NINA

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November 14, 2012
U7-C-NINA-NRC-120069

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Redacted Versions of Proprietary Attachments from U7-C-NINA-NRC-120065

Reference: Letter from Scott Head to the Document Control Desk, Questions from the October 2, 2012 Meeting with ACRS, U7-C-NINA-NRC-120065, dated October 16, 2012.

In the referenced letter, we provided responses to four questions from the ACRS Subcommittee meeting on October 2, 2012 on long-term core cooling. Two of those responses were proprietary. This letter provides the redacted versions of the proprietary responses submitted to the NRC in the referenced letter. Attachment 1 is a non-proprietary version of Attachment 1 from the referenced letter and Attachment 2 is a non-proprietary version of Attachment 4 from the referenced letter.

If there are any questions, please contact me at 979-316-3011, or Bill Mookhoek at 979-316-3014.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 11/14/12

Scott Head
Manager, Regulatory Affairs
NINA STP Units 3&4

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Attachments:

1. ACRS Item 102
2. ACRS Item 105

D091
NRO

STI 33622143

cc: w/o attachment except*
(paper copy)

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Basis for the 1 Cubic Foot of Fiber

RAI 06.02.02-4 initially discussed this in the response to an NRC question. The NRC reviewed a proprietary report provided by NINA in the Reading Room in support of their review of the RAI that documented items found in the containment of an operating Japanese plant after an outage. The results of that report were used to produce a proprietary derivative document, attached, that describes the fibrous material discovered in the containment and documented in that report.

Conservatively assuming all the rope fragments are 1/2 inch (1.27 cm) diameter and the yarn is 1/8 inch (0.32 cm) diameter, the total volume of the recovered fibrous debris is 0.0016 cubic feet. Based on the nominal density of intact rope, and converting to the surrogate density of 2.4 lb/cubic foot, the equivalent fibrous debris is 0.034 cubic feet. This supports the conclusion that the assumption of 1 cubic foot of fiber (around 30 times more than was found in the operating Japanese ABWR) is conservative.

PROPRIETARY INFORMATION

STP 3&4 obtained information about post-outage containment inspection results from an operating Japanese ABWR.

a(4)

Summary of Downstream Defense-In-Depth Analyses Assuming Fuel Assembly Inlet is Blocked

October 2012

Westinghouse

INTRODUCTION

This summary report is provided in response to an ACRS request at the meeting on October 2, 2012.

The licensing basis for downstream effects for STP 3 & 4 is based on a downstream debris deposition test under a license condition to be performed at least 18 months prior to operation. This test is described in COLA Appendix 6C. The calculations described in this report have been performed to demonstrate defense-in-depth, and to provide added assurance that downstream effects are not a challenge to long term cooling. These calculations are not intended to be part of the formal licensing basis.

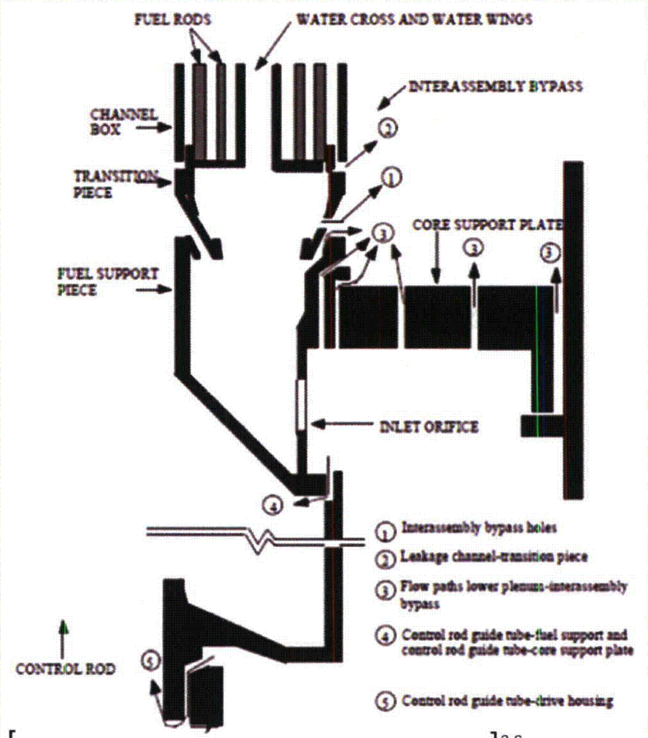
The following discussion presents three scenarios that would provide liquid to the upper plenum in the event of complete blockage of the fuel assembly inlets. These defense-in-depth calculations were performed to examine the long term effects of debris blockage downstream of the ECCS strainers. The LOCA event considered is a large break of one of the feedwater lines. These cases demonstrate that the core can be continuously cooled even if the fuel assembly debris filters become blocked completely.

Various flow paths connecting the lower plenum to the fuel assemblies are shown in Figure 1. Note that the figure does not show the debris filter or label the lower tie plate, both of which reside directly below the fuel rods. The fuel filter is located at the top of the transition piece, just below the lower tie plate. The figure shows the inter-assembly bypass flow path as path #1, which is comprised of two bypass flow holes per fuel assembly each having a diameter of 10.3 mm. These flow paths are designed to provide cooling to the control blades (located in the inter-assembly bypass region) and to prevent significant boiling in the bypass region. There are a number of smaller leakage paths through the core support plate that are shown as path #3 in Figure 1. These small leakage paths are assumed to become blocked by debris in all three calculations. Flow paths 2, 4 and 5 are also assumed to be blocked in these calculations.

There are also a number of intra-assembly bypass paths through the water channels within each fuel assembly. These channels vary by fuel design. Some of these channels would become blocked if the debris filter would become blocked; other intra-assembly channels bypass the debris filter.

In addition to the bypass flow paths, the high pressure core flooder (HPCF) pump(s) provides another source of liquid to the upper plenum. Both the bypass flow paths and the HPCF would provide liquid to the upper plenum (above the core). The resulting buildup of liquid in the upper plenum results in a periodic countercurrent flow of liquid downward into the fuel assemblies as the exit steam flow permits countercurrent flow. As a result, [

]^{a,c}.



[ ]^{a,c}

Figure 1 – Flow Paths Connecting the Lower Plenum to the Fuel Assemblies

RESULTS

All cases presented in this report use the 1971 decay heat standard plus 20% uncertainty. In addition, all cases simulate debris blockage [ ]^{a,c}. This corresponds to the time the unblocked transient [ ]^{a,c}. Selecting this time allows the effects of debris blockage to be seen clearly. Since the actual debris accumulation is expected to occur over approximately 2 hours (or longer), the time selected is a reasonable assumption.

Case 1: Cooling from Bypass Flow

If the inlets to the fuel assemblies should become blocked completely by debris, there are flow paths that allow coolant from the downcomer to bypass the core via the inter-assembly bypass region [ ]^{a,c}.[1] This water collects in the upper plenum where it can flow into the top of each fuel assembly countercurrent to the exiting steam flow.

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[1] [ ]^{a,c}

The analysis credits water injected by the Low Pressure Flooder (LPFL) pumps that bypass the core via the inter-assembly bypass region [ ]^{a,c}. Note that flow from the LPFL pumps is sufficient to maintain the downcomer filled to the elevation of the break. The other smaller bypass paths are assumed to become blocked when the debris filters are blocked.

The analysis assumes the blockage of the debris filters and the smaller leakage paths [ ]^{a,c} The resulting buildup of liquid in the upper plenum results in a periodic countercurrent flow of liquid downward into hot assembly as the exit steam flow permits counter-current flow, as shown in Figure 3. [ ]^{a,c} As shown, the void fraction at the exit of the hot assembly is maintained, on average, below 95%.

[ ]^{a,c} the cladding temperature is maintained [ ]^{a,c} as shown in Figure 5.[2]

[ ]^{a,c} Thus adequate cooling would be provided [ ]^{a,c}. Therefore the conclusion from this case is also applicable to other fuel designs.[3] This was confirmed by performing an additional sensitivity study (Case 1a). Case 1a was performed assuming the [ ]^{a,c}. The sensitivity study results are presented in Figure 6 and Figure 7. As shown, the core exit void fraction is maintained below 0.95 and the cladding temperatures [ ]^{a,c} (see footnote 2).

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[2] [ ]^{a,c}

[3] Fuel assemblies covered by this case include STP 3&4 COLA / ABWR DCD design basis fuel.

a,c

Figure 2 – Flows Through Bypass Regions (Case 1: 100% blockage)

a,c

Figure 3 – Liquid and Vapor Flux at the Hot Assembly Exit (Case 1: 100% blockage)

a,c

Figure 4 – Void Fractions in the Hot Assembly (Case 1: 100% blockage)

a,c

Figure 5 – Cladding Temperatures in the Hot Assembly (Case 1: 100% blockage)

a,c

Figure 6 – Void Fractions in Hot Assembly (Case 1a – no intra-assembly bypass flow)

a,c

Figure 7 – Cladding Temperatures in Hot Assembly (Case 1a – no intra-assembly bypass flow)

Case 2: Cooling by Limited Bypass Flow and HPCF Injection

Case 2 simulates fuel geometries [ ][a,c]. The calculation credits operation of one HPCF pump that delivers ECCS water directly to the upper plenum. Other assumptions are similar to the previous case [ ][a,c]. Coolant supplied by the LPFL pumps would be delivered to the upper plenum of the reactor via the inter-assembly bypass region and the bypass flow holes in each fuel assembly's transition piece, as in Case 1.

Similar to Case 1, the flow through fuel assembly bypass flow holes [ ][a,c] (see Figure 8). Injection from the HPCF pump and the LPFL pumps, via the bypass region, accumulated in the upper plenum. The coolant that collects in the upper plenum flows downward periodically into the top of the core. As a result, [ ][a,c], as shown in Figure 9 by the void fractions in the upper region of the hot assembly. As shown, the outlet void fraction is maintained below 0.95. Figure 10 shows the cladding temperatures in the upper region of the hot assembly, [ ][a,c] (see footnote 2, page 4).

a,c

Figure 8 – Flows Through Bypass Regions (Case 2: 100% blockage)

a,c

Figure 9 – Void Fractions in the Hot Assembly (Case 2: 100% blockage)

a,c

Figure 10 – Cladding Temperatures in Hot Assembly (Case 2: 100% blockage)

Case 3 – Cooling by HPCF

Case 3 is similar to Case 2 except that the inter-assembly bypass flow is completely blocked. As a result, there are no flow paths that provide cooling from below the core. The long term cooling of the core after complete blockage is provided by the injection of one HPCF pump. The LPFL pumps are assumed to continue to inject coolant into the downcomer, but that coolant either accumulates in the downcomer or flows out the feedwater line break via the feedwater sparger nozzles. The void fractions and cladding temperatures in the upper part of the hot assembly are presented in Figure 11 and Figure 12. As shown, the cladding temperatures [

$]^{a,c}$.

Note that the void fractions in the hot assembly [

$]^{a,c}$ The system reaches [
$]^{a,c}$. The cladding temperatures [
$]^{a,c}$ throughout this phase of the event (see footnote 2, page 4).

a,c

Figure 11 – Void Fractions in the Hot Assembly (Case 3 – 100% blockage)

a,c

Figure 12 – Cladding Temperatures in the Hot Assembly (Case 3 – 100% blockage)