May 24, 2002

MEMORANDUM TO: John A. Grobe, Director
Division of Reactor Safety
Region III

FROM: Ledyard B. Marsh, Acting Deputy Director ***/RA/***
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: RESPONSE TO TASK INTERFACE AGREEMENT 2001-009 REGARDING POTENTIAL UNISOLABLE REACTOR COOLANT LEAK OUTSIDE CONTAINMENT AT THE BYRON STATION (TAC NOS. MB2907 AND MB2908)

In a memorandum dated August 10, 2001, you requested assistance from the Office of Nuclear Reactor Regulation in addressing an Unresolved Item (URI) identified during an inspection of the Byron Station (Byron). The URI concerned the isolation capability of the component cooling water return line from the reactor coolant pump thermal barrier heat exchanger (TBHE). During the initial licensing of Byron, credit was given for redundant isolation capability for a TBHE rupture. In 1998, the licensee revised its Updated Final Safety Analysis Report (UFSAR) under 10 CFR 50.59 to revise the performance capabilities of the inboard isolation valve. Specifically you asked three questions of NRR regarding the UFSAR change. The three questions concern the acceptability of a modification made by the licensee which has reduced Byron's design capability for isolating a postulated rupture within a thermal barrier heat exchanger.

The NRR staff has reviewed the information provided in your request as well as additional information provided by the licensee in its November 16, 2001, letter. Our conclusion is that the licensee's changes to Byron do not comply with all of the applicable regulations and the current Byron licensing basis. The changes should not have been made under 10 CFR 50.59. Rather, NRC approval of the changes should have been sought through a license amendment request. The details of our review are contained in the attached Safety Evaluation.

This completes our action under TAC Nos. MB2907 and MB2908.

Docket Nos. STN 50-454 and STN 50-455

Attachment: Safety Evaluation

cc: B. Platchek, R-I
L. Plisco, R-II
K. Brockman, R-IV

MEMORANDUM TO: John A. Grobe, Director May 24, 2002
Division of Reactor Safety
Region III

FROM: Ledyard B. Marsh, Acting Deputy Director ***/RA/***
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: RESPONSE TO TASK INTERFACE AGREEMENT 2001-009 REGARDING POTENTIAL UNISOLABLE REACTOR COOLANT LEAK OUTSIDE CONTAINMENT AT THE BYRON STATION (TAC NOS. MB2907 AND MB2908)

In a memorandum dated August 10, 2001, you requested assistance from the Office of Nuclear Reactor Regulation in addressing an Unresolved Item (URI) identified during an inspection of the Byron Station (Byron). The URI concerned the isolation capability of the component cooling water return line from the reactor coolant pump thermal barrier heat exchanger (TBHE). During the initial licensing of Byron, credit was given for redundant isolation capability for a TBHE rupture. In 1998, the licensee revised its Updated Final Safety Analysis Report (UFSAR) under 10 CFR 50.59 to revise the performance capabilities of the inboard isolation valve. Specifically you asked three questions of NRR regarding the UFSAR change. The three questions concern the acceptability of a modification made by the licensee which has reduced Byron's design capability for isolating a postulated rupture within a thermal barrier heat exchanger.

The NRR staff has reviewed the information provided in your request as well as additional information provided by the licensee in its November 16, 2001, letter. Our conclusion is that the licensee's changes to Byron do not comply with all of the applicable regulations and the current Byron licensing basis. The changes should not have been made under 10 CFR 50.59. Rather, NRC approval of the changes should have been sought through a license amendment request. The details of our review are contained in the attached Safety Evaluation.

This completes our action under TAC Nos. MB2907 and MB2908.

Docket Nos. STN 50-454 and STN 50-455

Attachment: Safety Evaluation

cc: B. Platchek, R-I
L. Plisco, R-II
K. Brockman, R-IV

DISTRIBUTION:
PUBLIC

PDIII-2 r/f	LMarsh	SBajwa	AMendiola	GDick	CRosenberg
JLehning	WLyon	EMcKenna	MChawla	AStone, RIII	KO'Brien, RIII
GGrant, RIII	OGC	ACRS	RPulsifer		JJacobson, RIII

ADAMS Accession Number: ML021140426 *See previous concurrence

OFFICE	PDIII-2/PM	PDIII-2/LA	PDIII-2/SC	PDIII-D	DLPM/DD(A)
NAME	GDick	CRosenberg	AMendiola	LRaghavan for SBajwa	LMarsh
DATE	05/24/02	05/24/02	05/24/02	05/14/02	05/24/02

OFFICIAL RECORD COPY

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING TASK INTERFACE AGREEMENT 2001-009

POTENTIAL UNISOLABLE REACTOR COOLANT SYSTEM LEAK

OUTSIDE OF CONTAINMENT

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-454 AND STN 50-455

1.0 INTRODUCTION

In a memorandum dated August 10, 2001 (Reference 1), Region III initiated Task Interface Agreement (TIA) 2001-009, which requested that the Office of Nuclear Reactor Regulation (NRR) consider the acceptability of the containment isolation capability for the component cooling water (CCW) return line from the reactor coolant pump (RCP) thermal barrier heat exchangers at the Byron Station, Units 1 and 2. Currently, the Byron Updated Final Safety Analysis Report (UFSAR) credits a single automatic valve, CC685, for isolating the CCW return line following a postulated rupture within a thermal barrier heat exchanger (TBHE). However, from Byron's initial licensing until 1998, the UFSAR also credited a remotely operated manual isolation valve (CC9438) with providing redundant isolation capability for a postulated TBHE rupture. Thus, the licensee's 1998 UFSAR revision constitutes a design-basis modification which has, for this specific event, reduced the originally licensed dual-barrier containment isolation capability to a single-barrier capability.

The licensee made the above modification to the Byron design basis pursuant to10 CFR 50.59. In a letter dated November 16, 2001 (Reference 2), as requested by NRR, the licensee provided justification concerning the appropriateness of implementing this design modification without prior Nuclear Regulatory Commission (NRC) approval. NRR has considered the licensee's justification in its responses to the following three questions from Region III which constitute TIA 2001-009:

1) From a design and licensing basis perspective for system functional capability, should the plant design and licensing basis include the rupture of the reactor coolant pump thermal barrier cooler as a small break or inter-system loss-of-coolant accident?

2) From a design and licensing basis perspective for system functional capability, can the licensee rely upon the proper functioning of a single valve, the outboard containment isolation valve, as the only means by which to isolate a release of reactor coolant inventory outside of containment following an inter-system loss-of-coolant accident involving a rupture of the thermal barrier cooler?

3) From a licensing basis perspective, did the original Byron licensing review accept the radiological consequences of an unmitigated release of reactor coolant, through the component cooling water system return line?

2.0 BACKGROUND

2.1 Byron's Design Basis Modification

Each unit at Byron Station was designed with two containment isolation valves on the CCW return line from the RCP TBHEs: CC9438, the inboard valve, and CC685, the outboard valve. Valves CC9438 and CC685 both close automatically to isolate the containment in response to a Phase B isolation signal. In addition, to mitigate a postulated rupture in a TBHE, CC685 was designed to be capable of closing automatically on a high flow rate of 240 gallons per minute (gpm), and CC9438 was designed with the capability for remote-manual closure from the control room. The design basis of CC685 to automatically close in response to a TBHE rupture is described in Section 9.2.2.4.4 of the Byron UFSAR. Prior to the licensee's 1998 revision, the design basis of CC9438 to mitigate a TBHE rupture was described in UFSAR Section 9.2.2.4.4 as follows: "A second motor-operated valve in series with [CC685] is available for manual isolation of the line if required."[1] This redundant isolation capability, described in the Byron UFSAR, demonstrates that, prior to the licensee's 1998 design modification to CC9438, a TBHE rupture was considered to be isolable, given a single failure.

In the early 1990s, while responding to Generic Letter (GL) 89-10, the licensee discovered that, although valves CC685 and CC9438 were capable of closing in response to a Phase B containment isolation signal, they were incapable of closing as designed in response to the increased differential pressure that would result from a TBHE rupture because the "... valve actuator[s] did not have adequate thrust capability... " (Reference 2). Although valve CC685 was subsequently modified to close as designed in response to a TBHE rupture, the licensee did not upgrade CC9438 following the discovery of its deficiency. As stated in Reference 2, the licensee concluded that it was unnecessary to upgrade the actuator for valve CC9438 because: (1) CC9438 remained capable of automatically closing in response to a Phase B isolation signal, (2) CC9438 did not receive a signal to automatically close due to high flow in the TBHE return line, and (3) at the time, no specific instructions existed in the Emergency Operating Procedures (EOPs) to close valve CC9438 should valve CC685 fail to isolate.

The decision not to upgrade CC9438, following the discovery of its deficiency, was based on the licensee's belief that the valve was not required, by original design or licensing, to be capable of isolating a TBHE rupture as described in Section 9.2.2.4.4 of the Byron UFSAR. Thus, the inconsistency between the actual capability of CC9438 and its design-basis description in the UFSAR (which had apparently existed since initial licensing) further persisted until 1997, when the licensee performed a safety evaluation pursuant to 10 CFR 50.59 to resolve this long-standing design inconsistency. The licensee's 50.59 safety evaluation

---

[1]The NRR staff has verified that this statement concerning CC9438's design capability was included in the Byron Final Safety Analysis Report (FSAR) at the time Units 1 and 2 received their operating licenses on February 14, 1985, and January 30, 1987, respectively. Further, the staff has traced the origin of this statement to the licensee's FSAR submittals to the NRC from as early as October 1980 (Reference 3).

concluded that the capability for isolating a TBHE rupture could be removed from the design basis for CC9438, and, further, that this modification to Byron's design basis would not require a license amendment to be submitted to the NRC, in accordance with 10 CFR 50.90.

Without prior NRC approval, the licensee subsequently modified Section 9.2.2.4.4 of the Byron UFSAR in 1998, in an attempt to reflect its conclusion that the design basis for CC9438 does not include the isolation of a postulated TBHE rupture.[2] The current revision of UFSAR Section 9.2.2.4.4 indicates that locally dispatching an operator to manually close the CC685 valve is now considered the design-basis method of accommodating the single failure of CC685 to automatically close on a high-flow signal. Thus, for a TBHE rupture event, the licensee has reduced the originally licensed dual-barrier containment isolation capability for the CCW TBHE return line to the current single-barrier capability.

2.2 Historical Licensing Requirements for CCW TBHE Rupture Isolation

Though the specific design requirements to which other pressurized-water reactors (PWRs) were licensed have no regulatory bearing upon the Byron licensee, it should be noted that PWRs are designed with varying isolation capabilities for a TBHE rupture. Byron's design basis, as approved by the NRC during initial licensing, included an automatic outboard valve and a redundant, remote-manual inboard valve to provide dual-barrier containment isolation. Although a number of other PWRs employ similar isolation designs for a TBHE rupture, a limited background review performed by the NRR staff has revealed that PWRs credit a variety of isolation capabilities, ranging from automatic, dual-barrier isolation to single-barrier isolation. Considering the lack of specific regulatory guidance concerning requirements for mitigating the rupture of a TBHE and the variety of plant-specific isolation capabilities in the PWRs sampled by the staff, it is considered very likely that certain PWRs (especially earlier units) were licensed with a single isolation barrier to mitigate a TBHE rupture. Therefore, it should be recognized that NRR's conclusions regarding the adequacy of Byron's current CCW return line isolation capability may not necessarily be applicable to other PWRs.

3.0 EVALUATION

Based upon information from the references cited in Section 5.0, as summarized above in Section 2.1, NRR has provided its response to TIA 2001-009, below.

1) From a design and licensing basis perspective for system functional capability, should the plant design and licensing basis include the rupture of the reactor coolant pump thermal barrier cooler as a small break or inter-system loss-of-coolant accident?

NRR has reviewed the licensing basis for Byron Station and concluded that the NRC considered a rupture within an RCP TBHE to be a credible event at the time of licensing.

---

[2]The current revision of Section 9.2.2.4.4, however, does not appear to achieve full consistency with facility descriptions in other parts of the Byron UFSAR. Apparent contradictions and/or ambiguities cited from the staff's limited UFSAR review include Section 6.2.4.1.2.d, which states that "All lines on open systems for which isolation is required are provided with two barriers so that no single failure will prevent isolation," and Table 9.2-5, which states that the CCW "Lines penetrating the containment for the RCPs have redundant isolation valves" for the purpose of closing to secure flow.

Furthermore, the current revision of the Byron UFSAR (which reflects valve CC9438's reduced isolation capability) indicates that a TBHE rupture is presently also considered credible. In the original plant design, a TBHE rupture would have resulted in an isolable leak of reactor coolant. However, as a result of the licensee's 1998 design modification, this event could result in an unisolable loss-of-coolant accident (LOCA), in which the leaking reactor coolant would bypass the reactor containment.

The original version of the licensee's Final Safety Analysis Report (FSAR) describes the design basis that was reviewed and approved by the NRC before the Byron facility was licensed to operate. The licensee's FSAR (as well as revisions of the UFSAR prior to 1998) described a postulated TBHE rupture, and stated that two isolation barriers (i.e., valves CC9438 and CC685) were available for its isolation. The physical design requirements for these two valves, including CC685's automatic high-flow isolation and both valves' increased thrust requirements, confirm that they were intended to mitigate the rapid insurge of reactor coolant due to this credible event described in the FSAR. Thus, it is well established that a TBHE rupture was considered a credible event for Byron Station, and that the NRC licensed Byron based upon the understanding that redundant barriers were available to isolate this rupture.

Byron's current configuration is described in the most recent version of the UFSAR. The revised UFSAR describes a postulated TBHE rupture in a manner similar to the original FSAR, except that it does not credit valve CC9438 as being available for its isolation. In Reference 2, the licensee further affirmed that a TBHE rupture was reviewed and considered within Byron's design basis. Thus, it is also established that a TBHE rupture is currently considered a credible event for Byron Station, and that the licensee now relies upon a single barrier for its isolation.

In implementing single-barrier isolation for a TBHE rupture through its design modification to CC9438, the licensee has failed to adequately recognize that the postulated consequences of a TBHE rupture have become substantially different and significantly more severe than those analyzed in Byron's licensing basis. As the CCW return line had dual-barrier containment isolation capability at the time of initial licensing, the NRC did not then consider it credible to postulate an unisolable, containment-bypassing LOCA to result from a credible TBHE rupture event. Therefore, this unisolable LOCA resulting from a TBHE rupture was not then evaluated by the NRC staff or accepted into the Byron licensing basis. However, the licensee's modification that reduced the design capability of CC9438 has now introduced this new and unanalyzed accident into Byron's licensing basis, thereby creating an unreviewed safety question, as defined by 10 CFR 50.59.[3] The new accident created by the licensee's modification is further discussed in NRR's response to Question 3.

NRR also notes that, while a postulated TBHE rupture event is considered to be within the licensing basis for Byron Station, it does not appear that the NRC has ever specifically defined, either at the time of initial licensing or thereafter, exactly how severe a rupture is to be considered. In that dual isolation of a TBHE rupture was required by Byron's licensing basis, it may have been deemed unnecessary to perform a detailed analysis regarding a rupture that

---

[3]At the time the licensee's safety evaluation was prepared, 10 CFR 50.59 used the term "unreviewed safety question" for those unreviewed facility changes meeting the criteria for prior NRC approval. Thus, NRR's safety evaluation has maintained use of this terminology, despite the fact that the term "unreviewed safety question" is no longer defined in the currently existent 10 CFR 50.59.

was isolable through redundant barriers. In any case, the NRR staff is not aware that the NRC has ever performed a rigorous evaluation to determine the credibility of various sizes and types of ruptures concerning RCP TBHEs, either generically or for specific plants. The NRC has, at various times, sent generic communications to licensees (e.g., Information Notice 89-54) which referenced the results of Westinghouse calculations that were based upon the break of a single TBHE cooling coil;[4] however, the staff notes that these communications did not certify the NRC's review or endorsement of the Westinghouse analysis.

The Byron licensee stated in Reference 2 that 285 gpm is considered to be the maximum credible inleakage from a postulated TBHE rupture. Similarly to the Westinghouse analysis, the licensee's maximum credible inleakage value appears to consider the rupture of a single cooling coil as the worst postulated TBHE break. Based upon the staff's discussion in the previous paragraph, and the lack of justification provided in Reference 2, the licensee's basis for excluding larger TBHE breaks (e.g., a rupture in the 3-inch diameter CCW piping to or from the TBHE manifold, or a rupture in the manifold itself) from consideration is not apparent. Therefore, as neither the licensee's specific calculation nor its underlying methodology have been approved by the NRC, the NRR staff does not have sufficient basis to conclude that 285 gpm should necessarily be considered the maximum credible inleakage due to a TBHE rupture event. However, a precise determination of Byron's worst postulated TBHE rupture is within the scope of Region III's TIA request.

In summary, NRR has concluded that Byron's licensing basis includes a TBHE rupture as a credible event. At the time of initial licensing, it was not credible for the NRC staff to postulate this event resulting in an unisolable LOCA, due to the availability of dual isolation. However, the licensee's reduction of the design capability of valve CC9438 has now introduced into Byron's licensing basis an unisolable, containment-bypassing LOCA as the result of a postulated TBHE rupture. As this accident is new and previously unanalyzed, the licensee's modification has created an unreviewed safety question.

2) From a design and licensing basis perspective for system functional capability, can the licensee rely upon the proper functioning of a single valve, the outboard containment isolation valve, as the only means by which to isolate a release of reactor coolant inventory outside of containment following an inter-system loss-of-coolant accident involving a rupture of the thermal barrier cooler?

NRR has reviewed the licensing basis for Byron Station and concluded that it is unacceptable for the licensee to rely upon a single valve to isolate a release of reactor coolant to the outside of containment following a postulated rupture within a TBHE. As discussed below, the Byron licensee's current reliance upon a single valve to isolate this rupture does not comply with General Design Criteria 54 and 44 of Appendix A to 10 CFR 50, and 10 CFR 50.46. Additionally, as discussed in NRR's responses to Questions 1 and 3, the licensee's current reliance upon a single isolation valve for this event is inconsistent with Byron's safety analysis, and constitutes an unreviewed safety question, as defined by the revision of 10 CFR 50.59 that was effective at the time the modification was made.

---

[4]Information Notice 89-54 states that, for Surry Power Station, Westinghouse calculated the flow rate for a double-ended break in one ½-inch inner diameter coil to be approximately 275 gpm.

In Reference 2, the licensee justified its use of 10 CFR 50.59 to reduce the originally licensed dual-barrier isolation capability for a postulated TBHE rupture to a single containment isolation barrier. The licensee stated therein that the NRC licensed the isolation capability of the CCW return line from the RCP thermal barrier heat exchangers in accordance with the requirements of General Design Criterion (GDC) 56 of Appendix A to 10 CFR 50. GDC 56 explicitly applies to piping lines penetrating the containment which are open to the containment atmosphere; however, GDC 56 has additionally been invoked by the NRC staff to license other penetrations, which, though not directly connected to the containment atmosphere, were neither connected to the reactor coolant system (RCS) pressure boundary in accordance with GDC 55, nor considered closed systems inside containment in accordance with GDC 57. To satisfy GDC 56, valves CC685 and CC9438 were designed with the capability to automatically close in response to a Phase B containment isolation signal. Although the licensee has correctly identified that its modification to the design basis of CC9438 has not altered this valve's compliance with respect to GDC 56, the licensee has failed to adequately recognize the additional regulations and requirements that this valve must satisfy.

The current isolation capability of the licensee's CCW TBHE return line does not comply with GDC 54, which applies to "Piping systems penetrating containment." GDC 54 provides general requirements for the containment isolation system, including a provision that the isolation of containment penetrations shall have suitable redundancy. In Section 6.2 of the Standard Review Plan, Revision 2 (which was effective at the time of Byron's licensing), this requirement is interpreted to indicate that the NRC staff should ascertain "that no single fault can prevent isolation of the containment." In that allowing certain exceptions would provide greater safety, the NRC excepted certain containment penetrations (i.e., the containment pressure instrument lines and the ECCS suction lines from the recirculation sumps) from the requirement for redundant isolation. However, the staff specifically noted these exceptions in Section 6.2.4 of its Safety Evaluation Report for Byron Station, NUREG-0876 (Reference 4), such that it was clear that the general conclusion drawn concerning the Byron containment isolation system that "there are at least two barriers between the atmosphere outside containment and the reactor coolant system or the containment atmosphere on each fluid line penetrating containment," did not apply to the specifically excepted penetrations. The NRC staff did not note in NUREG-0876 that an exception to the dual-isolation requirement was made for the CCW TBHE return line; on the contrary, the FSAR submitted for Byron's licensing explicitly stated that, in the event of a TBHE rupture, dual isolation was available for this line. Therefore, the staff does not accept the licensee's contention (cited in Reference 1) that the NRC approved single-barrier isolation for a TBHE rupture during initial licensing. Rather, as the result of the licensee's design modification which made Byron's containment isolation system susceptible to a single failure, the NRR staff concludes that the licensee is currently out of compliance with GDC 54.

The current isolation capability of the licensee's CCW TBHE return line does not comply with GDC 44, which requires cooling water systems to be capable of performing their safety-related function(s) while accommodating a single failure. Byron's compliance with GDC 44 for the CCW system is described in UFSAR Section 9.2.2.4.1, which states that the redundancy of multiple trains prevents CCW system failure due to "any single active or passive failure." At the time of Byron's initial licensing, the capability of valves CC685 and CC9438 to isolate the safety-related portions of the CCW system from a failure induced by the inleakage of hot, pressurized reactor coolant through a postulated rupture in an RCP TBHE was specifically documented in FSAR Table 9.2-5, entitled "Component Cooling System Malfunction Analysis." Table 9.2-5, which was not revised by the licensee along with UFSAR Section 9.2.2.4.4,

currently still indicates that “Lines penetrating the containment for the RCPs have redundant isolation valves” to accommodate the single failure of one valve failing to secure flow. Thus, it is clear that the resultant failure of the CCW system due to reactor coolant inleakage following a postulated TBHE rupture was not considered a credible occurrence during Byron’s initial licensing, in that it would have required the postulation of multiple failures. However, as a result of the licensee’s reduction to the design capability of valve CC9438 in 1998, the single failure of CC685, following a TBHE rupture, would currently result in an unisolable leakage of reactor coolant into the CCW system. Therefore, although the licensee has indicated in Reference 2 that CC9438 is no longer credited with isolating a TBHE rupture, it is apparent that UFSAR Table 9.2-5 currently takes credit for the nonexistent isolation capability of CC9438 in its single-failure analysis for the CCW system. Properly accounting for the reduced capability of CC9438 in determining compliance with GDC 44 would instead require the licensee to demonstrate that the CCW system is capable of performing its safety-related functions despite a significant and unisolable inleakage of reactor coolant. Having reviewed Table 9.2-3 of the Byron UFSAR, entitled “Component Cooling System Design Parameters,” the NRR staff has concluded that the CCW system design parameters would be substantially exceeded by an unisolable TBHE rupture of 285 gpm.[5] In that each unit at Byron Station has a single, shared CCW surge tank, the staff concludes that a TBHE rupture, followed by the single failure to close of valve CC685, could potentially lead to the failure of the entire CCW system for the affected unit, thereby preventing long-term decay heat removal from the reactor core. Additionally, if NRR is unable to rule out break flow rates larger than 285 gpm, the staff does not have assurance that the relief capacity of the CCW system, as described in UFSAR Section 9.2.2.4.2, would be capable of preventing CCW system over-pressurization due to the inleaking reactor coolant. In summary, the NRR staff concludes that: (1) the licensee’s design modification to CC9438 has made the CCW system susceptible to a single failure, and (2) that the licensee is therefore currently not in compliance with GDC 44.

As reflected in the above discussions concerning the licensee’s noncompliance with GDCs 54 and 44, the staff does not accept the licensee’s contention in Reference 2 that the substitution of local, manual closure of CC685 for the remote-manual closure of CC9438 from the control room constitutes an acceptable design-basis method for addressing the postulated failure of CC685 to automatically close in response to a TBHE rupture. The licensee has justified the above substitution based upon its perceived compliance with guidance provided by Information Notice (IN) 97-78, “Crediting of Operator Actions in Place of Automatic Actions and Modification of Operator Actions, Including Response Times.” The NRR staff considers the licensee’s use of IN 97-78 for this purpose to be fundamentally flawed, in that the question of compliance with IN 97-78 is immaterial, when compliance with NRC regulations and other requirements in Byron’s licensing basis has not first been established. The availability of redundant means to actuate a single isolation barrier (CC685) is not sufficient to satisfy GDCs 54 and 44. The basis for the multiple barrier isolation required by these GDCs is that single failures may be postulated for a single isolation barrier, such as the CC685 valve (e.g., mechanical failures, such as severe stem binding or a broken valve), which would prevent its closure through both motor-powered and local manual operation. Additionally, in that local manual action is not capable of correcting severe mechanical failures of valve CC685 in a reasonable period of time, the staff cannot accept this type of action when addressing the single-failure criterion to

---

[5]Please refer to the staff’s discussion of the appropriateness of this value in NRR’s response to Question 1.

establish compliance with 10 CFR 50.46. Furthermore, in that the NRC has not categorically excluded consideration of potential TBHE breaks larger than a single cooling coil (see NRR's response to Question 1), the NRR staff is unable to accept the licensee's contention in Reference 2 that sufficient time and benign environmental conditions will permit the local manual operation of CC685. Based upon the above discussion, the staff has concluded that local manual closure of CC685 is not an acceptable design-basis method for addressing the single failure of CC685 to automatically close following a postulated TBHE rupture.

In summary, NRR has concluded that the licensee's current reliance upon a single barrier to isolate a postulated TBHE rupture does not comply with GDCs 54 and 44, 10 CFR 50.46, or the Byron safety analysis, as discussed in NRR's responses to Questions 1 and 3.

3) From a licensing basis perspective, did the original Byron licensing review accept the radiological consequences of an unmitigated release of reactor coolant, through the component cooling water system return line?

NRR has reviewed the licensing basis for Byron Station and concluded that the radiological consequences of an unisolable release of reactor coolant through the CCW return line from the RCP TBHEs were not accepted by the NRC at the time of initial licensing and, furthermore, have never been evaluated and accepted by the NRC.

As explained in NRR's response to Question 1, the licensing basis for Byron considers a rupture within an RCP TBHE to be a credible event. However, the unisolable loss of reactor coolant through the CCW return line to the outside of containment resulting from this event was not reviewed by the NRC during Byron's licensing, because this accident was not considered credible, based upon the requirement for redundant containment isolation in accordance with GDC 54. As the unisolable release of reactor coolant from the CCW return line was not considered to be a credible accident at the time of Byron's licensing, it is clear that the NRC neither reviewed nor accepted the radiological consequences resulting therefrom.

The licensee's 1998 modification to Byron's design basis, which reduced the design capability of valve CC9438, left valve CC685 as the single remaining barrier available to isolate a postulated TBHE rupture. In the current configuration of the plant, therefore, the application of the single-failure criterion to CC685, following a postulated TBHE rupture, no longer prevents the unisolable release of reactor coolant through the CCW return line from being considered a credible accident. Thus, the licensee's 1998 modification to CC9438 has introduced a new type of accident into Byron's licensing basis (namely, the unisolable, containment-bypassing release of reactor coolant through the CCW return line following a postulated TBHE rupture), which was not evaluated by the NRC at the time of initial licensing. Therefore, according to the revision of 10 CFR 50.59 effective at that time, the licensee's 1998 modification to CC9438 created an unreviewed safety question.

The initial licensing review for Byron specifically considered the radiological consequences of the design-basis accidents described in Chapter 15 of the Safety Evaluation Report for Byron Station, NUREG-0876 (Reference 4). Of the various types of accidents evaluated, the unisolable release of reactor coolant to the outside of containment due to a TBHE rupture is most similar to the accident evaluated in Section 15.4.6 of NUREG-0876, entitled "Failure of a

Small Line Carrying Primary Coolant Outside Containment."[6] In the analysis for this postulated accident, the licensee has considered a break in the chemical and volume control system (CVCS) letdown line, outside of containment, and downstream of the containment isolation valves. The analysis accounts for a break flow rate of 140 gpm during the 20 minute period assumed necessary for an operator to isolate the break.

The radiological consequences of an unisolable, containment-bypassing LOCA through the CCW return line appear to be significantly more severe than those resulting from the above similar accident evaluated in NUREG-0876. In the current configuration of Byron Station, the rupture of a TBHE would be postulated, after application of the single-failure criterion, to result in the unisolable leakage of reactor coolant to the outside of containment at a flow rate of 285 gpm or potentially greater. The licensee has contended, as cited in Reference 1, that the NRC accepted, at the time of initial licensing, the consequences of this unisolable, containment-bypassing LOCA due to a postulated TBHE rupture event. The NRR staff does not accept the licensee's contention based upon the two following observations: (1) an unisolable LOCA resulting from a postulated TBHE rupture was not considered credible at the time of licensing because the NRC licensed Byron with dual-barrier isolation for the CCW TBHE return line, and (2) it is not expected that the NRC would have evaluated and documented in NUREG-0876, a relatively small and limited release of reactor coolant to the environment through the CVCS letdown line, while simultaneously approving a larger, unisolable release of reactor coolant to the environment through the CCW return line without documenting a detailed accident evaluation.

Though the licensee has further contended in Reference 2 that the unisolable, containment-bypassing LOCA resulting from a TBHE rupture would be mitigated similarly to analyzed small-break LOCAs, Byron's current accident analyses do not fully consider the unique consequences of this new accident. The NRR staff has identified a number of new and unanalyzed concerns, such as the potential for increased radiological consequences, the potential for the resultant failure of the CCW system due to reactor coolant inleakage, and the potential for manifold, detrimental effects upon ECCS operation due to the leakage of significant amounts of reactor coolant to the outside of containment. Furthermore, in that the NRC has not categorically excluded the consideration of potential TBHE breaks larger than a single cooling coil (see NRR's response to Question 1), NRR's additional concerns may be more significant than the licensee might have assumed based on its discussion in Reference 2.

In summary, NRR has concluded that the radiological consequences of an unisolable, containment-bypassing LOCA due to a TBHE rupture event were not accepted by the NRC at the time of Byron's licensing. The unisolable LOCA resulting from a postulated TBHE rupture event was not considered credible at the time of licensing, and this accident has not been adequately analyzed by the licensee or evaluated by the NRC for acceptability. The licensee's design modification which has made this unisolable, containment-bypassing LOCA credible has created an unreviewed safety question, as defined by the revision of 10 CFR 50.59 in existence at the time the modification was made.

---

[6]Section 15.6.2 of the Standard Review Plan states that the piping lines to be considered in this analysis are those which are directly connected to the RCS in accordance with GDC 55. In that the CCW return line is not directly connected to the RCS, and was licensed under GDC 56, an unisolable loss of reactor coolant through this line must be considered a different type of accident.

4.0 CONCLUSION

The NRR staff has provided a detailed response to Region III's TIA 2001-009 in the foregoing evaluation. In summary, NRR has concluded the following:

(1) A TBHE rupture event is considered credible for Byron Station. The licensee's modification to CC9438 has introduced a previously unanalyzed, unisolable, containment-bypassing LOCA into Byron's licensing basis, thereby creating an unreviewed safety question.

(2) The Byron licensee may not rely upon a single valve to isolate a TBHE rupture event. Two isolation barriers are required for compliance with GDCs 54 and 44, 10 CFR 50.46, and the plant licensing basis.

(3) The NRC has not accepted the radiological consequences for Byron Station resulting from an unisolable, containment-bypassing LOCA through the CCW TBHE return line. This accident was not evaluated by the NRC during Byron's initial licensing because it was not considered credible, based upon the requirements to which Byron was licensed.

5.0 REFERENCES

(1) Memorandum from J. Grobe to L. Marsh, "Request for Technical Assistance - Potential Unisolable, Outside of Containment Reactor Coolant System Leak at the Byron Nuclear Plants (TIA 2001-009)," August 10, 2001. ADAMS Accession Number: ML012250315.

(2) Letter from R. Lopriore to U.S. NRC, “Response to a Request for Information Regarding the Basis of a Revision to the Updated Safety Analysis Report Addressing Isolation of the Thermal Barrier Cooler Return Line,” November 16, 2001. ADAMS Accession Number: ML020160035.

(3) Letter from W. Naughton to H. Denton, “Byron Station Units 1 and 2, Braidwood Station Units 1 and 2: Amendment No. 28, FSAR Amendment, to the Application For Construction Permits and Operating Licenses,” October 31, 1980. ADAMS Accession Number: 8011030544.

(4) “Safety Evaluation Report Related to the Operation of Byron Station, Units 1 and 2, NUREG-0876,” February 1982. ADAMS Accession Number: 8203050479.

Principle Contributors: J. Lehning
W. Lyon
E. McKenna

Date: May 24, 2002