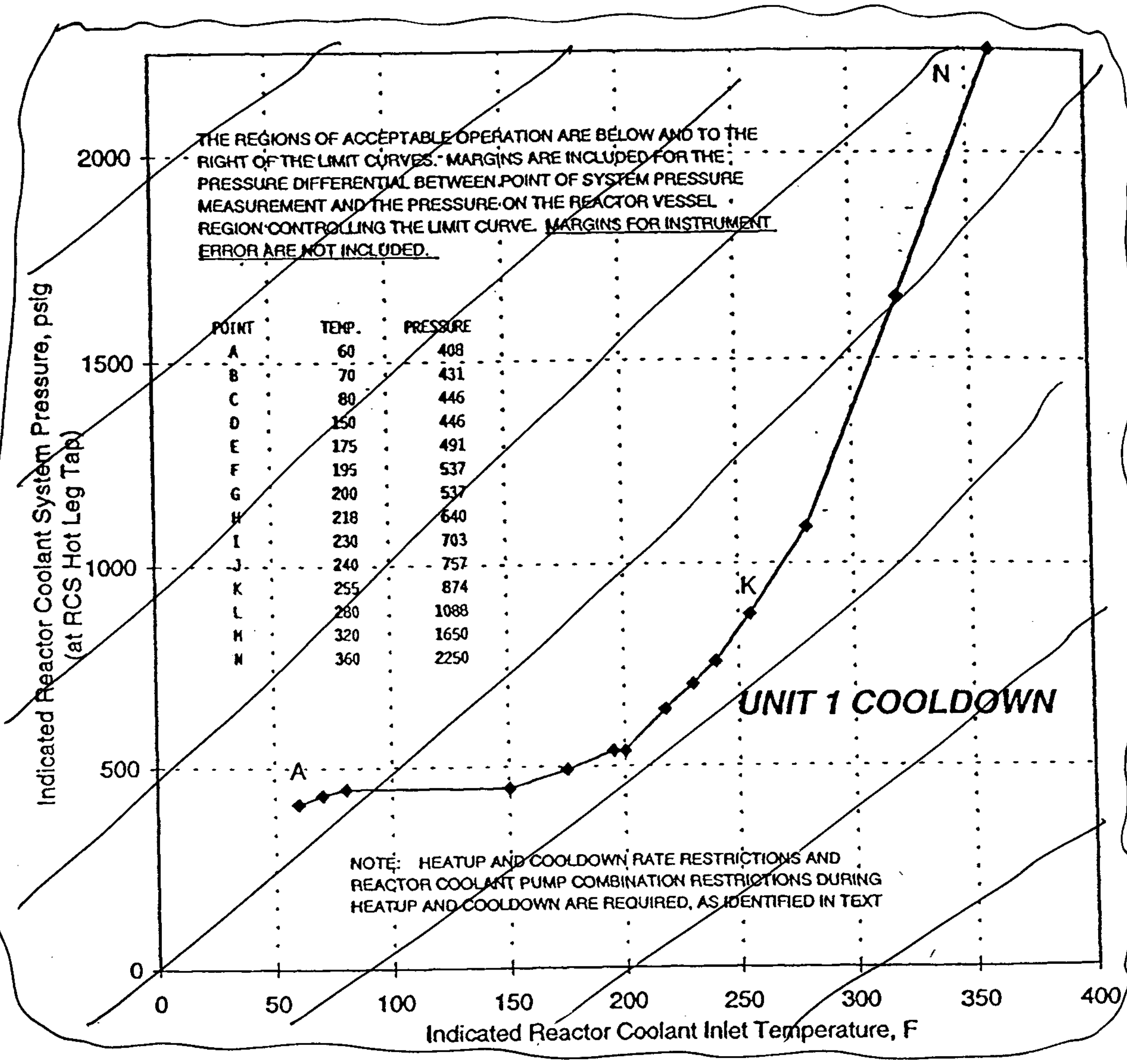



Figure 3.4.3-2 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First ~~26~~ 33 EFPY - Oconee Nuclear Station Unit 1

SEE NEW FIGURE

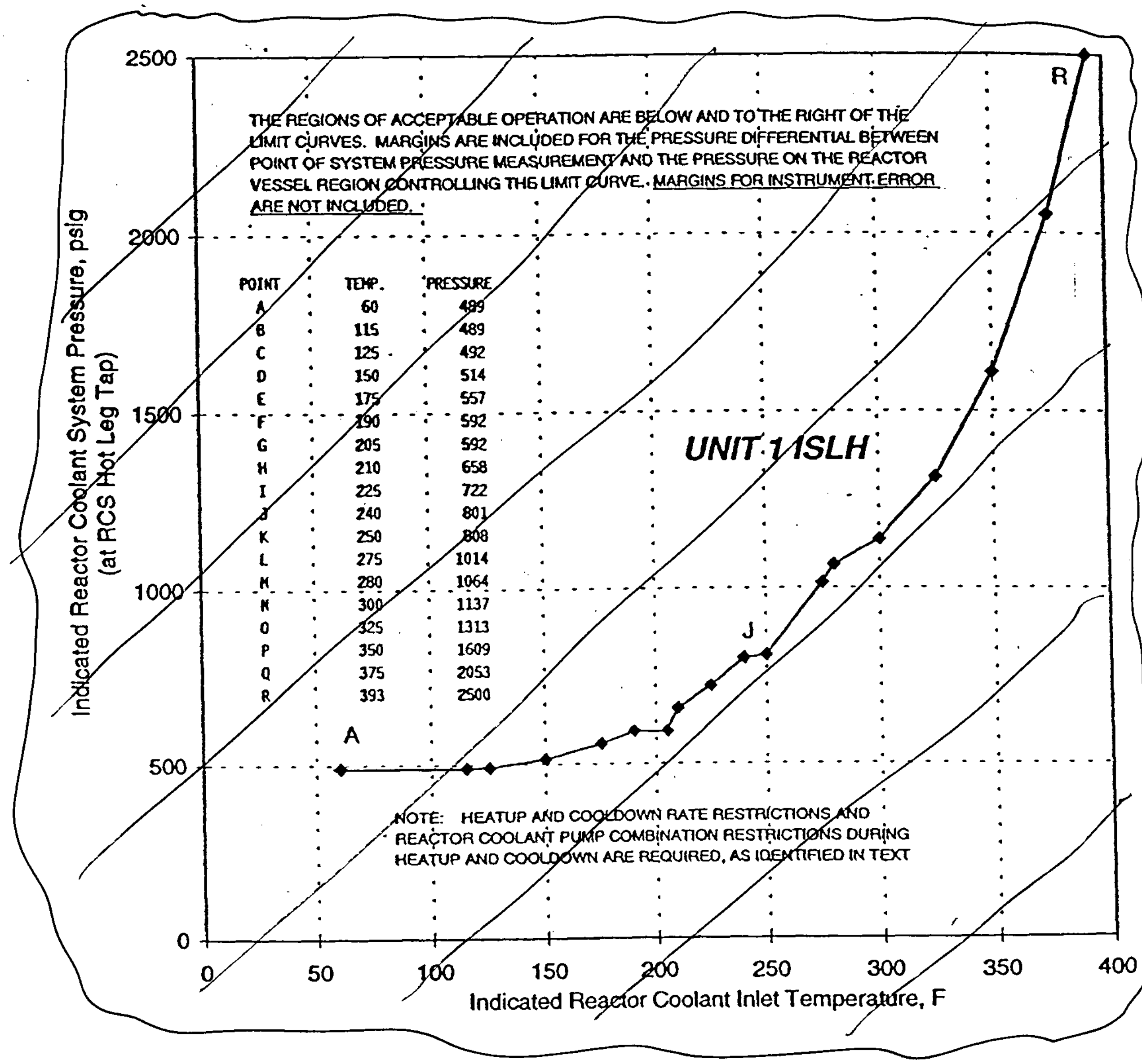



Figure 3.4.3-3 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First 26 EFPY - Oconee Nuclear Station Unit 1
33

SEE NEW FIGURE

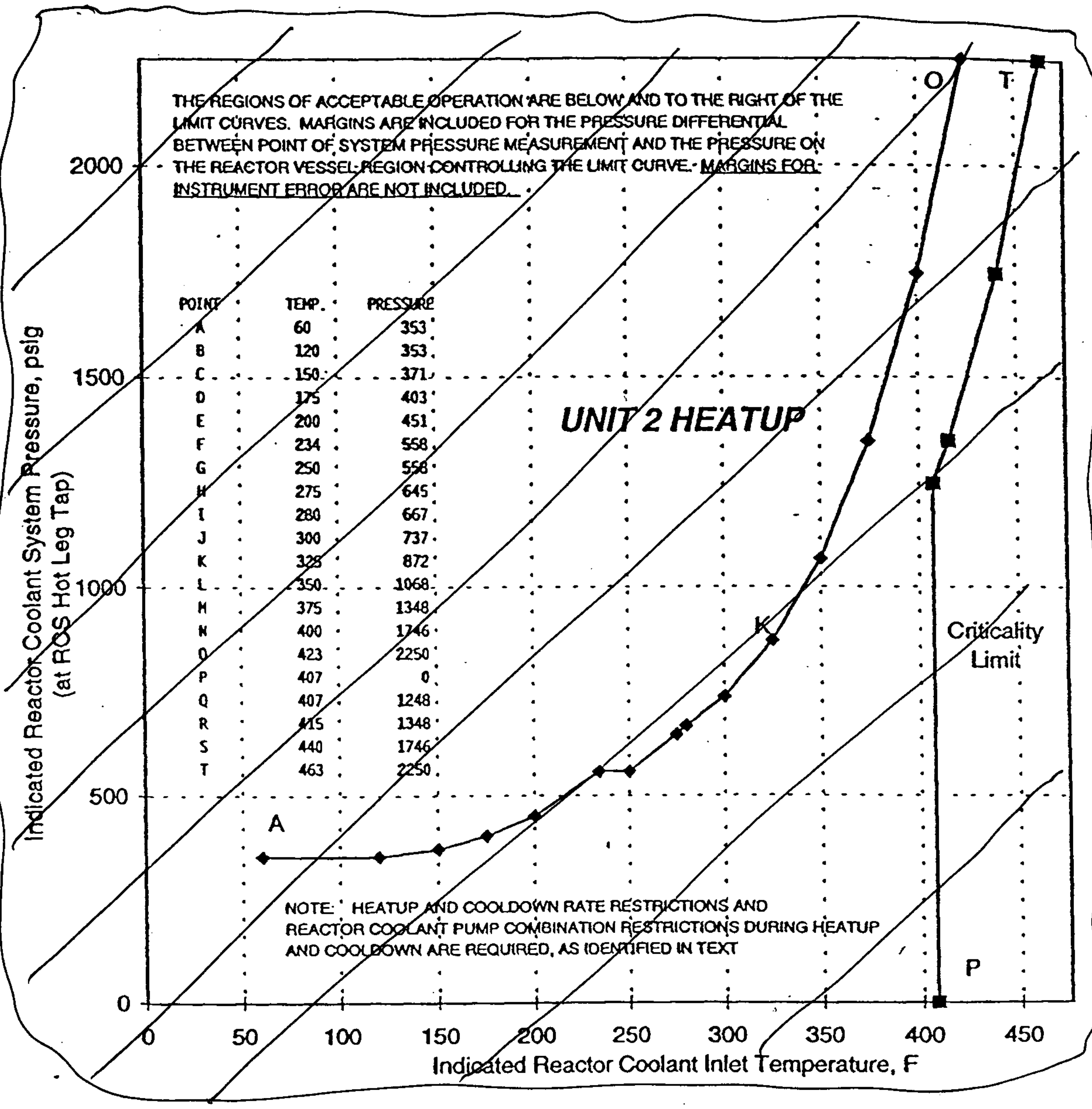



Figure 3.4.3-4 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First ~~26~~ 33 EFPY - Oconee Nuclear Station Unit 2

SEE NEW FIGURE

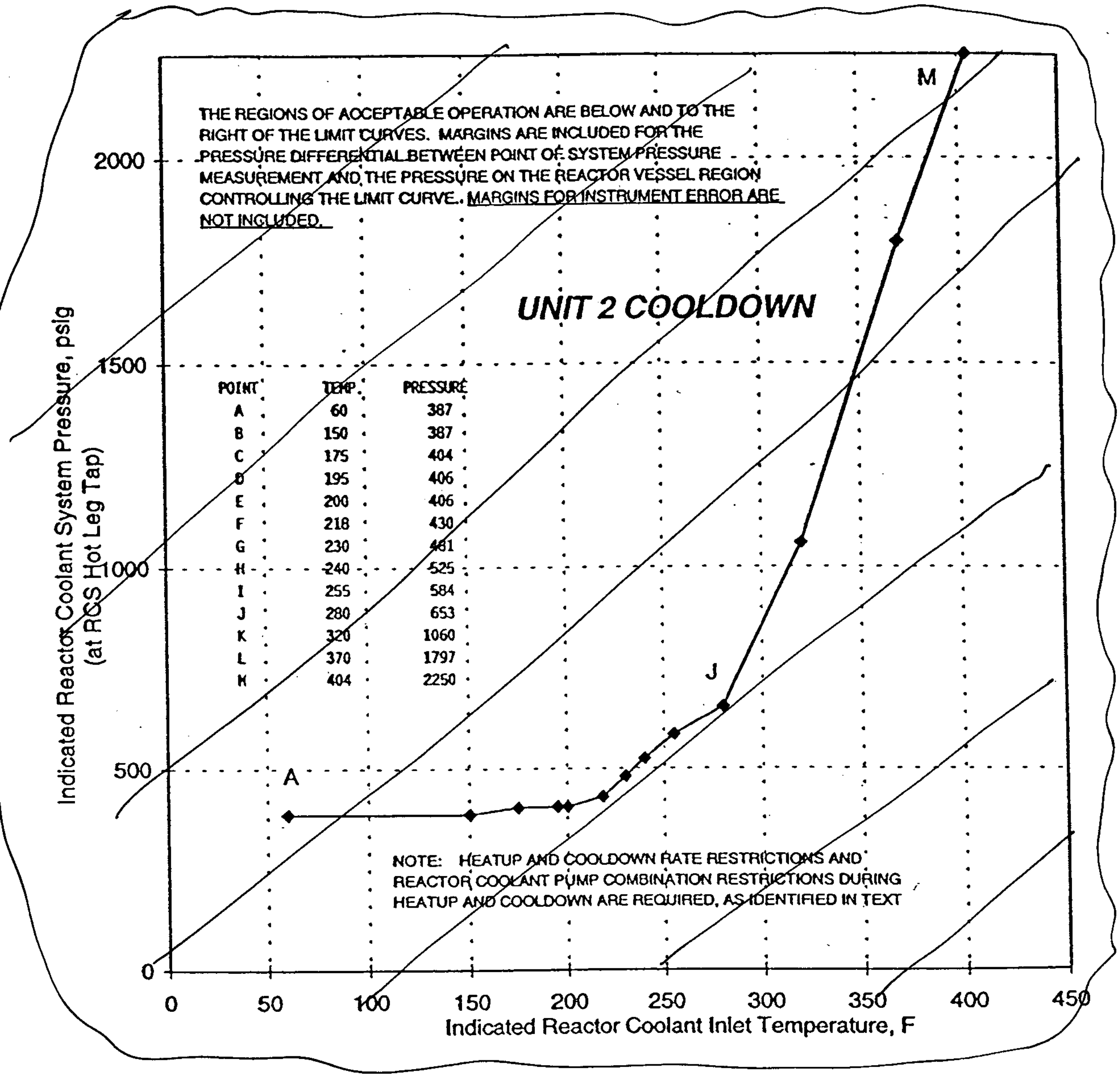



Figure 3.4.3-5 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First ~~26~~ EFPY - Oconee Nuclear Station Unit 2
33

SEE NEW FIGURE

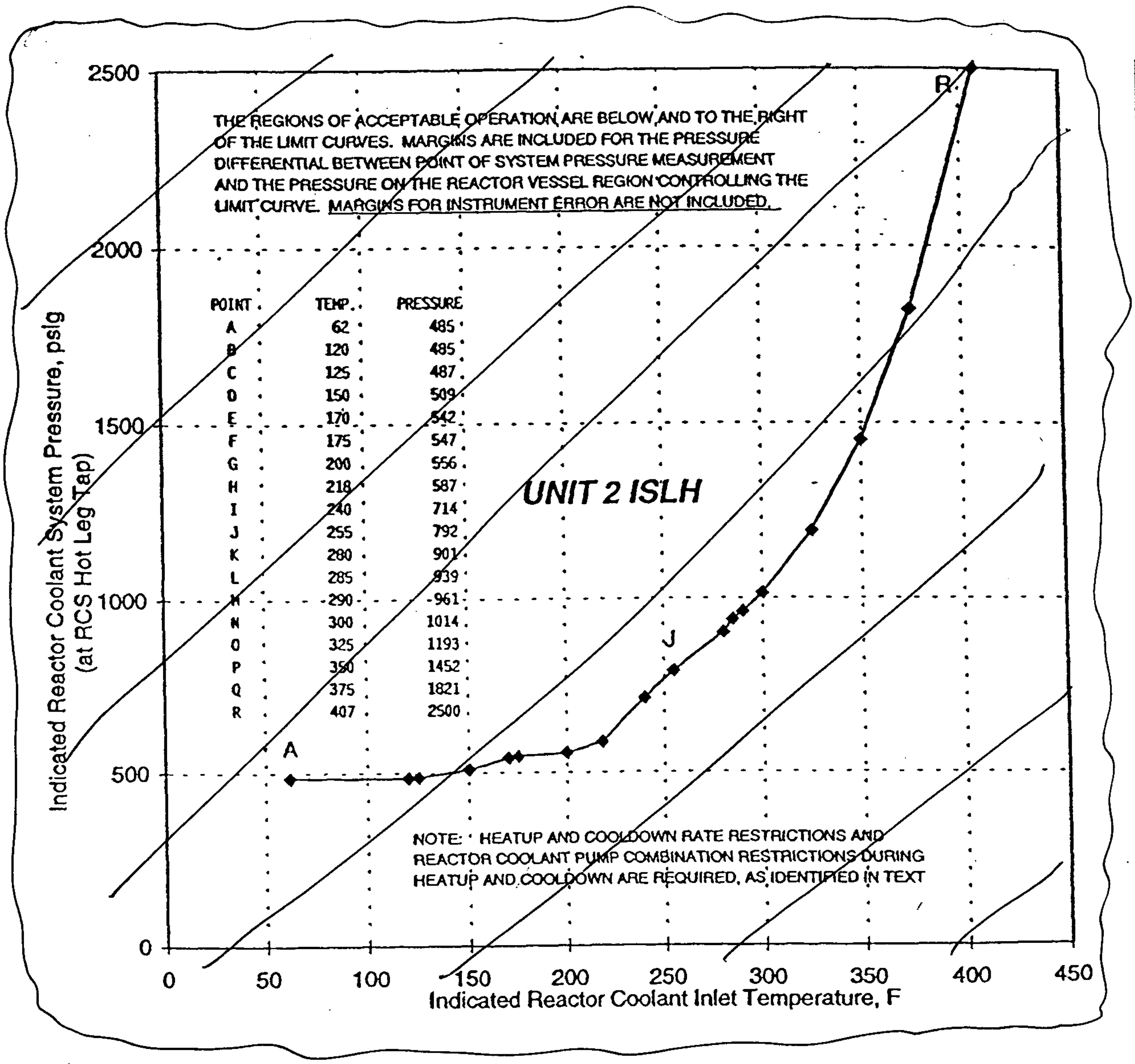
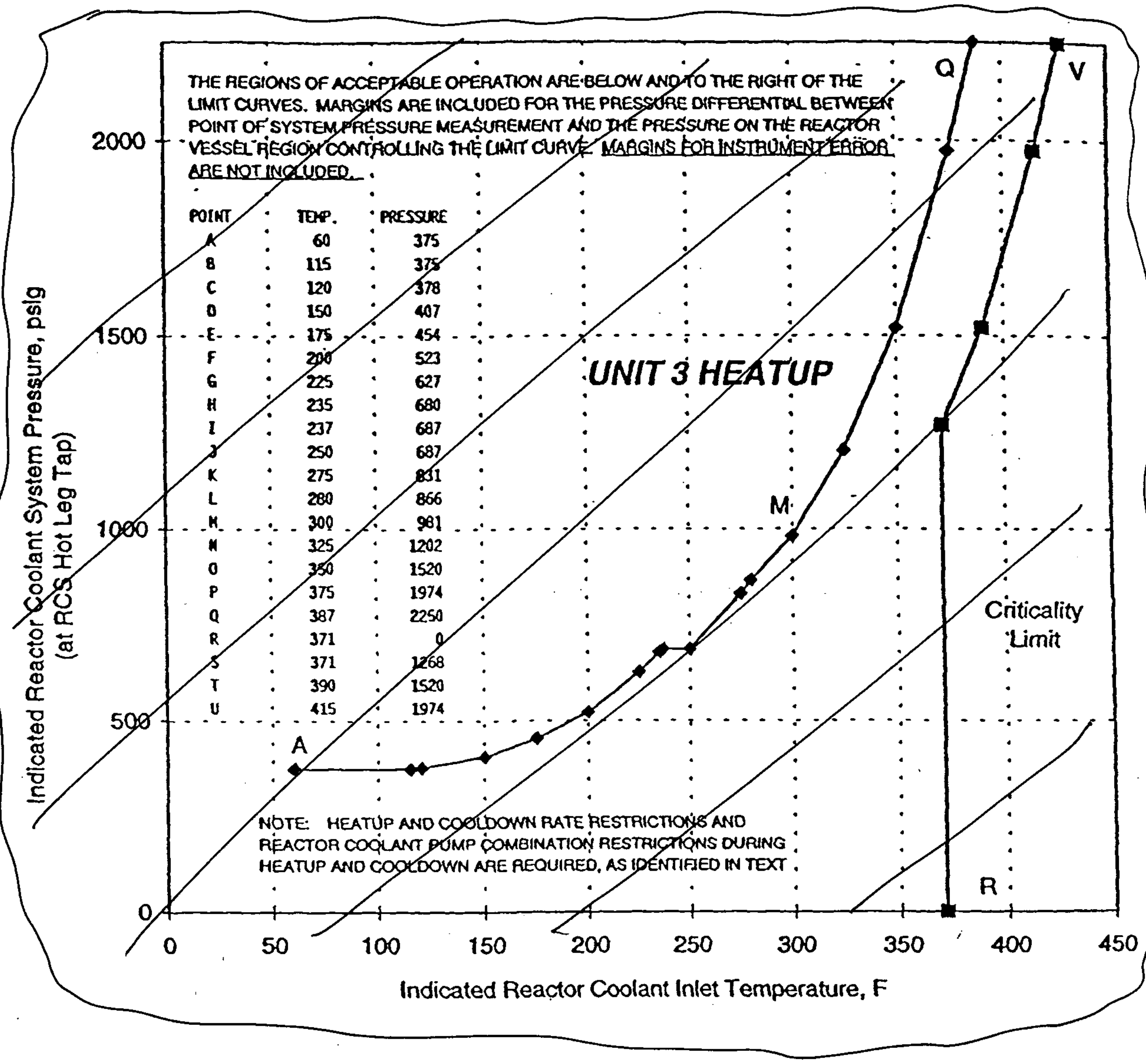



Figure 3.4.3-6 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First 26 EFPY - Oconee Nuclear Station Unit 2
33

SEE NEW FIGURE




| POINT | TEMP. | PRESSURE |
|---|---|---|
| A | 60 | 375 |
| B | 115 | 375 |
| C | 120 | 378 |
| D | 150 | 407 |
| E | 175 | 454 |
| F | 200 | 523 |
| G | 225 | 627 |
| H | 235 | 680 |
| I | 237 | 687 |
| J | 250 | 687 |
| K | 275 | 831 |
| L | 280 | 866 |
| M | 300 | 981 |
| N | 325 | 1202 |
| O | 350 | 1520 |
| P | 375 | 1974 |
| Q | 387 | 2250 |
| R | 371 | 0 |
| S | 371 | 1268 |
| T | 390 | 1520 |
| U | 415 | 1974 |

Figure 3.4.3-7 (page 1 of 1)
RCS Normal Operational Heatup Limitations
Applicable for the First ~~26~~ 33 EFPY - Oconee Nuclear Station Unit 3

SEE NEW FIGURE

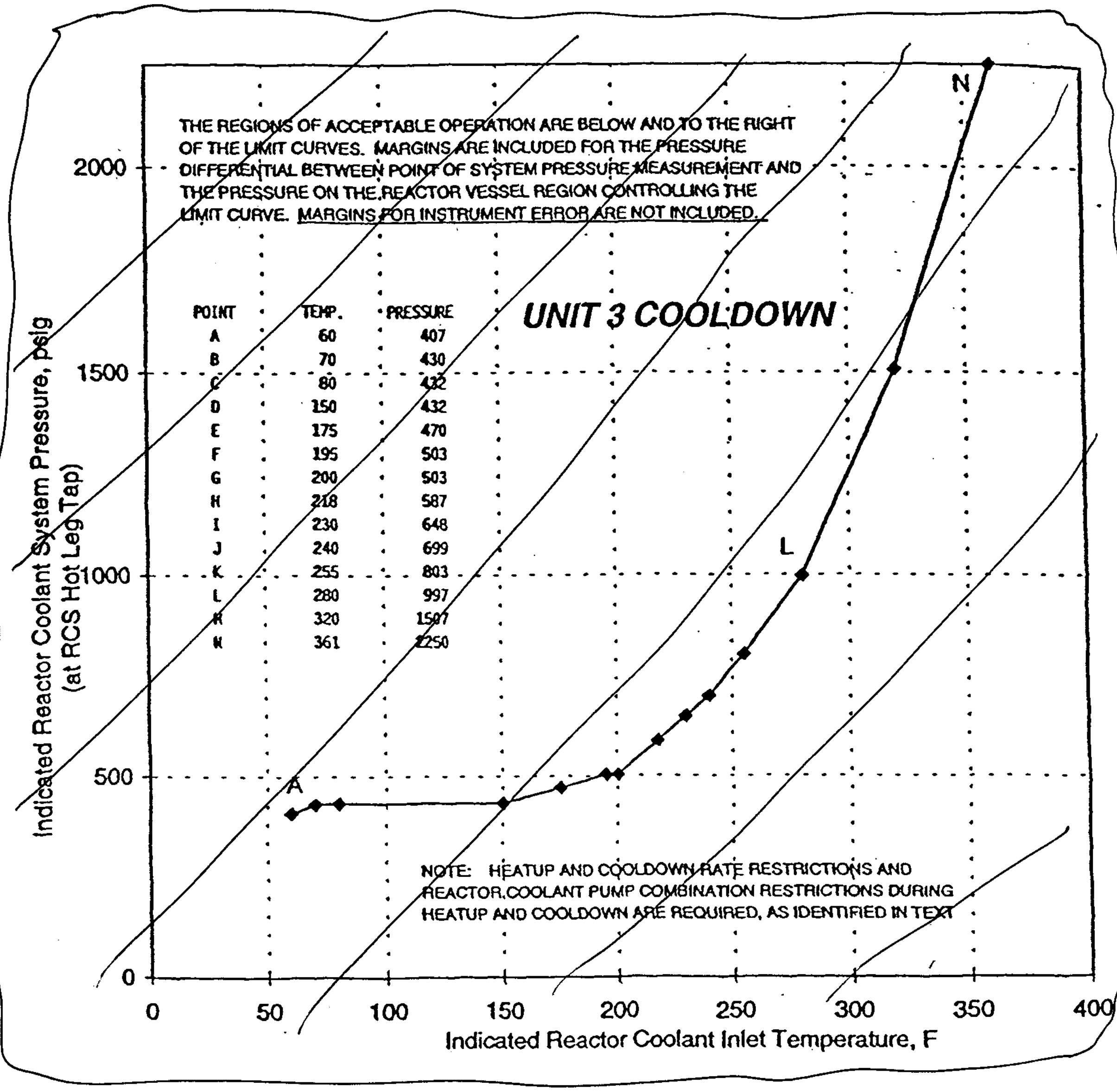
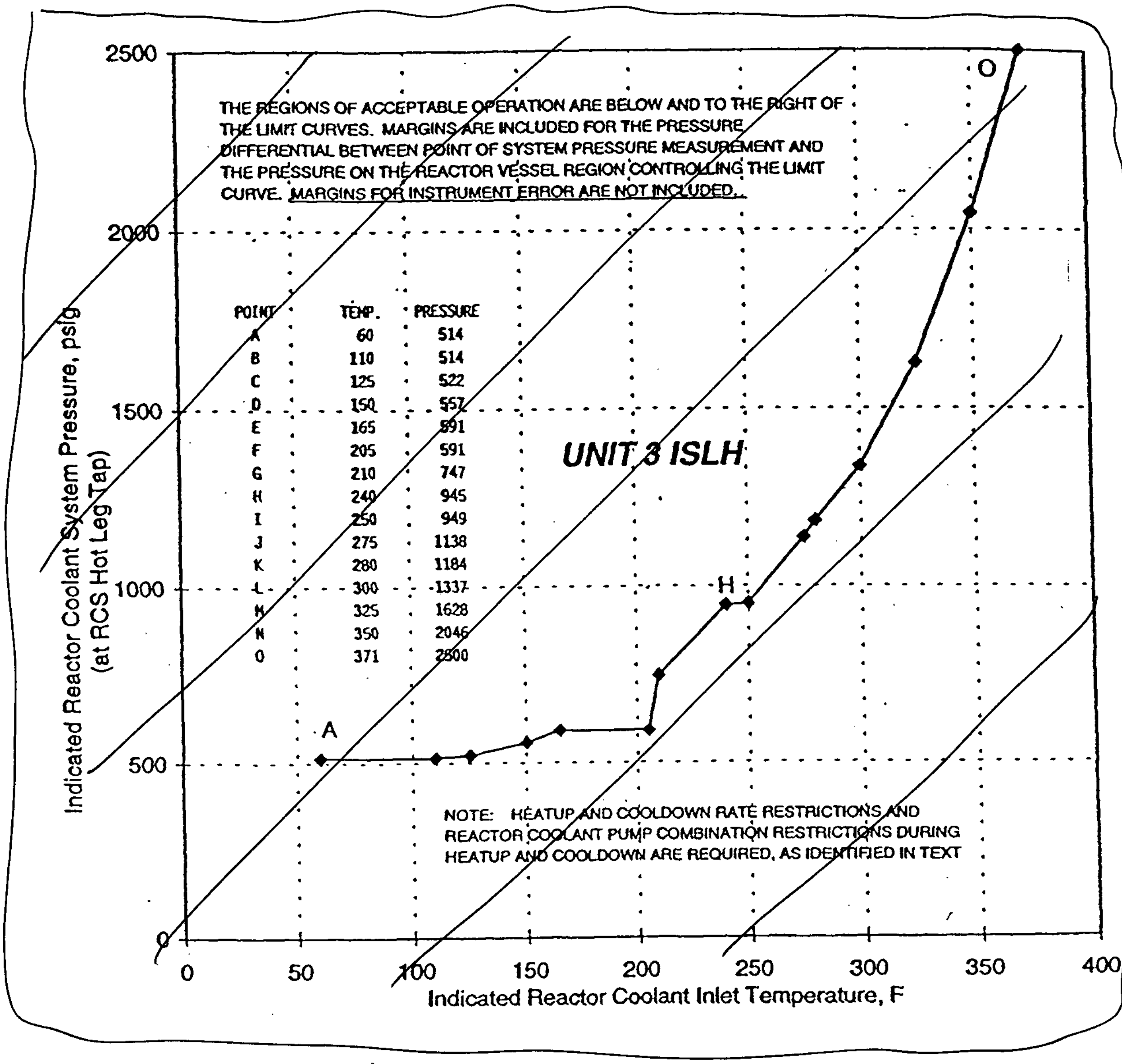



Figure 3.4.3-8 (page 1 of 1)
RCS Normal Operational Cooldown Limitations
Applicable for the First 26 EFPY - Oconee Nuclear Station Unit 3
33

SEE NEW FIGURE




| POINT | TEMP. | PRESSURE |
|---|---|---|
| A | 60 | 514 |
| B | 110 | 514 |
| C | 125 | 522 |
| D | 150 | 557 |
| E | 165 | 591 |
| F | 205 | 591 |
| G | 210 | 747 |
| H | 240 | 945 |
| I | 250 | 949 |
| J | 275 | 1138 |
| K | 280 | 1184 |
| L | 300 | 1337 |
| M | 325 | 1628 |
| N | 350 | 2046 |
| O | 371 | 2500 |

Figure 3.4.3-9 (page 1 of 1)
RCS Leak and Hydrostatic Test Heatup and Cooldown Limitations
Applicable for the First ~~26~~ 33 EFPY - Oconee Nuclear Station Unit 3

## 3.4 REACTOR COOLANT SYSTEM (RCS)

### 3.4.12 Low Temperature Overpressure Protection (LTOP) System

LCO 3.4.12 An LTOP System shall be OPERABLE with high pressure injection (HPI) deactivated, and the core flood tanks (CFTs) isolated and:

a. An OPERABLE power operated relief valve (PORV) with a lift setpoint of ≤ ~~460~~ psig; and

535

b. Administrative controls implemented that assure ≥ 10 minutes are available for operator action to mitigate an LTOP event.

APPLICABILITY: MODE 3 when any RCS cold leg temperature is ≤ 325°F, MODES 4, 5, and 6 when an RCS vent path capable of mitigating the most limiting LTOP event is not open.

---------------------------NOTES---------------------------

1. CFT isolation is only required when CFT pressure is greater than or equal to the maximum RCS pressure for the existing RCS temperature allowed by the pressure and temperature limit curves provided in Specification 3.4.3.

2. The PORV is not required to be OPERABLE when no HPI pumps are running and RCS pressure < 100 psig.

-----------------------------------------------------------

ACTIONS

| CONDITION | REQUIRED ACTION | | COMPLETION TIME |
|---|---|---|---|
| A. HPI activated. | A.1 | Initiate action to deactivate HPI. | Immediately |
| B. A CFT not isolated when CFT pressure is greater than or equal to the maximum RCS pressure for existing temperature allowed by Specification 3.4.3. | B.1 | Isolate affected CFT. | 1 hour |
| C. Required Action and associated Completion Time of Condition B not met. | C.1 | Be in MODE 4 with RCS temperature > ~~233~~ °F. 200 | 12 hours |
| | OR | | |
| | C.2 | Depressurize affected CFT to < 373 psig. | 12 hours |
| D. PORV inoperable. | D.1 | Restore PORV to OPERABLE status. | 1 hour |
| E. Required Action and associated Completion Time of Condition D not met. | E.1 | Be in MODE 3 with RCS average temperature > 325°F. | 23 hours |
| | OR | | |
| | E.2 | Depressurize RCS to < 100 psig. | 35 hours |

(continued)

## B 3.4 REACTOR COOLANT SYSTEM (RCS)

## B 3.4.3 RCS Pressure and Temperature (P/T) Limits

BASES

BACKGROUND

All components of the RCS are designed to withstand effects of cyclic loads due to system pressure and temperature changes. These loads are introduced by startup (heatup) and shutdown (cooldown) operations, power transients, and reactor trips. This LCO limits the pressure and temperature changes during RCS heatup and cooldown, within the design assumptions and the stress limits for cyclic operation.

Figures 3.4.3-1 through 3.4.3-9 contain P/T limit curves for heatup, cooldown, and leak and hydrostatic (LH) testing. Tables 3.4.3-1 and 3.4.3-2 contain data for the maximum rate of change of reactor coolant temperature.

INSERT 1

Figures 3.4.3-1, 3.4.3-2, 3.4.3-4, 3.4.3-5, 3.4.3-7 and 3.4.3-8 define an acceptable region for normal operation. The usual use of the curves is operational guidance during heatup or cooldown maneuvering, when pressure and temperature indications are monitored and compared to the applicable curve to determine that operation is within the allowable region.

The LCO establishes operating limits that provide a margin to brittle failure of the reactor vessel and piping of the reactor coolant pressure boundary (RCPB). The vessel is the component most subject to brittle failure, and the LCO limits apply mainly to the vessel. The limits do not apply to the pressurizer, which has different design characteristics and operating functions.

10 CFR 50, Appendix G (Ref. 1), requires the establishment of P/T limits for material fracture toughness requirements of the RCPB materials. Reference 1 requires an adequate margin to brittle failure during normal operation, anticipated operational occurrences, and system hydrostatic tests. It mandates the use of the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section III, Appendix G (Ref. 2).

Linear elastic fracture mechanics (LEFM) methodology is used to determine the stresses and material toughness at locations within the RCPB. The LEFM methodology follows the

(continued)

**Attachment 2**
**Inserts**

Insert 1 on page B 3.4.3-1

The minimum temperature indicated in the P/T limit curves and tables of 60°F is the lowest unirradiated nil ductility reference temperature ($RT_{ndt}$) of all materials in the reactor vessel. This temperature (60°F) is the minimum allowable reactor pressure vessel temperature if any head closure stud is not fully detensioned.

BASES

LCO
(continued)

leak tests of the RCS and leak tests of connected systems where RCS pressure and temperature are controlling, the RCS may be pressurized to the limits of the specified figures. Note 2 states that for thermal steady state hydro tests required by ASME Section XI RCS may be pressurized to the limits Specification 2.1.2 and the specified figures. The limits on the rate of change of reactor coolant temperature RCS P/T Limits are the same ones used for normal heatup and cooldown operations. Note 3 states the RCS P/T limits are not applicable to the pressurizer.

The LCO limits apply to all components of the RCS, except the pressurizer. These limits define allowable operating regions and permit a large number of operating cycles while providing a wide margin to nonductile failure.

Table 3.4.3-1 includes temperature rate of change limits with allowable pump combinations for RCS heatup while Table 3.4.3-2 includes temperature rate of change limits with allowable pump combinations for RCS cooldown.

INSERT 2

The limits for the rate of change of temperature control the thermal gradient through the vessel wall and are used as inputs for calculating the heatup, cooldown, and LH P/T limit curves. Thus, the LCO for the rate of change of temperature restricts stresses caused by thermal gradients and also ensures the validity of the P/T limit curves.

The limits on allowable RC pump combinations controls the pressure differential between the vessel wall and the pressure measurement point and are used as inputs for calculating the heatup, cooldown and LH P/T limit curves. Thus, the LCO for the allowable RC pump combinations restricts the pressure at the vessel wall and ensures the validity of the P/T limit curves.

~~The RCP operational restriction, of no more than one pump during cooldown at temperatures below 200°F, can be modified to allow running a 1-1 RCP combination briefly, provided the following procedure is observed:~~

~~After terminating the cooldown, begin a soak period. A 1/2 hour soak time should be maintained prior to operating the 1-1 pump combination. The soak condition should be as near constant temperature as practical, with as near a zero heatup or cooldown rate as possible. Specifically, the 1/2~~

(continued)

## Attachment 2
## Inserts

Insert 2 on page B 3.4.3-4

The breakpoints between temperature rate of change limits in these two tables are selected to limit reactor vessel thermal gradients to acceptable limits. The breakpoint between allowable pump combinations was selected based on operational requirements and are used to determine the change of RCS pressure associated with the change in number of operating reactor coolant pumps.

BASES

LCO (continued)

~~hour soak time is based on maintaining less than 10°F/hr rate of temperature change during the soak, i.e., the final temperature should be within approximately 5°F of the initial temperature. Reactor Coolant System (RCS) pressure shall be maintained below the cooldown P/T limit. This procedure applies between approximately 160°F and 180°F.~~

Violating the LCO limits places the reactor vessel outside of the bounds of the stress analyses and can increase stresses in other RCPB components. The consequences depend on several factors, as follows:

a. The severity of the departure from the allowable operating P/T regime or the severity of the rate of change of temperature;

b. The length of time the limits were violated (longer violations allow the temperature gradient in the thick vessel walls to become more pronounced); and

c. The existences, sizes, and orientations of flaws in the vessel material.

APPLICABILITY

The RCS P/T limits Specification provides a definition of acceptable operation for prevention of nonductile failure in accordance with 10 CFR 50, Appendix G (Ref. 1). Although the P/T limits were developed to provide guidance for operation during heatup or cooldown (MODES 3, 4, and 5) or LH testing, their applicability is at all times in keeping with the concern for nonductile failure. The limits do not apply to the pressurizer.

During MODES 1 and 2, other Technical Specifications provide limits for operation that can be more restrictive than or can supplement these P/T limits. LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits"; LCO 3.4.2, "RCS Minimum Temperature for Criticality"; and Safety Limit (SL) 2.1, "SLs," also provide operational restrictions for pressure and temperature and maximum pressure. MODES 1 and 2 are above the temperature range of concern for nonductile failure, and stress analyses have been performed for normal maneuvering profiles, such as power ascension or descent.

(continued)

No CHANGE THIS PAGE



BASES

BACKGROUND (continued)

The LTOP approach to protecting the vessel by limiting coolant addition capability requires controls upon RCS makeup flow, the number of available pressurizer heater banks, and requires deactivating HPI, and isolating the core flood tanks (CFTs).

Should one or more HPI pumps inject on an HPI actuation (HPI-ES) or a CFT discharge to the RCS, the pressurizer level and PORV may not prevent overpressurizing the RCS.

The administrative controls upon pressurizer level provides a compressible vapor space or cushion (either steam or nitrogen) that can accommodate a coolant insurge and prevent a rapid pressure increase, allowing the operator time to stop the increase. The PORV, with reduced lift setting, is the overpressure protection device that acts as backup to the operator in terminating an increasing pressure event.

With HPI-ES deactivated, the ability to provide RCS coolant addition is restricted. To balance the possible need for coolant addition, the LCO does not require the makeup system to be deactivated. Due to the lower pressures associated with the LTOP MODES and the expected decay heat levels, the makeup system can provide flow with the HPI pumps providing RCS makeup through the makeup control valve.

<u>PORV Requirements</u>

As required for LTOP, the PORV is signaled to open if the RCS pressure approaches a limit set in the LTOP actuation circuit. The LTOP actuation circuit monitors RCS pressure and determines when an overpressure condition is approached. When the monitored pressure meets or exceeds the setting, the PORV is signaled to open. Maintaining the setpoint within the limits of the LCO ensures the Reference 1 limits will be met in any event analyzed for LTOP.

When a PORV is opened in an increasing pressure transient, the release of coolant causes the pressure increase to slow and reverse. As the PORV releases steam, the RCS pressure decreases until a reset pressure is reached and the valve is signaled to close. The pressure continues to decrease below the reset pressure as the valve closes.

(continued)

No CHANGE THIS PAGE



BASES

BACKGROUND (continued)

Administrative Control Requirements

Administrative controls are necessary to assure the operator has at least ten minutes available to mitigate the most limiting LTOP event. These administrative controls include the following:

1) Limits on RCS pressure based on RCS temperature;

2) Limits upon pressurizer level;

3) Limits upon makeup flow capability;

4) OPERABLE Alarms;

5) Controls upon use of the High Pressure Nitrogen System; and

6) Restricting the number of available pressurizer heater banks.

Limiting RCS pressure based on RCS temperature provides a minimum margin to the RCS P/T limit. Restricting RCS makeup flow capability and pressurizer level and controls on the use of high pressure nitrogen limit the pressurization rate during an LTOP event. Restricting the number of available pressurizer heater banks limits the pressurization rate during an LTOP event. Alarms ensure early operator recognition of the occurrence of an LTOP event. The combination of minimum margin to the limit, limited pressurization rate and OPERABLE alarms ensure ten minutes are available for operator action to mitigate an LTOP event.

APPLICABLE SAFETY ANALYSES

Safety analyses (Ref. 3) demonstrate that the reactor vessel can be adequately protected against overpressurization transients during shutdown. In MODES 1, 2, and in MODE 3 with RCS temperature exceeding 325°F, the pressurizer safety valves will prevent RCS pressure from exceeding the Reference 1 limits. At nominally 325°F and below, overpressure prevention falls to an OPERABLE PORV, a restricted coolant level in the pressurizer and other administrative controls.

(continued)

No Change This Page



BASES

APPLICABLE SAFETY ANALYSES (continued)

The actual temperature at which the pressure in the P/T limit curve falls below the pressurizer safety valve setpoint increases as vessel material toughness decreases due to neutron embrittlement. Each time the P/T limit curves are revised, the LTOP System will be re-evaluated to ensure that its functional requirements can still be met with the PORV and pressurizer level/administrative controls method.

Transients that are capable of overpressurizing the RCS have been identified and evaluated. These transients relate to either mass input or heat input: actuating the HPI System, discharging the CFTs, energizing the pressurizer heaters, failing the makeup control valve open, losing decay heat removal, starting a reactor coolant pump (RCP) with a large temperature mismatch between the primary and secondary coolant systems, and adding nitrogen to the pressurizer. LTOP limits and restrictions take into account the presence of nitrogen and/or air in the RCS during LTOP conditions.

HPI actuation and CFT discharge are the transients that may result in exceeding P/T limits within < 10 minutes in which time no operator action is assumed to take place. Starting an RCP and adding nitrogen to the pressurizer are self limiting events. In the rest, operator action after that time precludes overpressurization. The analyses demonstrate that the time allowed for operator action is adequate, or the events are self limiting and do not exceed P/T limits.

The following controls are required during the LTOP MODES to ensure that transients do not occur, which either of the LTOP overpressure protection means cannot handle:

a. Limiting RCS makeup flow capability;

b. Deactivating HPI-ES;

c. Immobilizing CFT discharge isolation valves in their closed positions; and

d. Limiting the number of available pressurizer heater banks.

(continued)

BASES

**APPLICABLE SAFETY ANALYSES (continued)**

The Reference 3 analyses demonstrate the PORV can maintain RCS pressure below limits when both makeup flow capability and the number of available pressurizer heater banks is restricted. Consequently, the administrative controls require makeup flow capability and the number of available pressurizer heater banks to be limited in the LTOP MODES.

Since the PORV cannot protect the reactor vessel for engineered safeguards actuation of one or more HPI pumps, or discharging the CFTs, the LCO also requires the HPI-ES actuation circuits be deactivated and the CFTs isolated. The isolated CFTs must have their discharge valves closed and the valve power breakers fixed in their open positions.

Fracture mechanics analyses established the temperature of LTOP Applicability at 325°F. Above this temperature, the pressurizer safety valves provide the reactor vessel pressure protection. The vessel materials were assumed to have a neutron irradiation accumulation equal to 26 effective full power years (EFPYs) of operation for Units 1, 2, and 3.

33

This LCO will deactivate the HPI-ES actuation when the RCS temperature is ≤ 325°F.

Reference 3 contains the acceptance limits that satisfy the LTOP requirements. Any change to the RCS must be evaluated against these analyses to determine the impact of the change on the LTOP acceptance limits.

535

PORV Performance

The fracture mechanics analyses show that the vessel is protected when the PORV is set to open at ≤ 460 psig. The setpoint is derived by modeling the performance of the LTOP system for different LTOP events. The PORV setpoint at or below the derived limit ensures the Reference 1 limits will be met.

The PORV setpoint is re-evaluated for compliance when the revised P/T limits conflict with the LTOP analysis limits. The P/T limits are periodically modified as the reactor vessel material toughness decreases due to embrittlement

(continued)

NO CHANGE THIS PAGE



BASES

APPLICABLE SAFETY ANALYSES (continued)

induced by neutron irradiation. Revised P/T limits are determined using neutron fluence projections and the results of examinations of the reactor vessel material irradiation surveillance specimens. The Bases for LCO 3.4.3 discuss these examinations.

The PORV is considered an active component. Therefore, its failure represents the worst case LTOP single active failure.

Administrative Controls Performance

Limiting RCS pressure when RCS temperature is < 325°F provides a minimum margin to the RCS P/T limit. Restricting RCS makeup flow capability, the number of available pressurizer heater banks, pressurizer level, and controls on the use of high pressure nitrogen limit the pressurization rate during an LTOP event. Alarms ensure early operator recognition of the occurrence of an incipient LTOP event. The combination of minimum margin to the limit, limited pressurization rate and OPERABLE alarms ensure ten minutes are available for operator action to mitigate an LTOP event.

RCS Vent Requirements for Testing

With the RCS depressurized, analyses show:

a. For HPI System testing, a vent of ≥ 3.6 square inches is capable of mitigating the transient resulting from HPI-ES actuation testing in which three HPI pumps inject to the RCS through two injection flow paths.

b. For CFT Discharge Testing, a vent of ≥ 201 square inches is capable of mitigating the transient resulting for discharge of both CFTs to the RCS.

The capacity of vents of these minimum sizes is sufficient to limit the RCS pressure to ≤ 400 psig, which is less than the maximum allowable pressure at minimum RCS temperature.

(continued)

BASES

---

APPLICABLE SAFETY ANALYSES (continued)

The RCS vent size will also be re-evaluated for compliance each time P/T limit curves are revised based on the results of the vessel material surveillance.

These vents are passive and not subject to active failure.

The LTOP System satisfies Criterion 2 and Criterion 3 of 10 CFR 50.36 (Ref.6).

---

LCO

The LCO requires an LTOP System OPERABLE with a limited coolant input capability and a pressure relief capability. The LCO requires HPI to be deactivated and the CFTs to be isolated. For pressure relief, it requires the pressurizer coolant at or below a maximum level and the PORV OPERABLE with a lift setting ≤ the LTOP limit.

535

The PORV is OPERABLE when its block valve is open, its lift setpoint is set at ≤ ~~460~~ psig and testing has proven its ability to open at that setpoint, and power is available to the two valves and their control circuits.

An RCS vent path capable of mitigating the most limiting LTOP event (except for HPI-ES actuation or CFT discharge) has a minimum equivalent diameter of 1-3/32 inches, which is equal to the inner throat diameter of the PORV.

Implementation of the following administrative controls assure that ≥ 10 minutes are available for operator action to mitigate an LTOP event:

375

525

1. RCS pressure:

   < ~~320~~ psig when RCS temperature ≤ 220°F

   < ~~430~~ psig when RCS temperature > 220°F and ≤ 325°F

2. Pressurizer level is maintained within the following limits:

   a. RCS pressure is > 100 psig:

      ≤ 220 inches when RCS temperature ≤ 325°F

(continued)

BASES

LCO (continued)

b. RCS pressure is ≤ 100 psig:

≤ 310 inches when RCS temperature ≤ 220°F.

≤ 380 inches while filling or draining the RCS when RCS temperature ≤ 160°F and no HPI pumps are running.

When the RCS pressure is ≤ 100 psig, pressurizer level is normally maintained ≤ 220 inches except for certain RCS evolutions. The specified pressurizer level limits provide assurance that at least 10 minutes is available for operator action during those evolutions. The temperature limits are based on operational limits for the evolutions and are used in the analyses to determine allowable pressurizer levels.

3. Makeup flow is restricted with the HP-120 (makeup control valve) travel stop set to ≤ ~~90.0~~ 98.0 gpm for all three units.

4. Three audible pressurizer level alarms at ≤ 225 inches, ≤ 260 inches, and ≤ 315 inches from the temperature compensated pressurizer level indication.

5. Two audible RCS pressure alarms at ~~320~~ 375 psig and ~~430~~ 525 psig.

6. High pressure nitrogen system is administratively controlled to prevent inadvertent pressurization of the RCS.

7. Core Flood Tank(s) are isolated as required by the LCO by closing the appropriate isolation valve(s) (either CF-1 and/or CF-2), tagging open the valve breaker(s), and tagging the valve(s) in the closed position.

8. The HPI safety injection flowpaths must be deactivated.

(continued)

NO CHANGE THIS PAGE



BASES

LCO (continued)

a. Deactivating Train A of HPI is accomplished by either:

1) Shutting and deactivating valve HP-26 by tagging open the valve breaker and tagging the valve handwheel in the closed position, shutting valve HP-410 and tagging the valve switch in the closed position.

2) Deactivating all HPI pumps aligned to HPI train A and tagging the pump breakers open.

b. Deactivating Train B of HPI is accomplished by either:

1) Shutting and deactivating valve HP-27 by tagging open the valve breaker and tagging the valve handwheel in the closed position, shutting valve HP-409 and tagging the valve switch in the closed position.

2) Deactivating all HPI pumps aligned to HPI train B and tagging the pump breakers open.

9. Pressurizer heater bank 3 or 4 must be deactivated.

Operational parameters identified in TS 3.4.12 and this TS Bases include allowances for instrument uncertainty.

APPLICABILITY

This LCO is applicable in MODE 3 when any RCS cold leg temperature is ≤ 325°F, and in MODES 4, 5 and 6 when an RCS vent capable of mitigating the most limiting LTOP event is not open. The Applicability temperature of 325°F is established by fracture mechanics analyses. The pressurizer safety valves provide overpressure protection to meet LCO 3.4.3 P/T limits above 325°F. With the vessel head off, overpressurization is not possible. With an RCS vent capable of mitigating the most limiting LTOP event open, an LTOP event (including HPI-ES actuation or CFT discharge) is incapable of pressurizing the RCS above the RCS P/T limits.

(continued)

NO CHANGE THIS PAGE



BASES

APPLICABILITY (continued)

A RCS vent ≥ 3.6 square inches is capable of mitigating a HPI-ES actuation of three pumps through two flow paths to the RCS. A RCS vent ≥ 201 square inches is capable of mitigating a discharge of both CFTs.

LCO 3.4.3 provides the operational P/T limits for all MODES. LCO 3.4.10, "Pressurizer Safety Valves," requires the pressurizer safety valves OPERABLE to provide overpressure protection during MODES 1, 2, and 3 above 325°F.

The Applicability is modified by two Notes. Note 1 states that CFT isolation is only required when the CFT pressure is more than or equal to the maximum RCS pressure for the existing RCS temperature, as allowed in LCO 3.4.3. This Note permits the CFT discharge valve surveillance performed only under these pressure and temperature conditions.

Note 2 permits the PORV to be inoperable when no HPI pumps are running and RCS pressure is < 100 psig. PORV operability is not required when RCS pressure is < 100 psig and HPI pumps are not operating since credible LTOP events progress relatively slowly, thus giving the operator ample time to respond.

ACTIONS

A.1

With the HPI activated, immediate actions are required to deactivate HPI. Emphasis is on immediate deactivation because inadvertent injection with one or more HPI pump OPERABLE is the event of greatest significance, since these events cause the greatest pressure increase in the shortest time.

The immediate Completion Times reflect the urgency of quickly proceeding with the Required Actions.

(continued)

BASES

ACTIONS (continued)

B.1, C.1, and C.2

An unisolated CFT requires isolation within 1 hour only when the CFT pressure is at or more than the maximum RCS pressure for the existing temperature allowed in LCO 3.4.3.

If isolation is needed and cannot be accomplished in 1 hour, Required Action C.1 and Required Action C.2 provide two options, either of which must be performed in 12 hours. By placing the unit in MODE 4 with the RCS temperature > 233°F, the CFT pressure of 650 psig cannot exceed the LTOP limits if both tanks are fully injected. Depressurizing the CFTs below the LTOP limit of 373 psig also prevents exceeding the LTOP limits in the same event.

200

The Completion Times are based on operating experience that these activities can be accomplished in these time periods and on engineering judgement indicating that a limiting LTOP event is not likely in the allowed times.

D.1, E.1, and E.2

With the PORV inoperable, overpressure relieving capability is lost, and restoration of the PORV within 1 hour is required.

If restoration cannot be completed within 1 hour, either Required Action E.1 or Required Action E.2 must be performed. Required Action E.1 requires increasing RCS temperature within 23 hours to exit the Applicability of the specification. With RCS temperature > 325°F, the CFTs are not required to be isolated. Required Action E.2 requires the RCS be depressurized to less than 100 psig within 35 hours. With reactor pressure < 100 psig more time is available for operator action to mitigate an LTOP event.

These Completion Times also consider these activities can be accomplished in these time periods. A limiting LTOP event is not likely in these times.

(continued)

No CHANGE THIS PAGE



BASES

ACTIONS (continued)

F.1 and G.1

With Administrative Controls that assure ≥ 10 minutes are available to mitigate the consequences of an event not implemented, the capability for operator action to mitigate an LTOP event may be lost. In this circumstance, compensatory measures must be established to monitor for initiation of an LTOP event. Establishing a dedicated operator within 4 hours to monitor for initiation of an LTOP event is sufficient to compensate for inoperability of makeup flow restrictions, having too many pressurizer heater banks available, inoperability of required alarms, or deviation from pressure, temperature or level limits. Establishing a dedicated operator is not sufficient to compensate for not deactivating HPI or isolating CFTs. If the Required Action and associated Completion Time of Condition F is not met, the RCS must be depressurized and an RCS vent path capable of mitigating the most limiting LTOP event must be established within 12 hours. These Completion Times also consider that these activities can be accomplished in these time periods. A limiting LTOP event is not likely in these periods.

H.1 and H.2

With administrative controls which assure ≥ 10 minutes are available to mitigate the consequences of an LTOP event not implemented and the PORV inoperable; or the LTOP System inoperable for any reason other than cited in Condition A through G, the system must be restored to OPERABLE status within one hour. When this is not possible, Required Action H.2 requires the RCS depressurized and vented within 12 hours.

One or more vents may be used. A vent path capable of mitigating the most limiting LTOP event is specified. Because makeup may be required, the vent size accommodates inadvertent full makeup system operation. Such a vent keeps the pressure from full flow of the makeup pump(s) with a wide open makeup control valve within the LCO limit.

(continued)

No CHANGE THIS PAGE



BASES

ACTIONS

H.1 and H.2 (continued)

The Completion Time is based on operating experience that these activity can be accomplished in this time period and on engineering judgement indicating that a limiting LTOP transient is not likely in this time.

SURVEILLANCE REQUIREMENTS

SR 3.4.12.1 and SR 3.4.12.2

Verifications must be performed that HPI is deactivated, and the CFTs are isolated. These Surveillances ensure the minimum coolant input capability will not create an RCS overpressure condition to challenge the LTOP System. The Surveillances are required at 12 hour intervals. The 12 hour intervals are shown by operating practice to be sufficient to regularly assess conditions for potential degradation and verify operation within the safety analysis.

SR 3.4.12.3

Verification that the pressurizer level is less than the volume necessary to assure $\geq$ 10 minutes are available for operator action to mitigate an LTOP event by observing control room or other indications ensures a cushion of sufficient size is available to reduce the rate of pressure increase from potential transients.

The 30 minute Surveillance Frequency during heatup and cooldown must be performed for the LCO Applicability period when temperature changes can cause pressurizer level variations. This Frequency may be discontinued when the ends of these conditions are satisfied, as defined in plant procedures. Thereafter, the Surveillance is required at 12 hour intervals.

These Frequencies are shown by operating practice sufficient to regularly assess indications of potential degradation and verify operation within the safety analysis.

(continued)

No Change This Page



BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.12.4

Verification that the PORV block valve is open ensures a flow path to the PORV. This is required at 12 hour intervals.

The interval has been shown by operating practice to be sufficient to regularly assess conditions for potential degradation and verify operation is within the safety analysis.

SR 3.4.12.5

A CHANNEL FUNCTIONAL TEST is required within 12 hours after decreasing RCS temperature to ≤ 325°F and every 31 days thereafter to ensure the setpoint is proper for using the PORV for LTOP. PORV actuation is not needed, as it could depressurize the RCS.

The 12 hour Frequency considers the unlikelihood of a low temperature overpressure event during the time. The 31 day Frequency is based on industry accepted practice and is acceptable by experience with equipment reliability.

SR 3.4.12.6

Verification that administrative controls, other than limits for pressurizer level, that assure ≥ 10 minutes are available for operator action to mitigate the consequences of an LTOP event are implemented is necessary every 12 hours. This verification consists of a combination of administrative checks for alarm availability, verification that pressurizer heater bank 3 or 4 is deactivated, appropriate restrictions on pressurizer level, controls for High Pressure Nitrogen, etc., as well as visual confirmation using available indications that associated physical parameters are within limits.

The Frequency is shown by operating practice sufficient to regularly assess indications of potential degradation and verify operation within the safety analysis.

(continued)

No Change This Page



BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.12.7

The performance of a CHANNEL CALIBRATION is required every 18 months. The CHANNEL CALIBRATION for the LTOP setpoint ensures that the PORV will be actuated at the appropriate RCS pressure by verifying the accuracy of the instrument string. The calibration can only be performed in shutdown.

The Frequency considers a typical refueling cycle and industry accepted practice.

REFERENCES

1. 10 CFR 50, Appendix G.
2. Generic Letter 88-11.
3. UFSAR, 5.2.3.7.
4. 10 CFR 50.46.
5. 10 CFR 50, Appendix K.
6. 10 CFR 50.36.

ATTACHMENT 3

TECHNICAL JUSTIFICATION

## TABLE OF CONTENTS

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

## 1.0 Description of Proposed Changes

This proposed amendment revises the pressure-temperature (P-T) limits of Technical Specification (TS) 3.4.1 for Oconee Units 1, 2, and 3. The proposed amendment will revise the heatup, cooldown, and inservice test limitations for the Reactor Coolant System (RCS) of each unit. The service period for the new pressure-temperature limits will be to a maximum of 33 effective full power years (EFPY) for Units 1, 2 and 3.

The proposed amendment also revises TS Tables 3.4.3-1 and 3.4.3-2 to permit the Oconee Units to be operated during low temperature conditions with two Reactor Coolant Pumps (RCP) in operation in a single loop. The TS 3.4.3-1 Bases is revised to remove descriptions of RCP operational restrictions which are no longer applicable. The Bases is also revised to add descriptions of the bases for limiting minimum reactor pressure vessel temperature, and the breakpoints in the temperature rate of change of TS Tables 3.4.3-1 and 3.4.3-2.

This proposed amendment also revises TS 3.4.12, Low Temperature Overpressure Protection (LTOP) System setpoints. The RCS Power Operated Relief Valve (PORV) low setpoint is being increased from 460 psig to 535 psig as a result of the P-T limit changes. Other limits are revised to be consistent with the new P-T limits. These LTOP limits have been developed to be uniform for all three Oconee units. The TS 3.4.12 Bases is revised to describe the new limits and setpoints and to provide Administrative Controls consistent with the new P-T limits.

## 2.0 Background

Currently, Oconee Unit 1, 2, and 3 P-T limits have been evaluated for up to 26 EFPY. This amendment request provides Duke's evaluation of these limits in order to: 1) relax the P-T limits sufficiently to permit operation of two RCPs in one RCS loop, and 2) extend the evaluation period of the new P-T Limits to 33 EFPY. These changes rely on recently approved methodology for determining allowable P-T limits which is described below in more detail.

During relatively low temperature Reactor Coolant System (RCS) operations, the present Technical Specifications require no more than one Reactor Coolant Pump (RCP) be operated per loop. RCP operation at low pressure with either one pump in one RCS loop, or with one RCP in each RCS loop, results in gradual RCP impeller wear from cavitation. The degraded net positive suction head (NPSH) conditions are caused by the restricted P-T operating envelope at low pressures and temperatures. Cavitation induced wear to-date consists of excessive RCP impeller wear and one instance of a failed impeller blade. A portion of the failed blade was transported by reactor coolant flow to the bottom of the reactor vessel.

The cost to repair cavitation related RCP impeller wear incurred to-date is approximately $8 million. The estimated costs to repair existing impeller cavitation wear is about $13 million. These costs do not include lost generation.

The proposed TS changes will permit the Oconee units to be operated during low temperature conditions with two RCPs in operation in a single loop. With both RCPs operating in a loop, flow through each pump is significantly reduced thereby reducing the required NPSH and eliminating cavitation induced impeller wear. It is anticipated that following replacement of existing worn impellers that no further replacements will be needed and radiation exposure associated with impeller replacements eliminated. Additionally, the proposed changes would relax the LTOP operating envelope which would reduce challenges to the RCS power operated relief valve.

As a result of the above described benefits, Duke requests approval of this proposed amendment by October 6, 1999, to enable implementation of the new P-T and LTOP limits prior to shutdown of Oconee Unit 2 for the cycle 17 refueling outage currently projected to begin on November 6, 1999. Duke requests a 90-day grace period for implementation should this request be approved prior to October 6, 1999. Approval by this date will enable Unit 2 to minimize further RCP impeller wear during shutdown. The current mode of operation during shutdown for refueling involves prolonged single RCP pump operation at a relatively low RCS temperature to induce a burst of activated wear and corrosion products (CRUD) into the RCS. The CRUD is then removed from the coolant reducing radiation exposures during the outage.

Duke requested Framatome Technologies, Inc. (FTI), to perform reactor vessel integrity assessments and generate new P-T limit curves for Units 1, 2, and 3. These curves have been developed and envelope operation up to 33 EFPY for all three units.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

These assessments, P-T limit curves, and the LTOP analysis and limits proposed in this amendment application satisfy the requirements of 10 CFR 50.60(a) with three exceptions. These exceptions are new ASME Boiler and Pressure Vessel Code Cases which have not been included in the latest revisions to NRC Regulatory Guides 1.147, 1.85, and 1.84.

These exceptions are as follows:

A. ASME Code Case N-514, "Low Temperature Overpressure Protection" (Reference 1), provides a LTOP enabling temperature which provides a 40 °F wider operating window. Code Case N-514 is utilized for Oconee Units 1, 2 and 3, as described in the following Section 3.3.2.

B. ASME Code Case N-588, "Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels" (Reference 2), provides reactor coolant temperature, pressure and system heatup and cooldown rates with margins derived from postulating a circumferentially oriented reference flaw in a circumferential weld. Code Case N-588 is utilized for Oconee Units 1, 2 and 3 as described in the following Section 3.1.3. However, Oconee Unit 1 does not realize a benefit due to the Unit 1 reactor vessel containing both longitudinal and circumferential welds.

C. ASME Code Case N-626, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for Section XI, Division 1" (Reference 3), provides reactor coolant temperature, pressure and system heatup and cooldown rate limits with margins consistent with the fastest rate of temperature change allowed ($K_{1c}$ methodology). Code Case N-626 is utilized for Oconee Units 1, 2 and 3 as described in the following Section 3.1.3.

Duke requests exemptions to use ASME Code Cases N-514, N-588 and N-626, respectively pursuant to 10 CFR 50.60(b) under 10 CFR 50.12. These exemption requests are provided in Sections 3.4, 3.5, and 3.6, below.

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

## 3.0 Technical Justification

### 3.1 Pressure-Temperature Curves Justification

#### 3.1.1 Fluence Program

In 1976 several utilities with reactor vessels designed by Babcock & Wilcox (B&W), including Duke Power, requested exemptions from the 10 CFR 50, Appendix H requirement for an in-vessel material surveillance program. The Staff reviewed and evaluated each licensee's request for an exemption and the plan for an integrated surveillance program. The staff then granted the requested exemption.

A revised 10 CFR 50, Appendix H became effective in July 1983. Section II. C of the revised Appendix H allows an integrated surveillance program provided it was approved by the Director, Office of Nuclear Reactor Regulation. The revised Appendix H provided criteria that were to be used in the evaluation of the surveillance program. In a letter dated March 14, 1984, the B&W Owners Group submitted an updated integrated surveillance program for Staff review and approval. The program was documented in BAW-1543A, Revision 2, Integrated Reactor Vessel Surveillance Program (Reference 4). In the Safety Evaluation Report (SER) for BAW-1543A, the Staff concluded the topical report meets the evaluation criteria of Sections II. C of Appendix H. The following statements are from the conclusions section of the SER.

> In-cavity dosimetry testing should continue in order to reduce uncertainties in neutron fluence for vessels that do not contain in-vessel dosimetry. If these test results provide an effective method of monitoring vessel neutron fluence, the in-cavity dosimetry should be incorporated in plants.

In a letter dated September 16, 1985, the B&W Owner Group requested an evaluation of a "Cavity Dosimetry Program" under development for use in B&W plants. This program is described in Topical Report BAW-1875 (Reference 5). This report was approved by the Staff in June 1986. It was noted in BAW-1875 that the material surveillance program will have provided all the required empirical information for the fluence-toughness relationship by the mid-1990's. During this time, a portion of the surveillance capsules would have been removed. The cavity dosimetry program will then continue to provide vessel irradiation data beyond the end of the integrated surveillance capsule dosimetry program in an accurate and convenient manner.

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

The calculational methodology for predicting the fluence using the cavity dosimetry was validated in the benchmark phase of the cavity dosimetry program. The benchmark consisted of both surveillance capsule and cavity dosimetry comparisons of calculations to dosimetry measurements. The results of these benchmarks are documented in FTI Topical Report BAW-2241P (Reference 6). This report was approved by the Staff in February 1999. The results demonstrate the conclusions of the Oconee Units 1, 2, and 3 fluence data used to develop the P-T limits are sufficient for safety and licensing evaluations of reactor vessel embrittlement.

Fluence values used for this P-T limit submittal are based on calculations provided in References 7, 8, and 9 for Units 1, 2, and 3, respectively. These fluence values are provided in Tables 1, 2 and 3 for Units 1, 2, and 3, respectively.

3.1.2 Determination of Adjusted $RT_{NDT}$ (ART)

The projected 33 EFPY ART values at the 1/4 Thickness (1/4T) and 3/4 Thickness (3/4T) locations for the beltline regions of the Oconee reactor vessels were calculated by FTI. These calculations were in accordance with Regulatory Guide 1.99, Revision 2, and the guidelines presented by the NRC in the November 12, 1997, briefing concerning review of responses to Generic Letter 92-01, Revision 1, Supplement 1. The Regulatory Guide 1.99 credibility criteria are applied by FTI to determine the appropriate margin term. The calculations determined the ART for the various reactor Vessel (RV) materials using Regulatory Guide 1.99, Revision 2, Regulatory Positions 1.1 and 2.1. The selected controlling values are those RV locations with the highest ART for 1/4T and 3/4T whether determined using Regulatory Position 1.1 or 2.1 methodology. The fluence values for all reactor vessel materials at the limiting location for each material are summarized in Tables 1, 2, and 3, for Units 1, 2 and 3, respectively. The controlling values for Unit 1 were determined to be the circumferential weld (SA-1229) of the intermediate shell plates to the upper shell plates. The controlling values for Units 2 and 3 were determined to be those of the circumferential weld of the RV upper shell forging to the lower shell forging (WF-25 for Unit 2 and WF-67 for Unit 3). The maximum fluence values and controlling ART values for 33 EFPY for the Oconee units are also provided in Enclosure 1 to this attachment.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

### 3.1.3 Determination of Pressure-Temperature Limits

Introduction

The proposed P-T limits for Units 1, 2, and 3 were developed using FTI computer code PTPC 3.3 (Reference 10), as modified by ASME Code Case N-588 for circumferential flaws in welds and by Code Case N-626 for use of the $K_{1c}$ fracture toughness curve. The methods and criteria employed to establish operating pressure and temperature limits are described in NRC approved Topical Report BAW-10046A (Reference 11). The method of analysis consists of determining the P-T limits for the beltline region, the nozzle region and the closure head region of the reactor vessel for normal heatup, normal cooldown, and inservice leak and hydrostatic test.

Technical Justification for use of Code Case N-626

For Oconee Units 1, 2, and 3, ASME Code Case N-626 is utilized in the development of the proposed pressure temperature limits. These revised P-T limits have been developed using the $K_{1c}$ fracture toughness curve shown on ASME XI, Appendix A, Figure A-2200-1, in lieu of the $K_{1a}$ fracture toughness curve of ASME XI, Appendix G, Figure G-2210-1, as the lower bound for fracture toughness. The effect of granting this exemption is to change the fracture toughness curve used for development of the P-T curves from $K_{1a}$ to $K_{1c}$. The other margins involved with the ASME XI, Appendix G process of determining P-T limit curves remain unchanged. The unchanged margins are: 1) a flaw which is 1/4 vessel thickness in depth and 3/2 the vessel thickness in length, 2) safety factor of two on pressure stress for heatup and cooldown and a safety factor of 1.5 for testing, and 3) upper bound adjusted reference temperature ($RT_{NDT}$).

Use of the $K_{1c}$ curve in determining the lower bound fracture toughness in the development of P-T operating limits curves is more technically correct than the $K_{1a}$ curve. The $K_{1c}$ curve models the slow heatup and cooldown process of a reactor coolant system, with the fastest rate allowed being 100 °F per hour. The rate of change of pressure and temperature is virtually constant at low temperatures; therefore, the reactor vessel thermal stress is essentially nil for this transient. During development of Code Case N-626 and the accompanying Appendix G code change, the ASME Section XI, Working Group on Operating Plant Criteria (WGOPC), performed assessments of the margins inherent to $K_{1a}$ using realistic heatup and cooldown curves. These assessments led to the conclusion that utilization of the $K_{1a}$ curve was excessively conservative and the $K_{1c}$ curve provided adequate margin for protection from brittle fracture. Code Case N-626 and the accompanying Technical Bases Document developed by the WGOPC are included as Enclosure 2.

Use of this approach is justified by the initial conservatism of the $K_{1a}$ curve when the curve was codified in 1974. The initial conservatism was necessary due to limited experience and knowledge of the fracture toughness of reactor pressure vessel materials over time and usage. The conservatism also provided margin thought to be necessary to cover uncertainties and a number of postulated but unquantified effects.

Since 1974, additional knowledge has been gained from examination and testing of reactor pressure vessels that had been subject to the effects of neutron embrittlement in both an operating and test environment. The $K_{1a}$ curve was based on 125 data points. The $K_{1c}$ curve is based on more than 1500 data points. The additional data has significantly reduced the uncertainties associated with embrittlement effects and reduced other uncertainties. The added data ensures the $K_{1c}$ curve adequately statistically bounds the data. The new information indicates the lower bound on fracture toughness provided by the $K_{1a}$ curve is extremely conservative and is well beyond the margin of safety required to protect the public health and safety from potential reactor pressure vessel failure.

P-T limit curves based on the $K_{1c}$ methodology will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operations. There are two primary safety benefits in opening the lower temperature operating window. The first safety benefit is a reduction in the likelihood of a challenge to RCS power operated relief valve during low temperature operations. The second safety benefit is opening the low temperature pressure window sufficiently to enable normal operation of two RCPs in a single RCS loop. With two RCPs operating in a loop the required NPSH for the operating pumps is reduced and impeller cavitation wear is eliminated thereby reducing maintenance and radiation exposure.

<u>Technical Justification for Use of Code Case N-588</u>

For Oconee Units 1, 2, and 3, ASME Code Case N-588 is also utilized in the development of the proposed P-T limits. Code Case N-588 provides benefits in terms of calculating P-T limits by revising the Section XI, Appendix G reference flaw orientation for circumferential welds in reactor vessels. The 1/4T surface reference flaw is a postulated flaw which accounts for the possibility of a prior existing defect that may have gone undetected during the fabrication process. When considering a reference flaw with respect to a weld, the reference flaw would represent any prior existing defect that may have been introduced during fabrication. Thus, the intended application of a reference flaw is to account for prior existing defects that could physically exist within the geometry of the weldment. The current ASME Section XI, Appendix G approach mandates the consideration of an axial reference flaw in circumferential welds for purposes of calculating P-T limits. Postulating the Appendix G reference flaw in a circumferential weld is physically unrealistic and overly conservative, because the length of the flaw is 1.5 times the vessel thickness, which is much longer than the width of the reactor vessel girth weld. The possibility an axial flaw may extend from a circumferential weld into a plate/forging or axial weld is already adequately covered by the requirement that axial defects be postulated in plates/forging and axial welds. The fabrication of reactor pressure vessels for nuclear power plant operation involved precise welding procedures and controls designed to optimize the resulting weld microstructure and to provide the required material properties. These procedural controls were also designed to minimize defects that could be introduced into the weld during the fabrication process. Industry experience with the repair of weld indications found during pre-service inspection, and data taken from destructive examination of actual vessel welds, confirms any remaining defects are small, laminar in nature, and do not cross transverse to the weld bead orientation. Therefore, any potential defects introduced during the fabrication process, and not detected during subsequent nondestructive examinations, would only be expected to be oriented in the direction of weld fabrication. For circumferential welds this indicates a postulated defect with a circumferential orientation.

Due to progress made in NDE techniques over the last thirty years, it is very unlikely to have large, undetected defects present in the beltline region of reactor vessels. It is further unlikely to have axial cracks originating from a circumferential weld perpendicular to the weld seam orientation in reactor vessels. Both experience and engineering studies indicate the primary degradation mechanism affecting the beltline region of the reactor vessel is neutron embrittlement. No other service induced degradation mechanism exists at a pressurized water reactor to cause a prior existing defect located in the beltline region of the reactor vessel to grow while inservice. Based on these considerations, and the fact the P-T limit for reactor operation is the limiting pressure for any of the materials in the vessel, it is not necessary to include additional conservatism in the assumed flaw orientation for circumferential welds. ASME Section XI Code Case N-588 and the accompanying Appendix G Code change corrected this inconsistency in assumed flaw orientation for circumferential welds in vessels when calculating operating P-T limits.

Summary of Assumptions, Analysis, and Results

At the request of Duke, FTI conservatively provided 100% of the steady-state Appendix G limits applying Code Case N-588 and Code Case N-626 for all three Units. Instead of utilizing the provisions of Code Case N-626, § G-2214.3 to determine the radial thermal gradient, the equivalent linear stress method is used per the 1989 edition of ASME XI, § G-2214.3(b).

Since appropriate instrument error allowances are included in the operating procedures, the Technical Specification P-T limit curves do not include margins for instrument error. The analyses for Units 1, 2, and 3 are summarized in the Enclosure 1 to this attachment.

FTI's calculations of the proposed P-T limits utilized the following inputs:

- The operational reactor coolant pump constraints are those listed in the proposed Technical Specifications for various RCS temperature bands and are described in detail in Sections 3.2 and 3.3.3 below.

- The following linear heatup ramps which bound the limits of the Technical Specification:

    60 - 280 °F: 50 °F/hr
    280 - 570 °F: 100 °F/hr

ATTACHMENT 3

TECHNICAL JUSTIFICATION

- The cooldown transient was analyzed as a step transient which bounds the Technical Specification and is defined as follows:

| | |
|---|---|
| 570 °F - 280 °F: | 50 °F steps with 30 minute hold periods or equivalent |
| 280 °F - 150 °F: | 25 °F steps with 30 minute hold periods or equivalent |
| At 240 °F: | Decay heat removal system initiated which is modeled as a step change from 240 °F to 207 °F and held at 207 °F for one minute. Following this hold period, a step temperature increase to 227 °F is made. It is assumed that two RCPs in one loop are operating during this transient. This analysis bounds the situation where only one RCP is operating on initiation of decay heat removal. |
| 150 °F - 60 °F: | 10 °F steps with 60 minute hold periods or equivalent |

For a given transient, the maximum allowable pressure as a function of fluid temperature was obtained through a point-by-point comparison of the results at the 1/4T and 3/4T locations of the limiting beltline weld, the nozzle region and the closure head region. The maximum allowable pressure was taken to be the lowest of the calculated allowable pressures for a given time point. The resulting loci of the points determine the P-T limit curves. The Technical Specification P-T limit curves do not include margins for instrument error since allowances for the instrument uncertainty associated with operation within the limits represented by the curves are factored into the operating procedures.

FTI also provided steady state P-T limits for the development of the LTOP limits using ASME Code Case N-514. FTI used 100 % of the Appendix G curves since Code Case N-626 is utilized in conjunction with Code Case N-514. These curves are location adjusted. The LTOP P-T limits and usage of Code Cases N-514 and N-626 are described in Section 3.3 below.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

### 3.2 Justification for Changed Operating Reactor Coolant Pump Combinations

The limits on allowable operating RCP combinations controls the pressure differential between the reactor vessel wall and the pressure measurement point and are used as inputs for calculating the heatup, cooldown, and the leak and hydrotest limit curves. For example, with one reactor coolant pump operating in a loop, the pressure differential between the low range pressure transmitter tap and the actual pressure at the vessel beltline is approximately 20 psi. With two RCPs in the same loop this pressure differential is approximately 50 psi. The differential pressure created by the operation of two RCPs must be accounted for in the development of the P-T limit curves so the upper pressure limit is not allowed to be exceeded.

Limits on the number of allowable operating RCP(s) at low temperature became necessary as the pressure limits at low temperatures decreased. The pressure limits decreased due to both the effects of ongoing neutron exposure to reactor vessel materials and the conservative methodology then needed to assure P-T limit curves provided adequate protection from reactor vessel brittle fracture. As the pressure limits decreased, the higher pressure differential of two operating RCPs in a loop resulted in an ever shrinking operating P-T window. The number of operating RCPs is currently limited to increase the size of the operating P-T window.

As a result of the proposed P-T limits described in the foregoing Section 3.1.2, the pressure limits at low temperatures have been increased. The increase in the pressure limit restores sufficient pressure margin to accommodate operation of two RCPs in a loop or one RCP in each loop at low temperatures as proposed in TS Tables 3.4.3-1 and 3.4.3-2. Location adjustment for the allowable operating RCP combinations is summarized in the enclosure to this attachment.

### 3.3 LTOP Limits Justification

#### 3.3.1 Background

The low temperature P-T limits provide restrictions for the protection from nonductile failure of the RCS under transient conditions. The LTOP System protects the reactor vessel from excessive pressures at low temperature conditions. The design basis events for the LTOP System are as follows:

A. Erroneous actuation of the High Pressure Injection System
B. Erroneous opening of the core flood tank discharge valve
C. Erroneous addition of nitrogen to the pressurizer
D. Makeup control valve failing full open
E. Pressurizer heaters erroneously energized
F. Loss of the Decay Heat Removal System
G. Reactor Coolant Pump Start Induced Transients

3.3.2 LTOP Pressure-Temperature Limits

The LTOP transient P-T limits have been calculated in accordance with the methodology described in ASME Section XI, Code Case N-514. Since Duke is using Code Case N-626, in conjunction with ASME XI, Appendix G, to determine allowed P-T limits, LTOP limits are based on 100% of the steady state Appendix G limits. Code Case N-514 defines the enable temperature as the greater of the coolant temperature corresponding to a metal temperature of the $RT_{NDT}$ + 50 °F or a minimum of 200 °F. The Oconee Unit 2 $RT_{NDT}$ is the most limiting (i.e., the highest temperature and bounds the enable temperatures for Oconee Units 1 and 3), and is therefore used for the LTOP enable temperature for all three Oconee units. The most limiting $RT_{NDT}$ has been determined to be 248.4 °F for Oconee Unit 2 using the methodology described in the above Section 3.1.2. Therefore, this resulted in a LTOP enable temperature of 325 °F with the additional allowances of +50 °F for Code Case N-514, +11.6 °F for instrument uncertainty, and +15 °F for margin (248.4 °F + 11.6°F + 15 °F + 50 °F) for the limiting weld material (WF-25). The current LTOP enable temperature specified in TS 3.4.12 is 325 °F. Since the enable temperature includes an allowance for instrument uncertainty and provides additional margin, it will remain unchanged. Instrument uncertainties are factored into the RCS P-T limits of the LTOP Technical Specifications.

Since a pressurizer steam or nitrogen bubble is maintained whenever the RCS is pressurized, a LTOP transient is normally characterized as a slow moving transient with no sudden temperature or pressure changes. Although a LTOP transient is expected to occur when the gradient between the vessel and coolant is approximately 0°F, Duke has conservatively added a 15 °F margin term. It is noted the LTOP limits are based on 100% of the steady-state Appendix G limits. Therefore, by definition there is little or no thermal gradient through the reactor vessel wall thickness.

The maximum controlling $RT_{NDT}$ values given in the following table are located in Enclosures 1, 2 and 3. The instrumentation uncertainty value of 11.6 °F given in the following table was obtained from a Duke Energy Corporation uncertainty calculation.

| Unit | $RT_{NDT}$ | Instrumentation Uncertainty | Margin | CC N-514 | Total |
|---|---|---|---|---|---|
| 1 | 203.1 | 11.6 | 15 | 50 | 279.7 |
| 2 | 248.4 | 11.6 | 15 | 50 | 325.0 |
| 3 | 211.7 | 11.6 | 15 | 50 | 288.3 |

The following table provides the most restrictive Appendix G P-T limits that apply for the first 33 EFPY that the LTOP setpoints are meant to protect (i.e., P-T Limits under steady state reactor operation, the isothermal curve). These limits are based on a composite curve formed from all three Oconee units P-T limits. The final temperature of 295 °F is determined due to the pressure remaining constant at 3049 psig for all greater temperatures.

| Shell Fluid Temperature (°F) | * LTOP Pressure Limits per N-514 & N-626 (psig) | Shell Fluid Temperature (°F) | * LTOP Pressure Limits per N-514 & N-626 (psig) |
|---|---|---|---|
| 60 | 555 | 230 | 1352 |
| 65 | 557 | 235 | 1439 |
| 70 | 561 | 240 | 1534 |
| 75 | 561 | 245 | 1640 |
| 180 | 561 | 250 | 1729 |
| 185 | 862 | 255 | 1859 |
| 190 | 898 | 260 | 2002 |
| 195 | 937 | 265 | 2160 |
| 200 | 980 | 270 | 2335 |
| 205 | 1027 | 275 | 2512 |
| 210 | 1080 | 280 | 2654 |
| 215 | 1138 | 285 | 2811 |
| 220 | 1202 | 290 | 2985 |
| 225 | 1273 | 295 | 3049 |

* Pressure measured at Hot Leg Tap location.

TS 3.4.12, Required Action C.1 is changed to account for the new 33 EFPY P-T limits. Required Action C.2 is not changed even though this results in additional conservatism (i.e., the 33 EFPY P-T analytical limits are less limiting than the prior limit).

3.3.3 PORV Setpoint

The limiting point on the above P-T limit curve is the basis for the new PORV setpoint of 535 psig. Per this curve, the maximum allowed pressure at 60 °F is 555 psig. The new PORV setpoint is adjusted by -20 psi to account for the 12.9 psi instrument uncertainty associated with the RCS pressure instrumentation utilized during LTOP conditions and to provide additional margin.

A single PORV setpoint of 535 psig is used for the entire LTOP temperature range. This maximum allowed pressure bounds all other pressures over the LTOP temperature range. Additional margin will exist during an LTOP event when the RCS temperature is higher than 60 °F. For temperatures greater than 60 °F, the corresponding pressure limit increases.

The P-T limits provided in the above table include adjustments for RCP operation. The number of assumed operating RCPs is temperature dependent and is based on that proposed in TS Tables 3.4.3-1 and 3.4.3-2:

| | RCS Temperature °F | RCP Constraints |
|---|---|---|
| Heatup | T < 250 °F | No more than two pumps operating |
| | T ≥ 250 °F | Any |
| Cooldown | T < 250 °F | No more than two pumps operating |
| | T ≥ 250 °F | Any |

The transient pressure response during LTOP events is relatively slow since a steam or nitrogen bubble is maintained in the pressurizer during low temperature operations. As a result of the pressurizer bubble, 10 minutes are available for operator action to mitigate LTOP events that can exceed the PORV setpoint. Since the PORV is a fast opening valve (approximately 0.2 second stroke time after a 2.1 second delay), transient pressure overshoot is negligible during LTOP events. Therefore, the PORV setpoint is only adjusted for instrumentation uncertainty and additional margin.

# ATTACHMENT 3

## TECHNICAL JUSTIFICATION

### 3.3.4 Instrument Uncertainty

Duke Energy Corporation has an engineering directive that outlines the requirements for performing instrument uncertainty and setpoint calculations. The primary purpose of this directive is to provide a consistent methodology based on standard industry practices for performing instrument uncertainty and setpoint calculations. The calculation methodology is consistent with the intent of ISA-67.04, Part II, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation."

In brief, the methodology conservatively accounts for the typical uncertainty terms such as reference accuracy, drift, temperature effect, calibration effects (which include measurement and test equipment uncertainty, calibration tolerance and resolution), etc. The random-independent uncertainty terms are combined via the "square-root-sum-of-the-square" (SRSS) technique, whereas the random-dependent and bias uncertainty terms are combined via a combination of SRSS and/or algebraic techniques.

LTOP operating limits and parameters provided in this attachment, TS 3.4.12 and TS B 3.4.12 include an allowance for instrument error and uncertainty.

### 3.3.5 LTOP Administrative Controls

Administrative controls are implemented during LTOP conditions to ensure the LTOP event initiators are either not credible or that 10 minutes are available for operator action. The proposed administrative controls are listed below and are also included in the LCO section of the TS 3.4.12 Bases:

a. RCS pressure:

< 375 psig when RCS temperature $\leq$ 220 °F [D.2, E, F.1, and G] [1]

< 525 psig when RCS temperature > 220 °F and $\leq$ 325 °F [D.3, E, and G]

[1] The heading designations ("A", "B", etc.) in this list are provided to facilitate cross referencing. For example, a "[B and D.3]" refers the reader to all of section "B" and section "D", part 3, in the following Section 3.3.6, "Major Assumptions of LTOP Analysis" for the respective source(s) of the item.

b. Pressurizer level is maintained within the following limits:

1. RCS pressure is > 100 psig:

$\leq$ 220 inches when RCS temperature $\leq$ 325 °F [D.2, D.3, E, F.1, and G]

2. RCS pressure is $\leq$ 100 psig[2]:

$\leq$ 310 inches when RCS temperature $\leq$ 220 °F [D.1 and F.2]

$\leq$ 380 inches while filling or draining the RCS when RCS temperature $\leq$ 160 °F and no HPI pumps are running [F.3]

c. Makeup flow is restricted with the HP-120 (makeup control valve) travel stop set to $\leq$ 98.0 gpm for all three units. [D]

d. High pressure nitrogen system is administratively controlled to prevent inadvertent pressurization of the RCS. [C]

e. Three audible pressurizer level alarms at $\leq$ 225 inches, $\leq$ 260 inches, and $\leq$ 315 inches from the temperature compensated pressurizer level indication. [D, E, and F]

f. Two audible RCS pressure alarms at 375 psig and 525 psig. [D and F]

g. The Core Flood Tanks must be deactivated. [B]

h. The HPI safety injection flowpaths must be deactivated. [A]

j. Pressurizer heater bank 3 or 4 must be deactivated. [E]

These proposed administrative controls are based on the assumptions used in the LTOP analyses. A description of the major assumptions used in each LTOP analysis is provided below.

---

[2] When the RCS pressure is $\leq$ 100 psig, pressurizer level is normally maintained $\leq$ 220 inches except for certain RCS evolutions. The specified pressurizer level limits provide assurance at least 10 minutes is available for operator action during those evolutions. The temperature limits are based on operational limits for the evolutions and are used in the analyses to determine allowable pressurizer levels.

3.3.6 Major Assumptions of LTOP Analysis

A. Erroneous actuation of the High Pressure Injection System

The current Oconee TSs require that both trains of the High Pressure Injection System be deactivated during LTOP conditions. This may be accomplished by deactivating the safety injection flowpaths or the HPI pumps. If a safety injection flowpath is deactivated, the associated HPI pump may still be used for normal makeup to the RCS via the charging flowpath. No change to this requirement is proposed for the new P-T limits. Therefore, a LTOP analysis is not performed for this event since it is not considered a credible LTOP initiator.

B. Erroneous opening of the core flood tank discharge valve

The current Oconee TSs require that both core flood tanks be deactivated during LTOP conditions. No change to this requirement is proposed for the new P-T limits. Therefore, a LTOP analysis is not performed for this event since it is not considered a credible LTOP initiator.

C. Erroneous addition of nitrogen to the pressurizer

The high pressure nitrogen system is currently administratively controlled to prevent inadvertent pressurization of the RCS. No change to this administrative control is proposed for the new P-T limits. Therefore, a LTOP analysis is not performed for this event since it is not considered a credible LTOP initiator.

D. Makeup control valve failing full open

The maximum makeup flow rate is limited for this event to ensure that 10 minutes are available for operator action. A mechanical device is used to limit how far the makeup control valve can stroke open. The maximum allowed makeup flowrate has been re-evaluated for the new P-T limits.

The LTOP temperature range is divided into three regions for evaluating this event. The highest allowable makeup flow rate is determined for each region. The most limiting flow rate is then used to set the makeup flow restriction. The three regions evaluated and the major assumptions made in this analysis are discussed below.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

D.1 Region 1: RCS Pressure $\leq$ 100 psig and RCS Temperature $\leq$ 220 °F

The acceptance criterion for this region is that 10 minutes will be available for operator action from the time of the first alarm to the time when RCS pressure exceeds 535 psig. This setpoint accounts for instrument uncertainty. Either a steam bubble or a nitrogen bubble may be present in the RCS during this region of operation. The following initial conditions and boundary conditions are assumed for evaluating this region of operation:

a. The initial RCS pressure is 100 psig when steam is present in the pressurizer. This is the maximum pressure allowed per the proposed LTOP restrictions for this region of operation. The initial RCS pressure is 50 psig when nitrogen is present in the pressurizer. This bounds the guidance provided in procedures which requires RCS pressure to be maintained less than 45 psig when nitrogen is present in the RCS.

b. Different initial pressurizer levels ranging between 100 inches and 330 inches (this range includes a +20 inch uncertainty) are evaluated to determine the limiting initial condition. This is the range of levels permitted per the proposed LTOP restrictions for this region of operation.

c. No heat transfer occurs between the injected water and the RCS inventory. The makeup insurge flow is set to the same temperature as the initial RCS temperature. The maximum allowable flow rate is corrected to account for the differences in density that result from this assumption. The correction preserves the mass insurge rate.

d. The pressurizer PORV is assumed to be inoperable.

e. Uncertainty associated with the flow measurement instrumentation is included in the maximum allowed flowrate shown in the proposed LTOP restrictions.

f. The makeup flow rates do not vary with RCS pressure. This is conservative since the flow rate would decrease as RCS pressure increases.

g. The 535 psig P-T limit assumed in this analysis bounds the coldest allowable RCS temperature on the P-T curve (60°F).

There are three assumptions in this analysis that are different from those assumed in the analyses supporting the current LTOP restrictions. The first is that the RCS pressure limit used for the new analysis is 535 psig, whereas the current analysis assumed 460 psig. The second is that the RCS temperature range of 60°F to 220°F was evaluated whereas the current analysis assumed a temperature range of 150°F to 220°F. The third is that the initial RCS pressure is assumed to be 50 psig when nitrogen gas is present in the RCS. Only a steam bubble was evaluated in previous analyses.

During RCS filling and venting activities, nitrogen gas can be present in the RCS. Specific cases have now been analyzed to evaluate this potential operating condition. The LTOP limits and restrictions developed for the 33 EFPY P-T limits now account for the presence of nitrogen in the RCS during LTOP conditions. The 26 EFPY P-T limits currently in place have been reevaluated and appropriately adjusted to account for the presence of nitrogen. The RELAP5/MOD3.2DUKE computer code is utilized to perform the dynamic simulation of this transient involving nitrogen in the pressurizer steam space. RELAP5 is used due to its capacity to model nitrogen-steam-liquid water systems in a non-homogeneous, non-equilibrium fashion. A simplified model, consisting of a multi-node pressurizer, pressurizer surge line, a portion of a hot leg, and a lumped volume representing the remainder of the RCS, is utilized for this analysis. Due to the previous commitment to neglect steam condensation on the pressurizer walls, the only heat structures included in this model are those representing the pressurizer heaters. It should be noted that interfacial heat transfer between the pressurizer water and steam, previously neglected, is included in calculations using RELAP5.

D.2 Region 2: RCS Pressure > 100 psig and ≤ 375 psig when RCS Temperature ≤ 220 °F

The acceptance criterion for this region is that 10 minutes will be available for operator action from the time of the first alarm to the time when RCS pressure exceeds 535 psig. The following initial conditions and boundary conditions are assumed for evaluating this region of operation:

ATTACHMENT 3

TECHNICAL JUSTIFICATION

a. Initial RCS pressures as high as 375 psig (corresponding to the proposed maximum RCS pressure for this range of RCS temperatures) are evaluated.

b. An initial pressurizer level of 240 inches is assumed which includes a +20 inch instrument uncertainty. This corresponds to the proposed maximum pressurizer level of 220 inches when RCS pressure is > 100 psig.

c. No heat transfer occurs between the injected water and the RCS inventory. The makeup insurge flow is set to the same temperature as the initial RCS temperature. The maximum allowable flow rate is corrected to account for the differences in density that result from this assumption. The correction preserves the mass insurge rate.

d. The pressurizer PORV is assumed to be inoperable.

e. Uncertainty associated with the flow measurement instrumentation is included in the maximum allowed flowrate.

f. The makeup flow rates do not vary with RCS pressure. This is conservative since the flow rate would decrease as RCS pressure increases.

g. The 535 psig P-T limit assumed in this analysis bounds the coldest allowable RCS temperature on the P-T curve (60 °F).

There are two assumptions in this analysis that are different from those assumed in the analyses supporting the current LTOP restrictions. The first is that RCS pressure must be < 375 psig in this region of operation, whereas the current LTOP restrictions allow RCS pressure to be < 330 psig. The second different assumption is that the RCS pressure limit used for the new analysis is 535 psig, whereas the current analysis assumed 460 psig.

D.3 Region 3: RCS Pressure ≤ 525 psig and RCS Temperature ≥ 220 °F but ≤ 325 °F

The acceptance criterion for this region is that 10 minutes will be available for operator action from the time of the first alarm to the time when RCS pressure exceeds 1050 psig. This setpoint is the P-T limit associated with a 220 °F RCS temperature including instrument uncertainty. The following initial conditions and boundary conditions are assumed for evaluating this region of operation:

ATTACHMENT 3

TECHNICAL JUSTIFICATION

a. An initial RCS pressure of 525 psig is assumed. This pressure corresponds to the proposed maximum RCS pressure for this range of RCS temperatures.

b. An initial pressurizer level of 240 inches is assumed which includes a +20 inch instrument uncertainty. This corresponds to the proposed maximum pressurizer level of 220 inches when RCS pressure is > 100 psig.

c. No heat transfer occurs between the injected water and the RCS inventory. The makeup insurge flow is set to the same temperature as the initial RCS temperature. The maximum allowable flow rate is corrected to account for the differences in density that result from this assumption. The correction preserves the mass insurge rate.

d. The pressurizer PORV is assumed to be inoperable.

e. Uncertainty associated with the flow measurement instrumentation is included in the maximum allowed flowrate.

f. The makeup flow rates do not vary with RCS pressure. This is conservative since the flow rate would decrease as RCS pressure increases.

g. The 1050 psig P-T limit assumed in this analysis corresponds to a 220 °F RCS temperature on the P-T curve after instrument uncertainty is included.

There are two assumptions in this analysis different from those assumed in the analyses supporting the current LTOP restrictions. The first is RCS pressure must be < 525 psig in this region of operation, whereas the current LTOP restrictions allow RCS pressure to be < 430 psig. The second different assumption is that the RCS pressure limit used for the new analysis is 1050 psig, whereas the current analysis assumed 601 psig.

E. Pressurizer heaters erroneously energized

The acceptance criterion for this region is that 10 minutes will be available for operator action from the time of the first alarm to the time that RCS pressure exceeds 535 psig. This setpoint accounts for instrument uncertainty. Either a steam bubble or a nitrogen bubble may be present in the RCS during this region of operation. The following initial conditions and boundary conditions are assumed for evaluating this scenerio:

a. A range of initial RCS pressures allowed during LTOP conditions are evaluated to determine the limiting initial condition when steam is present in the pressurizer. The initial RCS pressure is 50 psig when nitrogen is present in the pressurizer. This bounds the guidance provided in procedures which requires RCS pressure to be maintained less than 45 psig when nitrogen is present in the RCS.

b. An initial pressurizer level of 80 inches is assumed which includes a 20 inch instrument uncertainty. This corresponds to a minimum pressurizer level of 100 inches. Previous analyses have shown that a low initial pressurizer level results in a more rapid pressurization rate for this event. Procedural guidance requires operators to maintain a pressurizer level of at least 100 inches to ensure that the heaters remain covered.

c. Pressurizer heater Banks 1, 2, and either 3 or 4 are assumed to be simultaneously energized at the beginning of this event. The LTOP restrictions require that either Bank 3 or 4 be deactivated prior to entering LTOP conditions. The rated power of Banks 3 and 4 are identical, thus the total heat input will be the same when either is assumed to be operable and available during this transient.

d. The pressurizer PORV is assumed to be inoperable.

e. The 535 psig P/T limit assumed in this analysis bounds the coldest RCS temperature on the P/T curve (60°F).

There are two assumptions in this analysis that are different from those assumed in the analyses supporting the current LTOP restrictions. The RCS pressure limit used for the new analysis is 535 psig, whereas the current analysis assumed 460 psig. The second is that the initial RCS pressure is assumed to be 50 psig when nitrogen gas is present in the RCS. Only a steam bubble was evaluated in previous analyses.

During RCS filling and venting activities, nitrogen gas can be present in the RCS. Specific cases have now been analyzed to evaluate this potential operating condition. The LTOP limits and restrictions developed for the 33 EFPY

P-T limits now account for the presence of nitrogen in the RCS during LTOP conditions. The 26 EFPY P-T limits currently in place have been reevaluated and appropriately adjusted to account for the presence of nitrogen. As previously stated, the RELAP5/MOD3.2DUKE computer code is utilized to perform the dynamic simulation of this transient involving nitrogen in the pressurizer steam space. RELAP5 is used due to its capacity to model nitrogen-steam-liquid water systems in a non-homogeneous, non-equilibrium fashion. A simplified model, consisting of a multi-node pressurizer, pressurizer surge line, a portion of a hot leg, and a lumped volume representing the remainder of the RCS, is utilized for this analysis. Due to the previous commitment to neglect steam condensation on the pressurizer walls, the only heat structures included in this model are those representing the pressurizer heaters. It should be noted that interfacial heat transfer between the pressurizer water and steam, previously neglected, is included in calculations using RELAP5.

F. Loss of the Decay Heat Removal System

The LTOP analyses evaluate three loss of decay heat removal events. The first case evaluates the scenario where a rapid cooldown to decay heat removal system conditions has been performed and the decay heat removal system is placed into service. End-of-cycle decay heat is assumed along with the maximum number of running RCPs such that the RCS heat load is maximized. A loss of decay heat removal is then simulated to verify that 10 minutes are available for operator action from the time of the first alarm to the time at which the P-T limit is exceeded. This case is referred to as Case 1 in this discussion.

The second case evaluates the scenario where a pressurizer cooldown is in progress when this event occurs. During these activities the LTOP restrictions allow pressurizer level to be as high as 310 inches with an HPI pump in operation provided RCS pressure is $\leq$ 100 psig. A loss of the decay heat removal system is simulated from this initial condition to verify that 10 minutes are available for operator action from the time of the first alarm to the time at which the P-T limit is exceeded. This case is referred to as Case 2 in this discussion.

The third case evaluates the scenario where RCS fill/drain activities are in progress when this event occurs. During these activities the LTOP restrictions allow pressurizer level to be as high as 380 inches, provided no HPI pumps are running and RCS pressure is $\leq$ 100 psig. A loss of the decay heat removal system is simulated from this initial condition to verify that 10 minutes are available for operator action from the time of the first alarm to the time at which the P-T limit is exceeded. This case is referred to as Case 3 in this discussion.

The major assumptions used in the three cases are discussed below.

F.1 Case 1 - Loss of Decay Heat Removal With Concurrent RCP Operation

The following initial conditions and boundary conditions are assumed for this case:

a. A range of initial RCS pressures allowed by the LTOP restrictions for this region of operation are evaluated to determine the limiting initial condition.

b. An initial pressurizer level of 240 inches is assumed which includes a +20 inch instrument uncertainty. This is the maximum level allowed by the LTOP restrictions for this region of operation.

c. The pressurizer PORV is assumed to be inoperable.

d. End-of-cycle decay heat is assumed which maximizes heat load to the RCS.

e. Two RCPs in one loop are in operation. This is the maximum number of RCPs allowed per Technical Specifications for this region of operation.

f. The secondary side of the steam generators are not modeled.

g. The 535 psig P-T limit assumed in this analysis bounds the coldest RCS temperature on the P-T curve (60 °F).

There are three assumptions in this analysis that are different from those assumed in the analyses supporting the current LTOP restrictions. The first is that the RCS pressure must be < 375 psig in this region of operation, whereas the current LTOP restrictions allow RCS pressure to be < 330 psig. The second different assumption is that the RCS pressure limit used for the new analysis is 535 psig, whereas the current analysis assumed 460 psig. The third different assumption is that the two RCPs in operation are assumed to be in the same loop, whereas the current analysis assumed one RCP per loop.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

F.2 Case 2 - Loss of Decay Heat Removal with RCS pressure $\leq$ 100 psig and HPI makeup available

The following initial conditions and boundary conditions are assumed for this case:

a. An initial RCS pressure of 100 psig is assumed. This is the maximum pressure allowed per the proposed LTOP restrictions for this region of operation.

b. An initial pressurizer level of 330 inches is assumed which includes a +20 inch instrument uncertainty. This is the maximum level allowed by the proposed LTOP restrictions for this region of operation.

c. The pressurizer PORV is assumed to be inoperable.

d. End-of-cycle decay heat is assumed to maximize the heat load in the RCS.

e. No RCPs are in operation since the RCS pressure is below that required for NPSH.

f. The secondary side of the steam generators are not modeled.

g. The 535 psig P-T limit assumed in this analysis bounds the coldest allowable RCS temperature on the P-T curve (60 °F).

There is only one assumption in the new analysis that is different from the current analysis. The new analysis assumes the RCS pressure limit is 535 psig, whereas the current analysis assumed 460 psig.

F.3 Case 3 - Loss of Decay Heat Removal with RCS pressure $\leq$ 100 psig and no HPI pumps

The following initial conditions and boundary conditions are assumed for this case:

a. An initial RCS pressure of 100 psig is assumed. This is the maximum pressure allowed per the proposed LTOP restrictions for this region of operation.

b. An initial pressurizer level of 240 inches is assumed which includes a +20 inch instrument uncertainty. An indicated pressurizer level of 380 inches is expected to be seen for short periods of time during filling and draining of the RCS, but only coincident with coexisting gas volumes in the upper region of the hot legs. A water filled RCS with the pressurizer at a 240 inch level bounds the scenerio where the pressurizer level is at 380 inches with gas volumes in the upper region of the hot legs.

c. The pressurizer PORV is assumed to be inoperable.

d. End-of-cycle decay heat is assumed to maximize the heat load in the RCS.

e. No RCPs are in operation since the RCS pressure is below that required for NPSH.

f. The secondary side of the steam generators are not modeled.

g. The 535 psig P-T limit assumed in this analysis bounds the coldest allowable RCS temperature on the P-T curve (60 °F).

There is only one assumption in the new analysis that is different from the current analysis. The new analysis assumes the RCS pressure limit is 535 psig, whereas the current analysis assumed 460 psig.

In previous LTOP analyses, only a steam bubble in the pressurizer was modeled. During RCS filling and venting activities, nitrogen gas can be present in the RCS. Due to the large margin seen during the steam bubble evaluation (operator action time in excess of 20 minutes), this scenerio is not analyzed with nitrogen gas present in the RCS. It can be inferred that 10 minutes would be available for operators to mitigate this event with nitrogen gas present.

G. Reactor Coolant Pump Start-Induced Transients

Two types of RCP induced LTOP transients are evaluated in Reference 12. The first transient is filling of the OTSG secondary side with hot water followed by starting of an RCP. The second transient is the restart of an RCP during heatup following a period of stagnant (no flow) conditions. The results discussed in Reference 12 showed a peak RCS pressure increase of ~130 psi for the first transient, and a peak RCS pressure increase of ~75 psi for the second transient. The initial conditions and assumptions assumed in Reference 12 were evaluated with regard to the current LTOP restrictions to ensure that they remained bounding.

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

This is done again with the new proposed LTOP restrictions. The initial conditions for the first transient were:

1. RCS pressure = 300 psig
2. RCS temperature = 140 °F
3. Initial pressurizer level = 315 inches
4. Steam generator temperature = 420 °F

All but one of these conditions (RCS pressure) is bounding relative to the new proposed restrictions and plant operating procedures. The new P-T limits are most restrictive at RCS temperatures ≤ 220 °F. The new maximum allowable operating pressure at these temperatures is 375 psig, which is somewhat higher than that assumed in the referenced analysis. The change in thermodynamic properties between 300 psig and 375 psig is negligible, thus the same magnitude of RCS pressurization (130 psig) would be expected from either initial condition during this transient. This would result in a peak RCS pressure of 375 + 130 = 505 psig which is within the new P-T limits. The pressurizer level is now also limited to 220 inches for RCS temperatures ≤ 220 °F, which is considerably lower than the 315 inches assumed in the referenced analysis.

The second RCP start-induced transient involves the circulation of a very cool mass of water through a heated RCS upon the start of an idle RCP. The RCS initial conditions assumed in the analyses described in the above letter were 450 psig and 275 °F. The resulting pressure increase was seen to be self-limiting, with a peak pressure increase of ~75 psi. Per the new operational limits and restrictions, the maximum allowable operating pressure for RCS temperatures between 220 °F and 325 °F is 525 psig. This would result in a maximum RCS pressure of 600 psig for this event, which does not exceed the new P-T limits (1050 psig with instrument uncertainty included) for this temperature range. For RCS temperatures below 220 °F, a smaller RCS pressurization will be seen due to the smaller change in temperature between the hot RCS inventory and the cooler mass. The new LTOP restrictions allow RCS pressure to be 375 psig for RCS temperatures ≤ 220 °F. Conservatively assuming a 75 psi increase for this case results in a peak RCS pressure of 450 psig, which is well below the P-T limit of 535 psig for this temperature range.

There are two assumptions in this analysis that are different from those assumed in the analyses supporting the current LTOP restrictions. The first is that RCS pressure must be < 375 psig when RCS temperature is ≤ 220 °F, and < 525 psig when RCS temperature is > 220 °F and ≤ 325 °F.

ATTACHMENT 3

TECHNICAL JUSTIFICATION

The current LTOP restrictions allow RCS pressure to be < 330 psig and 430 psig, respectively for the corresponding temperature ranges. The second different assumption is that the RCS pressure limit of 1050 psig is used for the new analysis, whereas the current analysis assumed a RCS pressure limit of 601 psig. This reflects the new P-T limit at a RCS temperature of 220 °F.

3.4 Justification for ASME Code Case N-514 Exemption Request

The following information provides the basis for the exemption request to 10 CFR 50.60 for use of ASME Section XI Code Case N-514, "Low Temperature Overpressure Protection Section XI, Division 1," in lieu of 10 CFR 50, Appendix G.

<u>10 CFR 50.12 Requirements</u>: The requested exemption to allow use of ASME Code Case N-514 to determine the LTOP enable temperature meets the criteria of 10 CFR 50.12 as addressed below. 10 CFR 50.12 states that the Commission may grant an exemption from requirements contained in 10 CFR 50 provided that:

1. <u>The requested exemption is authorized by law</u>: No law exists which precludes the activities covered by this exemption request. 10 CFR 50.60(b) allows the use of alternatives to 10 CFR 50, Appendices G and H when an exemption is granted by the Commission under 10 CFR 50.12.

2. <u>The requested exemption does not present an undue risk to the public health and safety</u>: A revised LTOP relief valve enable point is being proposed, as described in Section 3.2 above, for Oconee Units 1, 2, and 3. The enable temperature has been developed to provide bounding reactor vessel low temperature integrity protection during the LTOP design basis transients. The LTOP setpoint will utilize 100% of the pressure determined to satisfy Appendix G, paragraph G-2215 of ASME Section XI, Division 1, as a design limit. The approach is justified by consideration of the overpressurization design basis events and the resulting margin to reactor vessel failure.

   Restrictions on allowable operating conditions and equipment operability requirements have been established to ensure that operating conditions are consistent with the assumptions of the accident analysis. Specifically, RCS pressure and temperature values must be maintained within the heatup and cooldown rate dependent pressure-temperature limits specified in TS 3.4.3. Therefore, this exemption does not present an undue risk to the public health and safety.

3. The requested exemption will not endanger the common defense and security: The common defense and security are not endangered by this exemption request.

4. Special circumstances are present which necessitate the request for an exemption to the regulations of 10 CFR 50.60: Pursuant to 10 CFR 50.12(a)(2), the NRC will consider granting an exemption to the regulations if special circumstances are present. This exemption meets the special circumstances of paragraphs:

(a)(2)(ii) - demonstrates that the underlying purpose of the regulation will continue to be achieved;
(a)(2)(iii) - would result in undue hardship or other cost that are significant if the regulation is enforced and;
(a)(2)(v) - will provide only temporary relief from the applicable regulation and the licensee has made good faith efforts to comply with the regulations.

10 CFR 50.12(a)(2)(ii): ASME Code Case N-514 recognizes the conservatism of the ASME XI, Appendix G curves and allows setting the LTOP setpoint such that the ASME Section XI, Appendix G limits are not exceeded. Since Code Case N-514 is used in conjunction with Code Case N-626, 100% of the ASME XI, Appendix G limits is allowed. The code case permits use of a LTOP enable temperature equal to an [adjusted] $RT_{NDT}$ + 50 °F or 200 °F, whichever is greater for the limiting material. This allows for implementation of a LTOP setpoint that preserves an acceptable margin of safety while maintaining operational margins for reactor coolant pump operation at low temperatures and pressures. The LTOP setpoint established in accordance with ASME Code Case N-514 will also minimize the unnecessary actuation of protection system pressure relieving devices. Therefore, establishing the LTOP setpoint in accordance with ASME Code Case N-514 criteria satisfies the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable level of safety.

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

10 CFR 50.12(a)(2)(iii): The Reactor Coolant System pressure-temperature operating window at low temperatures is defined by the LTOP setpoint. Implementation of a LTOP setpoint without the additional margin allowed by ASME Code Case N-514 would unnecessarily restrict the pressure-temperature operating window. Removal of the restriction would eliminate continued RCP impeller cavitation wear while operating in the LTOP region and would reduce the potential for undesired actuation of the LTOP System. This constitutes an unnecessary burden that can be alleviated by the application of Code Case N-514. Implementation of a LTOP setpoint as allowed by ASME Code Case N-514 does not significantly reduce the margin of safety associated with normal operational heatup and cooldown limits.

10 CFR 50.12(a)(2)(v): The exemption provides only temporary relief from the applicable regulation and ONS has made a good faith effort to comply with the regulation. We request that the exemption be granted until such time that the NRC generically approves ASME Code Case N-514 for use by the nuclear industry. However, to retain sufficient pressure-temperature operating margin to the end of the proposed Oconee Units 1, 2 and 3 Technical Specification pressure-temperature limits, we require an exemption to use Code Case N-514.

Code Case N-514, Conclusion for Exemption Acceptability: Compliance with the specified requirements of 10 CFR 50.60 would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. ASME Code Case N-514 allows setting the LTOP actuation setpoint and enable temperature such that the ASME Section XI, Appendix G, limits are not exceeded by more than 10%. This proposed alternative is acceptable because the Code Case recognizes the conservatism of the ASME Appendix G curves and allows establishing a LTOP setpoint which retains an acceptable margin of safety while maintaining operational margins for reactor coolant pump operation at low temperatures and pressures. As discussed above, the Code Case provides an acceptable margin of safety to prevent reactor vessel failure, and reduces the potential for an undesired LTOP actuation. Therefore, application of Code Case N-514 for ONS will ensure an acceptable level of safety.

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

3.5 Justification for ASME Code Case N-588 Exemption Request

The following information provides the basis for the exemption request to 10 CFR 50.60 for use of ASME Section XI Code Case N-588, "Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels, Section XI, Division 1", in lieu of the 10 CFR 50, Appendix G.

<u>10 CFR 50.12 Requirements</u>: The requested exemption to allow use of ASME Code Case N-588 to determine stress intensity factors for postulated defects in maximum postulated defects for circumferential welds meets the criteria of 10 CFR 50.12 as addressed below. 10 CFR 50.12 states that the Commission may grant an exemption from requirements contained in 10 CFR 50 provided that:

1. <u>The requested exemption is authorized by law</u>: No law exists which precludes the activities covered by this exemption request. 10 CFR 50.60(b) allows the use of alternatives to 10 CFR 50, Appendices G and H when an exemption is granted by the Commission under 10 CFR 50.12.

2. <u>The requested exemption does not present an undue risk to the public health and safety</u>: 10 CFR 50, Appendix G, requires, in part, that Article G-2120 of ASME XI, Appendix G, be used to determine the maximum postulated defects in reactor pressure vessels (RPV) when determining pressure-temperature limits for the vessel. These limits are determined for normal operation and pressure test conditions. Article G-2120 specifies, in part, that the postulated defect be in the surface of the vessel material and normal (perpendicular in the plane of the material) to the direction of maximum stress. ASME XI, Appendix G, also provides methodology to determine the stress intensity factors for a maximum postulated defect normal to the maximum stress. The purpose of this article is, in part, to prevent nonductile fractures by providing procedures to identify the most limiting postulated fractures to be considered in the development of pressure-temperature limits.

   Due to progress made in NDE techniques over the last thirty years, it is very unlikely to have large, undetected defects present in the beltline region of reactor vessels. It is further unlikely to have axial cracks originating from a circumferential weld perpendicular to the weld seam orientation in reactor vessels. Both experience and engineering studies indicate that the primary degradation mechanism affecting the beltline region of the reactor vessel is neutron embrittlement. No other service induced degradation mechanism exists at a pressurized water reactor to cause a prior existing defect located in the beltline region of the reactor vessel to grow while inservice. Based on these considerations, and the fact that the pressure-temperature (P-T) limit for reactor operation is the limiting pressure for any of the materials in the vessel, it is not necessary to include additional conservatism in the assumed flaw orientation for circumferential welds. ASME Section XI, Code Case N-588, and the accompanying Appendix G Code change corrected this inconsistency in assumed flaw orientation for circumferential welds in vessels when calculating operating P-T limits.

Code Case N-588 provides benefits in terms of calculating P-T limits by revising the Section XI, Appendix G reference flaw orientation for circumferential welds in reactor vessels. The reference flaw is a postulated flaw that accounts for the possibility of a prior existing defect that may have gone undetected during the fabrication process. When considering a reference flaw with respect to a weld, the reference flaw would represent any prior existing defect that may have been introduced during fabrication. Thus, the intended application of a reference flaw is to account for prior existing defects that could physically exist within the geometry of the weldment. The current ASME Section XI, Appendix G approach mandates the consideration of an axial reference flaw in circumferential welds for purposes of calculating P-T limits. Postulating the Appendix G reference flaw in a circumferential weld is physically unrealistic and overly conservative, because the length of the flaw is 1.5 times the vessel thickness, which is much longer than the width of the reactor vessel girth weld. The possibility that an axial flaw may extend from a circumferential weld into a plate/forging or axial weld is already adequately covered by the requirement that axial defects be postulated in plates/forging and axial welds. The fabrication of reactor pressure vessels for nuclear power plant operation involved precise welding procedures and controls designed to optimize the resulting weld microstructure and to provide the required material properties. These procedural controls were also designed to minimize defects that could be introduced into the weld during the fabrication process. Industry experience with the repair of weld indications found during pre-service inspection, and data taken from destructive examination of actual vessel welds, confirms that any remaining defects are small, laminar in nature, and do not cross transverse to the weld bead orientation. Therefore, any potential defects introduced during the fabrication process, and not detected during subsequent nondestructive examinations, would only be expected to be oriented in the direction of weld fabrication. For circumferential welds this indicates a postulated defect with a circumferential orientation.

ASME Code Case N-588 addresses this issue by allowing consideration of maximum postulated defects oriented circumferentially with circumferential welds. Code Case N-588 also provides appropriate procedures to determine limiting circumferential weld defects and associated stress intensity factors for use in developing RPV P-T limits per ASME XI, Appendix G procedures. The procedures allowed by Code Case N-588 are conservative and provide a margin of safety in the development of RPV pressure-temperature operating and pressure test limits which will prevent nonductile fractures.

The proposed P-T limits include restrictions on allowable operating conditions and equipment operability requirements to ensure that operating conditions are consistent with the assumptions of the accident analysis. Specifically, RCS pressure and temperature must be maintained within the heatup and cooldown rate dependent pressure-temperature limits specified in TS 3.4.3. Therefore, this exemption does not present an undue risk to the public health and safety.

3. <u>The requested exemption will not endanger the common defense and security</u>: The common defense and security are not endangered by this exemption request.

4. <u>Special circumstances are present which necessitate the request for an exemption to the regulations of 10 CFR 50.60</u>: Pursuant to 10 CFR 50.12(a)(2), the NRC will consider granting an exemption to the regulations if special circumstances are present. This exemption meets the special circumstances of paragraphs:

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

(a)(2)(ii) - demonstrates that the underlying purpose of the regulation will continue to be achieved;
(a)(2)(iii) - would result in undue hardship or other cost that are significant if the regulation is enforced and;
(a)(2)(v) - will provide only temporary relief from the applicable regulation and the licensee has made good faith efforts to comply with the regulations.

<u>10 CFR 50.12(a)(2)(ii)</u>: The underlying purpose of 10 CFR 50, Appendix G and ASME XI, Appendix G, is to satisfy the requirement that: 1) The reactor coolant pressure boundary be operated in a regime having sufficient margin to ensure that when stressed the vessel boundary behaves in a non-brittle manner and the probability of a rapidly propagating fracture is minimized; And 2) P-T operating and test curves provide margin in consideration of uncertainties in determining the effects of irradiation on material properties.

Application of Code Case N-588 to determine P-T operating and test limit curves per ASME XI, Appendix G, provides appropriate procedures to determine limiting maximum postulated defects and considering those defects in the P-T limits. This application of the code case maintains the margin of safety originally contemplated for plates/forgings and axial welds.

Therefore, use of Code Case N-588, as described above, satisfies the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable level of safety.

<u>10 CFR 50.12(a)(2)(iii)</u>: The Reactor Coolant System pressure-temperature operating window is defined by the P-T operating and test curves developed in accordance with the ASME XI, Appendix G procedure. Continued operation with these P-T curves without the relief provided by ASME Code Case N-588 would unnecessarily restrict the pressure-temperature operating window for Oconee Units 1, 2, and 3. This restriction requires that under certain low temperature conditions that only one reactor coolant pump in a reactor coolant loop be operated. The effect of this restriction is undesirable degradation of reactor coolant pump impellers due to cavitation with either one pump or one pump in each loop in operation. Further, the proposed LTOP guidelines will reduce the potential for an undesired challenge to the reactor coolant system power operated relief valve.

## TECHNICAL JUSTIFICATION

This constitutes an unnecessary burden that can be alleviated by the application of Code Case N-588 in the development the proposed P-T curves. Implementation of the proposed P-T curves as allowed by ASME Code Case N-588 does not reduce the margin of safety originally contemplated by either the NRC or ASME.

10 CFR 50.12(a)(2)(v): The exemption provides only temporary relief from the applicable regulation and ONS has made a good faith effort to comply with the regulation. We request that the exemption be granted until such time that the NRC generically approves ASME Code Case N-588 for use by the nuclear industry. However, to retain sufficient pressure-temperature operating margin to the end of the proposed Oconee Units 1, 2 and 3 Technical Specification pressure-temperature limits, we require an exemption to use Code Case N-588.

Code Case N-588, Conclusion for Exemption Acceptability: Compliance with the specified requirements of 10 CFR 50.60 would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. ASME Code Case N-588 allows postulation of a circumferential defect in circumferential welds to be considered in lieu of requiring the defect to be oriented across the weld from one plate or forging to the adjoining plate or forging. This circumstance was not considered at the time ASME XI, Appendix G was developed and imposes restrictions on P-T operating limits beyond those originally contemplated.

This proposed alternative is acceptable because the Code Case maintains the relative margin of safety commensurate with that which existed at the time ASME XI, Appendix G, was approved in 1974. Therefore, application of Code Case N-588 for ONS will ensure an acceptable margin of safety. The approach is justified by consideration of the overpressurization design basis events and the resulting margin to reactor vessel failure.

Restrictions on allowable operating conditions and equipment operability requirements have been established to ensure that operating conditions are consistent with the assumptions of the accident analysis. Specifically, RCS pressure and temperature must be maintained within the heatup and cooldown rate dependent pressure-temperature limits specified in TS 3.4.3. Therefore, this exemption does not present an undue risk to the public health and safety.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

3.6 Justification for ASME Code Case N-626 Exemption Request

The following information provides the basis for the exemption request to 10 CFR 50.60 for use of ASME Section XI Code Case N-626, "Alternative Fracture Toughness for Development of P-T Limit Curves for ASME Section XI, Division I," in lieu of 10 CFR 50, Appendix G.

10 CFR 50.12 Requirements: The requested exemption to allow use of ASME Code Case N-626 in conjunction with ASME XI, Appendix G to determine the pressure-temperature limits meets the criteria of 10 CFR 50.12 as discussed below. 10 CFR 50.12 states that the Commission may grant an exemption from requirements contained in 10 CFR 50 provided that:

1. The requested exemption is authorized by law: No law exists which precludes the activities covered by this exemption request. 10 CFR 50.60(b) allows the use of alternatives to 10 CFR 50, Appendices G and H when an exemption is granted by the Commission under 10 CFR 50.12.

2. The requested exemption does not present an undue risk to the public health and safety: The revised pressure-temperature (P-T) limits being proposed for Oconee Units 1, 2 and 3, rely in part, on the requested exemption. These revised P-T limits have been developed using the $K_{1c}$ fracture toughness curve shown on ASME XI, Appendix A, Figure A-2200-1, in lieu of the $K_{1a}$ fracture toughness curve of ASME XI, Appendix G, Figure G-2210-1, as the lower bound for fracture toughness. The other margins involved with the ASME XI, Appendix G process of determining P-T limit curves remain unchanged.

   Use of the $K_{1c}$ curve in determining the lower bound fracture toughness in the development of P-T operating limits curve is more technically correct than the $K_{1a}$ curve. The $K_{1c}$ curve models the slow heat-up and cooldown process of a reactor vessel.

   Use of this approach is justified by the initial conservatism of the $K_{1a}$ curve when the curve was codified in 1974. This initial conservatism was necessary due to limited knowledge of reactor pressure vessel materials over time and usage. Since 1974, additional knowledge has been gained about the affect of usage on reactor pressure vessel materials. The additional knowledge demonstrates the lower bound on fracture toughness provided by the $K_{1a}$ curve is well beyond the margin of safety required to protect the public health and safety from potential reactor pressure vessel failure.

P-T curves based on the $K_{1c}$ curves will enhance overall plant safety by opening the pressure-temperature operating window with the greatest safety benefit in the region of low temperature operations. The two primary safety benefits in opening the low temperature operating window is a reduction in the challenges to RCS power operated relief valves and elimination of RCP impeller wear cavitation wear.

3. <u>The requested exemption will not endanger the common defense and security</u>: The common defense and security are not endangered by this exemption request.

4. <u>Special circumstances are present which necessitate the request for an exemption to the regulations of 10 CFR 50.60</u>: Pursuant to 10 CFR 50.12(a)(2), the NRC will consider granting an exemption to the regulations if special circumstances are present. This exemption meets the special circumstances of paragraphs:

   (a)(2)(ii) - demonstrates the underlying purpose of the regulation will continue to be achieved;
   (a)(2)(iii) - would result in undue hardship or other cost that are significant if the regulation is enforced and;
   (a)(2)(v) - will provide only temporary relief from the applicable regulation and the licensee has made good faith efforts to comply with the regulations.

   <u>10 CFR 50.12(a)(2)(ii)</u>: ASME XI, Appendix G, provides procedures for determining allowable loading on the reactor pressure vessel and is approved for that purpose by 10 CFR 50, Appendix G. Application of these procedures in the determination of P-T operating and test curves satisfied the underlying requirement for: 1) The reactor coolant pressure boundary be operated in a regime having sufficient margin to ensure, when stressed, the vessel boundary behaves in a non-brittle manner and the probability of a rapidly propagating fracture is minimized; And 2) P-T operating and test limit curves provide adequate margin in consideration of uncertainties in determining the effects of irradiation on material properties.

## ATTACHMENT 3

## TECHNICAL JUSTIFICATION

The ASME XI, Appendix G, procedure was conservatively developed based on the level of knowledge existing in 1974 concerning reactor pressure vessel materials and the estimated effects of operation. Since 1974, the level of knowledge about these topics has been greatly expanded. This increased knowledge permits relaxation of the ASME XI, Appendix G, requirements via application of ASME Code Case N-626, while maintaining the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable margin of safety.

<u>10 CFR 50.12(a)(2)(iii)</u>: The Reactor Coolant System pressure-temperature operating window is defined by the P-T operating and test limit curves developed in accordance with the ASME XI, Appendix G procedure. Continued operation of Oconee with these P-T curves without the relief provided by ASME Code Case N-626 would unnecessarily restrict the pressure-temperature operating window. This restriction requires, under certain low temperature conditions, only one reactor coolant pump in a reactor coolant loop to be operated. The effect of this restriction is undesirable degradation of reactor coolant pump impellers due to cavitation sustained with either one pump or one pump in each loop in operation.

This constitutes an unnecessary burden that can be alleviated by the application of Code Case N-626 in the development of the proposed P-T curves. Implementation of the proposed P-T curves as allowed by ASME Code Case N-626 does not significantly reduce the margin of safety.

<u>10 CFR 50.12(a)(2)(v)</u>: The exemption provides only temporary relief from the applicable regulation and ONS has made a good faith effort to comply with the regulation. We request the exemption be granted until such time that the NRC generically approves ASME Code Case N-626 for use by the nuclear industry. However, to retain sufficient pressure-temperature operating margin to the end of the proposed Oconee Units 1, 2 and 3 Technical Specification pressure-temperature limits, we require an exemption to use Code Case N-626.

<u>Code Case N-626, Conclusion for Exemption Acceptability</u>: Compliance with the specified requirements of 10 CFR 50.60 would result in hardship and unusual difficulty without a compensating increase in the level of quality and safety. ASME Code Case N-626 allows a reduction in the fracture

toughness lower bound used by ASME XI, Appendix G, in the determination of reactor coolant pressure-temperature limits. This proposed alternative is acceptable because the Code Case maintains the relative margin of safety commensurate with that which existed at the time ASME XI, Appendix G, was approved in 1974. Therefore, application of Code Case N-626 for ONS will ensure an acceptable margin of safety. The approach is justified by consideration of the overpressurization design basis events and the resulting margin to reactor vessel failure.

Restrictions on allowable operating conditions and equipment operability requirements have been established to ensure operating conditions are consistent with the assumptions of the accident analysis. Specifically, RCS pressure and temperature must be maintained within the heatup and cooldown rate dependent pressure-temperature limits specified in TS 3.4.3. Therefore, this exemption does not present an undue risk to the public health and safety.

## 4.0 Affected UFSAR Sections

Section 5.2.3.7 of the Oconee UFSAR will be revised with the implementation of this TS amendment request to reflect the changes to the LTOP analysis described in this amendment application. This UFSAR revision will be made in accordance with 10 CFR 50.71(e).

## 5.0 References

1. ASME Code Case N-514, "Low Temperature Overpressure Protection, Section XI, Division 1," February 12, 1992.

2. ASME Code Case N-588, Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels, Section XI, Division 1, December 12, 1997.

3. ASME Code Case N-626, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for ASME Section XI, Division I," September 18, 1998.

4. BAW-1543A, Revision 2, "Integrated Reactor Vessel Material Surveillance Program," A. L. Lowe, Jr., et al., B&W Nuclear Division, May 1985.

5. BAW-1875, "The B&WOG Cavity Dosimetry Program," S. Q. King, August 1985.

6. BAW-2241P, "Fluence and Uncertainty Methodologies," J. R. Worsham, III, et al., B&WOG Materials Committee, April 1997.

7. FTI Document 32-1266230-00, "ONS-1 PT Fluence Analysis Results - Cycles 11-16," S. Q. King, January 1998.

8. FTI Document 86-1258198-01, "ONS-2 PT Fluence Analysis Results - Cycles 9-14," January 1998.

9. FTI Document 32-1266234-00, "ONS-3 PT Fluence Analysis Results - Cycles 12-15," S. Q. King, January 1998.

10. FTI Document 32-1171775-05, Verification of PTPC & Users Manual," J. W. Moore, III, March 1994.

11. BAW-10046A, Rev. 2, "Methods of Compliance with Fracture Toughness and Operational Requirements of 10 CFR 50, Appendix G," H. W. Behnke, et al., BWNT, Lynchburg, VA, June 1986.

12. Letter, William O. Parker, Jr. (Duke) to Benard C. Rusche (NRC), Oconee Nuclear Station Docket Nos. 50-269, -270, -287, dated October 14, 1976

6.0 Tables

1. Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 1 - Applicable Through 33 EFPY

2. Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 2 - Applicable Through 33 EFPY

3. Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 2 - Applicable Through 33 EFPY

**ATTACHMENT 3**

**TECHNICAL JUSTIFICATION**

7.0 Enclosures

1. B&W Document I.D. 77-5003340-00, "Pressure-Temperature Limits for 33 EFPY for Oconee Nuclear Station Units 1, 2, and 3," D. E. Killian, January 1999.

2. Code Case N-626, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for ASME Section XI, Division I," September 18, 1998, including:

   - Technical Bases for Revised P-T Limit Curve Methodology, (ASME Code Case N-626), August 6, 1998, and

   - ASME XI, Appendix G, draft changes to incorporate methodology of Code Case N-626, (ISI-98-04)

# Attachment 3 - Technical Justification

## Table 1

## Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 1 - Applicable Through 33 EFPY

| Material Description | | | | Chemical Composition | | | | 33 EFPY Fluence, n/cm² | | | $\Delta RT_{NDT}$, F at 33 EFPY | | Margin | | ART, F at 33 EFPY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reactor Vessel Beltline Region Location | Matl. Ident. | Heat Number | Type | Cu wt% | Ni wt% | Initial $RT_{NDT}$ | Chemistry Factor | Inside Surface | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location |
| Regulatory Guide 1.99, Revision 2, Position 1.1 | | | | | | | | | | | | | | | | |
| Lower Nozzle Belt Forging | AHR 54 | ZV-2861 | A 508 Cl. 2 | 0.16 | 0.65 | +3 | 119.3 | 8.06E+17 | 4.86E+17 | 1.76E+17 | 34.4 | 19.0 | 70.7 | 64.8 | 108.1 | 86.8 |
| Intermediate Shell Plate | C2197-2 | C2197-2 | SA-302 Gr. BM* | 0.15 | 0.50 | +1 | 104.5 | 8.60E+18 | 5.18E+18 | 1.88E+18 | 85.3 | 58.0 | 63.6 | 63.6 | 150.0 | 122.6 |
| Upper Shell Plate | C3265-1 | C3265-1 | SA-302 Gr. BM* | 0.10 | 0.50 | +1 | 65.0 | 9.56E+18 | 5.76E+18 | 2.09E+18 | 55.0 | 37.7 | 63.6 | 63.6 | 119.6 | 102.4 |
| Upper Shell Plate | C3278-1 | C3278-1 | SA-302 Gr. BM* | 0.12 | 0.60 | +1 | 83.0 | 8.56E+18 | 5.76E+18 | 2.09E+18 | 70.2 | 48.2 | 63.6 | 63.6 | 134.8 | 112.8 |
| Lower Shell Plate | C2800-1 | C2800-1 | SA-302 Gr. BM* | 0.11 | 0.63 | +1 | 74.5 | 9.54E+18 | 5.75E+18 | 2.09E+18 | 62.9 | 43.2 | 63.6 | 63.6 | 127.6 | 107.8 |
| Lower Shell Plate | C2800-2 | C2800-2 | SA-302 Gr. BM* | 0.11 | 0.63 | +1 | 74.5 | 9.54E+18 | 5.75E+18 | 2.09E+18 | 62.9 | 43.2 | 63.6 | 63.6 | 127.6 | 107.8 |
| LNB to IS Circ. Weld (100%) | SA-1135 | 61782 | ASA/Linde 80 | 0.23 | 0.52 | -5 | 157.4 | 8.06E+17 | 4.86E+17 | 1.76E+17 | 45.4 | 25.0 | 60.1 | 46.7 | 100.4 | 66.7 |
| IS Longit. Weld (Both 100%) | SA-1073 | 1P0962 | ASA/Linde 80 | 0.21 | 0.64 | -5 | 170.6 | 6.72E+18 | 4.05E+18 | 1.47E+18 | 127.8 | 85.0 | 68.5 | 68.5 | 191.3 | 148.5 |
| IS to US Circ. Weld (ID 61%) | SA-1229 | 71249 | ASA/Linde 80 | 0.23 | 0.59 | +10 | 167.6 | 8.66E+18 | 5.22E+18 | N/A | 137.1 | N/A | 56.0 | N/A | [203.1] | N/A |
| IS to US Circ. Weld (OD 39%) | WF-25 | 299L44 | ASA/Linde 80 | 0.34 | 0.68 | -5 | 220.6 | N/A | N/A | 1.90E+18 | N/A | 122.8 | N/A | 68.5 | N/A | 186.3 |
| US Longit. Weld (Both 100%) | SA-1493 | 8T1762 | ASA/Linde 80 | 0.19 | 0.55 | -5 | 149.3 | 8.15E+18 | 4.91E+18 | 1.78E+18 | 119.7 | 81.0 | 68.5 | 68.5 | 183.1 | 144.4 |
| US to LS Circ. Weld (100%) | SA-1585 | 72445 | ASA/Linde 80 | 0.22 | 0.54 | -5 | 158.0 | 9.23E+18 | 5.56E+18 | 2.02E+18 | 132.1 | 90.4 | 68.5 | 68.5 | 195.6 | 153.8 |
| LS Longit. Weld (100%) | SA-1426 | 8T1762 | ASA/Linde 80 | 0.19 | 0.55 | -5 | 149.3 | 7.86E+18 | 4.74E+18 | 1.72E+18 | 118.2 | 79.7 | 68.5 | 68.5 | 181.6 | 143.2 |
| LS Longit. Weld (100%) | SA-1430 | 8T1762 | ASA/Linde 80 | 0.19 | 0.55 | -5 | 149.3 | 7.86E+18 | 4.74E+18 | 1.72E+18 | 118.2 | 79.7 | 68.5 | 68.5 | 181.6 | 143.2 |
| Regulatory Guide 1.99, Revision 2, Position 2.1 | | | | | | | | | | | | | | | | |
| LNB to IS Circ. Weld (100%) | SA-1135 | 61782 | ASA/Linde 80 | 0.23 | 0.52 | -5 | 133.0 | 8.06E+17 | 4.86E+17 | 1.76E+17 | 38.3 | 21.2 | 48.3 | 44.7 | 81.7 | 60.9 |
| IS to US Circ. Weld (OD 39%) | WF-25 | 299L44 | ASA/Linde 80 | 0.34 | 0.68 | -5 | 223.7 | N/A | N/A | 1.90E+18 | N/A | 124.5 | N/A | 68.5 | N/A | [188.0] |
| US to LS Circ. Weld (100%) | SA-1585 | 72445 | ASA/Linde 80 | 0.22 | 0.54 | -5 | 151.8 | 9.23E+18 | 5.56E+18 | 2.02E+18 | 126.9 | 86.8 | 48.3 | 48.3 | 170.2 | 130.1 |

* - SA-302 Gr. B modified by ASME Code Case 1339.

[ ] - Controlling values of the adjusted $RT_{NDT}$.

## Attachment 3 - Technical Justification

## Table 2

## Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 2 - Applicable Through 33 EFPY

| Material Description | | | | Chemical Composition | | | | 33 EFPY Fluence, n/cm$^2$ | | | $\Delta RT_{NDT}$, F at 33 EFPY | | Margin | | ART, F at 33 EFPY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reactor Vessel Beltline Region Location | Matl. Ident. | Heat Number | Type | Cu wt% | Ni wt% | Initial $RT_{NDT}$ | Chemistry Factor | Inside Surface | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location |
| Regulatory Guide 1.99, Revision 2, Position 1.1 | | | | | | | | | | | | | | | | |
| Lower Nozzle Belt Forging | AMX 77 | 123T382 | A 508 Cl. 2 | 0.13 | 0.76 | +3 | 95.0 | 8.57E+18 | 5.16E+18 | 1.88E+18 | 77.5 | 52.6 | 70.7 | 70.7 | 151.2 | 126.4 |
| Upper Shell Forging | AAW 163 | 3P2359 | A 508 Cl. 2 | 0.04 | 0.75 | +20 | 26.0 | 9.25E+18 | 5.57E+18 | 2.02E+18 | 21.8 | 14.9 | 21.8 | 14.9 | 63.5 | 49.8 |
| Lower Shell Forging | AWG 164 | 4P1885 | A 508 Cl. 2 | 0.02 | 0.80 | +20 | 20.0 | 9.16E+18 | 5.52E+18 | 2.01E+18 | 16.7 | 11.4 | 16.7 | 11.4 | 53.4 | 42.8 |
| LNB to US Circ. Weld (100%) | WF-154 | 406L44 | ASA/Linde 80 | 0.28 | 0.59 | -5 | 185.7 | 8.57E+18 | 5.16E+18 | 1.88E+18 | 151.4 | 102.9 | 68.5 | 68.5 | 214.9 | 166.4 |
| US to LS Circ. Weld (100%) | WF-25 | 299L44 | ASA/Linde 80 | 0.34 | 0.68 | -5 | 220.6 | 8.93E+18 | 5.38E+18 | 1.95E+18 | 182.4 | 124.4 | 68.5 | 68.5 | 245.9 | 187.9 |
| Regulatory Guide 1.99, Revision 2, Position 2.1 | | | | | | | | | | | | | | | | |
| Upper Shell Forging | AAW 163 | 3P2359 | A 508 Cl. 2 | 0.04 | 0.75 | +20 | 8.9 | 9.25E+18 | 5.57E+18 | 2.02E+18 | 7.4 | 5.1 | 7.4 | 5.1 | 34.9 | 30.2 |
| US to LS Circ. Weld (100%) | WF-25 | 299L44 | ASA/Linde 80 | 0.34 | 0.68 | -5 | 223.7 | 8.93E+18 | 5.38E+18 | 1.95E+18 | 185.0 | 126.2 | 68.5 | 68.5 | [248.4]* | [189.6]* |

---

* [ ] - Controlling values of the adjusted $RT_{NDT}$.

## Attachment 3 - Technical Justification

## Table 3

## Data for Preparation of Pressure-Temperature Limit Curves for Oconee Unit 3 - Applicable Through 33 EFPY

| Material Description | | | | Chemical Composition | | | | 33 EFPY Fluence, n/cm² | | | $\Delta RT_{NDT}$, F at 33 EFPY | | Margin | | ART, F at 33 EFPY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reactor Vessel Beltline Region Location | Matl. Ident. | Heat Number | Type | Cu wt% | Ni wt% | Initial $RT_{NDT}$ | Chemistry Factor | Inside Surface | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location | T/4 Location | 3/4T Location |
| Regulatory Guide 1.99, Revision 2, Position 1.1 | | | | | | | | | | | | | | | | |
| Lower Nozzle Belt Forging | 4680 | 4680 | A 508 Cl. 2 | 0.13 | 0.91 | +3 | 96.0 | 8.28E+18 | 4.99E+18 | 1.81E+18 | 77.4 | 52.4 | 70.7 | 70.7 | 151.1 | 126.1 |
| Upper Shell Forging | AWS 192 | 522314 | A 508 Cl. 2 | 0.01 | 0.73 | +40 | 20.0 | 9.13E+18 | 5.50E+18 | 2.00E+18 | 16.7 | 11.4 | 16.7 | 11.4 | 73.3 | 62.8 |
| Lower Shell Forging | ANK 191 | 522194 | A 508 Cl. 2 | 0.02 | 0.76 | +40 | 20.0 | 9.11E+18 | 5.49E+18 | 1.99E+18 | 16.6 | 11.4 | 16.6 | 11.4 | 73.3 | 62.7 |
| LNB to US Circ. Weld (100%) | WF-200 | 821T44 | ASA/Linde 80 | 0.25 | 0.63 | -5 | 181.0 | 8.28E+18 | 4.99E+18 | 1.81E+18 | 145.9 | 98.8 | 68.5 | 68.5 | 209.3 | 162.3 |
| US to LS Corc. Weld (ID 75%) | WF-67 | 72442 | ASA/Linde 80 | 0.26 | 0.60 | -5 | 180.0 | 8.82E+18 | 5.32E+18 | 1.93E+18 | 148.2 | 101.0 | 68.5 | 68.5 | [211.7] | [164.5] |
| US to LS Circ. Weld (OD 25%) | WF-70 | 72105 | ASA/Linde 80 | 0.32 | 0.58 | -26 | 199.3 | N/A | N/A | 1.93E+18 | N/A | 111.8 | N/A | 56.0 | N/A | 141.8 |
| Regulatory Guide 1.99, Revision 2, Position 2.1 | | | | | | | | | | | | | | | | |
| Upper Shell Forging | AWS 192 | 522314 | A 508 Cl. 2 | 0.01 | 0.73 | +40 | 47.4 | 9.13E+18 | 5.50E+18 | 2.00E+18 | 39.5 | 27.0 | 34.0 | 27.0 | 113.5 | 94.0 |
| Lower Shell Forging | ANK 191 | 522194 | A 508 Cl. 2 | 0.02 | 0.76 | +40 | 32.5 | 9.11E+18 | 5.49E+18 | 1.99E+18 | 27.1 | 18.5 | 17 | 17.0 | 84.1 | 75.5 |

[ ] - Controlling values of the adjusted $RT_{NDT}$.

**Attachment 3 - Technical Justification**

**ENCLOSURE**

Pressure-Temperature Limits for 33 EFPY
for Oconee Nuclear Station Units 1, 2, and 3