ATTACHMENT

OCONEE_EMERGENCY_PROCEDURE_GUIDELINE

INADEQUATE_CORE_COOLING_MONITORING_INSTRUMENTATION_GUIDANCE

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1.0 PURPOSE

The enclosed information is provided in accordance with item III.5 of the Order for Modification of License dated December 10, 1982. This item requests information for NRC review and approval regarding proposed emergency procedure revisions which implement the Inadequate Core Cooling Monitoring (ICCM) instrumentation.

2.0 SCOPE

The intent of this document is to outline proposed modifications to the Emergency Procedure Guidelines (EPG) relative to the installation of ICCM instrumentation. The EPG provides the technical basis from which the unit specific emergency procedures are written.

The complete safety grade ICCM package includes subcooled margin monitors, core exit thermocouples (CETC), redundent reactor vessel head and hot leg level indications as well as the non-safety grade reactor coolant pump (RCP) ammeters. A design description of this system has been submitted previously (References 1). The NRC staff has reviewed this design and responded with a Safety Evaluation Report (SER) accepting the design concept (Reference 2). Duke has presented conceptual emergency procedure guidance regarding ICCM level instrumentation in Reference 3. The information contained herein is intended to supplement and clarify this guidance.

EPG guidance currently exists which prescribes operator actions based upon subcooled margin and CETC indications. Portions of the existing guidance are included to provide a complete overview of the severe accident mitigation strategy. Application of the ICCM instrumentation will be demonstrated by illustrating how the EPG uses this instrumentation to identify, mitigate, and prevent the approach to actual ICC conditions. Additional applications of ICCM level instrumentation will also be discussed.

3.0 ICC IDENTIFICATION AND MITIGATION

3.1 Approach_to_ICC

All plant transients which lead to ICC conditions will result in a loss of subcooled margin, regardless of the initiating event. The EPGs therefore treat this symptom with absolute priority, and second only to CETC indications that ICC conditions already exist. Subcooled margin indications are available to the operator from a variety of sources including digital meters, P/T display, operator aid computer, and the new safety related ICCM plasma displays. The subcooled margin is provided for each hot leg as well as the core exit with the appropriate instrument errors corrections included in each indication. The operator is instructed to transfer to the EPG Loss of Subcooled Margin procedure anytime subcooling indications decrease to 0 F.

The Loss of Subcooled Margin procedure prescribes various operator actions designed to regain subcooling, if possible. If a break prevents recovery of the subcooled margin, conditions necessary for decay heat removal are established. The first and most important step in this procedure is to trip all reactor coolant pumps (RCP). This action is essential in the prevention of ICC conditons since continued RCP operation, in conjunction with a SBLOCA, may result in a highly voided reactor coolant system (RCS) and possible core uncovery. The EPG guidance is explicit throughout regarding tripping of RCPs on loss of sub-cooled margin and the operators are trained to understand the importance of this action and respond promptly. Continuous RCP operation with saturated coolant conditions is not permitted or expected due to the continued emphasis placed upon RCP trip upon loss of subcooled margin. RCPs are intentionally restarted with saturated coolant only when severe ICC conditions dictate such drastic action in order to cool the core by forced cooling.

After determining that a severe overcooling did not cause the loss of subcooling, the Loss of Subcooled Margin procedure instructs the operator to initiate injection flow and isolate possible RCS leaks. The steam generator levels are then raised to the saturated natural circulation setpoint in anticipation of the boiler-condenser heat transfer phase of a SBLOCA. All further actions concentrate on treating other possible symptoms or assessing subcooled margin recovery if no other symptoms exist.

Once the primary coolant becomes saturated, the operator may trend changes in coolant inventory by observing the ICCM plasma display. This display includes instrumentation which will indicate and trend coolant levels in both hot legs and in the reactor vessel head. Procedural guidance has been developed to take advantage of this instrumentation and assist the operator in identifying the approach to ICC conditions. The criteria for transfer to the ICC section of the EPG was enhanced by including low reactor vessel head level in addition to superheated CETC temperatures. These parameters will indicate the approach to ICC conditions and the actual onset of ICC conditions. A reactor vessel head level setpoint equivalent to the bottom of the hot leg (instrument errors included) was chosen to initiate a transfer to the ICC section. Below the setpoint, reliable coolant level indications will no longer be available to the operator to ensure that the core remains covered.

3.2 ICC Mitigation

The CETCs provide a relative indication of high core temperatures once level indications are off-scale low. CETC temperatures are therefore the basis for operator action once the ICC section of the EPG is entered. Initial efforts in this section focus on maximizing ECCS injection flow and attempting to restore some form of core cooling. All further actions are based upon the success of these actions as indicated by CETC temperatures. If CETC temperatures remain superheated and are not decreasing, then RCPs are used to initiate forced cooling.

3.2.1 RCP Operation With ICC

Continuous RCP operation with saturated coolant conditions is not permitted in the EPG with one exception. Sustained ICC conditions is the one circumstance which warrants possible RCP damage in lieu of severe core damage. A RCP is thus restarted if previous efforts to restore core cooling are unsuccessful and CETC temperatures remain superheated and are not decreasing.

Successive RCPs are restarted, as necessary, until the ICC condition is mitigated.

3.2.2 ICC Recovery

The recovery from an ICC condition may be gauged by the core exit subcooled margin, reactor vessel head level, or RCP amps if any RCPs are operating. Each of these parameters are used in the revised EPG to provide the operator with an unambiguous indication that actions performed in the ICC section have mitigated the ICC condition.

All RCPs which may have been restarted during ICC mitigation are secured prior to transferring out of the ICC section. This is accomplished once the CETCs are less than 400 F and the core exit subcooled margin is saturated or subcooled. RCP current must be stable and greater than the nominal current at full power operation prior to securing a RCP. Stable RCP current is an indication that single phase coolant is being pumped and the current setpoint assures that the coolant is indeed in the liquid phase. Correlations relating coolant void fraction to pump amps are not used due to the limited applicability of these correlations and the difficulty of use they present to the operator. Current stability will provide a more practical and less ambiguous indication of the relative coolant phase content.

Once all RCPs (if any) have been secured, reactor vessel head level is observed to ensure that the core remains covered. A transfer out of the ICC section is made only after the core exit subcooled margin is verified greater than or equal to 0 F and reactor vessel head level is on scale. The bottom of the hot leg (instrument errors included) is the setpoint chosen for this level since it is the same setpoint used to transfer into the ICC section.

4.0 SATURATED NATURAL CIRCULATION COOLING

Natural circulation cooling is assured in a B&W NSSS provided an adequate heat sink exists and the primary coolant remains subcooled. Primary coolant saturation presents a unique concern to a B&W plant, particularly when a SBLOCA results in draining of the hot leg piping and the subsequent interruption of saturated natural circulation cooling. Guidance based upon ICCM hot leg level has been included in the EPG to assist the operator in identifying conditions where natural circulation may be interrupted.

4.1 Interruption of Natural Circulation

The interruption of natural circulation may result when a hot leg void displaces primary coolant below the U-bend spillover elevation. Interruption of heat transfer can result with an ensuing heatup of the primary coolant. This condition will first be recognized through loss of heat transfer symptoms and may be confirmed with the ICCM hot leg level instrumentation. The EPG prescribes guidance designed to condense or vent hot leg voids and restore heat transfer.

4.2 Heat Transfer Recovery

Once loss of heat transfer symptoms are recognized, several actions are performed to reestablish heat transfer. If the core exit is saturated and hot leg level is below the U-bend spillover elevation (instrument errors considered), then the hot leg high point vents are opened in each loop with low level. This level will confirm that voids have formed in the hot legs and are blocking natural circulation flow. By opening the high point vents, the operator will lessen the RCS pressure increase due to coolant heatup. ECCS injection flow will therefore be maximized and the void will be vented as injection flow refills the hot legs.

The EPG uses RCP pump bumps to help restore natural circulation flow since they are an effective means of condensing steam voids. Hot leg level indications are used to help determine which RCP to bump and assist in evaluating the effectiveness of each bump. RCPs are bumped in the loop with the lowest hot leg level and level is trended to determine if the pump bump was effective. This process is repeated until the voids have been condensed or the RCP successive restart limit is reached.

If no RCPs are operable or noncondensible gases are present, pump bumps may not successfully restore natural circulation. The hot leg high point vents are then used to vent the voids and allow ECCS injection flow to refill the hot legs and restore heat transfer. If all efforts fail to restore natural circulation heat transfer, then the feed-and-bleed cooling mode is entered to provide decay heat removal while efforts continue to restore steam generator heat transfer.

5.0 VOID IDENTIFICATION AND MITIGATION

One of the more obvious applications of the ICCM instrumentation is the ability to identify void formation in the reactor vessel head and the hot legs during subcooled operation. The ICCM level instrumentation has therefore been included in the EPG as a direct indication of void formation and is used to determine when the void has been removed.

5.1 Subcooled Natural Circulation Cooldown

The current EPG subcooled natural circulation cooldown strategy relies on reactor vessel head venting to prevent a head void from forming. This strategy has been reviewed and approved by the NRC (Reference 4). It was suggested that additional guidance be provided should a void form during the cooldown. The natural circulation cooldown guidance has been modified to monitor for head void formation and take appropriate actions as suggested. A step has been added to the guidance which monitors vessel head level and reduces the cooldown and depressurization rates, as necessary, to limit the void size. Vessel head level is maintained at the top of the head with instrument uncertainties considered.

5.2 Void Mitigation

The ICCM level instrumentation is also utilized to prepare the operator for the consequences of a RCP restart. Whenever a unusual transient has resulted in primary coolant saturation and subcooling is subsequently recovered, steam voids may still exist in the reactor vessel head and/or the hot legs. These voids will be rapidly condensed when a RCP is restarted. As a result, a drop in both pressurizer level and RCS pressure will be observed which is proportional to the void size. The EPG cautions the operator about this phenomenon and instructs him to increase pressurizer level prior to the restart if the level instrumentation indicates a void. The setpoint at which a void is indicated is chosen as the top of the hot leg or the top of the reactor vessel head. Instrument errors were not factored into these setpoints for conservatism since the higher pressurizer level setpoint will not adversely affect the restart procedure.

The final applications of the ICCM level instrumentation assist the operator in identifying and removing voids when the primary coolant is subcooled and no RCPs are operating. The setpoint below which a head void is indicated with certainty is chosen as the top of the vessel (instrument errors included). The corresponding hot leg level setpoint is the top of the hot leg (instrument errors included). When a void external to the pressurizer is indicated, one of several options are exercised to remove the void. These options include RCS repressurization, high point venting, and RCP restart. In all instances, pressurizer level is increased to accomodate the liquid volume required to refill the void volume. Level instrumentation is then used to verify that the void has been successfully removed.

6.0 SUMMARY

The basic applications of ICCM instrumention included in the EPG are summarized in Table 1. Although subcooled margin is used for a variety of operator actions, only those actions related to ICC monitoring and mitigation are presented in this table.

The ICCM instrumentation, when coupled with the proposed procedural guidance, should provide the operator with a definitive means of identifying the approach to ICC conditions. If actual ICC conditions result, the severity of this condition may be determined and the effectiveness of operator actions may be promptly evaluated.

The procedural guidance has been designed to utilize the instrumentation in a manner consistent with its capabilities and accuracy. Complicated interpretations of these indications by the operator have been avoided to enhance the diagnostic capabilities of the instrumentation.

7.0 REFERENCES

1) Duke Power Company Final Design Description, Instrumentation to Detect Inadequate Core Cooling, submitted July 1, 1985.

2) NRC letter, J. F. Stolz to H. B. Tucker, Safety Evaluation Report (SER), NUREG-0737,II.F.2, Submittals of March 10 and August 25, 1983.

3) Duke Power Company response to "Order for Modification of License", NUREG-0737, II.F.2, December 10, 1982, submitted March 10, 1983.

4) NRC letter, J. F. Stolz to H. B. Tucker, Safety Evaluation Report of Natural Cooldown Strategy, June 5, 1985.

Table 1

Summary of EPG ICCM Related Guidance

Instrument	Application
Subcooled Margin Monitors	-Trip all RCPs when saturated -Maximize ECCS injection flow -Increase SG levels to saturated setpoint at saturation -Indicate recovery from ICC conditions
Reactor Vessel & Hot Leg Levels	-Transfer to ICC section on low vessel head level -Ensure recovery from ICC conditions -Operate high point vents to restore heat transfer -Establish appropriate pressurizer level prior to RCP restart -Identify and mitigate voiding when subcooled -Identify and mitigate a head void during a natural circulation cooldown
CETC Temperatures	-Transfer to ICC section when superheated -Determine the severity of actions performed during ICC mitigation -Ensure recovery from ICC conditions
RCP Current	-Indicates no significant RCS voiding during saturated RCP operation -Used to secure RCPs during ICC recovery