Crystal River Unit 3

GSI-191 Strainer Fiber Bypass Test Plan

November 1, 2012

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CR3 Strainer Fiber Bypass Test Plan

- Introductions
  - Duke
  - Enercon
  - Alion
  - NRC
- Purpose
  - Present draft Crystal River Unit 3 debris preparation and bypass test plan for NRC review and comment

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CR3 GSI-191 Project Status

- CR3 was Pilot Plant for GSI-191
- Sump was modified in 2005
- Chemical Effects Testing was conducted in 2007/2008
- Bypass Testing was conducted in 2008
  - used pre-fiber reduction debris source term
- Supplemental response for GL 2004-02 provided in 2008
- 6 of 7 RAIs accepted/closed
- In-vessel Downstream Effects is only remaining RAI

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CR3 GSI-191 Project Status

- Fiber Reduction Efforts
  - Replaced Nukon on pressurizer and associated piping with RMI
  - Replaced Mineral Wool on Steam Generators and associated piping with RMI
  - No known fiber insulation remains in LBLOCA ZOI
  - 10 ft^3 of Nukon assumed to remain for conservatism/margin
- Latent fiber source term is 30 lbm
  - Based on 15% of 200 lbm

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CR3 Bypass Test Configuration

- Single Prototype Top Hat Strainer
  - 3’-2” long (compared to 7’-6” design)
  - 1/8” holes (same as design)
- Top Hat oriented vertically in test tank
- Gaps included to represent fit-up allowances
- Deionized water
- Flow rate manually controlled for constant approach velocity
- Fiber settlement in stagnant areas prevented without disturbing debris bed
- Bypassed debris will be captured in 5 micron filter bags

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CR3 Bypass Test Procedure – Debris Preparation

- Nukon fiber prepared in accordance with NEI ZOI Fibrous Debris Preparation Procedure, Revision 1 (January 2012)
- Purchased pre-baked from PCI
- Fines
  - Cut, weighed, and separated using pressure washer
  - Verified to meet Class 1 – 3 fiber characteristics
  - Staged for test @ ≤0.21 lbm/gal
- Smalls
  - Cut, soaked, and stirred until saturated and separated using paddle
  - Verified to meet Class 4 – 6 fiber characteristics

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CR3 Bypass Test Procedure – Debris Introduction

- Debris added directly over submerged sparger, allowing flow to carry debris to the top hat
- Internal tank mixing in stagnant areas
  - Promote transport of fibers to strainer
  - Care taken to avoid disturbing debris bed
- Batch sizes will ensure test tank concentration ≤ plant concentration
- Four “fines” additions
  - ~0.053” nominal bed thickness per batch (max)
- One “smalls” addition
  - ~0.012” nominal bed thickness

CR3 Bypass Test Procedure – Acceptance Criteria

- Stabilization Criteria
  - At least 5 pool turnovers after each debris addition
  - Filter bag will be switched out just prior to the next debris addition
- Minimum of 13 hours of total test time
- Minimum of 6 hours of recirculation after last debris addition
  - Filter bags switched out every 30 minutes during the first 2 hours
  - Filter bags switched out every hour after the first 2 hours
  - Two consecutive filter bags must appear clean

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CR3 Bypass Test Schedule

- Bypass Test currently scheduled for week of November 26, 2012, at Alion's test facility in Warrenville, Illinois
- Exact day(s) to be determined

CR3 Bypass Test – NRC Staff Q&A

1. Considering that a 38 inch top hat is used in the bypass test and CR has 7.5 ft (90 inch) strainers, has the effect of the potential for greater non-uniformity on the taller plant strainer been considered with respect to the testing? It is possible that a shorter strainer would allow lower bypass than a larger strainer since the top hats seem to collect debris relatively non-uniformly with the majority of debris collecting at the base. Since CR has a very low fiber load this may not be a significant concern since there may be open strainer area at the end of the test.

   As postulated above, previous testing performed on a 3x3 array of 38 inch top hats has demonstrated that substantial clean screen area exists with the existing fiber debris load.

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CR3 Bypass Test – NRC Staff Q&A

2. How will it be ensured during filter handling, valve alignment changes, etc, that loss of fiber or filter mass will not occur? This question is intended to cover the lifetime of the filter and any contents from initial weighing to final weighing.

   Alion controlled procedures are utilized throughout the lifetime of the filter bag to preclude any loss of fiber or filter mass. These procedures cover pre-weighing, testing (installation and removal), post-weighing, and storage. Filter bags are kept in sealed containers before testing, when transporting during testing, and after testing to prevent contamination and any loss of fiber or filter mass.

3. How is it ensured that fiber cannot bypass the filter and that filter damage will not occur due to high dP?

   Bypass flow through parallel paths is prevented by double valve isolation of the out-of-service filters. Filter differential pressure will be monitored throughout the test to prevent damage to the filter bags.

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CR3 Bypass Test – NRC Staff Q&A

4. How is it validated that the filter bypass valve (SBV-01) is fully seated prior to the initiation of the test and that all flow is through the intended filter (not other filters, etc.)?

   SBV-01 is a lever-operated butterfly valve, providing positive position indication. To demonstrate seating performance, pre-test and post-test instructions utilize drain valve PD-01 to check for valve leakage. Flow through the stand-by filters is prevented by double valve isolation (inlet and outlet).

5. Under section 4.1, could a diagram or additional discussion regarding the gaps and dimensions be provided? The written description is difficult to understand.

   See following drawing and pictures:

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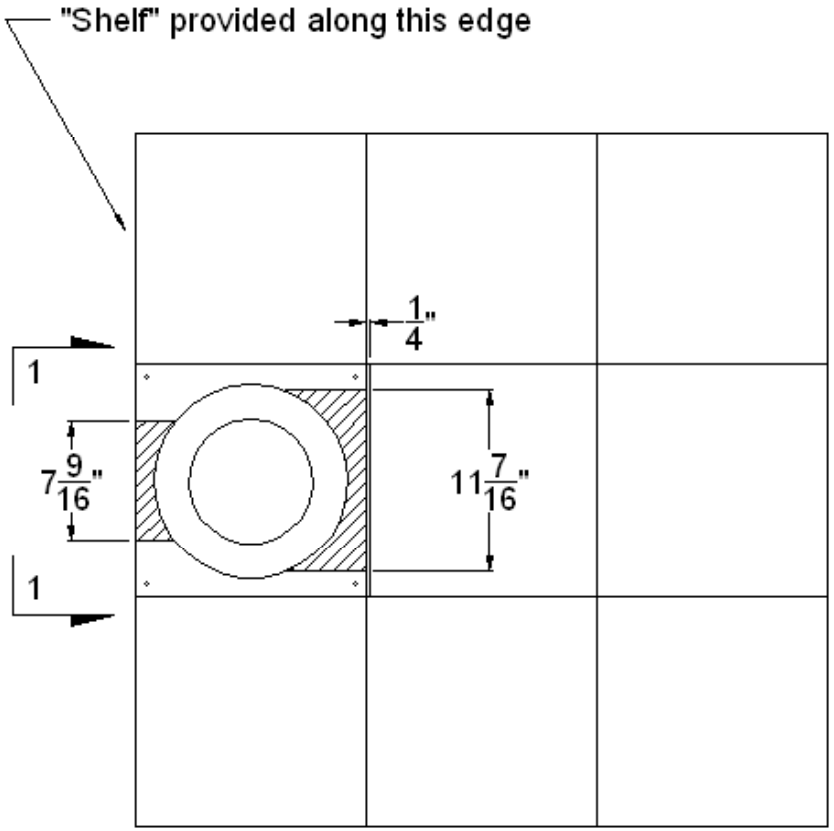
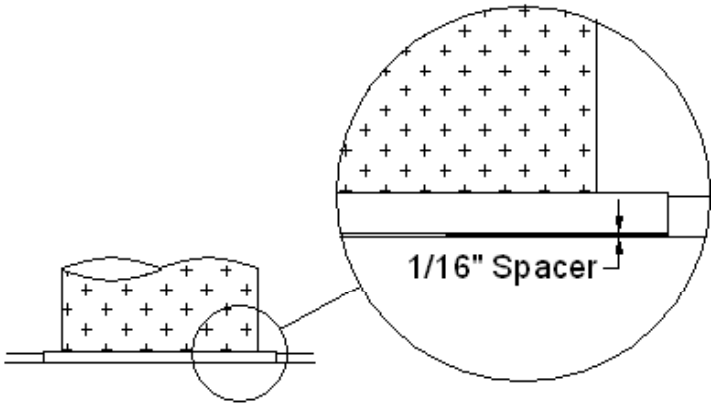
CR3 Bypass Test – NRC Staff Q&A



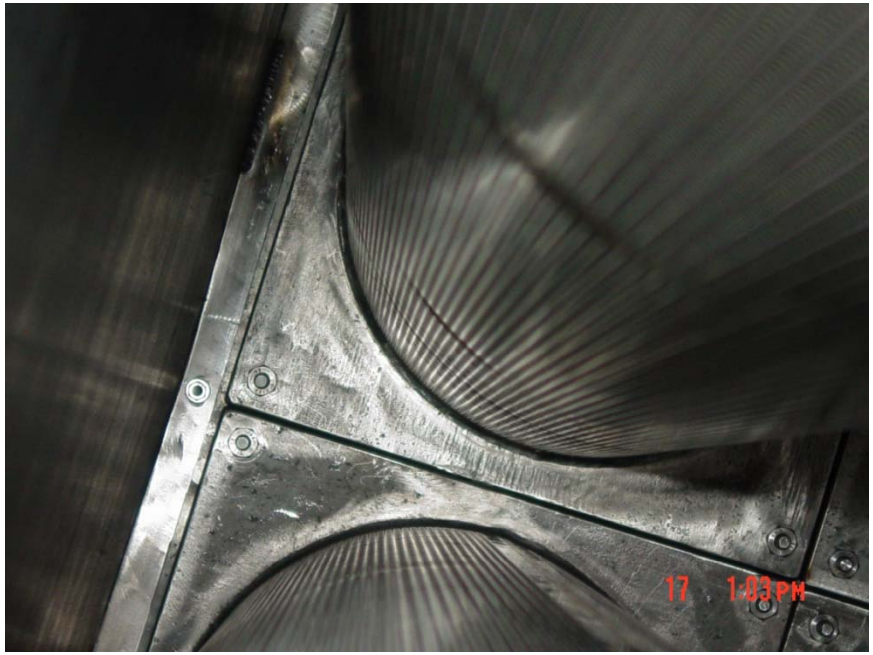


Section 1-1

1/16" gap between top hat base and plenum frame

Note: Interior gap can be on any of the three interior sides

CR3 Bypass Test – NRC Staff Q&A



CR3 Bypass Test – NRC Staff Q&A

6. Section 4 states that the fiber will be cut, weighed out, and separated using a commercially available pressure washer. How is it verified that fiber is not lost in the handling and separation process after weighing?

   Alion controlled procedures are utilized for debris preparation through the addition of fiber to the test tank. Fiber is cut before it is weighed. After weighing, it is placed in a sealed container with a clear top containing a small hole, only large enough for the pressure washer wand to be inserted, to ensure fiber stays in the container. Following separation with the pressure washer, the fiber remains in the container until it is added to the test tank.

CR3 Bypass Test – NRC Staff Q&A

7. Has it been verified that demin water is representative of the plant buffered, borated water or conservative? Have sensitivities with buffered borated water been performed on a small scale or has this been otherwise evaluated?

   Sensitivity studies performed by STP has shown there is no significant difference in bypass testing results using tap water or buffered, borated water. There are no known sensitivity studies specifically regarding deionized or demineralized water. However, it is felt that the level of processing that plant water receives makes deionized water more prototypical.

CR3 Bypass Test – NRC Staff Q&A

8. Does the debris enter the area around the top hat in the test similarly to the plant?

   The plant top hats are installed vertically in a sump pit, such that all debris must approach the top hat from above. In the bypass test configuration, the top hat is oriented vertically, but there are no walls to mimic the sump. The fiber debris will be carried with the flow to the exposed top hat. It is expected that the level of conservatism in the fiber debris load will compensate for any uncertainties in the test top hat configuration.

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CR3 Bypass Test – NRC Staff Q&A

9. Why was 13 hours selected as the minimum test time? Why was 6 hours selected for the minimum time after the final addition? How do the times relate to plant or test parameters?

   13 hours was selected as it is the approximate minimum time at which Aux Pressurizer Spray is considered effective for Boron Precipitation control (APS is the closest alignment to “hot leg injection” at CR3).

   6 hours is consistent with the NEI guidance. Due to the relatively low fiber load, clean screen area, and corresponding very low strainer head loss (as experienced in the Chemical Effects testing), the minimums of 6 hour post-debris additions and 13 hours total are expected to provide an adequate test duration.

CR3 Bypass Test – NRC Staff Q&A

10. The staff is not sure that visually inspecting the bags for fiber to determine test termination is a valid method. It is potentially a good method, but if fiber is undetected and weight of the filters increases following the test, some methodology of quantifying continuing bypass may have to be developed. It may be better to run the test long enough to ensure that bypass has stopped or reached a constant low value.

    Alion's previous bypass test experience has demonstrated that visual assessment of bag contents has been successful, and has been confirmed by subsequent weighing of filter bags.

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CR3 Bypass Test – NRC Staff Q&A

11. Do plant procedures require pump alignments to be changed or other activities that could affect flow through the strainer? Do these need to be accounted for during testing? Beyond design basis backflush or strainer clearing by some other means does not need to be considered.

    The test flow rate is based on all pumps (BS, DH, HPI) operating at maximum error-corrected flow rates. As accident conditions allow, the flow rate through the strainer may be reduced as pumps are shut off or injection flow rates are reduced. CR3 does not shut off and restart pumps to accomplish various system alignments.

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CR3 Bypass Test – NRC Staff Q&A

12. Section 4.3 states that 20% of the smalls transport to the strainer with 13% remaining smalls and 7% eroding to fines. The staff did not understand the methodology used to determine the amount of debris reaching the strainer. It is possible that some of the smalls that transport would erode, but this has not been assumed in past evaluations. The guidance is that some percentage of the small and large pieces left in the pool, not those transported, will erode to fines and transport to the strainer. Original guidance was 90% of debris in the pool erodes, but staff had accepted 10% for CR based on plant specific evaluations. In table A 1-2 it appears that 2 ft^3 of fines and 8 ft^3 of smalls are generated. The staff reviewed the CR GL2004-02 submittal and the values cited in the test document are consistent with the submittal. 92% of the fines transport There is some hold up in inactive volumes. The transport of 7% of the smalls as fines (eroded) appears to be non-conservative with respect to guidance. This fraction should be 10% of the small pieces that don't transport. Should 0.8 ft^3 transport instead of 0.56 ft^3? This is not a big change. The staff may just misunderstand how the calculation was done. *[continued on next page]*

CR3 Bypass Test – NRC Staff Q&A

Similar comment on Table 3 of attachment A. The CR submittal stated that CR intended to eliminate all fibrous insulation in the ZOI, but retained 10 ft^3 in the design basis for conservatism. There may be some way to credit some of the conservatism in the bypass testing debris source term. Additionally, sampling of the CR containment showed less than 100 lb of latent debris and CR assumed 200 lb. Both of these conservatisms are significant because the CR fiber source term is so low.

This test is using the same debris loads as the 2008 head loss testing and is documented in the supplemental response to GL 2004-02

- 10% erosion factor was used for smalls that remain in the pool and do not transport.
- 25% of smalls are retained on structures where erosion is only 1% (described in supplemental response to GL 2004-02).
- 12% of smalls are transported to the reactor cavity where no erosion occurs.
- Results in 7% of total smalls that erode to fines.

It is recognized that CR3 may have some conservatism that may be harvested with regards to debris source term and latent debris. However, at this time, we wish to maintain the conservatism.

CR3 Bypass Test – NRC Staff Q&A

13. Table 3 of Attachment A lists some large pieces as transporting. How were these accounted for in the test (including erosion)? This does not appear to be consistent with the GL 2004-02 submittals.

Transport fractions were taken directly from the transport calculations (also shown in supplemental response to GL 2004-02) which were written to address the pre-steam generator configuration as well as current configuration.

No large pieces are generated for the current configuration; therefore, no large pieces will be used in test.

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CR3 Bypass Test – NRC Staff Q&A

14. When will the filters be changed? This may be important if some value other than a single bounding bypass amount is used in the plant evaluation. For CR it may be okay to use a single bounding amount because the source term is very low.

    The filters will be changed just prior to each debris addition. For this test, there will be five debris additions. In addition, the filters will be changed every ½ hour during the first 2 hours following the last debris addition, and each hour after that, until the test termination criteria is met.

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CR3 Bypass Test – Summary of Action Items

- Action Items: