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TECHNICAL DOCUMENT COVER PAGE

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Document Title: Robinson Nuclear Plant: Bypass Fiber Quantity Test Plan		
Project No: 261-8707		
Project Name: H. B. Robinson Plant Top Hat Strainer Bypass Testing		
Client: ENERCON		

Document Purpose/Summary:

This document presents the Alion Test Plan for the H. B. Robinson Plant Top Hat Strainer Bypass Testing measurement. All design inputs are based on the Enercon Design Input Letter [Ref. 10].

This test plan is prepared Safety-related in accordance with the Alion Science and Technology Innovative Technology Solutions Operation Nuclear Quality Assurance Program.

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Design Verification Method:

X Design Review

_____ Alternative Calculation

_____ Qualification Testing

Professional Engineer (if required) Approval:_____Date_____

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REVISION HISTORY LOG

Document Number: ALION-PLN-ENER-8707-02 Revision: 0C

Document Title: Robinson Nuclear Plant: Bypass Fiber Quantity Test Plan

Instructions:
Project Manager is to provide a brief description of each document revision including rationale for the change and, if applicable, identification of source documents used for the change.

REVISION	DATE	Description
0A	9/28/2012	DRAFT Issue
0B	10/15/2012	Incorporated client comments in Sections1, 2, 2.2, 3.1, 3.4, 3.5, 4.1, 4.4, 4.5, 4.6.1, 4.6.2, 4.6.3, 4.7, 4.10, 5, 7.2, 11, 12 and Appendix 1 and Attachment A.
0C	DRAFT	Added "DRAFT" watermark. Incorporated client comments in Sections 2.0, 3.4, 4.2, 4.4, 4.6.1, 4.6.3, 5.0, 8.1.

Note - This test plan was marked up by H.B. Robinson to reflect an initial test approach velocity of 1.5X design (0.003 ft/s). A revision is planned to incorporate the approach velocity and to add measurement of bypass following stopping and restarting the test pump.

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ACRONYMS AND DEFINITIONS

“	inches (length)
°C	Degrees Celsius
°F	Degrees Fahrenheit
Alion	Alion Science and Technology
CFR	Code of Federal Regulations
cm	centimeter
D	Diameter
dp	differential pressure
ECCS	Emergency Core Cooling System
FE	Flow Element
GL	Generic Letter
gpm	gallons per minute (flow)
GSI	Generic Safety Issue
ft	Feet (of water)
HDFG	High Density Fiberglass
in	inch
ITSO	Innovative Technology Solutions Operation
kg	Kilogram
LDFG	Low Density Fiberglass
lb	Pound
LOCA	Loss of Coolant Accident
MSDS	Material Safety Data Sheet
NI	National Instruments
PCI	Performance Contracting, Inc.
PWR	Pressurized Water Reactor
QA	Quality Assurance
RNPP	Robinson Nuclear Power Plant
S or sec	second
TB	Turbidity
USNRC/NRC	United States Nuclear Regulatory Commission

1.0 BACKGROUND

The design of the Emergency Core Cooling System (ECCS) at the Robinson Nuclear Power Plant provides a suction source for the ECCS pumps, allowing the ECCS to operate in a containment recirculation mode. If a Loss-of-Coolant-Accident (LOCA) inside containment were to occur, it could generate debris that, if transported to and deposited on the containment sump screens, could pass through the screens and affect downstream components and/or the ability to maintain long term core cooling.

The United States' Nuclear Regulatory Commission (NRC) Staff has identified Generic Safety Issue (GSI) –191, "Assessment of Debris Accumulation on PWR Sump Performance." To this end, on September 13, 2004, the NRC issued Generic Letter (GL) 2004-02 to Pressurized Water Reactor (PWR) Owners for action to ensure that LOCA-generated debris does not degrade ECCS performance.

2.0 TEST OBJECTIVES

The objective of this test program is to measure the mass of the fibrous debris that passes through the screen perforated area using:

- Prototype strainer hydraulic tank testing
- 5-micron nominal inline filters to capture bypassed fiber and subsequently take the difference of pre and post-test weights
- Incremental fiber loading to ensure conservative measurement of fiber bypass

2.1 Strainer Design

A double ring top-hat array with debris bypass eliminators will be installed in the Alion test tank. The strainer layout utilized for testing will be a top hat array with four top hats installed horizontally, see Figure 2-1 and Figure 2-2. Debris bypass eliminators, commonly referred to as "mesh", will be installed in both the inner and outer annuluses of all four Top-Hats in the prototype test array.

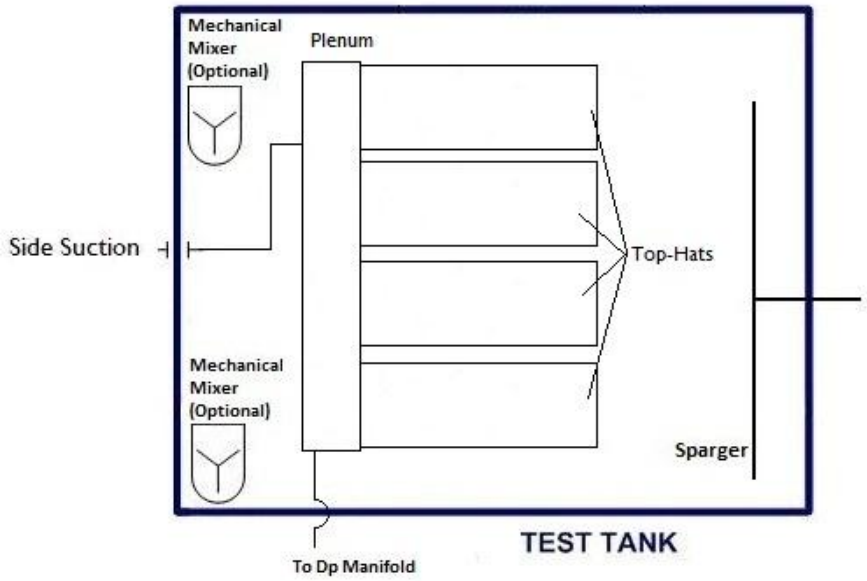

Figure 2-1: Strainer and Test Tank Layout

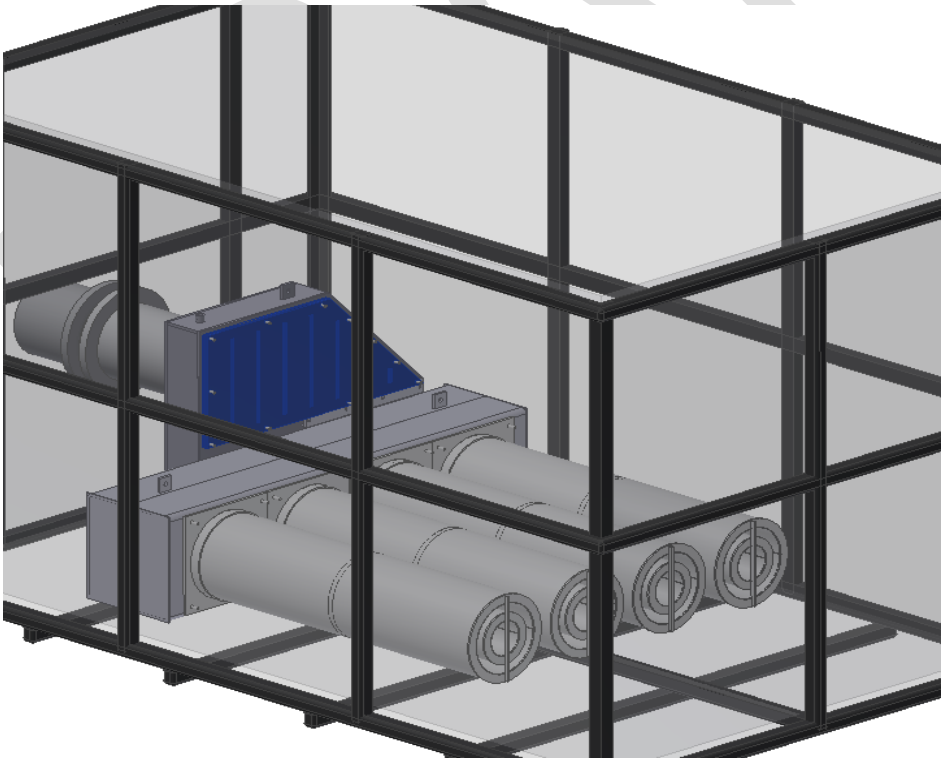

Figure 2-2: Arrangement of the 1 X 4 Array in the Test Tank

2.2 Fiber Bypass Testing

Alion will perform a fiber bypass test on a prototypical section of the sump strainer that is comprised of four Top Hats to measure the maximum fiber bypass quantity. The testing will be performed in the Alion Test tank located in Warrenville, Illinois.

3.0 TECHNICAL APPROACH

The discussion of technical approach implemented in this plan includes the following:

- an overview of testing strategy
- debris load definition
- scaling of plant quantities for testing
- filter bags
- assumptions

3.1 Overview of Testing Strategy

The technical approach implemented in this test plan is to measure the bypassed fiber quantity for a prototypical ECCS strainer using test conditions that conservatively maximize fiber bypass. Alion will perform bypass testing for Enercon in accordance with the requirements of the project plan [Ref. 14]. A representative approach velocity will be passed through a prototypical strainer. Incremental fiber additions simulate the worst-case scenario for fiber bypass by minimizing the concentration, which prevents early bed formation. Bypassed fiber will be captured using downstream 5-micron filter bags via a 100% pass through alignment in the flow stream, so that bypassed fiber can be captured and measured. See Section 3.4 for filter bag preparation, processing and measuring. The test report will show the measured bypassed fiber quantities per addition and the total quantity of bypassed fiber.

3.2 Debris Load Definition

Debris load definition is provided by the Enercon Design Input Letter which identifies the fibrous debris source terms for the current plant configuration. The current debris types are NUKON, Temp-Mat, Kaowool, Unibestos, and other fiberglass (LDFG) [Ref. 10]. The debris source terms are scaled for the test article in Appendix 1. NUKON will be the surrogate utilized during testing to represent the different fibrous types (see Section 4.7). NUKON fines and smalls will be created according to the current revision of the NEI ZOI Fibrous Debris Preparation [Ref. 12].

3.3 Scaling of Debris Quantities for Testing

Scaling of debris quantities is detailed in Appendix 1.

3.4 Filter Bags

The filter bags used for this test will be 5-micron mesh size, which will capture bypassed NUKON particles/fibers, which typically have a diameter of 7-micron and are expected to have a much longer

characteristic length, thereby facilitating high capture efficiencies. Before use and in accordance with ALION-SPP-LAB-2352-70 [Ref. 3], the filters will be prewashed to remove any loose material. The filters will be dried and weighed before and after testing to calculate the amount of NUKON that was captured in the filter bags during the test. Alion lab procedure ALION-SPP-LAB-2352-70, "Filter Bag Preparation and Processing Procedure", will be the procedure utilized to measure the collected NUKON.

At least 13 filter bags will be prepared before each test. During testing one filter bag will be set up to capture NUKON, another used as a control, and the remaining filter bags will be switched out one at a time for each fiber addition. Also, filter bags may be replaced as required to maintain acceptable filter bag differential pressure. Filter bags will be dried with set drying times until the difference in weight change between drying sessions is minimal. The test procedures will specify drying time intervals and the weight change differential. Additionally, the filter bags will be stored for future analysis, if required.

Prior to testing, another set of cleaning filter bags shall be used to completely filter out any latent debris that would affect the post-test mass of the testing filter bags.

3.5 Assumptions

The following assumptions are made:

- Ten percent of the total volume of Unibestos will be in fibrous form. Unibestos is the trade name for a calcium-silicate material containing asbestos fibers [Ref. 8]. Alion experiences with various calcium-silicate materials have shown that they contain a 0-4% fibrous component [Ref. 15]. Therefore, it is conservative to assume 10% of the total volume of Unibestos will be in fibrous form.
- The effective surface area of the strainer is 4178 ft^2 [Ref. 10]. However, testing will be performed using a scaling ratio based on a 4000 ft^2 strainer. This incorporates margin into the results for tag/label sacrificial area or in case it becomes necessary to remove Top Hat strainer modules in the future.
- The fiber from each addition collects on the screen and does not remain suspended in the tank volume.

4.0 TEST DESCRIPTION

The test will be performed at the Alion Hydraulics Laboratory located in Warrenville, IL. A diagram of a typical test tank instrumentation setup is illustrated in Figure 4-1.

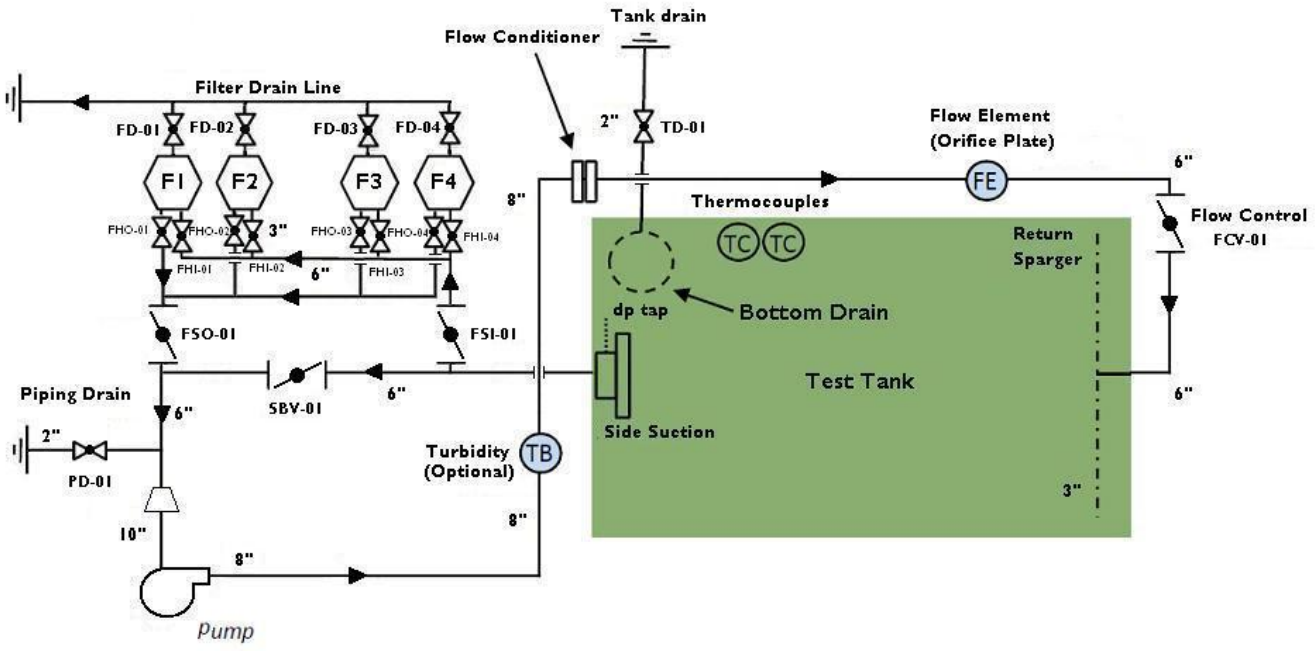

Figure 4-1: Alion Hydraulic Test Tank Diagram

4.1 Scaling and Selection of Prototype

A prototype section of the strainer will be tested in the tank. This assures a 1 to 1 scaling ratio for dimensions and perforated plate hole size including gaps installed at the base of Top Hats at the plenum. The height of the gap between the plenum and Top Hat will be 1/16 inch (+1/32", -0"). The total length of the gap between the Top Hats and the plenum will be 8' 9-3/8" (+/- 1/16"). Additionally, there are ½" gaps in the two cover plates on the transition plenum. The two cover plates will be separated by 1/16" (+1/32", -0") and the length of the gaps will be 5' 9-1/4" (+/- 1/16"). The effective surface area of the plant strainer and the test module (four Top Hats) are 4178 ft^2 and 121.24 ft^2, respectively [Ref. 10]. Testing will be performed using a ratio based on a 4000 ft^2 strainer. This incorporates margin into the results for tag/label sacrificial area or in case it becomes necessary to remove top hats in the future. The other test parameters are scaled and are included in Appendix 1.

4.2 Debris and Flow Scaling

All testing parameters will be based on the project inputs outlined in the Design Input Letter [Ref. 10]. These parameters will be scaled based on the ratio of testing strainer area to plant net effective area. This scaling factor and its use in determining test parameters are shown in Appendix 1.

4.3 Fiber Debris Size Distribution

Fibrous debris size distributions are developed for the following debris types:

- NUKON
- Temp-Mat
- Kaowool
- LDFG
- Unibestos

The fiber debris size distribution given in the design input letter [Ref.10] for the above debris types classifies the fibrous debris as "small fines". For the tests outlined in this document, two fibrous debris classifications will be used, "fines" characterized as Classes 1-3 in NUREG/CR-6224 [Ref.11] and "smalls" characterized as Classes 4-6 in NUREG/CR-6224. Classes 1-3 "fines" will be used to represent the latent debris source term for all tests.

The "small fines" characterized in the design input letter [Ref. 10] are broken into 17% fines and 38% smalls for destroyed NUKON and Temp-Mat insulation and 22% fines and 63% smalls for Kaowool, Unibestos and fiberglass debris.

Unibestos – Unibestos is the trade name for a calcium-silicate material containing asbestos fibers [Ref. 8]. NUKON fines will be the surrogate used to represent the fibrous portion of the Unibestos material. Alion experiences with various calcium-silicate materials have shown that they contain a 0-4% fibrous component [Ref. 15]. Therefore, it is conservative to assume 10% of the total volume of Unibestos will be in fibrous form.

4.4 Debris Preparation–Fiber

Debris will be prepared according to the NEI ZOI Fibrous Debris Preparation procedure [Ref. 12]. This procedure produces the required size distribution of fiber fines and smalls that are easily transportable and readily disperse in the testing medium. Fines are defined in the NEI procedure document [Ref. 12] as readily suspendable in water and are Classes 1 through 3 while smalls are class 4 and 5 of Table 3-2 of NUREG/CR-6808 [Ref. 13]. Table 3-2 is in Attachment B. All fiber will be Performance Contracting, Inc. (PCI) NUKON single side baked between 6 and 8 hours. Fibrous fines will be cut, weighed out and separated using a commercially available pressure washer, and then verified to meet the correct classification of fiber sizes. Fiber fines are then combined to maintain a fiber mass to volume ratio less than or equal to 0.21 lbs/gal. Fibrous smalls will be cut for the appropriate mass for each specific addition, soaked in water and stirred with a hand paddle until the pieces are fully saturated and separated from each other. Samples of fiber smalls and fines will be examined and photographed using a

light-board, or equivalent device, to ensure fiber preparation is consistent with the guidance provided in Reference 12.

4.5 Debris Introduction

Debris will be introduced into the tank in areas of high velocities near the pump return line. This will allow the flow within the tank to carry the debris to the Top Hats. Adjustable tank internal mixing will be added to areas of low velocities. Batches of fiber will be added in increments that ensure the concentration in the test tank is less than or equal to the plant's concentration. The plant concentration is calculated in Appendix 1.

Fiber additions are included in the test matrix in Section 5.0.

4.6 Hydraulic Test Conditions

4.6.1 Strainer Approach Velocity

Plant and prototype strainer surface areas for which the approach velocity is used to calculate the testing flow rates are given in the design input letter [Ref. 10] and are specified Appendix 1. The approach velocity at the start of the test is 0.003 ft/s. After full screen coverage is achieved, the flow will be reduced to the normalized approach velocity of 0.00213 ft/s based off the ECCS flow rate of 3820 gpm (see Appendix 1) [Ref. 10]. Screen coverage must be determined through visual, tactile, or other means that do not disrupt the debris bed. The equivalent flow rates for the approach velocities are 164 gpm and 116 gpm, respectively.

4.6.2 Water Temperature and Chemistry

The water temperature will be maintained above 60 °F during the course of the test. Temperature shall not exceed the maximum limit of 110 °F. Deionized/demineralized water will be used and the chemistry will not be monitored or controlled during this test other than initially verifying the use of deionized/demineralized water.

4.6.3 Water Level

The pool water level for the bypass test will be initially set at 36 inches. If vortexing occurs, a vortex suppressor will be installed or the water level will be increased. Any required actions will be recorded in the test logs. The water level will be recorded during testing and increase with each debris addition. Test tank water may be removed to mix the next debris addition and re-introduced into the test tank. Test tank water may be discarded after visually verifying there is an insignificant quantity of fiber within the water to ensure there is room for further debris additions.

4.6.4 pH

pH will not be monitored or controlled during this test.

4.6.5 Turbidity

The tank liquid may be sampled for turbidity when determined by the test engineer. Turbidity measurements will be recorded for informational purposes only.

4.7 Debris Type

A description of each of the debris materials and surrogates used for testing follows:

- NUKON - The low density fiberglass insulation quantities that transport to the strainer will be accurately represented by NUKON. NUKON, provided by PCI, is specified as the plant fibrous insulation. The as-fabricated density of NUKON is 2.4 lb/ft^3 and the fiber diameter is 7 microns [Ref. 8]. Attachment D contains Material Safety Data Sheet (MSDS) information.

- Temp-Mat – Temp-Mat is a woven fiberglass fabric with a fiber diameter of 9 microns. The as-fabricated density of Temp-Mat is 11.8 lb/ft^3 [Ref. 8]. NUKON will be used as a surrogate for Temp-Mat throughout testing. The use of NUKON, a LDFG, as a surrogate is conservative due to the smaller fiber diameter and characteristic length. Additionally, previous Alion testing has shown that smaller diameter fibers with shorter characteristic lengths consistently causes higher bypass. Attachment D contains Material Safety Data Sheet (MSDS) information.

  When determining the volume of the scaled NUKON debris load from the mass calculated in Appendix I to be used in the tests, the density of NUKON (2.4 lb/ft^3) will be used. This results in a larger apparent scaled volume of fiber to be used for testing. This alternate, lower density is chosen due to Alion's previous testing observations regarding the destroyed density of Temp-Mat. The 2.4 lb/ft^3 density more accurately represents destroyed Temp-Mat's volume. This density is then used to calculate an equivalent bed thickness for a determined volume of fiber. Equivalent bed thickness is the only use of the scaled debris volume in testing.

- Unibestos – Unibestos is the trade name for a calcium-silicate material containing asbestos fibers [Ref. 8]. NUKON fines will be the surrogate used to represent the fibrous portion of the Unibestos material. Alion experiences with various calcium-silicate materials have shown that they contain a 0-4% fibrous component [Ref. 15]. These fibers have comparable characteristics to both NUKON and Temp-Mat that can be seen in the table below [Ref. 8].

Table 4-1 – Fibrous Material Comparison

	NUKON	Temp-Mat	Asbestos Fibers
Destruction Pressure (psi)	10*	17	10
Characteristic length (um)	7	9	1-8
Material Density (lb/ft^3)	2.4	11.8	7-10

* Destruction pressure for Unjacketed NUKON

4.8 Test Control

All testing actions and control must be noted in the test log. This includes flow adjustments, debris addition (beginning and completion), stirring (including the duration of the stir), and all other acts that affect the testing environment. The test logs shall be able to describe everything about the test without recourse to the test engineer.

The flow rate of the system should be maintained at - 10 gpm, +20 gpm of the prescribed value. Stabilization criteria for each subtest are given in Section 8.0.

4.9 Preparation

The test tank must be arranged and equipped as per the following (see Figure 2-1):

- A sparger system will be installed on the return line to aid in the suspension of the debris within the water. Mechanical mixers may be utilized in low velocity areas to ensure settled debris becomes re-suspended. Hydraulic shakedown testing can be conducted to ensure that the return flow will create adequate turbulence to suspend the test debris.

- The differential pressure tubing, both the High and Low lines must be securely fastened inside the tank to prevent vibrations that cause noisy signals. Furthermore, the Low side must be securely fastened to the plenum to prevent ambient leakage.

The National Instruments' LabVIEW™ data acquisition program must be programmed to match the test parameters, such as screen area and correct orifice plate conversion (see Section 7.0). Imperial units will be displayed and recorded in the test logs and data during testing.

The debris batches of Section 5 must be prepared according to the test matrix and the latest NEI debris preparation procedure [Ref. 12]. The debris preparation documentation from Reference 3 will be included with the execution of this Test Plan.

4.10 Debris Addition

All debris will be added in two places directly over the sparger system, which will allow the flow within the tank to carry debris to the Top Hat. . This will allow for equal debris bed growth on the top hats. The debris must be added in a controlled manner as to not disturb the debris bed through unnecessary turbulence.

Also, visual observations shall be made to ensure that a vortex does not form during the testing. If a vortex does form, water shall be added to the tank to raise the water level until no vortices are observed or a vortex suppressor may be installed.

5.0 TEST MATRIX

To maintain the correct debris concentration below that of the plant and to maintain the correct fiber mass to volume ratio given in the NEI debris preparation procedure [Ref. 12], the volume of water per addition is specified. The six gallons of water added to the test tank per stage will satisfy both criteria above while maintaining practical testing actions during testing. It is worth noting that the last addition for each addition will have a different concentration because the addition represents the remaining amount of scaled test fiber for that size classification. See Section 4.6.1 regarding which flow rate will be used during testing.

Table 5-1 – Bypass Test Matrix

Stage #	Flow Rate (GPM)	NUKON Fines (lbs)	NUKON Smalls (lbs)	Tank Volume (gal)	Tank Level (in)	Nominal Bed Thickness (in)	Concentration (ft^3/gal)	lbs/gallon Added (NEI Criterion)	Gallons Added
F.1	164/116	1.22	0	1500	36.00	0.050	0.00034	0.20	6
F.2	164/116	1.23	0	1506	36.16	0.101	0.00034	0.20	6
F.3	164/116	1.23	0	1512	36.32	0.152	0.00034	0.21	6
F.4	164/116	1.24	0	1518	36.48	0.203	0.00034	0.21	6
F.5	164/116	0.72	0	1518	36.48	0.233	0.00020	0.12	6
S.1	164/116	0	1.24	1524	36.64	0.284	0.00034	0.21	6
S.2	164/116	0	1.25	1530	36.80	0.336	0.00034	0.21	6
S.3	164/116	0	1.25	1536	36.96	0.387	0.00034	0.21	6
S.4	164/116	0	1.26	1542	37.12	0.439	0.00034	0.21	6
S.5	164/116	0	1.26	1548	37.28	0.491	0.00034	0.21	6
S.6	164/116	0	1.27	1554	37.44	0.544	0.00034	0.21	6
S.7	164/116	0	0.92	1554	37.44	0.582	0.00025	0.15	6

6.0 TEST PROCEDURES

The Alion Test Program has developed generic test procedures for debris preparation, fill and start-up testing, and head loss testing. These generic test procedures are applicable, and the current revisions at the time of testing will be used to perform the testing specified in this test plan. Generic test procedures are listed in References 2 through 7.

The Test Lab Safety Procedure, ALION-SPP-LAB-2352-21 [Ref. 7] shall be followed at all times.

The general sequence of the test is as follows:

1. Prepare test filter bags in accordance with procedure ALION-SPP-LAB-2352-70 [Ref. 3].
2. Verify the tank has been cleaned in accordance with ALION-SPP-LAB-2352-45 [Ref. 4] and filled according to ALION-SPP-LAB-2352-44 [Ref. 5].
3. Verify the tank is setup correctly and dimensional variations from the general layout included in Figure 2-1 and Figure 4-1 are approved by the Project Manager and/or Test Coordinator.
4. Debris shall be prepared in accordance with the latest NEI debris preparation Procedure [Ref. 12].
5. Photographs of typical samples of prepared debris will be taken.

6. For cleaning purposes, filter bags shall be used to filter water in the tank for at least 5 turnovers prior to adding any debris at a cleaning flow rate greater than the test flow rate to ensure that no residual debris interferes with the measured bypass quantities.
7. Strainer bypass testing will be performed in accordance with test specific procedures and the Test Matrix described in Section 5 of this Test Plan.
8. Photographs of the debris bed and any non-attached settled debris must be taken when visibility permits.
9. At the conclusion of testing, process test filter bags in accordance with ALION-SPP-LAB-2352-70 [Ref. 3].
10. Drain and clean the Test Tank in accordance with Test Tank Draining and Cleaning Procedure, ALION-SPP-LAB-2352-45 [Ref. 4].

7.0 TEST EQUIPMENT AND SPECIFICATIONS

This section details the test specification requirements in which the test instrumentation must conform. In addition, the test equipment used and the accuracy of each instrument are discussed.

7.1 Equipment Specifications

The equipment employed during testing and their associated accuracies are given in Section 7.2. The data acquisition system is used to collect flow rate, differential pressure, and temperature data throughout the performance of the test. This system also allows for the creation of graphs of the data as well as tables of the raw data.

Due to instrument noise and combined instrument uncertainties, the data that is displayed via LabVIEW™ (version controlled by [Ref. 1] and verification controlled by [Ref. 2]) is a floating-average, averaged over the previous 10 data points, with each data point recorded every 2 seconds. This averaging may lead to small discrepancies in instrument readouts. In such a case, the most conservative measurement for any given instrument will be recorded in the test logs. For instance, the lowest flow rate, highest differential pressure, and highest temperature shall be recorded in the test logs.

7.2 Test Equipment and Accuracy

The details of the equipment used and the calibration of the following instruments in this testing are identified and controlled in the Test Program Description, ALION-PLN-LAB-2352-003, "Hydraulic Testing of Debris Program Description: Test Tank" [Ref. 1] and Alion "Test Equipment Verification Procedure" [Ref. 2]. Note that tape measures are commercial instruments and are excluded from the Alion QA Program. The following is a summary of the equipment used in this testing:

- Scales and Balances, as needed (balances verified prior to use)
  - 0 to 150 lbs range, +/- (1% of reading + 0.1 lbs)
  - 0 to 610 grams range, +/- 0.02 grams

  - 0 to 6 kilograms range, +/- 0.002 kilograms
  - 0 to 10 kilograms range, +/- 0.006 kilograms
- Pressure transmitters, as needed
  - 0 to 100 inches of water range, +/- 0.17% accuracy of upper range
  - 0 to 250 inches of water range, +/- 0.17% accuracy of upper range
  - 0 to 300 inches of water range, +/- 0.25% accuracy of upper range
  - 0 to 25 psi range, +/- 0.25% accuracy of upper range
  - 0 to 50 psi range, +/- 0.25% accuracy of upper range
- Flow orifice
  - 70 gpm to 900 gpm, +/- 0.25 % of measured velocity
- Thermocouples
  - 32 °F to 1652 °F range, +/- 3 °F, LabVIEW™ verified to ±5%
- Temperature probe
  - -40 °F to 1999 °F range, +/- (0.1% reading + 2 °F)
  - -50 to 300 °C range, +/- 1 °C
- NI LabVIEW™ data acquisition system, (version controlled by [Ref. 1])
  - Real-time analog data acquisition system, allowing continuous display of test parameter values and trends. Data is sampled every two seconds, and averaged over the previous 10 data points. Test data is recorded for each instrument in a simple spreadsheet for later analysis.
- 5-micron nominal filter bags
- Digital Caliper
  - 0 to 6 inches, +/- 0.001 inches
- Commercially Available Tape Measure
  - 0-25', 1/16th inch divisions
  - 0-12', 1/32th inch division up to one foot, 1/16th inch division after one foot

8.0 TEST ACCEPTANCE CRITERIA

In accordance with the test objective, the acceptance criterion for this testing is to conduct the fiber bypass test in accordance with applicable test procedures outlined in this document and to successfully collect and record data. The duration of the test shall be no shorter than 11 hours.

8.1 Fiber Bypass

Fiber that bypasses the test strainer will be collected continuously throughout the test, examined and quantified at the conclusion of testing.

8.2 Head Loss

Head loss measurements will be recorded continuously throughout the test and are used to determine the stability of the debris bed before ending the test.

To prevent structural failure to the prototype or tank system, a head loss limit of 15 ft-water will be imposed during testing. Above this head loss, the Test Module, tank pump, and other components may become susceptible to fatigue or failure; therefore, the head loss across the debris bed should not exceed this value. If the head loss approaches this value, the flow rate of the system will be reduced to maintain a value slightly less than the limit.

8.3 Testing Stabilization Criteria

The head loss measurements for this test will be continuously recorded by the data acquisition system. The test will be monitored by lab personnel and measurements will additionally be recorded manually throughout the test. There are multiple stabilization points throughout the test, each with a particular level of required stability. The criteria are listed in the following sections. Note that pool turnover times are based on water level and flow rate, and must be calculated separately for each addition.

8.3.1 Step Stabilization Criteria

At least 5 pool turnovers must occur after the end of the debris addition and before the beginning of the next debris addition.

At the completion of each fiber addition step in the test matrix, settled debris shall be agitated manually with the intent to ensure that debris reaches the strainer module and that no significant quantities of debris are allowed to settle elsewhere in the tank environs. However, manual agitation shall continue only until further manual stirring has no noticeable effect on the system head loss or the amount of settled debris. Agitation may be provided through use of a wooden oar or through temporary adjustment of the mechanical mixers. Supplemental agitation shall be conducted carefully to avoid disturbing the debris bed on the strainer module.

8.3.2 Final Stabilization Criteria

Manual agitation of settled debris will be done to ensure all debris reaches the strainer. Additionally, head loss stabilization may be required by the test coordinator. The test can be considered complete after the following criteria are satisfied:

- The bypass test has to have run for at least 11 hours.
- A minimum of 4 hours have elapsed since the last debris batch was added to the tank.
- During the first 2 hours of the 4-hour hold, the filter bags must be switched out every 30 minutes (this results in at least 4 filter bags being used for this step) and once every hour after the 2-hour hold.

- Two consecutive filter bags appear to be clean during or after the 4-hour hold (e.g. No visible fiber, etc.). These filter bags cannot be the first two filter bags changed out during the first 2 hours of the 4-hour hold.

8.4 Test Termination

The following cases require that the test be immediately terminated and the pump secured OFF to avoid equipment damage or personal injury:

a) The head loss across the debris bed should not exceed 15 ft-water. If reached, the flow rate will be reduced as specified in the test procedure. If reducing the flow rate as specified fails to maintain the head loss below 15 ft-water, the test must be terminated and the pump must be secured OFF.

b) Any catastrophic system failure, such as loss of power or equipment malfunction (for which no spare is available), will require test termination if deemed necessary by the Project Manager or Test Coordinator.

9.0 TEST DOCUMENTATION AND RECORDS

The test specific procedure and Test Matrix provide the instructions for performing the required test steps and the associated signatures provide documentation for the performance and witnessing of critical steps. The test specific procedure also provides a test log, which is used to document significant points during the performance of the test.

The Test Equipment Verification Procedure [Ref. 2] provides the means to verify the calibration and setup of each instrument before testing to ensure error-free data acquisition. Furthermore, the procedure is run again near the end of testing to check for instrument failure or inaccuracies produced during testing.

Other test laboratory procedures are provided in Section 6.0.

The test logs are used to track the overall progression of testing and not used as safety-related measurements. The data file recorded by the data acquisition system is used for all stabilization calculations, post-test analysis, trending, and application. The Fiber Bypass Report will further clarify how the test data can be utilized.

10.0 DEBRIS HANDLING REQUIREMENTS

This test plan identifies a test matrix using fiberglass. All appropriate MSDS shall be followed and the following will be used when handling (preparing, mixing, and adding into the test tank) the materials:

- Safety glasses with side shields or goggles,

- Cloth or Tyvek® laboratory coat,
- Dust mask with a N95 rating similar to 3M Model 8210,
- Latex, nitrile or neoprene gloves (leak check gloves before use),
- Long-sleeved shirt and long pants (recommended),
- Fire extinguisher with water, foam, carbon dioxide or dry powder, and
- Filled eye wash station in proximity to debris.

None of the testing debris is directly harmful under normal testing use (submerged in the test tank water); therefore, the above personnel safety equipment is unnecessary between debris additions or preparation.

11.0 QUALITY ASSURANCE REQUIREMENTS

The test program is developed, implemented, and maintained in accordance with the Alion Science and Technology Innovative Technology Solutions Operation (ITSO) Quality Assurance (QA) Program for nuclear safety-related services. Those processes that affect the quality of the output are identified and controlled by project specific procedures.

The goal of the testing program is to develop bypass data that may be used to support safety related analyses; therefore, the data shall be obtained and developed in accordance with the Alion ITSO 10CFR50 Appendix B QA Program. Although this test is designed to measure the quantity of fiber that bypasses the strainer, head loss data will be monitored to ensure strainer integrity is maintained and therefore the Alion QA program will be followed. Materials, parts, and components used by the testing program do not perform safety related functions and are not designated for installation and use in nuclear facilities. The data developed from the testing program, however, will be used to validate the performance and/or form the basis for design of components installed in a nuclear facility. Measuring and test equipment is calibrated in accordance with the ITSO QA Program.

It should be noted that the performance or critical characteristics of the test apparatus and equipment are not the same as that required for a nuclear safety-related system (i.e. not withstand a design basis accident); however, to ensure a quality output, the input and process will be controlled in a quality manner. Those processes that affect quality will be identified and controlled by project-specific procedures. Those processes that affect quality are preparation of test specimens, measurement and test equipment (procurement, calibration, and data collection), and test operation.

The fit, form, and function of materials, parts, and components used for testing and analysis by Alion are controlled by specification to ensure the required design characteristics are established to duplicate and/or model safety-related nuclear components. Certificates of conformance and compliance may be

used to document specification or design compliance for materials, parts, or components. Debris materials tested are supplied commercially from original equipment manufacturers.

12.0 REFERENCES

Current revisions of all Alion procedures shall be used.

1. ALION-PLN-LAB-2352-003 – Hydraulic Testing of Debris Program Description: Test Tank, Revision 6, 1/9/09
2. ALION-SPP-LAB-2352-13 – Test Equipment Verification Procedure
3. ALION-SPP-LAB-2352-70 – Filter Bag Preparation and Processing Procedure
4. ALION-SPP-LAB-2352-45 – Test Tank Draining and Cleaning Procedure
5. ALION-SPP-LAB-2352-44 – Test Tank Fill Procedure
6. ALION-SPP-LAB-2352-46 – Test Tank Debris Head Loss Procedure
7. ALION-SPP-LAB-2352-21 – Test Lab Safety Procedure
8. NEI 04-07, Volume 1, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Rev. 0, December 2004
9. NEI 04-07, Volume 2, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02," Rev. 0, December 6, 2004
10. Enercon Design Input Letter, PER-021-LTR-001, Revision 2, October 9, 2012 (Included as Attachment A)
11. NUREG/CR-6224 "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris.", October 1995
12. Nuclear Energy Institute, ZOI Fibrous Debris Preparation: Processing, Storage and Handling Revision 1, January 2012
13. NUREG/CR-6808 "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Core Cooling Sump Performance," February 2003
14. ALION-PLN-ENER-8707-01, Revision 0, "H.B. Robinson Plant Top Hat Strainer Bypass Testing"
15. Calcium Silicate Product Data Sheet (Included in Attachment D)

Appendix 1 – Calculation of Testing Parameters

Inputs:

Net surface area of 48 in test top hat = 30.31 ft^2 [Ref. 10]
RNP total plant strainer screen area 4000 ft^2 net (see Section 4.1)
Start-of-test approach velocity = 0.003 ft/s [Ref. 10]
ECCS Flow Rate = 3820 gpm [Ref. 10]
NUKON Insulation =164.8 ft^3 [Ref. 10]
Temp-Mat Insulation = 16.3 ft^3 [Ref. 10]
NUKON or Temp-Mat = 0.8 ft^3 [Ref. 10]
Temp-Mat or Kaowool Insulation = 4.6 ft^3 [Ref. 10]
Unibestos Insulation = 32.2 ft^3 [Ref. 10]
Fiberglass (LDFG) = 11.8 ft^3 [Ref. 10]
Latent Fiber = 60.0 lbm [Ref. 10]
Maximum Containment Water Volume = 56533 ft^3 [Ref. 10]
Tank volume = 37.5 gallons/inch (approximately) +150 gallons (piping volume)

Determination of Test Tank Flow Rates

Top-hat array surface area (4 top hats) = 4 x Net surface area of 48 in test top hat
Top-hat array surface area (4 top hats) = 4 x 30.31 ft^2
Top-hat array surface area (4 top hats) = 121.24 ft^2

Scaling factor (Test Surface Area / Plant Strainer Screen Area) = 121.24 ft^2 / 4000 ft^2= 0.0303

The testing flow rates are determined by the following formulas, as mentioned in Section 4.6.1:

Test Flow Rate (Pre-Full Screen Coverage) = Approach Velocity (ft/s) x Strainer Screen Area (ft^2)
Test Flow Rate (Pre-Full Screen Coverage) = 0.003 ft/s x Strainer Screen Area (ft^2)
Test Flow Rate (Pre-Full Screen Coverage) =0.003 ft/s x 121.24 ft^2 x 448.83 gpm/ft^3/s
Test Flow Rate (Pre-Full Screen Coverage) = 163.2 gpm

Approach Velocity (Post-Full Screen Coverage) = Plant Flow (gpm) / Plant Strainer Area (ft^3)
Approach Velocity (Post-Full Screen Coverage) = 3820 gpm / (4000 ft^2 x 448.8 gpm/ft^3/s)
Approach Velocity (Post-Full Screen Coverage) = 0.00213 ft/s

Test Flow Rate (Post-Full Screen Coverage) = Approach Velocity (ft/s) x Strainer Screen Area (ft^2)
Test Flow Rate (Post-Full Screen Coverage) = 0.00213 ft/s x Strainer Screen Area (ft^2)
Test Flow Rate (Post-Full Screen Coverage) = 0.00213 ft/s x 121.24 ft^2 x 448.83 gpm/ft^3/s
Test Flow Rate (Post-Full Screen Coverage) = 115.9 gpm

The flow is rounded up to the nearest gpm for practicality in testing therefore, 164 gpm and 116 gpm will be used for the pre- and post-full screen coverage flow rates respectively.

Table A1-1: Scaling of Flow Rate

Stage	Scaling Ratio	Plant Strainer Net Effective Screen Area (ft^2)	Approach Velocity (ft/s)	Scaled Test Tank Flow (gpm)
Pre-Full Coverage	0.0303	4000	0.003	164
Post-Full Coverage	0.0303	4000	0.00213	116

Determination of Plant Concentration and Batch Size

The plant concentration is determined by taking the total debris transported to the sump divided by the maximum containment water volume. This concentration is maintained throughout testing with the exception of the last debris batches for each debris size. The initial batch (F.1) is calculated below. The water level changes with each addition and therefore the amount of NUKON required to maintain the plant concentration also changes. See the following calculations:

Plant Concentration = Total Transported Debris (ft^3) / Maximum Containment Water Volume (gal)
Plant Concentration = 141.72 ft^3 / (56533 ft^3 * 7.48 gal/ft^3)
Plant Concentration = 0.00034 ft^3 / gallon

Initial Batch Size = Initial Tank Volume * Plant Concentration * NUKON Density
Initial Batch Size = [(36 inches * 37.5 gallons/inch) +150 gallons] * 0.00034 ft^3/gallon * 2.4 lb/ft^3
Initial Batch Size = 1.22 lbs

This batch size will model the fiber suspended in the sump pool.

Determination of Scaled Mass Values for Test Debris Loads

NUKON will be used throughout testing as the surrogate debris for Temp-Mat and LDFG. This is conservative, as previous Alion experience has shown NUKON to result in higher bypass quantities

than Temp-Mat. NUKON also has a characteristically smaller diameter (7 um versus 9 um) [Ref. 8], The mass of NUKON surrogate quantities will be scaled by volume via density for Temp-Mat and Kaowool. The debris transport fractions are taken from the Enercon Design Input Letter [Ref. 10].

For low density fibrous debris, the mass is determined by multiplying the volume of fiber by the density of NUKON (2.4 lb/ft^3) [Ref. 8].

For high-density fibrous debris, the mass is determined by multiplying the volume of fiber by the density of Temp-Mat (11.8 lb/ft^3) [Ref. 8]. The scaled mass is determined by multiplying the mass by the scaling factor (0.0303). The scaled volume is then determined by dividing the scaled mass by the density of NUKON (2.4 lb/ft3) rather than that of Temp-Mat due to previous testing observations regarding the destroyed density of Temp-Mat, and then the bed thickness is determined by dividing the scaled volume by the prototype strainer area (121.2 ft^2) [Ref. 10].

Unibestos – Unibestos is the trade name for a calcium-silicate material containing asbestos fibers [Ref. 8]. NUKON will be the surrogate used to represent the fibrous portion of the Unibestos material. Alion experiences with various calcium-silicate materials have shown that they contain a 0-4% fibrous component (see Attachment D). These fibers have comparable characteristics to both NUKON and Temp-Mat that can be seen in the table below [Ref. 8]. Therefore, it is conservative to assume 10% of the total volume of Unibestos will be in fibrous form. The scaled mass of NUKON surrogate is determined by multiplying the transported volume by the 10% fibrous portion then by the scaling factor (0.0303) and the density of the NUKON (2.4 lb/ft^3).

The latent debris source term is documented in the Enercon Design Input Letter is treated at LDFG and will be scaled in the same manner as NUKON above.

The "small fines" characterized in the design input letter [Ref. 10] are broken into 17% fines and 38% smalls for destroyed NUKON and Temp-Mat insulation and 22% fines and 63% for Kaowool, Unibestos and fiberglass debris.

For the debris source term defined as "NUKON or Temp-Mat" the debris is assumed to be Temp-Mat, and for the debris source term defined as "Temp-Mat or Kaowool" the debris is assumed to be Kaowool. These quantities are calculated in Table A1-2 and tabulated in the test matrix in Table A1-3. It is worth noting that the last addition for each size will have a different concentration due to it being the remaining amount of scaled test fiber.

Table A1-2: Scaling Fiber for Test Quantities

Debris Type	Volume Generated (ft^3)	Transport Fraction		Volume Transported to Sump (ft^3)	Scaled Volume Transported to Sump (ft3)	Surrogate Material	Material Density (lbs/ft^3)	Scaled Surrogate Mass (lbs)
NUKON	164.8	0.38	(Smalls)	62.62	1.90	NUKON	2.4	4.6
		0.17	(Fines)	28.02	0.85			2.0
Temp-Mat	16.3	0.38	(Smalls)	6.19	0.19	NUKON	11.8	2.2
		0.17	(Fines)	2.77	0.08			1.0
NUKON or Temp-Mat	0.8	0.38	(Smalls)	0.30	0.01	NUKON	11.8	0.1
		0.17	(Fines)	0.14	0.004			0.0
Temp-Mat or Kaowool	4.6	0.63	(Smalls)	2.90	0.09	NUKON	11.8	1.0
		0.22	(Fines)	1.01	0.03			0.4
Unibestos	32.2	0.85	(Fines)	2.74**	0.08	NUKON	2.4	0.2
Fiberglass (LDFG)	11.8	0.63	(Smalls)	7.43	0.23	NUKON	2.4	0.5
		0.22	(Fines)	2.60	0.08			0.2
Latent Fiber (lbs)	60.0*	1	(Fines)	25.00	0.76	NUKON	2.4	1.8
		TOTAL:		141.7	4.29		TOTAL:	14.1

*Latent fiber is treated as LDFG and scaled directly from the mass given as an input in the Enercon Design Input Letter [Ref. 10]. The volume is calculated using the density of NUKON.

**This value included the 10% fibrous assumption (see Section 3.5).

Table A1-3: Test Matrix

Stage #	Flow Rate (GPM)	NUKON Fines (lbs)	NUKON Smalls (lbs)	Tank Volume (gal)	Tank Level (in)	Nominal Bed Thickness (in)	Concentration (ft^3/gal)	lbs/gallon Added (NEI Criterion)	Gallons Added
F.1	164/116	1.22	0	1500	36.00	0.050	0.00034	0.20	6
F.2	164/116	1.23	0	1506	36.16	0.101	0.00034	0.20	6
F.3	164/116	1.23	0	1512	36.32	0.152	0.00034	0.21	6
F.4	164/116	1.24	0	1518	36.48	0.203	0.00034	0.21	6
F.5	164/116	0.72	0	1518	36.48	0.233	0.00020	0.12	6
S.1	164/116	0	1.24	1524	36.64	0.284	0.00034	0.21	6
S.2	164/116	0	1.25	1530	36.80	0.336	0.00034	0.21	6
S.3	164/116	0	1.25	1536	36.96	0.387	0.00034	0.21	6
S.4	164/116	0	1.26	1542	37.12	0.439	0.00034	0.21	6
S.5	164/116	0	1.26	1548	37.28	0.491	0.00034	0.21	6
S.6	164/116	0	1.27	1554	37.44	0.544	0.00034	0.21	6
S.7	164/116	0	0.92	1554	37.44	0.582	0.00025	0.15	6

Attachment A

Design Input Letter

ENERCON

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enercon.com
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October 9, 2012
PER-021-LTR-001
Rev. 2

Ms. Megan Stachowiak
Alion Science and Technology
15505 Howe St.
Overland Park, KS 66224

Subject: Design Inputs for Robinson Strainer Fiber Bypass Testing

Dear Ms. Stachowiak,

I am providing the following design inputs for Alion's use in the Robinson Strainer Fiber Bypass Prototypical Array Test Plan:

1. Conventional Debris Amounts for the Test Case:

   The conventional (non-chemical) debris types, densities, and volumes generated for the test case are documented in RNP-M/MECH-1761, "RNP Containment Vessel GSI 191 Debris Generation Calculation", Rev. 5. Inputs collected from calculation RNP-M/MECH-1761 can be seen in Attachment A, Tables 1and 2. In addition to the debris quantities shown in Tables 1 and 2 of Attachment A, there is 6 ft^2 of tags and labels in containment that could transport to the strainer.

2. Debris Transport Fractions:

   The debris transport fractions are documented in RNP-M/MECH-1762, "RNP Containment Vessel GSI 191 Debris Transport Calculation", Rev. 2. An RAI Response has given a further break down of the debris transport fraction into small fines and fines for Nukon and Temp-Mat Fibrous Debris. Table 3 of Attachment A displays the debris transport fractions from calculation RNP-M/MECH-1762.

3. Hydraulic and Dimensional Parameters

   The hydraulic and dimensional parameters that will be used for testing can be seen in the table below:

Hydraulic and Dimensional Parameters

Input	Value	Reference
Total Net Strainer Surface Area (ft^2)	4,178	RNP-M/MECH-1786 Rev. 2
Net Surface Area of 48 in Test Top Hat (ft^2)	30.31	RNP-M/MECH-1764 Rev. 3
ECCS Flow Rate (gpm)	3,820	RNP-M/MECH-1786 Rev. 2
ApproachVelocity at Start of Test (fps)	0.004	RNP-M/MECH-1786 Rev. 2
Maximum Containment Water Volume (ft^3)	56,533	RNP-M/MECH-1622 Rev. 0
Submergence (in)	3.5(±0.25)	RNP-M/MECH-1786 Rev. 2
Test Strainer Head Loss Limit	15 ft (6.5 psid)	EC 63481

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Page 2 of 2

4. Testing Termination Criteria

   Testing termination criteria shall be in accordance with Section 6.5 of the revised draft of the Generic Guideline for Strainer Fiber Bypass Test Protocol (12/7/2011) as published on the NEI Sump Performance Task Force website. This includes consideration of the hot leg injection time for final test termination. At Robinson, hot leg injection is initiated "approximately 11 hours after a primary loss of coolant has occurred" (Ref. EPP-10).

5. Gap Lengths

   The test Top Hats shall be installed onto the test plenum such that there is a gap available for flow between the baseplate and the plenum (bypassing the perforated plate). The height of the gap between the test plenum and each Top Hat shall be 1/16" (+1/32", -0"). The total length of the gap between the Top Hats and the plenum shall be 8' 9-3/8" (±1/16"). Additionally, there are ½" gaps in the two cover plates on the transition plenum to model the gaps between plenums in the plant. The two cover plates shall be separated by 1/16" (+1/32", -0"), and the length of gaps shall be 5' 9-1/4" (±1/16"). See Attachment B for the detailed calculation of these values.

Regards,

Kip Walker
Mechanical Engineering Lead

Waqas Abbasi
Mechanical Engineer

Eric Crabtree, P.E.
Mechanical Engineering Manager

Janet Caldwell
Project Manager

Cc:
Don Phillips

Attachment A: Tables of Calculation Results

Table 1: Limiting Particulate-to-Fiber Insulation Ratio Debris Source Term - Break No.4 LBLOCA (Pump Bay B)

Insulation Type	Quantity Destroyed (ft^3)	Size Distribution Large Pieces/Small Fines	Large Pieces (ft^3)	Small Fines	
				Amount (ft^3)	Characteristic Size (micron)
Nukon	164.8	40% / 60%	65.92	98.9	7
Temp Mat	16.3	40% / 60%	6.52	9.8	9
Nukon or Temp Mat	0.8	40% / 60%	0.32	0.5	7
Temp Mat or Kaowool	4.6	0% / 100%	0.0	4.6	9
Unibestos	32.2	0% / 100%	0.0	32.23	2
Fiberglass (assume LDFG)	11.8	0% / 100%	0.0	11.8	7
Sum Total	230.5		72.8	157.8	

Table 2: Latent Debris Source Term

Debris Type	Density (lb/ft^3)	Weight (lbs)
Latent Fiber	175	60.0

Table 3: Debris Transport Fractions

Load Case	*Debris Transport Fraction (DTF)*	
LBLOCA for Nukon and Temp-Mat Fibrous Debris (Small Fines)	Small Pieces	38%*
	Fines	17%*
LBLOCA for Nukon and Temp-Mat Fibrous Debris (Large Pieces)	0%	
LBLOCA for Unisbestos, Kaowool and Fiberglass Fibrous Debris (small fines)	Small Pieces	63%*
	Fines	22%*
Latent Debris (Fibers)	100%	

*See page A121 of RNP-M/MECH-1764 Rev. 3 for derivation of these values

ENERCON

ATTACHMENT B:

Robinson Nuclear Plant Bypass Testing Total Test Gap

Originator: Kip Walker Date: 10/9/12
Kip Walker

Reviewer: Date: 10/9/2012
Priya Chhiba

Objective

This attachment provides a calculation of the total gap length that may be used in the strainer bypass testing for Robinson Nuclear Plant (RNP).

Design Inputs

1. Report PER003-PR-001 (Ref. 4), Robinson Unit 2 Sump Strainer Fibrous Debris Bypass Summary Report, contains an attachment (Attachment 1 – Robinson Unit 2 Potential Strainer Gaps Not Protected by the Debris Bypass Eliminator) that calculates the total amount of 1/16 in. gaps that may potentially be present in the installed configuration at RNP. The attachment provides the following calculated 1/16 in. gaps:

    a. Gaps between Top Hat base plates and flow plenums = 3.15 ft^2

    b. Gaps between flow plenum and end plate connections = 0.05 ft^2

    c. Gaps between flow plenum to flow plenum plate connection = 1.10 ft^2

    d. Gaps between transition plenum to transition plenum plate connection = 1.40 ft^2

    e. Gaps between inspection port plates and plenums = 0.56 ft^2

    f. Gaps between vent plates and transition plenums = 0.06 ft^2

    This results in a total gap between the plenum and Top Hat strainer modules of 3.15 ft^2, while the total gap between the remaining pieces of the strainer assembly is 3.17 ft^2.

2. The total net strainer surface area is 4178 ft^2 per calculation RNP-M/MECH-1786 (Ref. 5).

3. The net surface area of a single 48 in. test Top Hat strainer module is 30.31 ft^2 per calculation RNP-M/MECH-1764 (Ref. 6)

Assumptions

1. Drawings PGENR021-C-201 and PGENR021-C-204, Sh. 1 and 2, (Refs. 1, 2, and 3) show that the plenums that are directly attached to Top Hat strainer modules have wire rope gaskets that seal the gaps between adjacent plenum connections. Thus, these gaps between adjacent Top Hat plenums are not assumed to contribute to fiber bypass, and were not considered in the calculation of the gaps needed for bypass testing. From Attachment 1 of Report PER003-PR-001,

1.10 ft^2 of gaps (Gaps between flow plenum to flow plenum plate connection) are therefore neglected. Thus, leaving a total plenum gap of 2.07 ft^2.

2. It is assumed that there will be 4 test Top Hat modules used during testing. Per Design Input 3, the surface area of a single test Top Hat module is 30.31 ft^2. Therefore, the total test strainer surface area is 121.24 ft^2 (= 4 × 30.31 ft^2).

3. It is conservatively assumed that all of the gaps between the sealing plates and the plenums as well as the clearance between the Top Hats and the plenums are equal to the 1/16 in. clearance as specified on Drawing PGENR021-C-201 (Ref. 1). The clearance specified on this drawing is the maximum allowable clearance. Most of these connected components are expected to have little or no clearance between the connected components.

4. Progress Energy directed ENERCON to use 50% of the total gap length in the testing based on the following rational. When mating the Top Hat to the plenum or mating two plenums together, at least two points must be in direct contact. Therefore, the maximum gap dimension of 1/16 in. would only be present on one side of the connection. On a four sided connection, this would result in one side with no gap, two sides with a triangular gap, and one side with the 1/16 in. gap. This is mathematically equal to 50% of the total gap area. Therefore for testing purposes it is assumed that only 50% of the total gap length is available for bypass flow.

References

1. Drawing PGENR021-C-201, Containment Building Unit 2 – Sump Strainer Location Plan, Rev. 4
2. Drawing PGENR021-C-204 SH. 1, Containment Building Unit 2 – Sump Strainer Section & Details, Rev. 3
3. Drawing PGENR021-C-204 SH. 2, Containment Building Unit 2 – Sump Strainer Section & Details, Rev. 0
4. Report PER003-PR-001, Robinson Unit 2 Sump Strainer Fibrous Debris Bypass Summary Report, Rev. 2
5. Calculation RNP-M/MECH-1786, Hydraulic Analysis of Top Hats and Containment Sump Structure, Rev. 2
6. Calculation RNP-M/MECH-1764, RNP Containment Vessel GSI-191 Recirculation Sump-Screen Debris-Bed Head Loss Calculation, Rev. 3

Calculation and Results

Design Input 1 indicates that the total area between the plenum and Top Hat strainer modules is 3.15 ft^2, while the total gap between the remaining pieces of the strainer assembly is determined to be 2.07 ft^2 per Assumption 1. However, these areas can be converted to a linear length by dividing the gap width of 1/16 in. as shown in Equation 1. The resulting total strainer gap lengths are provided in the Table 1.

$$\text{Gap Length} = \frac{\text{Gap Area}}{(1/16\text{ in})\times(1\text{ ft}/12\text{ in})} \qquad \text{Equation 1}$$

Table 1. Installed Plant Strainer Gap Lengths

	Gap Area (ft^2)	Gap Length (ft)
Top Hat Gap	3.15	604.80
Plenum and Plate Gap	2.07	397.44
Total Gap	5.22	1002.24

The linear gap lengths to be used for testing are calculated by scaling the gap lengths in Table 1 using the ratio of the total test strainer surface area (121.24 ft^2) to the total net strainer surface area installed in RNP (4178 ft^2). Equation 2 shows the methodology for calculating the total test gap length.

$$\text{Test Gap Length} = \text{Plant Gap Length} \times \frac{\text{Test Strainer Area}}{\text{Plant Net Strainer Area}} = \text{Plant Gap Length} \times \frac{121.24\text{ ft}^2}{4178\text{ ft}^2} \qquad \text{Equation 2}$$

Table 2 presents the total gap length to be used for testing. The table presents 100% of the scaled test gap length and the value for 50% of the scaled value for test gap lengths. Note that there is some discrepancy in the presented values due to rounding errors.

Table 2. Scaled Test Gap Lengths

	Plant Gap (ft)	100% Scaled Test Gap (ft)	50% Scaled Test Gap (ft)
Top Hat Gap	604.80	17.55	8.78
Plenum and Plate Gap	397.44	11.53	5.77
Total Gap	1002.24	29.08	14.54

Attachment B

Table 3-2 of NUREG/CR-6808

Table 3-2 Size Classification Scheme for Fibrous Debris[3-2]		
No.	Description	
1		Very small pieces of fiberglass material; "microscopic" fines that appear to be cylinders of varying L/D.
2		Single, flexible strands of fiberglass; essentially acts as a suspending strand.
3		Multiple attached or interwoven strands that exhibit considerable flexibility and that, because of random orientations induced by turbulent drag, can exhibit low settling velocities.
4		Fiber clusters that have more rigidity than Class 3 debris and that react to drag forces as a semi-rigid body.
5		Clumps of fibrous debris that have been noted to sink when saturated with water. Generated by different methods by various researchers but easily created by manual shredding of fiber matting.
6		Larger clumps of fibers lying between Classes 5 and 7.
7		Fragments of fiber that retain some aspects of the original rectangular construction of the fiber matting. Typically precut pieces of a large blanket to simulate moderate-size segments of original blanket.

Attachment C

Vortex Strength Scale

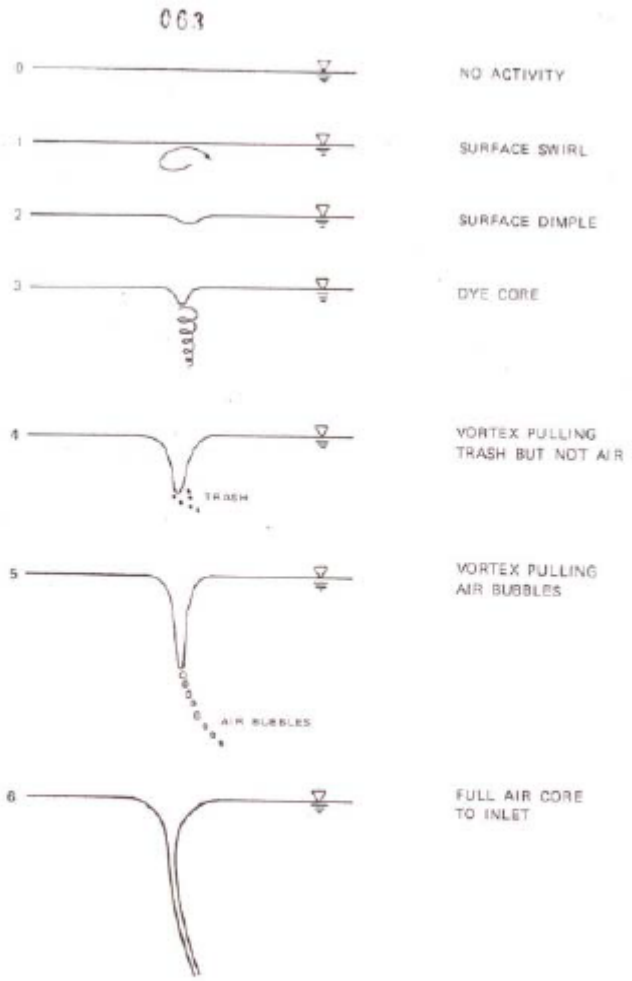

FIGURE 6 VORTEX STRENGTH SCALE FOR INTAKE STUDY

Attachment D

Material Safety and Data Sheets

Cal-Sil

IIG Industrial Insulation Group
A Calsilite/Johns Manville Joint Venture

Date: 8/31/2005
MSDS ID: 20501
Rev: 1.0.4
Replaces: 10/6/2003

Material Safety Data Sheet

Material Name: Calcium Silicate Insulation

Section 1— Chemical Product and Company Identification

Product Name: Thermo-12® Gold Calcium Silicate Insulation
CAS# Mixture/None Assigned
Generic Name: Insulation (Calcium Silicate)
Formula: Mixture
Chemical Name: Synthetic Calcium Silicate

Manufacturer Information
Industrial Insulation Group
2100 Line Street
Brunswick, GA. 31520

Phone number for Health and Safety Information: 970.858.6211 (M-F, 7:00a.m. to 4:00p.m., Mountain Time)

Trade Name: Thermo-12 Gold

Section 2 — Composition and Information on Ingredients

CAS #	Component	Percent	OSHA PEL	ACGIH TLV	NIOSH REL	UNITS
1344-95-2	Synthetic Calcium Silicate	> 93	15(T) 5(R)	10	10(T) 5(R)	mg/M^3
51274-00-1	Iron-based color	< 1	15(T) 5(R)	10	NE	mg/M^3
65997-17-3	Synthetic Vitreous Fiber	0 - 2	15(T) 5(R)	5	5	mg/M^3
9004-34-6	Cellulose Fiber	0 - 2	15(T) 5(R)	10	10(T) 5(R)	mg/M^3
1344-09-8	Sodium Silicate	0 - 6	15(T) 5(R)	10	NE	mg/M^3

NE = Not Established
ACGIH TLVs are 2003 values. OSHA PELs are those in effect on the date of preparation of this MSDS. The listed PELs, TVLs and RELs are time weighted average exposure limits.
Component Related Regulatory Information
This product may be regulated, have exposure limits or other information identified as the following:
Nuisance particulates.

Section 3 — Hazards Identification

Emergency Overview
APPEARANCE AND ODOR: Odorless, Yellow semi-circle or block insulation with coloring throughout as a visual marker to indicate this is an asbestos-free product.

This product is an article and under normal conditions of use, this product is not expected to create any unusual emergency hazards. However, cutting, sawing, or abrading may increase the risk of personnel exposure.

Inhalation of excessive amounts of dust created when fabricating, cutting, or other mechanical alterations of the product may cause temporary upper respiratory irritation and/or congestion— remove affected individuals to fresh air.

Skin irritation may be treated by gently washing affected area with soap and warm water.

Eye irritation may be treated by flushing eyes with large amounts of water. If irritation persists, contact a physician.

Prolonged contact with dust from this product may cause Dermatitis.
In the event of fire, use normal fire fighting procedures to prevent inhalation of smoke and gases.

HMIS Rating: Health: 1, Fire: 0, Reactivity 0, Other: 0
WHMIS Class: Thermo-12 Gold is not a WHMIS controlled product

Potential Health Effects
Summary
Breathing dust from this product may cause a scratchy throat, congestion, and slight coughing.

Getting dust or fibers on the skin, or in the eyes may cause itching, rash, or redness.

Breathing large amounts of dust or fibers from this product may lead to chronic health effects as discussed in Section 11 of this material safety data sheet.

Inhalation
Irritation of the upper respiratory tract (scratchy throat), coughing, and congestion may occur in extreme exposures.
Skin
Temporary irritation (itching) or redness may occur.
Absorption
Not applicable
Ingestion
This product is not intended to be ingested or eaten under normal conditions of use. If ingested, it may cause temporary irritation to the gastrointestinal (GI) tract, especially the stomach.
Eyes
Temporary irritation (itching) or redness may occur.
Target Organs
Upper respiratory passages, skin, and eyes.
Primary Routes of Entry (Exposure)
Inhalation (breathing dust), skin, and eye contact.
Medical Conditions Aggravated by Exposure
Pre-existing chronic respiratory, skin, or eye diseases or conditions may be aggravated by exposure to this product

Section 4 — First Aid Measures

First Aid: Inhalation
Remove to fresh air. Drink water to clear throat, and blow nose to remove dust.
First Aid: Skin
Wash gently with soap and warm water to remove dust. Wash hands before eating or using the restroom.
First Aid: Ingestion
Product is not intended to be ingested or eaten. If this product is ingested, irritation of the gastrointestinal (GI) tract may occur, and should be treated symptomatically. Rinse mouth with water to remove fibers, and drink plenty of water to help reduce the irritation. No chronic effects are expected following ingestion.
First Aid: Eyes
Do not rub or scratch your eyes. Dust particles may cause the eye to be scratched. Flush eyes with large amounts of water for 5-15 minutes. If irritation persists, contact a medical professional.
First Aid: Notes to Physician
This product is a mechanical irritant, and is not expected to produce any chronic health effects from acute exposures. Treatment should be directed toward removing the source of irritation with symptomatic treatment as necessary.

Section 5 — Fire Fighting Measures

Flash Point:	Not applicable	**Method Used:**	Not applicable
Upper Flammable Limit (UFL):	Not applicable	**Lower Flammable Limit (LFL):**	Not applicable
Auto Ignition:	Not determined	**Flammability Classification:**	Non combustible
Rate of Burning:	Not applicable		

General Fire Hazard
There is no potential for fire or explosion.
Extinguishing Media
Use any extinguishing media appropriate for the surrounding fires

Fire Fighting Equipment/Instructions

No special procedures are expected to be necessary for this product. Normal fire fighting procedures should be followed to avoid inhalation of smoke and gases produced by other materials.

Section 6 — Accidental Release Measures

Containment Procedures

Pick up large pieces. Vacuum dusts. If sweeping is necessary, use a dust suppressant such as water. Do not dry sweep dust accumulation or use compressed air for clean-up. These procedures will help to minimize potential exposures.

Clean-Up Procedures

Wastes are not hazardous as defined by the RCRA (40 CFR 261). Comply with state and local regulations for disposal of these products. If you are unsure of the regulations, contact your local Public Health Department, or the local office of the Environmental Protection Agency (EPA).

Section 7 — Handling and Storage

Handling Procedures

Use protective equipment as described in Section 8 of this material safety data sheet when handling uncontained material. Good housekeeping practices should be used to prevent generation and accumulation of dusts. After handling product, wash face and hands before eating, drinking, or smoking.

Storage Procedures

Warehouse storage should be in accordance with package directions, if any. Material should be kept dry, and protected from the elements.

Section 8 — Exposure Control and Personal Protection

General Product Information

This product may contain trace amounts of crystalline silica as a natural contaminant in the raw materials. However, standard industrial hygiene air monitoring surveys conducted under normal and test (worst-case) situations have not detected any airborne respirable crystalline silica in the occupational environment.

Personal Protective Equipment

Personal Protective Equipment: Eyes/Face

Safety glasses with side shields are recommended to keep product out of the eyes.

Personal Protective Equipment: Skin

Leather or cotton gloves should be worn to prevent skin contact and irritation. Barrier creams may also be used to reduce skin contact and irritation caused by fiber glass.

Personal Protective Equipment: Respiratory

A respirator should be used if ventilation is unavailable, or is inadequate for keeping dust and fiber levels below the applicable exposure limits. In those cases, use a NIOSH-certified disposable or reusable particulate respirator with an efficiency rating of N95 or higher (under 42 CFR 84) when working with this product. For exposures up to five times the established exposure limits use a quarter-mask respirator, rated N95 or higher; and for exposures up to ten times the established exposure limits use a half-mask respirator (e.g., MSA's DM-11, Racal's Delta N95, 3M's 8210), rated N95 or higher.

Operations such as sawing, blowing, tear out, and spraying may generate airborne fiber concentrations requiring a higher level of respiratory protection. For exposures up to 50 times the established exposure limits use a full-face respirator, rated N99 or higher.

Ventilation

In fixed manufacturing settings, local exhaust ventilation should be provided at areas of cutting to remove airborne dust and fibers. General dilution ventilation should be provided as necessary to keep airborne dust and fibers below the applicable exposure limits and guidelines. The need for ventilation systems should be evaluated by a professional industrial hygienist, while the design of specific ventilation systems should be conducted by a professional engineer.

Personal Protective Equipment: General

Loose-fitting, long-sleeved clothing should be worn to protect the skin from irritation. Exposed skin areas should be washed with soap and warm water after handling.

Section 9 — Physical & Chemical Properties

Appearance: Semi-circle or block insulation with yellow coloring throughout as a visual marker to indicate this is an asbestos free product.

Odor:	Odorless	**pH:**	Not applicable
Physical State:	Solid	**Vapor Density:**	Not applicable
Vapor Pressure:	Not applicable	**Melting Point:**	1200-1500°C
Boiling Point:	Not applicable	**Specific Gravity:**	0.24-0.27
Solubility (H2O):	Nil	**Freezing Point:**	Not applicable
Viscosity:	Not applicable	**Evaporation Rate:**	Not applicable
VOC:	Not applicable	**Percent Volatile:**	0

Section 10 — Chemical Stability & Reactivity Information

Chemical Stability
This is a stable material. This product is not reactive.
Hazardous Decomposition
None.
Hazardous Polymerization
Will not occur.

Section 11 — Toxicological Information

Acute Toxicity
A: General Product Information
The primary acute health effects of this product include mechanical irritation of the skin and eyes and skin dryness as a result of contact with dust, amorphous silica, and fibers.
B: Component Analysis - LD50/LC50
No LD50/LC50's are available for this product or its components.
Carcinogenicity
A: General Product Information
OSHA, NTP, IARC, and ACGIH have not classified this product in its entirety as a carcinogen.
B: Component Carcinogenicity
Calcium silicate (1344-95-2)
ACGIH: A4 - Not Classifiable as a Human Carcinogen
Synthetic Vitreous Fiber (65997-17-3)
ACGIH: A4 - Not Classifiable as a Human Carcinogen (related to rock wool fiber)
IARC: Monograph 43, 1988 (related to Glass filaments) (Group 3 (not classifiable))

Section 12 — Ecological Information

Ecotoxicity
A: General Product Information
No data available for this product.
B: Component Analysis - Ecotoxicity - Aquatic Toxicity
No ecotoxicity data are available for this product's components.

Section 13 — Disposal Considerations

US EPA Waste Number & Descriptions
A: General Product Information
This product, as supplied, is not regulated as a hazardous waste by the U.S. Environmental Protection Agency (EPA) under Resource Conservation and Recovery Act (RCRA) regulations. Comply with state and local regulations for disposal. If you are unsure of the regulations, contact your local Public Health Department, or the local office of the EPA.
B: Component Waste Numbers
No EPA Waste Numbers are applicable for this product's components.
Disposal Instructions
Dispose of waste material according to Local, State, Federal, and Provincial Environmental Regulations.

Section 14 — Transport Information

US DOT Information

Shipping Name: This product is not classified a hazardous material for transport.

Section 15 — Regulatory Information

US Federal Regulations

A: General Product Information

No information on this product as a whole.

B: Component Analysis

None of this product's components are listed under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), or CERCLA (40 CFR 302.4).

State Regulations

A: General Product Information

No information available for the product.

Other Regulatory Information

A: General Product Information

No information available for the product.

B: TSCA Status

No information available for the product.

International Regulations

Canada Workplace Hazardous Materials Information System (WHMIS)

WHMIS Classification: D2B– Irritant

Product classified as a manufactured article as defined in HPA, Section 11(1). Section 12(l) exempts it from the WHMIS supplier label and MSDS requirements of the Act.

Component Analysis - WHMIS IDL

The following components are identified under the CHPA IDL:

Sodium Silicate—CAS 1344-09-8

Section 16 — Other Information

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

Key/Legend:

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; NFPA = National Fire Protection Association; HMIS = Hazardous Material Identification System; CERCLA = Comprehensive Environmental Response, Compensation and Liability Act; SARA = Superfund Amendments and Reauthorization Act; DSL = Canadian Domestic Substance List; EINECS = European Inventory of New and Existing Chemical Substances; WHMIS = Workplace Hazardous Materials Information System; CAA = Clean Air Act; CHPA=Canadian Hazardous Product Act; IDL=Canadian Hazardous Disclosure List

Revision Summary:

This is a revised MSDS which replaces Revision 1.0.3 with new formatting and clarified exposure limits. Get this and other MSDS forms electronically via Internet: http://www.iig-llc.com or by calling 1-970-858-6200.

As of the date of preparation of this document, the foregoing information is believed to be accurate and is provided in good faith to comply with applicable federal and state law(s). However, no warranty or representation with respect to such information is intended or given.

IMPORTANT SAFETY NOTICE: The information in this MSDS relates only to the specific material described herein and does not relate to use in combination with any other material or substance or in any process.
Because of the use of this information and the conditions of use of this product are not within the control of Industrial Insulation Group, it is the users obligation to determine the conditions of safe use of this product. Users of this product should study this MSDS and become aware of the product hazards and safety information before using this product. Users should also notify their employees, agents, and contractors regarding information contained in this MSDS and any product hazards and safety information in order to provide for safe use of this product.

NUKON

Material Safety Data Sheet

Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

*** Section 1 - Chemical Product and Company Identification ***

Product Name(s): 700 Series Board, AF 220, AF 500 Series, AT-400 Series, Equipment & Appliance, Fabrication Board, Fiberglass Basic for Molding, FlexWrap, Insul-Quick®, Jet-Cel Acoustical, Muffler Packing, NuKon® insulation blanks, Pipe & Tank Insulation, Railroad, SCR Board, Select Sound Sanded Acoustical Board, SR & HT Range, TIW Thermal Insulation Wool, Transportation, Type 1000.

Owens Corning
One Owens Corning Parkway, World Headquarters
Attn. Product Stewardship
Toledo, OH 43659, USA

Emergency Contacts:
Emergencies ONLY (after 5pm ET and weekends): 1-419-248-5330,
CHEMTREC (24 hours everyday): 1-800-424-9300,
CANUTEC (Canada - 24 hours everyday): 1-613-996-6666.

Health and Technical Contacts:
Health Issues Information (8am-5pm ET): 1-800-GET-PINK,
Technical Product Information (8am-5pm ET): 1-800-GET-PINK.

*** Section 2 - Composition / Information on Ingredients ***

CAS #	Component	Percent by Wt.
65997-17-3	Fiber Glass Wool (Fibrous Glass)	85-96
25104-55-6	Urea, polymer with formaldehyde and phenol	4-15

Component Related Regulatory Information
This product may be regulated, have exposure limits or other information identified as the following: Fiber Glass wool, Fibrous glass, Nuisance particulates.

Component Information/Information on Non-Hazardous Components
No additional information available.

*** Section 3 - Hazards Identification ***

Appearance and Odor: Pink, yellow, or tan fibrous material with faint resin odor. Some products have a vinyl, brown paper, foil or polypropylene facing.

Emergency Overview

Acrid smoke may be generated in a fire. High temperature applications may release significant airborne concentrations of thermal decomposition products such as ammonia, formaldehyde and carbon monoxide, especially in enclosed or poorly ventilated areas during the first high temperature cycle.

Potential Health Effects

Inhalation:
Dusts and fibers from this product may cause mechanical irritation of the nose, throat, and respiratory tract.

OWENS CORNING

Material Safety Data Sheet

Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

Skin Contact:
Dusts and fibers from this product may cause temporary mechanical irritation to the skin.

Eye Contact:
Dusts and fibers from this product may cause temporary mechanical irritation to the eyes.

Ingestion:
Ingestion of this product is unlikely. However, ingestion of product may produce gastrointestinal irritation and disturbances.

Medical Conditions Aggravated by Exposure:
Chronic respiratory or skin conditions may temporarily worsen from exposure to these products.

*** Section 4 - First Aid Measures ***

Inhalation:
If inhaled, remove the affected person to fresh air. If irritation persists get medical attention.

Skin Contact:
For skin contact, wash with mild soap and running water. Use a washcloth to help remove fibers. To avoid further irritation, do not rub or scratch affected areas. Rubbing or scratching may force fibers into the skin. If irritation persists get medical attention.

Never use compressed air to remove fibers from the skin. If fibers are seen penetrating from the skin, the fibers can be removed by applying and removing adhesive tape so that the fibers adhere to the tape and are pulled out of the skin.

Eye Contact:
Immediately flush eyes with plenty of running water for at least 15 minutes. If irritation persists get medical attention.

Ingestion:
Ingestion of this material is unlikely. If it does occur, watch the person for several days to make sure that partial or complete intestinal obstruction does not occur. Do not induce vomiting unless directed to do so by medical personnel.

*** Section 5 - Fire Fighting Measures ***

Flash Point: None
Upper Flammability Limit: Not applicable
Flammability Classification: Non-flammable
Flash Point Method: Not applicable
Lower Flammability Limit: Not applicable

Extinguishing Media:
Dry chemical, foam, carbon dioxide, water fog.

Unusual Fire & Explosion Hazards:
These products may release acrid smoke in a sustained fire.

Fire-Fighting Instructions:
Use self-contained breathing apparatus (SCBA) and full bunker turnout gear in a sustained fire.

OWENS CORNING

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Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

Hazardous Combustion Products:
Primary combustion products are carbon monoxide, carbon dioxide, ammonia, and water. Other undetermined compounds could be released in small quantities.

*** Section 6 - Accidental Release Measures ***

Containment Procedures:
This material will settle out of the air. If concentrated on land, it can then be scooped up for disposal as a non-hazardous waste. This material will sink and disperse along the bottom of waterways and ponds. It cannot easily be removed after it is waterborne; however, the material is non-hazardous in water.

Clean-Up Procedures:
Scoop up material and put into a suitable container for disposal as a non-hazardous waste.

Response Procedures:
Isolate area. Keep unnecessary personnel away.

Special Procedures:
None.

*** Section 7 - Handling and Storage ***

Handling Procedures:
Keep product in its packaging, as long as practicable to minimize potential dust generation. Keep work areas clean. Avoid unnecessary handling of scrap materials.

Storage Procedures:
Material should be kept dry and undercover.

*** Section 8 - Exposure Controls / Personal Protection ***

Exposure Guidelines:
A: General Product Information
Follow all applicable exposure limits.

B: Component Exposure Limits
ACGIH and OSHA exposure limit lists have been checked for those components with CAS registry numbers.
Fiber Glass Wool (Fibrous Glass) (65997-17-3)
ACGIH: 1 f/cc TWA for respirable fibers longer than 5 um with a diameter less than 3 um; (Listed under "Synthetic vitreous fibers") (related to Glass wool fibers)
10 mg/m3 TWA (inhalable particulate); 3 mg/m3 TWA (respirable particulate) (These values are for particulate matter containing no asbestos and <1% crystalline silica) (related to Particulates not otherwise classified (PNOC))
OSHA: 1 fiber/cc (respirable) TWA (a) (See Note Below) (related to Glass wool fiber)

Notes: (a) Voluntary PEL was established by the North American Manufactures Association (NAIMA) and OSHA per the Health and Safety Partnership Program (HSPP) agreement for Synthetic Vitreous Fibers (SVF).

OWENS CORNING

Material Safety Data Sheet

Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

Ventilation:

General dilution ventilation and/or local exhaust ventilation should be provided as necessary to maintain exposures below regulatory limits. Dust collection systems should be used in operations involving cutting or machining and may be required in operations using power tools.

PERSONAL PROTECTIVE EQUIPMENT
Respiratory Protection:

Fiber Glass Wool: If thermal decomposition products are not anticipated, a properly fitted NIOSH or MSHA approved N 95 series disposable dust respirator such as the 3M model 8210 (model 8271 in high humidity environments) or equivalent should be used when: high dust levels are encountered; the level of glass fibers in the air exceeds the occupational exposure limits; irritation occurs; or installing or removing any of these products in poorly ventilated spaces. As an extra precaution you may choose, but are not required, to wear a disposable dust respirator at all times.

Hot Use Applications: When the temperature of the surface being insulated exceeds 250°F (121°C), including initial system startup, the binder in these products may undergo various degrees of decomposition depending on the temperature of the application. The need for respiratory protection will vary according to the airborne concentration of the decomposition products released and accumulated in the area.

If the insulation is installed on hot surfaces above 250°F (121°C), but below 650°F (343°C), a full-face respirator with cartridges approved for protection against organic vapors (or formaldehyde if available) should be used. In areas with good general and/or local exhaust ventilation where exposures are controlled below the formaldehyde, carbon monoxide, and ammonia PEL or STEL, and additive effects have been factored in, then respiratory protection is normally not needed.

Formaldehyde: In some high temperature applications these products may initially release concentrations of formaldehyde equal to or greater than 0.1 ppm, but less than 0.5 ppm. Airborne concentrations should be assessed to determine the appropriate type of respiratory protection to be used. When in doubt, use supplied air respiratory protection.

Ammonia: Significant quantities of ammonia may be released initially in high temperature applications. Ammonia has good warning properties and any respirator wearer experiencing irritation while wearing an air-purifying respirator should leave the area.

Simultaneous respiratory protection against formaldehyde and ammonia requires use of a supplied air system. A careful assessment of the workplace environment should be made to determine the appropriate respiratory protection required. If air-purifying respirator is used for ammonia protection, it should be full face with cartridges approved for ammonia.

Carbon Monoxide: Respiratory protection generally requires a supplied air system. Carbon monoxide has poor warning properties.

Use respiratory protection in accordance with respirator manufacturer's instructions and in accordance with your company's respiratory protection program, local regulations and OSHA regulations under 29 CFR 1910.134.

Skin Protection:

Normal work clothing (long sleeved shirt, long pants, amd gloves) is recommended. Skin irritation is known to occur chiefly at the pressure points such as around the neck, wrists, waist and between the fingers.

Eyes/Face Protective Equipment:

Wear safety glasses, goggles or face shield.

OWENS CORNING

Material Safety Data Sheet

Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Fibrous	**Odor:**	Organic
Physical State:	Solid	**pH:**	Not applicable
Vapor Pressure (mm Hg @ 20 C):	Not applicable	**Vapor Density (Air=1):**	Not applicable
Boiling Point:	Not applicable	**Solubility (H2O):**	Insoluble
Specific Gravity (Water=1):	Not applicable	**Freezing Point:**	Not applicable
Evaporation Rate (n-Butyl Acetate=1):	Not applicable	**Viscosity:**	Not applicable

Physical Properties: Additional Information
No additional information available.

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Stability:
This is a stable material.

Conditions to Avoid:
None expected.

Incompatible Materials:
None expected.

Hazardous Decomposition Products:
Primary combustion products are carbon monoxide, carbon dioxide, ammonia, and water. Other undetermined compounds could be released in small quantities.

Hazardous Polymerization:
Will not occur.

* * * Section 11 - Toxicological Information * * *

Acute and Chronic Toxicity:
A: General Product Information

Dusts may cause mechanical irritation to eyes and skin. Ingestion may cause transient irritation of throat, stomach and gastrointestinal tract. Inhalation may cause coughing, nose and throat irritation, and sneezing. Higher exposures may cause difficulty breathing, congestion, and chest tightness.

If this product is subject to high temperature processing, or if product is applied to hot surfaces, formaldehyde gas may be released. Ammonia gas and carbon monoxide may also be released. Formaldehyde may irritate or burn the skin and eyes. Formaldehyde is a lung sensitizer, causing an asthma-like allergy. Future exposures may cause allergy attacks with shortness of breath, wheezing, coughing and chest tightness. Repeated exposure may cause bronchitis. Formaldehyde may cause allergic skin sensitization reactions. Ammonia gas can cause respiratory tract and eye irritation. Breathing carbon monoxide can cause headaches, nausea, dizziness and can be fatal at high concentrations.

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Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

B: Component Analysis - LD50/LC50

Urea, polymer with formaldehyde and phenol (25104-55-6)
Oral LD50 Rat : 7 gm/kg
Oral LD50 Mouse : 7 gm/kg

C: Component Analysis - LD50/LC50 For Chemicals Which May Be Released During Use

Ammonia (7664-41-7)
Inhalation LC50 Rat : 2000 ppm/4H
Inhalation LC50 Mouse : 4230 ppm/1H

Carbon monoxide (630-08-0)
Inhalation LC50 Rat : 1807 ppm/4H
Inhalation LC50 Mouse : 2444 ppm/4H

Formaldehyde (50-00-0)
Flow-through LC50 Fathead Minnow: 24.1 mg/L (96 hr)
Flow-through LC50 Bluegill: 0.10 mg/L (96 hr)

Fiber Glass Wool: In October 2001, the International Agency for Research on Cancer (IARC) classified fiber glass wool as Group 3, "not classifiable as to its carcinogenicity to humans." The 2001 decision was based on human studies and animal research that have not shown an association between inhalation exposure to dust from fiber glass wool and the development of respiratory disease. This classification replaces the IARC finding in 1987 of a Group B designation "possibly carcinogenic to humans."

In May 1997, the American Conference of Governmental Industrial Hygienists (ACGIH) adopted an A3 carcinogen classification for glass wool fibers. The ACGIH A3 classification considers glass wool to be carcinogenic in experimental animals at relatively high doses, by routes of administration, at sites, or by mechanisms that it does not consider relevant to worker exposure. It also reviewed the available epidemiological studies and concluded that they do not confirm an increased risk of cancer in exposed humans. Overall, the ACGIH found that the available medical/scientific evidence suggests that glass wool is not likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.

In 1994, the National Toxicology Program (NTP) classified glass wool (respirable size) as "reasonably anticipated to be a human carcinogen." This classification was primarily based upon the 1987 IARC classification. NTP is currently considering reclassifying this material.

Carcinogenicity:

A: General Product Information

No information available for the product.

B: Component Carcinogenicity

ACGIH, IARC, OSHA, and NTP carcinogen lists have been checked for those components with CAS registry numbers.

Fiber Glass Wool (Fibrous Glass) (65997-17-3)

IARC: Group 3 "not classifiable as to its carcinogenicity to humans" (related to Glasswool) October 2001 Meeting
ACGIH: A3 - animal carcinogen (related to Glass wool fibers)
NTP: Reasonably anticipated to be a human carcinogen (related to glasswool) (possible select carcinogen)

OWENS CORNING

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Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

*** Section 12 - Ecological Information ***

No data available for this product. This material is not expected to cause harm to animals, plants or fish.

*** Section 13 - Disposal Considerations ***

US EPA Waste Number & Descriptions:
A: General Product Information
This product, if discarded, is not expected to be a characteristic hazardous waste under RCRA.

B: Component Waste Numbers
No EPA Waste Numbers are applicable for this product's components.

Disposal Instructions:
Dispose of waste material according to Local, State, Federal, and Provincial Environmental Regulations.

*** Section 14 - Transportation Information ***

US DOT Information
Shipping Name: Not regulated for transport.
Hazard Class: None
UN/NA #: None
Packing Group: None
Required Label(s): None

TDG Information
Shipping Name: Not regulated for transport.
Hazard Class: None
UN/NA #: None
Packing Group: None
Required Label(s): None
Additional Info.: None

Additional Transportation Regulations:
No additional information available.

*** Section 15 - Regulatory Information ***

US Federal Regulations:
A: General Product Information
No additional information available.

B: Component Analysis
This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).
None

OWENS CORNING

Material Safety Data Sheet

Material Name: 700 Series Board **MSDS No.: 15-MSD- 17020-01-M**

The following is provided to aide in the preparation of SARA Section 311 and 312 reports.

SARA 311/312
Acute Health Hazard: Yes
Chronic Health Hazard: Yes
Fire Hazard: No
Sudden Release of Pressure Hazard: No
Reactive Hazard: No

C: Clean Air Act

The following components appear on the Clean Air Act-1990 Hazardous Air Pollutants List:
None

State Regulations:

A: General Product Information

No additional information available.

B: Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS #	CA	FL	MA	MN	NJ	PA
Fiber Glass Wool (Fibrous Glass) (related to Mineral wool fiber)	65997-17-3	Yes[1]	No	Yes[1]	Yes[1]	No	Yes[1]

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):
WARNING! This product contains a chemical known to the state of California to cause cancer.

Other Regulations:

A: General Product Information

No additional information available.

B: Component Analysis - Inventory

Component	CAS #	TSCA	DSL	EINECS
Fiber Glass Wool (Fibrous Glass)	65997-17-3	Yes	Yes	Yes
Urea, polymer with formaldehyde and phenol	25104-55-6	Yes	Yes	No

C: Component Analysis - WHMIS IDL

The following components are identified under the Canadian Hazardous Products Act Ingredient Disclosure List:

Component	CAS #	
Fiber Glass Wool (Fibrous Glass)	65997-17-3	1% item 768 (884) (related to Fibrous glass)

WHMIS Status: Controlled
WHMIS Classification: D2A- Carcinogenicity
D2B- Irritation

Temp-Mat

Material Safety Data Sheet

O1 Blanket

Pyrotek

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Section I — Product Identity

Identity: O1 Blanket
Synonyms: Temptmat
MSDS Date: 07/25/2001
Verified as Current: 08/12/2004
Description: Fibrous Matting

Section II — Hazardous Ingredients and Exposure Limits

Hazardous Components	CAS	% [1]	Exposure Limits
Continuous Filament/Fiber Glass	65997-17-3	97.0-99.5	OSHA/PEL TWA: 15 mg/m³ cuM ACGIH TLV TWA: 10 mg/m³ NIOSH REL TWA: 3 fiber/cc
Starch & Oil Sizes	None	0.5-3.0	None Established

Canadian classification per W.H.M.I.S.: Not controlled

[1] Optional. May not be listed if component composition is proprietary.

Section III — Physical/Chemical Characteristics

Boiling Point: N/A
Vapor Pressure: N/A
Vapor Density: N/A
Solubility in Water: Not soluble
Specific Gravity: 2.5
Melting Point: 800° C
Evaporation Rate: N/A
Chemical Family: N/A
Appearance and Odor: Woven fiberglass fabric; no discernible odor.
pH: 6 - 8 (in water)

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used): None
Flammable Limits: Nonflammable LEL: N/A UEL: N/A
Extinguishing Media: Water is the best extinguishing media. Or use that which is appropriate for the surrounding area.
Special Fire Fighting Procedures: Do not release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full face piece operated in pressure-demand or positive-pressure mode.
Unusual Fire and Explosion Hazards: None

Section V — Reactivity Data

Stability: Stable Conditions to Avoid: None
Incompatibility (Materials to Avoid): None
Hazardous Decomposition or Byproducts: Any sizing, binders or coatings on the fiberglass fabric might form hazardous decomposition products during a sustained fire. Follow fire-fighting procedures and use proper fire-fighting equipment.
Hazardous Polymerization: Will Not Occur Conditions to Avoid: None

Section VI — Health Hazard Data

Primary Route(s) of Entry: Inhalation? Yes Skin? No Ingestion? No Eyes? No
Target Organs: None
Health Hazards (Acute and Chronic): ACUTE: May cause mechanical irritation of the mouth, nose throat, eyes and skin.
Carcinogenicity: NTP? No IARC Monographs? No OSHA Regulated? No
Signs and Symptoms of Exposure —
Eyes: Direct contact will cause mechanical irritation.
Skin: Transient mechanical irritation. Occasionally there might be skin irritation noted by individuals who are initially exposed to fiberglass.
Ingestion: Unlikely to occur. However, if ingested in sufficient quantities, may cause GI irritation.
Inhalation: Mechanical irritation of the mouth, nose and throat.
Conditions Aggravated by Exposure: Skin, eyes, and respiratory irritation.
Emergency and First Aid Procedures
Eyes: Flush with water for at least 15 minutes. Get medical attention if irritation persists.
Skin: Wash with soap and water.
Ingestion: Observe individual. If symptoms of GI irritation develop, consult a physician.
Inhalation: Remove affected person to fresh air and have person drink water to clear throat and blow nose to expel fibers.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled: Prevent the spread of fiberglass dust and avoid dust generation conditions. Vacuum clean dusts and fiber. If sweeping is necessary, use a dust suppressant. Those involved in he clean-up of fiberglass should use appropriate personal protective equipment.
Waste Disposal Method: Disposal must be made in accordance with federal, state and local laws.
Precautions to Be Taken in Handling and Storing: Handle properly to prevent the spread of fiberglass dust or fibers. Store in proper containers to prevent the spread of dusts and fibers. Low humidity levels will increase the spread of dusts and fibers.
Other Precautions: Keep airborne dusts and fiber concentrations below regulatory levels.

Section VIII — Control Measures

Respiratory Protection (Specify Type): Where airborne dusts or fibers exceed the TLV, use NIOSH approved respirator to protect a against nuisance dusts. Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, levels of airborne contamination and presence of sufficient oxygen.
Ventilation —
Local Exhaust: Provide local exhaust ventilation systems to maintain airborne dust or fiber concentrations below OSHA PELs (Section II). Local exhaust ventilation is preferred because it prevents contaminant dispersion into work area by controlling it at its source.
Mechanical (General): Provide general exhaust ventilation systems to maintain airborne dust or fiber concentrations below OSHA PEL's (Section II).
Special: Not normally required.

Other: Not normally required.

Skin Protection: If necessary wear protective gloves, boots, aprons, and gauntlets to protect against any mechanical irritation.

Eye Protection: Wear protective eyeglasses or chemical safety glasses, per OSHA eye-and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of , or in conjunction with contact lenses.

Other Protective Clothing or Equipment: Make emergency eye wash stations, safety/quick-drench showers, and washing facilities available in work area.

Work/Hygienic Practices: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Wash hands after handling material.

Section IX — Toxicological Information

Toxicological Information:

Toxicity Data:

Fiber Toxicity: Glass Fiber diameter determines whether the fiber is respirable. NIOSH has determined that man-made mineral fibers with diameters equal or greater than 3.5 microns are non-respirable. Respirable fibers will penetrate deep into the lungs. All E-glass continuous filament fiberglass has a fiber diameter larger than 3.5 microns and therefore are non-respirable.

Carcinogenicity: The following organizations have found that the continuous fiberglass filaments are not considered to be carcinogenic based on human and animals tests conduced within the last 10 years.

Internal Agency for Research on Cancer - IARC
American Conference of Governmental Industrial Hygienists - ACGIH
Occupational Safety and Health Administration - OSHA
National Toxicity Program - NTP 7th Annual Report on Carcinogens.

Section X — Regulatory Information

Regulatory Information:

All substances contained in this product are listed, as required, by the Toxic Substances Control Act Inventory List:

- Glass, oxide, chemicals (65997-17-3)

EPA Regulations:

RCRA Hazardous Waste Number: Not listed (40 CFR 261.33)

RCRA Hazardous Waste Classification (40 CFR 261): Not classified.

CERCLA Hazardous Substance (40 CFR 302.4) listed/unlisted specific per RCRA, Sec. 3001; CWA Sec. 311 (b)(4); CWA Sec. 307 (a), CAA Sec. 112.

CERCLA Reportable Quantity (RQ): No. RQ

SARA 311/312 Codes: N/A

SARA Toxic Chemical (40 CFR 372.65): Not listed

SARA EHS (Extremely Hazadous Substance) (40 CFR 355): Not listed, Threshold Planning Quantity (TPQ): None

OSHA Regulations:

Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

OSHA Specifically Regulated Substance (29 CFR 1910.): No

State Regulations: None

Section XI — Additional Information

Additional Information:

NFPA Hazard Ratings:

Health: 1 Flammability: 0 Reactivity: 0 Unusual Hazards: None

HMIS Hazard Ratings:
Health: 1 Flammability: 0 Reactivity: 0 PPE: Sec. 8*

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