BWR OWNERS' GROUP

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BWROG-14032
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Project No. 691

Mr. Victor Cusumano
Safety Issues Resolution Branch Chief
Division of Safety Systems
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Submittal of BWROG Responses to NRC Questions Associated with BWROG Report – "BWR Material Dissolution Test Plan," BWROG-ECCS-WP-4-1 R4" (BWROG-14003 originally submitted on January 23, 2014)

REFERENCE:

1. NRC Letter, ML14071A519 dated March 26, 2014, NRC Staff Feedback on Boiling Water Reactor Owners' Group Report BWROG-ECCS-TP-4-1, Revision 4
2. BWROG Letter, BWROG-14003 dated January 23, 2014, Submittal of BWROG Report – "BWR Material Dissolution Test Plan," BWROG-ECCS-WP-4-1 R4, for NRC Information and Commentary
3. BWROG Letter, BWROG-11002 dated January 8, 2010, "BWROG ECCS Suction Strainers Action Item No. 15 Status"
4. NRC Letter, ML102290064 dated August 2, 2010, from Mr. J.E. Dyer to Mr. Frederick P. Schiffley regarding waiver of NRC review fees in accordance with 10 CFR 170.11(a)(1)(ii)

Dear Mr. Cusumano:

Enclosed for your information and commentary is the BWROG response to NRC Staff feedback on BWROG-ECCS-WP-4 R4 (Reference 1). The original submittal commencing the exchange is captured in Reference 2.

The BWROG respectfully requests NRC Staff review of the enclosed content, with written feedback provided in accordance with Reference 3, within seven weeks (35 working days) of Staff's receipt of this letter.

In accordance with the provisions of 10 CFR 170.11(a)(1)(ii), the BWROG requests the waiver of NRC review fees associated with this project, as captured in Reference 4.

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A002

We look forward to continued cooperation regarding the ECCS Suction Strainer project scope.

Respectfully,

Lesa P. Hill

Lesa P. Hill
BWROG Chairman
(205) 992-5727

cc: J. A. Golla, US NRC Project Manager
BWROG Executive Committee
BWROG Primary Representatives
BWROG ECCS SS Committee
K. A. McCall, BWROG Program Manager
M. A. Iannantuono, BWROG ECCS SS Committee Project Manager

Commitments: None

Enclosures:

1. Responses to NRC Questions on Material Dissolution Test Plan, Revision 4 – Non-Proprietary Information (GEH Class I)
2. Survey Information – US BWR Chemical Effect Design Input – Non-Proprietary Information (GEH Class I)

ENCLOSURE 1

Responses to NRC Questions on Material Dissolution Test Plan, Revision 4 – Non-Proprietary Information (GEH Class I)

Responses to NRC Questions on Material Dissolution Test Plan, Revision 4 – Non-Proprietary Information (GEH Class I)

1. Although the staff agrees that early communication is very helpful to both the NRC and BWROG, it is important for the NRC staff to more fully understand current BWR plant materials to make informed comments concerning test materials, environments, and other test plan features. Therefore, consistent with the staff's previous comments on the "BWROG ECCS Suction Strainers Chemical Effects Strategy" document, the staff is interested in obtaining a summary of BWR plant materials survey. It would be acceptable to the staff if this information was provided with individual plants identified by letter or number instead of the specific plant name. While the summary provided by the BWROG (Agency wide Documents Access and Management System (ADAMS) Accession No. ML12093A141) in response to our previous request was useful, it does not provide enough detail for the staff to judge the appropriateness of the test plan.

   Response:

   The BWROG has provided the results of the BWR plant reactive materials survey in Enclosure 2 with plant names redacted.

2. The stated test objective is to quantify the amount and characteristics of species released to the coolant when BWR containment materials are exposed to simulated suppression pool/torus water from a bounding post-loss-of-coolant accident (LOCA) temperature excursion at a BWR. The ratio of coolant mass to the area or mass of each material during testing will simulate the ratio at a typical BWR. In this context, is the "typical" amount of material intended to represent: (i) a median or mean for the fleet, (ii) a median or mean for only plants containing that particular material, or (iii) some other value?

   Response:

   The goal of the test program is to generate chemical effect test data that will benefit the largest number of plants in the fleet. To achieve this goal, absolute values of a given material (lbs/ft^3 volume or ft^2/ft^3 volume), and the ratio of that material to other materials will be considered during development of the test plan. A bounding temperature curve will be used during each test.

3. In general, the Material Dissolution Test Plan does not yet have sufficient details to provide comments. Sections 2.2 and 2.3 identify the test materials and ratios of materials to coolant. These sections state that these values will be finalized following completion of the BWROG site survey of materials. Therefore, the staff is not able to comment on the adequacy of these test parameters until the completed BWROG materials survey results are available.

Response:

The BWROG has provided the results of the BWR plant reactive materials survey in Enclosure 2 with plant names redacted.

4. Section 2.4 states that the release rate tests will be performed in BWROG suppression pool chemistries representative of un-buffered and buffered (Standby Liquid Control injection) environments. Information previously provided by the BWROG (Accession No. ML12093A141) indicates the amount of sodium pentaborate injected can vary by more than a factor of 20 between the minimum and maximum plant values. In order to provide feedback on the test plan, the staff will need to understand the range in concentrations of boron produced by the different amounts of sodium pentaborate addition and the boron concentrations planned for the test matrix.

Response:

Since any quantity of sodium pentaborate can be injected from zero to the maximum for any plant, determination of what concentration of NaPB is limiting is required regardless of the variation between individual plants. Based on preliminary BWROG test data, aluminum dissolution was shown to increase in buffered NaPB solutions. Since steel and zinc corroded significantly more in unbuffered coolant than BWR-buffered coolant and are known not to corrode in BWR NaPB buffered coolant, it can be assumed that the minimum concentration of buffer is limiting with regard to these metals. Based on such considerations, testing is planned with demineralized water (no boron) and the fleet maximum coolant boron concentration following NaPB injection.

5. Defining the appropriate chemical environment for testing may not be straightforward due to: (1) variability in the amount, if any, of sodium pentaborate injection, (2) pH transients resulting from the types and quantities of insulation materials that may dissolve, (3) differences in environment or flow conditions in locations where debris could collect, and (4) the potential for formation of acids following a LOCA. Therefore, the staff is interested in understanding the assumptions and other supporting information that is being used to determine the test matrix.

Response:

1) BWROG survey results will be assessed to estimate the range of B concentrations that can be present in the containment solutions.
2) In the borated solution case, the pH range is expected to be minimal. However, in the non-borated case, the range can be significant. However, by conducting several tests in each coolant chemistry, pH changes and their effect on corrosion and dissolution can be determined.

3) The test plan assumes all coolant is well mixed, and all materials are exposed to flowing coolant.
4) pH changes due to radiological effects are expected to be insignificant compared to pH changes due to dissolving materials and buffer. Effects of the release of materials to the containment solution due to radiation induced decomposition is not expected to be significant. However, this issue will be re-evaluated prior to finalizing the test plan.

6. Section 2.5.1 indicates that the precipitate formation tests will be held at approximately 200°F for approximately 24 hours. Please provide the basis for the test duration. In addition, this section states that filters will be weighed to quantify the amount of precipitate. Are the filters going to be dried prior to weighing? Staff notes that drying some precipitates from pressurized water reactor related testing (NUREG/CR-6915, p20) resulted in a roughly 90 percent weight loss.

Response:

1) The bench- top test exposure at 200°F will be extended to 48 hours followed by holds at 140°F for 24 hours and 110°F for 24 hours. The initial hold for 48 hours at 200 °F will be made to allow the release rate to decrease to less than 10% of the rate observed over the first hour of the exposure.
2) The sample filters will initially be dried at room temperature and weighed. This should not lead to loss of water from hydrated species. The filters will then be dried for approximately 6 hours in an oven. This is expected to lead to loss of some/all water from hydrated species. Filters will then be reweighed. This approach should allow development of qualitative insights into the nature of any solid phase collected on the filters from the changes in filter weight as a result of drying.

7. The material release tests will be conducted using a bounding BWR suppression pool temperature profile. Release rate estimates as a function of temperature from 140°F to 210°F will be developed from the data. Please describe how the release rates will be determined from tests with continual changes in temperature?

Response:

To estimate release rates, filter inlet and outlet concentrations will be intermittently measured. This will allow the rate of change in the loop solution liquid inventory of each chemical species and the filter cake removal rate of each chemical species to be determined. The sum of these values will be used to estimate material release rates. Since the rate of change in the solution temperature with time will be relatively slow except during the first several hours of the tests, the release rates can be determined as a function of temperature.

During the bench-top tests, the temperature will be stepped, and samples taken at the beginning and end of each interval.

8. Please discuss how the precipitation samples will be the cooled from 200°F to either 140°F or 110°F. The staff notes that the cooling rate can affect the characteristics of a precipitate.

   Response:

   It currently is planned to remove the polycarbonate containers from the 200°F constant temperature bath after 48 hours and transfer them immediately to an oven maintained at 140°F during the bench-top tests. The containers would then be moved to another oven maintained at 110°F after 24 hours. A thermocouple will be suspended in each container, and the temperature monitored during the cooling process. There currently are no plans to consider the rate of temperature reduction on precipitate formation during the bench-top tests. The effect of the temperature reduction rate is being addressed in the loop tests by simulation of the post-LOCA temperature profile. The bench-top tests are being performed to assist in determining the tendency for precipitate formation in selected post-LOCA event chemical environments.

9. According to the test plan, the post-LOCA test apparatus exposure vessel volume is approximately 5 liters. The staff questions if the resulting material sample sizes will be so small that inhomogeneous materials, such as insulation materials, will be prone to significant differences in dissolution tests due to sampling issues. For instance, if a test called for a very small mass of fiberglass to properly scale to the solution volume, that sample may contain only fibers that were exposed to the hot plate temperature during the baking process or conversely only fibers that were not adjacent to the hot plate depending on how the sample was taken. Small samples could also contain a non-representative amount of binder.

   Response:

   The total test loop volume will be 25 to 125 gallons depending on the operating status of the loop. The concerns regarding sample size were recognized, and the test loop volume increased in an attempt to address such concerns and improve process simulation.

   Since fibers are baked and then shredded after baking, homogeneous mixing of fibers subjected to various degrees of baking can be expected.

10. Page 7 of the Dissolution Test Plan states that a Nukon cake will be loaded onto a stainless steel screen prior to testing. Please provide additional details concerning how this cake will be formed, including any thermal or mechanical processing of the fibers prior to cake formation, the amount of material, and

whether these materials are intended to represent a strainer debris bed. The staff notes that previous vertical loop testing has shown fiber preparation techniques can significantly impact the filtering characteristics of a fiber bed. Please provide the flow area for the face of the cake. If the purpose of the cake is to detect chemical precipitates, please describe how it will be verified that the fiberglass cake is an adequate detector of precipitation?

Response:

1) Processing of the NUKON material prior to injecting it into the feed tank and recirculating it through the filter assembly for cake formation will be proceduralized to enable test repeatability. Current plans are to bake but not boil the NUKON prior to testing to simulate the pre-LOCA fiberglass condition at a BWR. Processing the baked and shredded NUKON fiber through a commercial blender is currently being considered to eliminate fiber clumping and improve the homogeneity of the material during cake formation.
2) The currently proposed filter design includes a 3/32-inch hole with 5/32-inch staggered spacing screen with a diameter of approximately 3.5-inches. The plate will be contained in polycarbonate filter housing.
3) The effect of retention of precipitates on the filter cake will be monitored by the change in pressure drop across the filter plate.
4) The filter assembly is designed to allow the removal of the filter cake for sectioning, visual inspection and chemical analysis of the cake as a function of filter cake depth.
5) Precipitate formation and removal by the filter cake will be assessed from the variations in the filter inlet and outlet total and soluble species concentrations. Injection of a synthetic chemical precipitate such as aluminum hydroxide will be considered to determine debris bed chemical precipitate detection capability.
6) Procedures for performing the assessments outlined above will be developed.

11. Preliminary results from the BWROG site materials survey indicated that significant areas of uncoated concrete are not generally present in the BWR containment. Therefore, concrete is not currently included in the test plan. Did the survey consider amounts of degraded coatings on concrete that could fail in a post-LOCA environment? Did the survey consider the potential area of concrete exposed within the zone of influence by a jet?

Response:

The BWROG Design Input Request item for concrete reads "Concrete Surface Area (exposed or non-Q coated)", so the responses include coatings that could fail in a post-LOCA environment. Possible releases of calcium and silica from exposed concrete in the ZOI will be considered when developing the test plan. During the work done for PWRs, exposed concrete was determined to be an

insignificant contributor to chemical effects when compared to Nukon, other insulation and aluminum.

12. Please confirm that all in-stream filters used to pre-filter solution samples will be visually examined after each test to check for precipitates. Will filter time be recorded as a potential diagnostic tool?

Response:

Sample filters will be weighed after room temperature and oven drying (See response to Question 6). However, the sensitivity of the weighing approach relative to identifying the presence of filterable solids is limited.

For example, the approximate weight of a 45 millimeter 0.45 micron Millipore HA filter is approximately 100 milligrams. If a 200 ml sample (approximate sample volume) is passed through the filter, the filter weight increase will only be approximately 1 milligram if 5 ppm of filterable solids is present in the process fluid. This is only 1% of the initial filter weight and generally a difference in weight of 1% would not be considered a "measureable increase".

Although sample filters will be visually inspected after room temperature and oven drying, such information generally will not allow quantification of the amount of filterable material.

If a sufficient amount of material is present based on the weight change data, consideration will be given to possible approaches to determine the nature of the precipitate.

Sample filter time will not be monitored during the loop tests.

13. Section 3.5.3.2 indicates that Nukon and calcium silicate samples removed from tests will be photographed, dried in an oven prior to weighing, and then stored for possible post-test analysis. Will a visual exam be performed prior to drying?

Response:

A visual inspection will be performed prior to drying.

14. Section 3.5.3.3 discusses inorganic zinc (IOZ) samples but the test matrices do not include IOZ.

Response:

The BWROG survey results indicate that IOZ will need to be considered at some plants. Zinc release from galvanized carbon steel also will be considered.

15. Tables 4-1 and 4-2 show the preliminary test matrices for post-LOCA Simulation Testing and Precipitate Formation Testing, respectively. There does not appear to be any repeat testing shown in either table. The staff is interested in how repeatability will be assessed.

Response:

Concentration and chemical release rate data developed during the bench-top and loop tests will be compared to values developed during Alion and Westinghouse studies. Soluble species concentrations also will be compared to predictions based on thermodynamic calculations. Internal consistency of results obtained during the bench-top and loop tests will be evaluated to determine the need to perform duplicate tests for results validation.

16. Since Table 4-2 shows the preliminary types of materials but does not provide quantities, it is not clear if the quantity of each material is constant or changes throughout the test matrix. Use of a "typical" amount in each test may not evaluate the range of conditions that could exist following a LOCA. For example, testing with large quantities of Nukon may seem conservative from a material quantity perspective, however, the presence of silica in sufficient concentrations will inhibit aluminum corrosion possibly resulting in a non-conservative result for plants/pipe breaks with less Nukon. Please discuss if the precipitate formation assessment tests include an evaluation of threshold quantities of species that would result in precipitate formation in the representative environments.

Response:

It is accepted that release from a given material when exposed in the presence of other materials can increase or decrease depending on the release from the other materials. This synergism can impact on the tendency for precipitate formation Such effects will be considered during development of the bench-top and loop test plans.

17. Based on the information provided, the staff is not able to determine the velocity of the fluid past the materials in the exposure vessel. The effects of fluid velocity should be evaluated for the projected plant conditions. For example, corrosion product on galvanized steel coupons may remain on the test sample in quiescent or low flow conditions. In tests performed in Germany, water falling over galvanized steel grating produced zinc based corrosion products that transported to a fibrous debris bed and resulted in significant head loss.

Response:

The coupons of aluminum, galvanized carbon steel, etc., will be arrayed in a vertical 4 to 6-inch diameter stainless steel vessel, and the velocity across the

coupons established based on a qualitative assessment of expected velocities past containment materials during the post-LOCA event.

18. Page 7 of the Dissolution Test Plan states that the flow rate will be controlled between 1 and 5 gallons per minute. This will yield a velocity through the column of about 0.1 feet per second. Please provide the basis for the 0.1 feet per second column velocity and clarify if the flow rate is constant during the test or varies by a factor of 5. If the flow rate varies as discussed above, please discuss how a constant column velocity is maintained.

Response:

Each loop test will be done at a constant filter cake facial velocity. The expected range of velocities is 0.02 to 0.1 feet per second. Test velocities will be established during test plan development based on BWROG survey results.

The flow rate through the fiber bed may be increased during some tests to yield a measurable head loss so that any chemical effects on head loss can be observed.

19. The staff has several questions related to the test apparatus schematic shown on page 7 of the Dissolution Test Plan. a. Please describe the purpose of the chamber labeled "Nukon." b. What is the unlabeled chamber shown to the left of the Exposure Vessel? c. How are materials such as fiberglass and calcium silicate (Cal-Sil) restricted from transporting around the test loop? The staff notes that efforts to contain these types of materials in mesh bags need to strike a balance between preventing transport to the filter cake and permitting representative exchange between the test fluid and the test materials. d. Please discuss how it will be ensured that precipitates, if formed, will transport to the filter cake instead of settle in various areas of the test loop.

Response:

1) A revised loop schematic will be submitted with the final test plan. The "box" on the schematic labeled NUKON was included in the preliminary design when a "chemical feed pot" approach was being considered for adding fibrous material to the loop. The currently planned approach is to add the fibrous material to the feed tank to allow a low concentration slurry to be pumped to the filter vessel over an extended time. For example, at a flow rate of 1 gpm and a feed tank volume of 25 gallons, the feed tank concentration will decrease with a half-life of approximately 15 minutes assuming 100% removal by the filter plate simulant.

2) After establishing flow through the feed tank through the filter vessel while bypassing the exposure tank, fibrous material will be added to the feed tank. The feed tank liquid volume will be 25 to 125 gallons so the fibrous material

will be present as a dilute suspension in the liquid. This will improve simulation of the conditions present following a LOCA.

3) Fibrous material that initially passes through the filter screen will be recirculated through the feed tank back to the filter inlet until the process fluid is visually clear, i.e., the fibrous material has been collected on the filter screen. Once this has been accomplished the exposure vessel will be valved in.

4) The exposure vessel will be designed to minimize dropout. Flow through the stainless steel piping from the exposure vessel to the vertical filter vessel will be turbulent so minimum settling and deposition is expected. As a result, the major removal mechanism for the fibrous material, particulate material released from the test specimens and any precipitates formed in the solution will be collected on the filter cake.

20. Sections 3.4.2 and 3.4.3 describe the preparation of Cal-Sil and Nukon test materials. Please discuss if these materials are intended to be part of the filter cake or are test materials being evaluated solely for their contribution to the chemical source term. Please clarify whether the Nukon is baked or shredded first. Please discuss if there are any differences between the processing for Nukon prepared for the filter cake as compared to Nukon exposed elsewhere in the test loop.

Response:

Current plans are to expose the fibrous materials in the form of a filter cake. It there are significant areas of fibrous materials that are exposed to the containment liquid compared to the amount expected to be collected on the ECCS suction strainer, exposure of this material can also be made in the exposure vessel. If this is the case, the material will be retained between fine mesh stainless steel screens and suspended in the solution with the solid specimen materials. The fibrous material retained between the stainless steel screens will be limited in thickness to approximately ¼-inch.

Current plans are to use baked and shredded Nukon for all testing. Processing the baked and shredded NUKON fiber through a commercial blender is currently being considered to eliminate fiber clumping and improve the homogeneity of the slurried material during cake formation.

ENCLOSURE 2

Survey Information – US BWR Chemical Effect Design Input – Non-Proprietary Information (GEH Class I)

Survey Information – US BWR Chemical Effect Design Input – Non-Proprietary Information (GEH Class I)

An ECCS suction strainer chemical effects design input survey was distributed to members of the BWROG to gather coolant chemistry parameters and reactive material types and quantities for design input for the BWROG fleet chemical effects test program. The survey responses have been summarized are included below.

The coolant chemistry parameters requested included the following:

1. Maximum and Minimum Coolant/Suppression Pool Volume
2. Maximum and Minimum pH (SLC and non-SLC, respectively)
3. Maximum quantity of NaPB injection

The reactive material survey included the following materials:

1. Aluminum RMI (area and mass)
2. Other aluminum (area and mass)
3. Uncoated (or non-Q coated) carbon steel (area and mass)
4. Sludge quantity (mass)
5. Inorganic Zinc Coatings (area, mass, and thickness)
6. Galvanized Steel (area and mass)
7. Other Zinc (area and mass)
8. Fiberglass (mass)
9. Calcium Silicate (mass)
10. Kaowool/Aluminum Silicate (mass)
11. Rock Wool (mass)
12. Min-K (mass)
13. Microtherm (mass)
14. Exposed or non-Q coated concrete (area)

Blank and zero responses were treated equally and left as blanks for data analysis. For brevity, only the relevant quantities of each material are reported (areas for reactive surfaces, masses for reactive insulation and sludge). The quantities of each material reported are the quantities destroyed and/or exposed to coolant.

The quantities are taken from "BWR CE DIR Summary 4-21-2014.xlsm", 1301438.201

1 Plant Coolant Parameters

Suppression Pool Coolant Volume		
Plant #	**Maximum Suppression Pool Volume (ft^3)**	**Minimum Suppression Pool Volume (ft^3)**
1	134,600	122,120
2	134,600	122,120
3	133,690	133,690
4	133,690	133,690
5	149,740	145,927
6	118,124	113,954
7	138,701	135,291
8	131,400	121,500
9	131,400	121,500
10	131,400	121,500
11	91,100	87,650
12	68,312	58,900
13	128,100	117,161
14	147,610	146,145
15	89,750	86,450
16	89,750	86,450
19	117,887	112,197
20	107,619	106,442
21	123,469	57,390

Survey Information – US BWR Chemical Effect Design Input – Non-Proprietary Information (GEH Class I)

Suppression Pool Coolant Volume		
Plant #	**Maximum Suppression Pool Volume (ft^3)**	**Minimum Suppression Pool Volume (ft^3)**
22	72,910	59,219
23	94,000	84,000
24	115,000	111,500
25	115,000	111,500
27	129,830	116,300
28	129,830	116,300
29	85,402	78,190
30	165,100	108,333
31	167,100	162,805
32	131,900	128,800
33	131,900	128,800
34	131,550	122,120
35	131,550	122,120
39	154,794	145,495

Suppression Pool Chemistry Details			
Plant #	**Max pH**	**Min pH**	**Maximum Amount of NaPB (lbm)**
1	8.6	5.3	256
2	8.6	5.3	256
3	8.6	5.3	3108
4	8.6	5.3	3108
5	7	7	4246
6	8.7	5.3	Borax= 5327 lbm; Boric Acid = 4221 lbm
7	7.2	6	2008.6
8	8.5	5.3	398
9	8.5	5.3	398
10	8.5	5.3	398
11	8.5	6.8	6539
12	8.3	5.6	2440
13	9	3	2520
14	8.6	5.3	2780
15	8.5	5.8	2759
16	8.5	5.8	2759
19	8.3	5.3	6650
20	n/a	6	5245
21	8.3	4.4	6000

Survey Information – US BWR Chemical Effect Design Input – Non-Proprietary Information (GEH Class I)

Suppression Pool Chemistry Details			
Plant #	**Max pH**	**Min pH**	**Maximum Amount of NaPB (lbm)**
22	>7		1800
23	n/a	6	337
24	7.5	5.6	4492
25	7.5	5.6	4492
27	8.2	4.9	3482
28	8.2	4.9	3482
29	8.4	3.5	5800
30	8.4	7.2	1975
31	8.4	7.2	1975
32	8.3	2.8	6310
33	8.3	2.8	6310
34	8.6	5.7	755
35	8.6	5.7	755
39	8.2	3.4	1424

2 Exposed Reactive Metals and Concrete

Aluminum	
Plant #	Area (ft^2)
5	52,977
6	108
7	19,597
13	50,000
15	1,652
16	1,652
19	4,503
20	27,720
23	4,810
27	120
28	120
29	25,000
30	295
31	31
32	7,758
33	7,758

Exposed or Non-Q Coated Steel	
Plant #	Area (ft^2)
1	2,135
2	2,135
6	627
7	44,279
8	6,230
9	6,230
10	6,230
14	12,000
15	8,685
16	8,685
30	4,748
31	4,560

Galvanized Steel	
Plant #	Area (ft^2)
5	46,263
6	168
7	1,000
8	10,909
9	10,909
10	10,909
27	4,730
28	4,730

Concrete	
Plant #	Area (ft^2)
7	6500
14	4000
22	1510
27	1662
28	1662

Inorganic Zinc Coatings	
Plant #	Area (ft^2)
1	1
2	1
5	123,603
7	1,474
8	12,476
9	12,476
10	12,476
21	1,525
30	47,989
31	46,739
34	14,600
35	10,150

3 Insulation and Sludge Debris

Fiberglass	
Plant #	Mass (lbm)
1	2,108
2	2,108
3	1,845
4	2,626
6	3,600
8	217
9	217
10	217
11	88
12	438
13	90
14	4,320
15	698
16	698
20	1,905
21	3,134
22	1,680
23	63
27	93
28	93
29	663
34	5
35	5
39	59

Calcium Silicate	
Plant #	Mass (lbm)
6	102
7	1,411
11	12
14	1
15	70
16	70

Kaowool	
Plant #	Mass (lbm)
7	306

Rock Wool	
Plant #	Mass (lbm)
20	264

Min-K	
Plant #	Mass (lbm)
13	10
14	0.3
20	56
21	26
34	16.5
35	16.5

Microtherm	
Plant #	Mass (lbm)
15	20
16	20
33	2
33	2

Sludge			
Plant #	Mass (lbm)	Plant #	Mass (lbm)
1	2,000	20	3,000
2	2,000	21	300
3	1,000	22	300
4	1,000	23	500
5	2,150	24	280
6	500	25	280
7	500	27	170
8	100	28	170
9	100	29	2,800
10	100	30	150
11	552	31	150
12	500	32	750
13	300	33	750
14	500	34	1,691
15	600	35	1,691
16	600	39	250
19	650		