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

NRC INSPECTION MANUAL

SRXB

TEMPORARY INSTRUCTION 2515/103

LOSS OF DECAY HEAT REMOVAL (GENERIC LETTER NO. 88-17) 10 CFR 50.54(f) PROGRAMMED ENHANCEMENTS (LONG TERM) REVIEW

2515/103-01 PURPOSE

To assure PWR licensee actions to prevent and, if necessary, respond to loss of decay heat removal (DHR) during reduced reactor coolant system (RCS) inventory operation.

2515/103-02 OBJECTIVE

To verify licensee preparation for non-power operation in accordance with the programmed enhancements phase of "Loss of Decay Heat Removal (Generic Letter No. 88-17), 10 CFR 50.54(f)," October 17, 1988.

2515/103-03 DEFINITIONS

Containment Closure. A containment condition where at least one integral barrier to the release of radioactive material is provided by the containment and associated barriers.

Mid-Loop Condition. A condition where the RCS water level is below the top of the flow area of the hot legs at the junction with the reactor vessel (RV).

Non-Power operation (with respect to Generic Letter (GL) 88-17 and TI 2515/101, 103). Operation of the nuclear steam supply system (NSSS), the containment, and supporting systems under conditions for which RCS cooling is or normally would be provided by DHR systems.

Reduced Inventory Condition. A condition where the RV water level is lower than three feet (nominal) below the RV flange. A mid-loop condition is a reduced inventory condition.

2515/103-04 BACKGROUND

Loss of DHR during non-power operation and the consequences of such a loss are of concern. Many events of loss of DHR have occurred while the RCS has been drained down for mid-loop activities such as steam generator (SG) inspection or repair of a reactor coolant pump. These activities are often

in progress with two of the three principle fission product barriers breached. (The RCS pressure boundary and the containment are often open. The remaining barrier is the fuel cladding.)

GL 87-12, "Loss of Residual Heat Removal (RHR) While the Reactor Coolant System (RCS) is Partially Filled," was issued to all licensees of operating PWRs and holders of construction permits on July 9, 1987. Responses indicated that licensees did not understand the identified problems, and the problems have continued, as evidenced by occurrence of events since the generic letter was issued.

The seriousness and continuation of these problems resulted in issuance of GL 88-17. It required the recipients to respond with two plans of actions:

a. A short-term program entitled "expeditious actions" that was essentially limited to reduced inventory conditions.

b. A longer-term program entitled "programmed enhancements."

TI 2515/101 addressed the licensee program for "expeditious actions." This TI addresses the licensee program for "programmed enhancements."

2515/103-05 INSPECTION REQUIREMENTS

05.01 General. This TI addresses aspects of non-power operation while there is irradiated fuel in the RV. It should be initiated:

a. Following receipt of the NRR report that reviews the licensee programmed enhancements submittal.

b. When licensee progress allows an accurate assessment of licensee resolution of the GL 88-17 recommendations.

Alternatively, the TI may be initiated earlier, but may not be completed until items 05.01 a. and b. are satisfied.

GL 88-17 identified the expeditious actions as applicable to reduced inventory conditions. The programmed enhancements are covered by the GL statements that they apply during shutdown cooling or during conditions where such cooling would normally be provided, with the additional qualification that there is irradiated fuel in the RV. The intent is to provide complete coverage of reduced inventory conditions. This includes prevention of an unidentified or unplanned entry into a reduced inventory condition and preparation for deliberate entry. It does not cover all possible non-power operation conditions. For example, level instrumentation should cover the range above reduced inventory to allow control of level, thus avoiding inadvertent entry. Normal procedures should cover non-reduced inventory operation so that there is a stable base from which to enter reduced inventory. Containment closure operations are addressed for reduced inventory operation, the area of greatest risk.

05.02 Instrumentation (GL item 1). Verify that the licensee has provided reliable indications in the control room (CR) that describe the state of the

RCS and the operation of systems used to cool the RCS. Verify that procedures and administrative controls reasonably assure the indications are operational when needed. (See 05.03 and 06.02.)

05.03 Procedures (GL item 2)

a. Verify that procedures and administrative controls have been implemented that cover the NSSS, the containment, and supporting systems.

b. Verify that written instructions and/or training reasonably assure that emergency procedures or the equivalent apply to reduced inventory operation and that these are entered upon:

1. Accidental loss of a system that is operating to cool the RCS.

2. Unsuccessful attempt to start a system when the system was to be used for RCS cooling and the RCS was not being cooled by another DHR system. Entry into emergency procedures may be delayed if the time to close containment remains sufficient to accomplish closure and if:

(a) Measured temperature representative of core exit conditions is less than 140°F or RCS temperature has increased by less than 5°F since the initial start attempt was made.

(b) The start attempt was made as part of a planned transition from one DHR pump to another, in which case another (normally the initially running) DHR pump shall be immediately and successfully started.

3. Uncontrolled and significant loss of RCS inventory.

4. Any valid symptom of loss of control of the thermodynamic state of the RCS, such as uncontrolled temperature increase, uncontrolled pressurization, or the attainment of values of these parameters which are sufficiently high that action is required that is not contained within normal procedures.

5. Significant core damage expected.

6. Any valid symptom of significant core damage is observed.

c. Verify that it is not necessary to identify the actual event or cause of the event to achieve effective mitigation when the entire package of emergency procedures is considered.

05.04 Equipment (GL item 3)

a. Verify that adequate reliable equipment is provided for normal core cooling, including support equipment.

b. Verify that at least two reliable means of cooling the core are provided during reduced inventory operation that are in addition to the normal DHR systems. The verification should provide confirmation that:

1. At least one high head safety injection pump or an equally effective pumped system is provided.

2. At least one other method is provided for long term core cooling. If the other method consists of gravity flow, it meets the intent of GL 88-17 only:

   (a) If it can be established at the equilibrium RCS pressure existing if bulk boiling is fully established.

   (b) If flow sufficient to prevent core uncovery can be provided by this technique for a sufficient time that an additional means of cooling the core can be reasonably achieved. This additional means may not be the other means that was counted in meeting the original stipulation of two means of core cooling.

3. Flow path(s) have been fully evaluated and tested if necessary.

4. Long-term heat removal has been considered, including provision of an adequate exit path for water and/or steam from the RCS and/or steam generators where necessary for viable cooling.

5. Sufficient support equipment is available, such as electrical power and component cooling water, as appropriate.

c. Verify that reliable communications will exist between CR personnel and personnel outside the CR (such as radios, or at locations of specific emergency activities in containment and in the auxiliary building) under accident conditions.

05.05 Analyses (GL item 4). Verify that analyses have been performed or referenced where such analyses are necessary to properly prepare procedures.

05.06 Technical Specifications (TSs) (GL item 5). Verify that necessary changes in TSs have been addressed.

05.07 RCS Perturbations (GL item 6)

a. Verify that the licensee has completely considered potential perturbations of the RCS and supporting systems by training, procedures, and controls that reasonably avoid perturbing activities when RCS inventory is low and decay heat is high.

b. Verify that extra precautions are taken where such potentially perturbing activities must be so conducted.

2515/103-06 GUIDANCE

06.01 General Guidance. This inspection addresses plant operation when a non-power operation condition exists and there is irradiated fuel in the RV. It encompasses the programmed enhancement recommendations of GL 88-17 and follows up on some expeditious actions recommended in GL 88-17. Reduced inventory operation is emphasized since more than 85 percent of the risk is predicted for these conditions. Most of this 85 percent is associated with

mid-loop operation. Risk decreases rapidly as the decay heat generation rate decreases, and more latitude is allowable after 3 or 4 weeks have elapsed since full power operation.

GL 88-17, the licensee responses, and NRR review of the responses form the basis for TI 2515/101 and TI 2515/103. This material and the inspection results will determine whether the intent of the GL has been achieved, or whether additional NRC action is necessary.

06.02 Inspection Requirement 05.02, Instrumentation (GL item 1). The inspection should verify that the following indications will be provided in the CR and that appropriate procedures exist for their use:

a. RCS Level. Two independent RCS level indications should be operational before entering a reduced inventory condition (GL items 1a and 1d). An audible low level alarm should sound upon inadvertent entry into each of the following conditions:

   1. Reduced inventory.

   2. Mid-loop.

   3. Level lower than 4 inches below the top of the hot leg flow area at the junction with the RV (B&W only).

   4. Loss of sufficient level for reliable DHR pump operation.

   Limiting the operational alarm to transition to the next lower RCS level from the existing operating condition is acceptable.

   Deviations which meet the intent of GL 88-17 will be addressed in the NRR review of licensee responses to the GL. Publication of a GL 88-17 supplement that addresses this topic is being considered.

b. RCS Temperature. At least two independent temperature measurements representative of the core exit and a suitable high temperature audible alarm should be operational during reduced inventory operation whenever the RV head is on the vessel (GL items 1b and 1d). An alarm setting roughly 10°F above expected operating temperature may be appropriate. A short time of non-operability is reasonable for actual head movement provided the time is minimized and suitable compensatory measures are taken to minimize the chance of a loss of DHR event.

c. DHR System Monitoring. Indications and audible malfunction alarms should be operational whenever the DHR system is operating. (GL items 1c and 1d). Sufficient information should be provided in the CR so that an approaching malfunction is clearly indicated. The licensee should have considered such items as motor current, suction pressure, and pump noise, and normally at least one of these parameters should be used. A display that shows a historical trace is more valuable since "noise" due to air ingestion is readily seen, and may be one of the earliest indications of an approach to inadequate pump suction conditions. Where computer difficulties do not allow continuous processing, provision of high/low data since the last provided

point may be useful. Both audible alarms and a CR indication should be provided.

06.03 Inspection Requirement 05.03, Procedures (GL item 2). The verification should cover both normal operation and operation under emergency, abnormal, off-normal, or equivalent conditions. Coverage that should be provided by the licensee in procedures or administrative controls includes:

a. DHR operation.

b. Containment control as recommended in GL 88-17 expeditious action item (2).

c. Avoidance of perturbations while in a reduced inventory condition, including:

   1. Informing CR personnel immediately before initiating operations.

   2. Immediately informing CR personnel of any unanticipated activity or symptom.

   3. Informing CR personnel when operations are ended.

   4. If unavoidable, then such operations are conducted when decay heat is low or additional measures are taken to prevent DHR loss and to ensure timely response to a possible loss of DHR.

   (See also Sections 05.07 and 06.07.)

d. RCS draining and monitoring the level tanks receiving drained water, including prerequisites for:

   1. Initiation of RCS draining.

   2. Entry into a reduced inventory condition.

   3. Entry into and operation in a mid-loop condition.

   4. Entry into a condition of level lower than 4 inches below the top of the hot leg flow area at the junction with the RV (B&W only).

e. Containment closure as recommended in GL 88-17 expeditious action item (2), including:

   1. Control of containment penetrations.

   2. Assurance that containment can be closed.

   3. Consideration of a possible hostile containment environment, including that steam produced by RCS boiling may prevent further containment closure activities.

   4. Consideration that plant-specific equipment hatch features, including the number of bolts for closure and differences between external and internal hatches, are addressed (the type of hatch

and hatch closure activities should be reported in the inspection report because NRR management needs this information for possible future action).

5. Consideration of pressure caused by hydrogen burns during a core damage accident. Generally, closures should at least withstand the design basis conditions of pressure and temperature. For ice condenser containments, closures should not be a weakness in the pressure boundary and one igniter train should be available to prevent large hydrogen accumulations.

f. DHR recovery.

g. Means to add water inventory to the RCS and to provide long-term cooling if normal DHR systems become inoperative during reduced inventory operation.

SG cooling is a viable means of cooling the RCS if there is little RCS inventory loss, and should be addressed by procedures. It may not be considered as one of the two means addressed in Section 05.04c, since it will not compensate for loss of inventory. However, it is appropriate to consider SG cooling in conjunction with an inventory addition scheme. For example, if the RCS pressure which resulted from SG cooling was sufficiently low that a low head pump or gravity makeup could be used, then the combination may be used for one of the two water addition/cooling means.

h. Supporting equipment operation, including:

1. Electrical power.

2. Component cooling water or equivalent.

3. Service water or equivalent.

Some licensees may not have implemented the GL 88-17 recommendations since they do not plan to enter reduced inventory or mid-loop conditions. Such licensees should be identified.

06.04 Inspection Requirement 05.04, Equipment (GL item 3). Verification of provision of reliable DHR equipment includes verification that the licensee has:

a. Addressed the autoclosure interlock during reduced inventory operation (if applicable to the plant in question) and has effectively eliminated its contribution to loss of DHR while also addressing overpressure protection and prevention of loss of coolant accidents outside containment.

b. Considered the often contradictory needs for a DHR flow rate to satisfy core cooling, boron mixing, and vortexing considerations.

06.05 Inspection Item 05.05, Analyses (GL item 4). Inspectors do not have to address actual analyses. It is sufficient to identify their existence and in selected cases to verify that the results are reasonable and meet the needs of the procedures. For example, gravity feed requires a sufficiently

large vent or steam generator cooling in combination with a vent so that steam backpressure does not prevent the necessary water flow rate into the RCS. These must be established by analyses or test. Similarly, the resistance of the actual flow path from the storage tank to the RCS must have been considered insofar as necessary to establish that the necessary flow rate will be obtained.

06.06 Inspection Item 05.06, TSs (GL item 5). It is not necessary to evaluate the TS changes since this will be done by NRR.

06.07 Inspection Item 05.07, RCS Perturbations (GL item 6). The licensee should have procedures or administrative controls for reduced inventory operation which cover such topics as:

a. Potential for causing a perturbation.

b. The potential for activities where a single malfunction could cause loss of inventory or loss of DHR.

c. Potential perturbation of instrument indications.

d. Extra precautions should an activity be necessary that potentially causes a perturbation, such as:

   1. Enhanced ability to maintain or recover RCS inventory.

   2. A closed containment.

   3. Enhanced ability to close containment.

2515/103-07 REPORTING REQUIREMENTS

The inspection findings should be documented in a routine inspection report, with a copy sent to:

Warren C. Lyon, Sr. Reactor Engineer
Reactor Systems Branch, NRR
OWFN, 8E23

Findings of significant deficiencies in the licensee's implementation of GL 88-17 should be communicated by telephone conference call between the inspector, the inspector's supervision (as appropriate), the NRR project manager for the plant, and Warren Lyon at 301-492-0891.

NRR plans to perform in-depth inspections at approximately six sites, after the completion of this TI. These sites will be selected on the basis of licensee performance as assessed in the inspections conducted under this TI. Inspector recommendations in identifying these sites are welcomed.

2515/103-08 COMPLETION SCHEDULE

This inspection should be completed when licensee progress allows a complete assessment of expected end results and the NRR evaluation of the licensee submittals in response to GL 88-17 have been completed. In some cases,

significant licensee work may remain to be accomplished but licensee plans allow a complete assessment. In others, it may be necessary to wait until the licensee has completed all work. "Progress" reports and partial inspection reports are acceptable and sometimes valuable, especially in situations where unsatisfactory results are obtained or expected. Such decisions are at the region's discretion.

2515/103-09 EXPIRATION

This TI expires two years after date of issuance.

2515/103-10 CONTACT

Questions should be addressed to Warren C. Lyon, Reactor Systems Branch, NRR, 301-492-0891.

The lead project manager is Charles Trammell, NRR, 301-492-3121.

2515/103-11 STATISTICAL DATA REPORTING

Record actual inspection time to procedure 255103 for the 766/RITS card system input and to 2515/103 for RITS input with IPE code of SI (safety issue).

The SIMS issue number for this TI is L8-17.

The SALP category for this TI is Safety Assessment/Quality Verification (SOSAQV-0).

2515/103-12 ORIGINATING ORGANIZATION INFORMATION

12.01 Organizational Responsibility

NRR/SRXB originated this TI and retains responsibility for the technical review of responses to GL 88-17.

12.02 Estimated Resources

The following direct inspection effort is estimated:

Item	Hours Effort
Instrumentation	6
Procedures	16
Equipment	4
Analyses	2
TSs	2
RCS perturbations	4
Correspondence review	16
Total	50

END