

Proposed STP Strainer Fiber Bypass Test Protocol
(Based on 2/27/12 Draft Revised FPL Bypass Test Protocol)

Table of Contents

SECTION		PAGE
1.	SCOPE.....	2
2.	PURPOSE.....	2
3.	DEFINITIONS.....	2
4.	GENERAL REQUIREMENTS.....	2
5.	PROCESS.....	3
5.1	Safety.....	3
5.2	Test Loop Setup.....	3
5.3	Test Loop Operation – Pre-Test.....	4
5.4	Test Loop Operation.....	4
6.5	Photographs of Bypass Testing.....	5
6.6	Records.....	5
6.	REFERENCES.....	6

APPENDICES

Appendix A Test Sequence

Proposed STP Strainer Fiber Bypass Test Protocol (Based on 2/27/12 Draft Revised FPL Bypass Test Protocol)

1. SCOPE

This document provides the minimum considerations necessary for performance of fiber only strainer bypass testing for STP using either flume testing or tank testing. The steps provided in this guideline are intended to be incorporated into the STP strainer bypass test plan.

2. PURPOSE

The purpose of this document is to determine the mass quantity and characteristics (length distribution) of fibrous debris that bypasses the STP strainer for a plant specific to a plant. The quantification and characterization of the fiber that bypasses is intended to be used for downstream effects analysis, both ex-vessel and in-vessel.

3. DEFINITIONS

- 3.1 STP Bypass Test Plan – The document that will be developed that provides the specific details of the STP bypass testing process.
- 3.2 Test Loop – The tank or flume in which the bypass testing will be performed. The test loop will normally include the test strainer, pump(s), metrology, debris capture devices and will have the capability for continuous recirculation of the water.
- 3.3 Debris Capture Device – Device installed downstream of the strainer to capture bypassed debris, containing removable filter media. This can also be used to clean up the loop prior to a test.

4. GENERAL REQUIREMENTS

- 1) STP will develop a test plan based on the protocol described in this document. The STP by-pass test plan shall be reviewed by the NRC prior to implementation to provide greater assurance that the results will be accepted by the NRC.
- 2) The test plan shall determine the appropriate scaling factor for the testing to be performed based on consideration of test strainer size and test loop flow rate capability.
- 3) The test plan shall determine the test loop turnover time and the containment sump pool turnover time.
- 4) The test plan shall define the STP specific fiber debris loads and plant parameters.
- 5) Testing will be performed at ambient temperature – between 55 and 80°F. The test plan shall specify the required temperature and the allowable deviation from the target temperature.
- 6) The fiber required for the testing shall be prepared in accordance with the NEI “ZOI Fibrous Debris Preparation: Processing, Storage and Handling”, Rev 2.

- 7) The test plan shall provide the steps necessary for introducing the prepared fibrous debris into the test loop while minimizing significant agglomeration of the debris.
- 8) The test plan should also provide for post-test fiber length measurement which could be used as an input for downstream effects evaluations and fuel blockage testing.
- 9) All weight measurements shall be performed using calibrated scales with sufficient accuracy for the intended purpose.
- 10) The weighed debris must be stored and clearly labelled with weight, type, and date. This is done to prevent the possibility of incorrectly identifying the material at the time of its use or following the completion of testing. Documentation of the weighed debris shall be per the requirements of the test plan.
- 11) All filter media utilized during performance of the test plan shall be carefully controlled and handled to ensure the results obtained are an accurate reflection of the captured debris and test conditions. These controls should be specified in the applicable sections of the test plan.
- 12) The debris must be handled in a safe manner to ensure minimal hazard to personnel. Each relevant material safety data sheet (MSDS) must be read before handling debris and each worker must wear appropriate personal protective equipment (PPE).
- 13) The test plan should contain the data sheets necessary to fully document the relevant information associated with the testing.

5. PROCESS

This section identifies the generic requirements for the performance of strainer bypass testing that should be included in the STP by-pass test plan.

5.1 Safety

Due to their potential negative effect on health, the materials identified for use may require appropriate safety precautions when handling. These requirements shall be detailed in the vendor test plan to ensure operator safety.

5.2 Test Loop Setup

The test loop shall be established per the test plan and will include consideration of the following, as applicable:

- 1) Strainer type
- 2) Strainer arrangement
- 3) Flow rate
- 4) Flume design for establishing the correct approach velocity and turbulence.
- 5) An appropriate method for introduction of debris into the test loop that does not disrupt the debris bed developing on the strainer.
- 6) Bypassed debris capture including the capability to swap debris filters during testing without disruption to the debris bed developing on the strainer.

- 7) The filters will have the capability of filtering out debris greater in size than approximately 5 microns.
- 9) Use of qualified instrumentation for differential pressure, flow rate and temperature measurement.
- 10) Use of data acquisition devices for capture and retention of the data generated by the instrumentation.

5.3 Test Loop Operation – Pre-Test

The test plan will provide, at a minimum, the following for performance of the pre-test which is the test loop clean-up and equipment checkout portion of the overall bypass test.

- 1) Prior to performing bypass testing, a 1 micron filter should be installed in the test loop with all flow circulating through these filters (if partition flow is being used, that portion of the test loop also needs to be directed to the filter media).
- 2) If not already completed, fill the test loop with tap water.
- 3) Recirculate the test loop for a minimum of 10 pool turnovers, at the maximum calculated test flow rate, to remove all residual debris from the test loop.
- 4) Ensure the data gathering system is functioning properly.
- 5) Upon completion of the pre-test filtering, the test loop should be secured, and the loop clean-up filter media removed.
- 6) Install the filter media to be used for the bypass testing into the debris capture device.

5.4 Test Loop Operation

The test plan will provide the specific steps for this testing based on the plant specific configuration, the applicable general requirements specified in this guideline, and the following considerations.

- 1) The filter media shall be weighed dry and marked or labelled with a unique identifier.
- 2) The test loop pre-test shall be completed and the test filter media shall be installed.
- 3) If determined to be necessary, the concentration of total fiber that could be introduced to the test loop should be determined based on the concentration that would exist in the containment sump pool at the initiation of recirculation.
- 4) The total quantity of fiber that is calculated to erode should be added to the fiber quantity determined in the previous step, as a function of concentration in the pool. These quantities of eroded fibers should be added commensurate with the time period during which the erosion occurs, considering the compressed timeline for this testing.
- 5) The test loop shall be placed in service with the filter media in-line. Clean strainer head loss should be determined during this portion of the sequence.
- 6) Should the testing be performed in a tank type test loop, some settling of debris may occur. If agitation is used to force the settled debris onto the strainer, the agitation shall not be used to develop a uniform debris bed across the strainer.

Care will be taken to not disrupt the developing debris bed which could result in a greater quantity of fiber bypass.

- 7) Debris additions to the test loop shall consider the total quantity of debris, the debris concentration, the thickness of the developed debris bed, the time necessary to introduce the debris to the test loop, the time to swap filter media and replace filters, and the expected time for the debris to transport to the containment sump strainer(s). A sensitivity study may be needed to determine the detailed debris addition method, including debris amount for each addition and total debris amount.
- 8) The STP bypass test plan will be conducted by batching fibers as indicated in the Appendix A table. The sequence assumes that the first 8 additions result in less than or equal to an equivalent 1/16 inch debris bed addition to the strainer per batch addition (total of 1/2 inch thickness on strainer). If the debris quantity per batch addition results in a calculated bed thickness greater than 1/16 inch the debris quantity should be reduced by a sufficient quantity to ensure less than 1/16 equivalent bed thickness on the strainer per batch addition. If the total debris addition results in a calculated bed thickness of less than approximately 1/8 inch, then the debris addition should be completed in a minimum of 4 batch additions.
- 9) Following final debris addition, the test loop should be allowed to run for an additional time that depends on plant specific requirements, e.g., at least as long as the hot leg switchover time for the plant, or longer, depending on the plant operating conditions.
- 8) Following completion of the minimum attributes above, tests shall not be terminated if the head loss has not yet stabilized (i.e. no head loss increase greater than 1% for two consecutive 30 minute intervals) or, if below the measurement threshold, then termination would be based solely on test time and minimal increase in captured debris downstream of the strainer.
- 9) The filter media, with debris collected during the test shall be dried and weighed for determination of the debris captured during the test.
- 10) The total quantity of debris captured divided by the test strainer surface area will determine the strainer by-pass quantity, e.g. lbs/sqft
- 11) The by-pass fiber debris will also be analyzed to obtain a fiber length distribution.
- 12) Debris collected during this testing may be retained for use in future testing such as site specific fuel assembly testing.

6.5 Photographs of Bypass Testing

Photographs of the various steps of the bypass testing may be taken as additional confirmation that the testing did meet the test plan requirements.

6.6 Records

The test plan shall specify the methods to be used for documenting all aspects of the bypass testing.

6. REFERENCES

- 1) Revised Guidance for Review of Final Licensee Responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage On Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors", March 28, 2008 (ML080230234)
- 2) EPRI 1011753, "Design Basis Accident Testing of Pressurized Water Reactor Unqualified Original Equipment Manufacturer Coatings", September, 2005 (ML071130069)
- 3) ZOI Fibrous Debris Preparation: Processing, Storage and Handling, NEI, Rev 2

Appendix A

Test Sequence

Step	Batch Size (% of total)	Cumulative (%)	Addition Interval	Filter Change Interval / Sample Collection
1	6.25	6.25	≥5 min. after stable flow in test loop	Within 2 minutes prior to next debris addition
2	6.25	12.5	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
3	6.25	18.75	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
4	6.25	25	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
5	6.25	31.25	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
6	6.25	37.5	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
7	6.25	43.75	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
8	6.25	50	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
9	12.5	62.5	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
10	12.5	75	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
11	12.5	87.5	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition
12	12.5	100	Greater of 10 min. or 5 test loop pool turnovers	Within 2 minutes prior to next debris addition

13	Following final debris addition, the test loop should be allowed to run for an additional 4 to 12 hours (based on hot leg switchover time for the plant), based on the thickness of the debris bed formed and the continued capture of debris in the filter media, with consideration of the head loss developed across the strainer.	Following the final filter swap, subsequent filter swaps should be performed every 30 minutes for the next 2 hours, and then hourly until completion of the test.
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