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July 14, 1981

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U.S. NUCLEAR REGULATORY COMMISSION

Refer to: PPD-WEO-370

Nuclear Regulatory Commission
Attention: Mr. Robert L. Tedesco
Assistant Director for Licensing
Division of Licensing
Washington, DC 20555

Dear Mr. Tedesco:

Enclosed are the answers to the questions generated by the NRC in response to our December 1979 submittal of the Topical Report PPI-TR-7701, Rev. 1, reference your letter of April 28, 1981.

I now understand that approval of the V.C. Summer radwaste facility is dependent on those responses, so we request your prompt action on the Topical Report revision. We will be pleased to answer any further questions promptly to assist V.C. Summer personnel.

Thank you for your consideration.

Sincerely,

Wm E Osmeyer

William E. Osmeyer
Product Manager
Protective Packaging Division

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REFERENCE: REPORT PPD-TR-7701
Rev. 1

Additional Information for the
U-Form Radwaste Solidification System

360.1 a) Provide a list of equipment, solidification components and process chemicals which are within your scope of supply.

Answer: The generic system consists of a waste blending tank with accessories, two chemical addition tanks, a catalyst solution tank, a urea formaldehyde concentrate (UFC) tank, a radwaste pump, a catalyst pump, two chemical addition pumps, a recirculating pump, a UFC pump, and associated valves, flow detectors, plus the control console. In general all items shown in Figure 1-5 of the reference topical report are supplied by Teledyne Energy Systems. In some cases the users may select to provide tanks, pumps, etc. of their own choosing.

Components which are supplied for solidification include disposable containers, sparging apparatus, flexible hoses, level indicators, flow indicators, radiation detectors, etc., and T.V. monitoring stations.

Teledyne Energy Systems does not supply chemicals. Users are required to purchase chemicals from the appropriate chemical suppliers.

360.1 b) Provide a list of interfaces between the U-Form Radwaste Solidification System (UFRSS) and the required plant services.

Answer: The interface connections required for operation of the UFRSS are:

1. A resin input line which delivers a resin slurry to the waste blending tank. Pumping power to be supplied by user.

2. A radwaste liquid line (evaporator bottoms, floor drains, filter aids) which delivers radwaste to the waste blending tank. Pumping power to be supplied by user.

3. A flush water input line which delivers non-contaminated water to the UFRSS. Pumping power and water to be supplied by user.

4. An air line input which delivers air to the sparging system at 50 psig. Pumping power and air to be supplied by user.

5. Ventilation air for the radwaste room not part of UFRSS.

6. Electrical power (nominal 115, 230, 460 V AC 3 phase) is required at various locations to power pumps, valves, detectors, control console etc. Electric power to be supplied by user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

7. Output drain lines are required for the UFRSS. User provides sumps and/or lines which return liquids to their radwaste holding tanks.

8. Output air vent lines are required for the UFRSS. User provides vent ducts which collect UFRSS vented air for controlled monitoring and release through plant system.

9. Output flush water lines are required for the UFRSS. User provides lines to return water to their radwaste holding tanks.

10. Output of radwaste liquids, e.g., spent resin dewater liquid lines are required for UFRSS. User provides lines to return radwaste liquid to their radwaste holding tanks.

360.1 c) What plant services are required for waste input, transfer liquid return, flush water, overflow, drainage, compressed air, ventilation air, electric power and waste transfer to a truck?

Answer: See part b) above "interfaces." Transfer of waste to truck normally accomplished by crane and/or a type of fork lift truck. Transfer function of casks, drums, liners, etc. normally selected by user.

360.2 a) Provide the processing capacity of the UFRSS and compare it with the expected total waste input to the system for both PWR's and BWR's with a rating of 3400 MWt.

Answer: The UFRSS can comfortably process 200 ft^3 of radwaste per shift based on a two hour cycle per 50 ft^3 liner. An average yearly output from Oconee, Brunswick, Calvert Cliffs, Dresden, Farley, Indian Point, Millstone, Oyster Creek, Palisades, Pilgrim, Salem and Zion is about 17,000 ft^3 of radwaste with a maximum of 48,000 ft^3 for Brunswick and a minimum of 2,500 ft^3 for Calvert Cliffs. Thus for the average of 17,000 ft^3 per year the UFRSS would be used on 85 shifts or 8 percent of a total of 1,095 shifts per year. (The "expected" waste volumes from a given plant are usually much lower than the actuals due to problems encountered in normal operation of a nuclear facility, thus we have selected the comparison based on actual waste production as reported by the facilities listed above.)

360.2 b) Clarify whether the UFRSS can handle solidification of the slurry of depleted resins arising from backwashes of condensate demineralizers?

Answer: Yes, slurries can be solidified in the same volume ratio as resins. The purpose of dewatering is to reduce the volume of radwaste to be shipped to burial sites. It is economical to return the resin carrier water back to the resin holding tank of the user.

REFERFNCE: REPORT PPD-TR-7701
Rev. 1

360.3 Explain how the air sparger can ensure adequate mixing of the waste in the waste container.

Answer: Earlier designs of the UFRSS used mixing blades with a mixer motor mounted on the liner for blending the radwaste and binder chemicals. This technique proved inadequate (mainly due to operator attention to procedures, condition of mixer blades, etc.). The system was then engineered for an air sparger technique which was interfaced with the control system to provide the proper timing of the mix cycle and was proven to provide a more homogenous mixture of the radwaste and chemicals prior to solidification. With mixer blades, dead spots were found to exist in corners of the liner; with the sparger system the mixing flow pattern sweeps out all areas of the liner including corners. The advantage of sparging is most effective when mixing resins which tend to stay trapped in the liner corners when blades are used to mix the radwaste.

360.4 Clarify the following items relating to the piping and instrumentation diagram, Figure 1-5 of the report.

a) What do "BDTS", "LWPS" and "DW" stand for?

Answer: BDTS and LWPS stand for two types of resins used in one UFRSS system in Spain. As an example, the V.C. Summer facility in South Carolina might label the lines Resin Tank 1 (for a Westinghouse Nuclear Systems Resin - WNES/ATRS) and Resin Tank 2 (Nuclear Blow Down Resins - XTK-108-NB). These input lines and their nomenclature are site specific. For the purpose of this report consider them as Tank 1 and Tank 2 for two types of resins as required.

DW stands for dewater line which is located at the liner or radwaste disposable container.

b) Do the waste inputs shown in the figure include condensate polishing demineralizer resins?

Answer: Input lines to the Waste Blending Tank can range from one to many depending on the user's desires. In the figure, five input lines are shown: 2 resins, 1 evaporator bottom, 1 drain and 1 for filter aids. This is a site specific item and the UFRSS has no restriction on the number of lines the user may have to deliver radwaste to the system. Note Valve MOV 4 is the single point input for radwaste to the waste blending tank. MOV 4 is the interface point between the UFRSS and the introduction of user radwaste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.4 c) Correct the discrepancies in the capacities of the various tanks given in Figures 1-4 and 1-5.

Answer: Delete gallon labels on Figure 1-4. This was a simple block diagram to show relationships of the UFRSS tank subsystem. Tank gallon labels were a carryover from a prior presentation slide. Tank capacities are not germane to operation of the UFRSS system but are sized for user convenience and cost considerations for storage capacity, chemical delivery schedules, etc. Each radwaste system will vary in tank size depending on user preference.

360.5 Clarify the following items relating to flush water.

a) What water is used as flush water?

Answer: Flush water is supplied by the user. It can be tap water or demineralized water but should not be contaminated.

b) How is flush water in the waste container ultimately disposed?

Answer: Flush water in the waste container can be pumped through the dewater line to the spent resin storage tank, or drained through the container bottom plug into an acceptable radwaste room drain collector, or pumped (with a portable pump) to any appropriate contaminated water holding tank including the Waste Blending Tank. Flush water is ultimately recycled for solidification through the Waste Blending Tank under normal operation.

c) What effect will flush water have on the solidification process.... and is there a limit on the quantity of flush water which the waste container can accept?

Answer: Flush water has no effect on solidification, except to say a few more gallons of water must be processed than if one didn't flush when the system was through with a solidification cycle. The limit of flush water the waste container can accept is equal to the size of the waste container. If one fills the waste container full of flush water, that water must be recirculated and solidified, which obviously yields two containers of solidified waste.

d) In Section IV under step 25 (pg. 55) it has been stated that the liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner. Explain this statement.

Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.6 In Section IV of the report (pg. 67) reference has been made to some parameters such as temperature profiles, hardness, dryness and uniformity for waste samples. State criteria for acceptability of these parameters.

Answer: Sample verification test parameters are as follows:

1. Take a radwaste sample ~100-300 cc.

2. Add catalyst in proportions given for the boric acid, sodium sulfate or resin formulae.

3. Stir until the catalyst is completely mixed with the radwaste.

4. Adjust temperature of sample to between 110-120°F (43-49°C).

5. Add UFC in proportions given for the radwaste being sampled.

6. When UFC is added observe and record temperature as it increases.

7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) ± 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).

8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.

9. Let sample cool and vent till condensation beads are no longer formed and/or are present.

10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

High oil content can affect solidification if the oil content is greater than 40% of the total volume. However, long term observations have shown that for oil concentrations greater than 10% volume the oil will slowly seep out of the billet like beads of perspiration. The recommendation is not to solidify more than 10% oil in any mixture of radwaste. No pretreatment is necessary if the concentration of oil is less than 10%.

In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using U-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
   All were dry after initial solidification

2. Dewatered Resin Beads (Anion & Cation) in Ratio of 1.5:1
   Billet Size: 55 gal. drum
   No. of billets: 5
   All were dry after initial solidification

3. Dewatered Resin Beads (Anion & Cation) in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
   Billet Size: 55 gallon drum
   No. of billets: 1
   Billet was dry after initial solidification

4. Sodium Sulfate 22.9% @ ratio of 0.8:1
   Billet Size: 55 gallon drum
   No. of billets: 2
   Billets dry after initial solidification

b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout forany user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration, heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

Long term storage (>9 months) also showed no generation of free water under temperatures of less than 80°F. If billets are subjected to temperatures greater than 80°F for long periods of time, weep water is produced at the bottom of the liner. Tests were conducted at Teledyne to determine these weep rates. The results are as follows:

Temperature held for 24 hours	cc per day per 50 cu. ft. liner
80°	100
85°	400
90°	500
95°	550
100°	600

Based on a 1/2% free water burial criteria currently in effect, the conservative times (since reabsorption is not considered but in fact occurs) for transporting the radwaste from the reactor plant to the burial site is:

Temperature held for 24 hours	Days allowed for transportation
80°	71
85°	18
90°	14
95°	13
100°	12

During these weep tests, the test billets were static loaded with an equivalent of 50 feet of U-F. No significant change in weep rate was noted between loaded and unloaded billets. Thus we conclude only temperature can effect the weep rate production of free water. (Cooling even to freezing has shown weep water to be reabsorbed into the billet.)

REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection ports, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quality Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be solidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection ports provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

3. N.A. V. C. Summer responsibility.

IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

3. N.A. V. C. Summer responsibility.

4. N.A. V. C. Summer responsibility.

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Rev. 1

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d) In Section IV under step 25 (pg. 55) it has been stated that the liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner. Explain this statement.

Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

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5. Add UFC in proportions given for the radwaste being sampled.

6. When UFC is added observe and record temperature as it increases.

7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) ± 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).

8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.

9. Let sample cool and vent till condensation beads are no longer formed and/or are present.

10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

REFERENCE: REPORT PPD-TR-7701
Rev. 1

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

High oil content can affect solidification if the oil content is greater than 40% of the total volume. However, long term observations have shown that for oil concentrations greater than 10% volume the oil will slowly seep out of the billet like beads of perspiration. The recommendation is not to solidify more than 10% oil in any mixture of radwaste. No pretreatment is necessary if the concentration of oil is less than 10%.

In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using U-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
   All were dry after initial solidification

2. Dewatered Resin Beads (Anion & Cation)
   in Ratio of 1.5:1
   Billet Size: 55 gal. drum
   No. of billets: 5
   All were dry after initial solidification

3. Dewatered Resin Beads (Anion & Cation)
   in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
   Billet Size: 55 gallon drum
   No. of billets: 1
   Billet was dry after initial solidification

4. Sodium Sulfate 22.9% @ ratio of 0.8:1
   Billet Size: 55 gallon drum
   No. of billets: 2
   Billets dry after initial solidification

b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout for ny user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

Long term storage (>9 months) also showed no generation of free water under temperatures of less than 80°F. If billets are subjected to temperatures greater than 80°F for long periods of time, weep water is produced at the bottom of the liner. Tests were conducted at Teledyne to determine these weep rates. The results are as follows:

Temperature held for 24 hours	cc per day per 50 cu. ft. liner
80°	100
85°	400
90°	500
95°	550
100°	600

Based on a 1/2% free water burial criteria currently in effect, the conservative times (since reabsorption is not considered but in fact occurs) for transporting the radwaste from the reactor plant to the burial site is:

Temperature held for 24 hours	Days allowed for transportation
80°	71
85°	18
90°	14
95°	13
100°	12

During these weep tests, the test billets were static loaded with an equivalent of 50 feet of U-F. No significant change in weep rate was noted between loaded and unloaded billets. Thus we conclude only temperature can effect the weep rate production of free water. (Cooling even to freezing has shown weep water to be reabsorbed into the billet.)

REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection ports, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quali Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be solidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection por.s provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

3. N.A. V. C. Summer responsibility.

IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

3. N.A. V. C. Summer responsibility.

4. N.A. V. C. Summer responsibility.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Additional Information for the U-Form Radwaste Solidification System

360.1 a) Provide a list of equipment, solidification components and process chemicals which are within your scope of supply.

Answer: The generic system consists of a waste blending tank with accessories, two chemical addition tanks, a catalyst solution tank, a urea formaldehyde concentrate (UFC) tank, a radwaste pump, a catalyst pump, two chemical addition pumps, a recirculating pump, a UFC pump, and associated valves, flow detectors, plus the control console. In general all items shown in Figure 1-5 of the reference topical report are supplied by Teledyne Energy Systems. In some cases the users may select to provide tanks, pumps, etc. of their own choosing.

Components which are supplied for solidification include disposable containers, sparging apparatus, flexible hoses, level indicators, flow indicators, radiation detectors, etc., and T.V. monitoring stations.

Teledyne Energy Systems does not supply chemicals. Users are required to purchase chemicals from the appropriate chemical suppliers.

360.1 b) Provide a list of interfaces between the U-Form Radwaste Solidification System (UFRSS) and the required plant services.

Answer: The interface connections required for operation of the UFRSS are:

1. A resin input line which delivers a resin slurry to the waste blending tank. Pumping power to be supplied by user.

2. A radwaste liquid line (evaporator bottoms, floor drains, filter aids) which delivers radwaste to the waste blending tank. Pumping power to be supplied by user.

3. A flush water input line which delivers non-contaminated water to the UFRSS. Pumping power and water to be supplied by user.

4. An air line input which delivers air to the sparging system at 50 psig. Pumping power and air to be supplied by user.

5. Ventilation air for the radwaste room not part of UFRSS.

6. Electrical power (nominal 115, 230, 460 V AC 3 phase) is required at various locations to power pumps, valves, detectors, control console etc. Electric power to be supplied by user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

7. Output drain lines are required for the UFRSS. User provides sumps and/or lines which return liquids to their radwaste holding tanks.

8. Output air vent lines are required for the UFRSS. User provides vent ducts which collect UFRSS vented air for controlled monitoring and release through plant system.

9. Output flush water lines are required for the UFRSS. User provides lines to return water to their radwaste holding tanks.

10. Output of radwaste liquids, e.g., spent resin dewater liquid lines are required for UFRSS. User provides lines to return radwaste liquid to their radwaste holding tanks.

360.1 c) What plant services are required for waste input, transfer liquid return, flush water, overflow, drainage, compressed air, ventilation air, electric power and waste transfer to a truck?

Answer: See part b) above "interfaces." Transfer of waste to truck normally accomplished by crane and/or a type of fork lift truck. Transfer function of casks, drums, liners, etc. normally selected by user.

360.2 a) Provide the processing capacity of the UFRSS and compare it with the expected total waste input to the system for both PWR's and BWR's with a rating of 3400 MWt.

Answer: The UFRSS can comfortably process 200 ft^3 of radwaste per shift based on a two hour cycle per 50 ft^3 liner. An average yearly output from Oconee, Brunswick, Calvert Cliffs, Dresden, Farley, Indian Point, Millstone, Oyster Creek, Palisades, Pilgrim, Salem and Zion is about 17,000 ft^3 of radwaste with a maximum of 48,000 ft^3 for Brunswick and a minimum of 2,500 ft^3 for Calvert Cliffs. Thus for the average of 17,000 ft^3 per year the UFRSS would be used on 85 shifts or 8 percent of a total of 1,095 shifts per year. (The "expected" waste volumes from a given plant are usually much lower than the actuals due to problems encountered in normal operation of a nuclear facility, thus we have selected the comparison based on actual waste production as reported by the facilities listed above.)

360.2 b) Clarify whether the UFRSS can handle solidification of the slurry of depleted resins arising from backwashes of condensate demineralizers?

Answer: Yes, slurries can be solidified in the same volume ratio as resins. The purpose of dewatering is to reduce the volume of radwaste to be shipped to burial sites. It is economical to return the resin carrier water back to the resin holding tank of the user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.3 Explain how the air sparger can ensure adequate mixing of the waste in the waste container.

Answer: Earlier designs of the UFRSS used mixing blades with a mixer motor mounted on the liner for blending the radwaste and binder chemicals. This technique proved inadequate (mainly due to operator attention to procedures, condition of mixer blades, etc.). The system was then engineered for an air sparger technique which was interfaced with the control system to provide the proper timing of the mix cycle and was proven to provide a more homogenous mixture of the radwaste and chemicals prior to solidification. With mixer blades, dead spots were found to exist in corners of the liner; with the sparger system the mixing flow pattern sweeps out all areas of the liner including corners. The advantage of sparging is most effective when mixing resins which tend to stay trapped in the liner corners when blades are used to mix the radwaste.

360.4 Clarify the following items relating to the piping and instrumentation diagram, Figure 1-5 of the report.

a) What do "BDTS", "LWPS" and "DW" stand for?

Answer: BDTS and LWPS stand for two types of resins used in one UFRSS system in Spain. As an example, the V.C. Summer facility in South Carolina might label the lines Resin Tank 1 (for a Westinghouse Nuclear Systems Resin - WNES/ATRS) and Resin Tank 2 (Nuclear Blow Down Resins - XTK-108-NB). These input lines and their nomenclature are site specific. For the purpose of this report consider them as Tank 1 and Tank 2 for two types of resins as required.

DW stands for dewater line which is located at the liner or radwaste disposable container.

b) Do the waste inputs shown in the figure include condensate polishing demineralizer resins?

Answer: Input lines to the Waste Blending Tank can range from one to many depending on the user's desires. In the figure, five input lines are shown: 2 resins, 1 evaporator bottom, 1 drain and 1 for filter aids. This is a site specific item and the UFRSS has no restriction on the number of lines the user may have to deliver radwaste to the system. Note Valve MOV 4 is the single point input for radwaste to the waste blending tank. MOV 4 is the interface point between the UFRSS and the introduction of user radwaste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.4 c) Correct the discrepancies in the capacities of the various tanks given in Figures 1-4 and 1-5.

Answer: Delete gallon labels on Figure 1-4. This was a simple block diagram to show relationships of the UFRSS tank subsystem. Tank gallon labels were a carryover from a prior presentation slide. Tank capacities are not germane to operation of the UFRSS system but are sized for user convenience and cost considerations for storage capacity, chemical delivery schedules, etc. Each radwaste system will vary in tank size depending on user preference.

360.5 Clarify the following items relating to flush water.

a) What water is used as flush water?

Answer: Flush water is supplied by the user. It can be tap water or demineralized water but should not be contaminated.

b) How is flush water in the waste container ultimately disposed?

Answer: Flush water in the waste container can be pumped through the dewater line to the spent resin storage tank, or drained through the container bottom plug into an acceptable radwaste room drain collector, or pumped (with a portable pump) to any appropriate contaminated water holding tank including the Waste Blending Tank. Flush water is ultimately recycled for solidification through the Waste Blending Tank under normal operation.

c) What effect will flush water have on the solidification process.... and is there a limit on the quantity of flush water which the waste container can accept?

Answer: Flush water has no effect on solidification, except to say a few more gallons of water must be processed than if one didn't flush when the system was through with a solidification cycle. The limit of flush water the waste container can accept is equal to the size of the waste container. If one fills the waste container full of flush water, that water must be recirculated and solidified, which obviously yields two containers of solidified waste.

d) In Section IV under step 25 (pg. 55) it has been stated that the liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner. Explain this statement.

Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.6 In Section IV of the report (pg. 67) reference has been made to some parameters such as temperature profiles, hardness, dryness and uniformity for waste samples. State criteria for acceptability of these parameters.

Answer: Sample verification test parameters are as follows:

1. Take a radwaste sample ~100-300 cc.

2. Add catalyst in proportions given for the boric acid, sodium sulfate or resin formulae.

3. Stir until the catalyst is completely mixed with the radwaste.

4. Adjust temperature of sample to between 110-120°F (43-49°C).

5. Add UFC in proportions given for the radwaste being sampled.

6. When UFC is added observe and record temperature as it increases.

7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) $\pm$ 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).

8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.

9. Let sample cool and vent till condensation beads are no longer formed and/or are present.

10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

REFERENCE: REPORT PPD-TR-7701
Rev. 1

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

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In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using U-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
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2. Dewatered Resin Beads (Anion & Cation)
   in Ratio of 1.5:1
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3. Dewatered Resin Beads (Anion & Cation)
   in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
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   Billet Size: 55 gallon drum
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b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout forany user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration, heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

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REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection ports, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quality Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be solidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection ports provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

3. N.A. V. C. Summer responsibility.

IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

3. N.A. V. C. Summer responsibility.

4. N.A. V. C. Summer responsibility.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Additional Information for the
U-Form Radwaste Solidification System

360.1 a) Provide a list of equipment, solidification components and process chemicals which are within your scope of supply.

Answer: The generic system consists of a waste blending tank with accessories, two chemical addition tanks, a catalyst solution tank, a urea formaldehyde concentrate (UFC) tank, a radwaste pump, a catalyst pump, two chemical addition pumps, a recirculating pump, a UFC pump, and associated valves, flow detectors, plus the control console. In general all items shown in Figure 1-5 of the reference topical report are supplied by Teledyne Energy Systems. In some cases the users may select to provide tanks, pumps, etc. of their own choosing.

Components which are supplied for solidification include disposable containers, sparging apparatus, flexible hoses, level indicators, flow indicators, radiation detectors, etc., and T.V. monitoring stations.

Teledyne Energy Systems does not supply chemicals. Users are required to purchase chemicals from the appropriate chemical suppliers.

360.1 b) Provide a list of interfaces between the U-Form Radwaste Solidification System (UFRSS) and the required plant services.

Answer: The interface connections required for operation of the UFRSS are:

1. A resin input line which delivers a resin slurry to the waste blending tank. Pumping power to be supplied by user.

2. A radwaste liquid line (evaporator bottoms, floor drains, filter aids) which delivers radwaste to the waste blending tank. Pumping power to be supplied by user.

3. A flush water input line which delivers non-contaminated water to the UFRSS. Pumping power and water to be supplied by user.

4. An air line input which delivers air to the sparging system at 50 psig. Pumping power and air to be supplied by user.

5. Ventilation air for the radwaste room not part of UFRSS.

6. Electrical power (nominal 115, 230, 460 V AC 3 phase) is required at various locations to power pumps, valves, detectors, control console etc. Electric power to be supplied by user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

7. Output drain lines are required for the UFRSS. User provides sumps and/or lines which return liquids to their radwaste holding tanks.

8. Output air vent lines are required for the UFRSS. User provides vent ducts which collect UFRSS vented air for controlled monitoring and release through plant system.

9. Output flush water lines are required for the UFRSS. User provides lines to return water to their radwaste holding tanks.

10. Output of radwaste liquids, e.g., spent resin dewater liquid lines are required for UFRSS. User provides lines to return radwaste liquid to their radwaste holding tanks.

360.1 c) What plant services are required for waste input, transfer liquid return, flush water, overflow, drainage, compressed air, ventilation air, electric power and waste transfer to a truck?

Answer: See part b) above "interfaces." Transfer of waste to truck normally accomplished by crane and/or a type of fork lift truck. Transfer function of casks, drums, liners, etc. normally selected by user.

360.2 a) Provide the processing capacity of the UFRSS and compare it with the expected total waste input to the system for both PWR's and BWR's with a rating of 3400 MWt.

Answer: The UFRSS can comfortably process 200 ft^3 of radwaste per shift based on a two hour cycle per 50 ft^3 liner. An average yearly output from Oconee, Brunswick, Calvert Cliffs, Dresden, Farley, Indian Point, Millstone, Oyster Creek, Palisades, Pilgrim, Salem and Zion is about 17,000 ft^3 of radwaste with a maximum of 48,000 ft^3 for Brunswick and a minimum of 2,500 ft^3 for Calvert Cliffs. Thus for the average of 17,000 ft^3 per year the UFRSS would be used on 85 shifts or 8 percent of a total of 1,095 shifts per year. (The "expected" waste volumes from a given plant are usually much lower than the actuals due to problems encountered in normal operation of a nuclear facility, thus we have selected the comparison based on actual waste production as reported by the facilities listed above.)

360.2 b) Clarify whether the UFRSS can handle solidification of the slurry of depleted resins arising from backwashes of condensate demineralizers?

Answer: Yes, slurries can be solidified in the same volume ratio as resins. The purpose of dewatering is to reduce the volume of radwaste to be shipped to burial sites. It is economical to return the resin carrier water back to the resin holding tank of the user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.3 Explain how the air sparger can ensure adequate mixing of the waste in the waste container.

Answer: Earlier designs of the UFRSS used mixing blades with a mixer motor mounted on the liner for blending the radwaste and binder chemicals. This technique proved inadequate (mainly due to operator attention to procedures, condition of mixer blades, etc.). The system was then engineered for an air sparger technique which was interfaced with the control system to provide the proper timing of the mix cycle and was proven to provide a more homogenous mixture of the radwaste and chemicals prior to solidification. With mixer blades, dead spots were found to exist in corners of the liner; with the sparger system the mixing flow pattern sweeps out all areas of the liner including corners. The advantage of sparging is most effective when mixing resins which tend to stay trapped in the liner corners when blades are used to mix the radwaste.

360.4 Clarify the following items relating to the piping and instrumentation diagram, Figure 1-5 of the report.

a) What do "BDTS", "LWPS" and "DW" stand for?

Answer: BDTS and LWPS stand for two types of resins used in one UFRSS system in Spain. As an example, the V.C. Summer facility in South Carolina might label the lines Resin Tank 1 (for a Westinghouse Nuclear Systems Resin - WNES/ATRS) and Resin Tank 2 (Nuclear Blow Down Resins - XTK-108-NB). These input lines and their nomenclature are site specific. For the purpose of this report consider them as Tank 1 and Tank 2 for two types of resins as required.

DW stands for dewater line which is located at the liner or radwaste disposable container.

b) Do the waste inputs shown in the figure include condensate polishing demineralizer resins?

Answer: Input lines to the Waste Blending Tank can range from one to many depending on the user's desires. In the figure, five input lines are shown: 2 resins, 1 evaporator bottom, 1 drain and 1 for filter aids. This is a site specific item and the UFRSS has no restriction on the number of lines the user may have to deliver radwaste to the system. Note Valve MOV 4 is the single point input for radwaste to the waste blending tank. MOV 4 is the interface point between the UFRSS and the introduction of user radwaste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.4 c) Correct the discrepancies in the capacities of the various tanks given in Figures 1-4 and 1-5.

Answer: Delete gallon labels on Figure 1-4. This was a simple block diagram to show relationships of the UFRSS tank subsystem. Tank gallon labels were a carryover from a prior presentation slide. Tank capacities are not germane to operation of the UFRSS system but are sized for user convenience and cost considerations for storage capacity, chemical delivery schedules, etc. Each radwaste system will vary in tank size depending on user preference.

360.5 Clarify the following items relating to flush water.

a) What water is used as flush water?

Answer: Flush water is supplied by the user. It can be tap water or demineralized water but should not be contaminated.

b) How is flush water in the waste container ultimately disposed?

Answer: Flush water in the waste container can be pumped through the dewater line to the spent resin storage tank, or drained through the container bottom plug into an acceptable radwaste room drain collector, or pumped (with a portable pump) to any appropriate contaminated water holding tank including the Waste Blending Tank. Flush water is ultimately recycled for solidification through the Waste Blending Tank under normal operation.

c) What effect will flush water have on the solidification process.... and is there a limit on the quantity of flush water which the waste container can accept?

Answer: Flush water has no effect on solidification, except to say a few more gallons of water must be processed than if one didn't flush when the system was through with a solidification cycle. The limit of flush water the waste container can accept is equal to the size of the waste container. If one fills the waste container full of flush water, that water must be recirculated and solidified, which obviously yields two containers of solidified waste.

d) In Section IV under step 25 (pg. 55) it has been stated that the liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner. Explain this statement.

Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.6 In Section IV of the report (pg. 67) reference has been made to some parameters such as temperature profiles, hardness, dryness and uniformity for waste samples. State criteria for acceptability of these parameters.

Answer: Sample verification test parameters are as follows:

1. Take a radwaste sample ~100-300 cc.

2. Add catalyst in proportions given for the boric acid, sodium sulfate or resin formulae.

3. Stir until the catalyst is completely mixed with the radwaste.

4. Adjust temperature of sample to between 110-120°F (43-49°C).

5. Add UFC in proportions given for the radwaste being sampled.

6. When UFC is added observe and record temperature as it increases.

7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) $\pm$ 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).

8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.

9. Let sample cool and vent till condensation beads are no longer formed and/or are present.

10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

REFERENCE: REPORT PPD-TR-7701
Rev. 1

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

High oil content can affect solidification if the oil content is greater than 40% of the total volume. However, long term observations have shown that for oil concentrations greater than 10% volume the oil will slowly seep out of the billet like beads of perspiration. The recommendation is not to solidify more than 10% oil in any mixture of radwaste. No pretreatment is necessary if the concentration of oil is less than 10%.

In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using U-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
   All were dry after initial solidification

2. Dewatered Resin Beads (Anion & Cation)
   in Ratio of 1.5:1
   Billet Size: 55 gal. drum
   No. of billets: 5
   All were dry after initial solidification

3. Dewatered Resin Beads (Anion & Cation)
   in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
   Billet Size: 55 gallon drum
   No. of billets: 1
   Billet was dry after initial solidification

4. Sodium Sulfate 22.9% @ ratio of 0.8:1
   Billet Size: 55 gallon drum
   No. of billets: 2
   Billets dry after initial solidification

b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout forany user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration, heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

Long term storage (>9 months) also showed no generation of free water under temperatures of less than 80°F. If billets are subjected to temperatures greater than 80°F for long periods of time, weep water is produced at the bottom of the liner. Tests were conducted at Teledyne to determine these weep rates. The results are as follows:

Temperature held for 24 hours	cc per day per 50 cu. ft. liner
80°	100
85°	400
90°	500
95°	550
100°	600

Based on a 1/2% free water burial criteria currently in effect, the conservative times (since reabsorption is not considered but in fact occurs) for transporting the radwaste from the reactor plant to the burial site is:

Temperature held for 24 hours	Days allowed for transportation
80°	71
85°	18
90°	14
95°	13
[illegible]	12

During these weep tests, the test billets were static loaded with an equivalent of 50 feet of U-F. No significant change in weep rate was noted between loaded and unloaded billets. Thus we conclude only temperature can effect the weep rate production of free water. (Cooling even to freezing has shown weep water to be reabsorbed into the billet.)

REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection ports, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quality Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be solidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection ports provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

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IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

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REFERENCE: REPORT PPD-TR-7701
Rev. 1

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Answer: The generic system consists of a waste blending tank with accessories, two chemical addition tanks, a catalyst solution tank, a urea formaldehyde concentrate (UFC) tank, a radwaste pump, a catalyst pump two chemical addition pumps, a recirculating pump, a UFC pump and associated valves, flow detectors, plus the control console. In general all items shown in Figure 1-5 of the reference topical report are supplied by Teledyne Energy Systems. In some cases the users may select to provide tanks, pumps, etc. of their own choosing.

Components which are supplied for solidification include disposable containers, sparging apparatus, flexible hoses, level indicators, flow indicators, radiation detectors, etc., and T.V. monitoring stations.

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Answer: The interface connections required for operation of the UFRSS are:

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3. A flush water input line which delivers non-contaminated water to the UFRSS. Pumping power and water to be supplied by user.

4. An air line input which delivers air to the sparging system at 50 psig. Pumping power and air to be supplied by user.

5. Ventilation air for the radwaste room not part of UFRSS.

6. Electrical power (nominal 115, 230, 460 V AC 3 phase) is required at various locations to power pumps, valves, detectors, control console etc. Electric power to be supplied by user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

7. Output drain lines are required for the UFRSS. User provides sumps and/or lines which return liquids to their radwaste holding tanks.

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10. Output of radwaste liquids, e.g., spent resin dewater liquid lines are required for UFRSS. User provides lines to return radwaste liquid to their radwaste holding tanks.

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REFERENCE: REPORT PPD-TR-7701
Rev. 1

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Answer: Earlier designs of the UFRSS used mixing blades with a mixer motor mounted on the liner for blending the radwaste and binder chemicals. This technique proved inadequate (mainly due to operator attention to procedures, condition of mixer blades, etc.). The system was then engineered for an air sparger technique which was interfaced with the control system to provide the proper timing of the mix cycle and was proven to provide a more homogenous mixture of the radwaste and chemicals prior to solidification. With mixer blades, dead spots were found to exist in corners of the liner; with the sparger system the mixing flow pattern sweeps out all areas of the liner including corners. The advantage of sparging is most effective when mixing resins which tend to stay trapped in the liner corners when blades are used to mix the radwaste.

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REFERENCE: REPORT PPD-TR-7701
Rev. 1

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Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

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4. Adjust temperature of sample to between 110-120°F (43-49°C).
5. Add UFC in proportions given for the radwaste being sampled.
6. When UFC is added observe and record temperature as it increases.
7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) ± 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).
8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.
9. Let sample cool and vent till condensation beads are no longer formed and/or are present.
10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

REFERENCE: REPORT PPD-TR-7701
Rev. 1

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

High oil content can affect solidification if the oil content is greater than 40% of the total volume. However, long term observations have shown that for oil concentrations greater than 10% volume the oil will slowly seep out of the billet like beads of perspiration. The recommendation is not to solidify more than 10% oil in any mixture of radwaste. No pretreatment is necessary if the concentration of oil is less than 10%.

In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using "-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
   All were dry after initial solidification

2. Dewatered Resin Beads (Anion & Cation)
   in Ratio of 1.5:1
   Billet Size: 55 gal. drum
   No. of billets: 5
   All were dry after initial solidification

3. Dewatered Resin Beads (Anion & Cation)
   in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
   Billet Size: 55 gallon drum
   No. of billets: 1
   Billet was dry after initial solidification

4. Sodium Sulfate 22.9% @ ratio of 0.8:1
   Billet Size: 55 gallon drum
   No. of billets: 2
   Billets dry after initial solidification

b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout forany user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration, heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

Long term storage (>9 months) also showed no generation of free water under temperatures of less than 80°F. If billets are subjected to temperatures greater than 80°F for long periods of time, weep water is produced at the bottom of the liner. Tests were conducted at Teledyne to determine these weep rates. The results are as follows:

Temperature held for 24 hours	cc per day per 50 cu. ft. liner
80°	100
85°	400
90°	500
[illegible]	550
	600

Based on a 1/2% free water burial criteria currently in effect, the conservative times (since reabsorption is not considered but in fact occurs) for transporting the radwaste from the reactor plant to the burial site is:

Temperature held for 24 hours	Days allowed for transportation
80°	71
85°	18
90°	14
95°	13
100°	12

During these weep tests, the test billets were static loaded with an equivalent of 50 feet of U-F. No significant change in weep rate was noted between loaded and unloaded billets. Thus we conclude only temperature can effect the weep rate production of free water. (Cooling even to freezing has shown weep water to be reabsorbed into the billet.)

REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection [illegible]s, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

   1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

   1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

   1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quality Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be solidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection ports provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

3. N.A. V. C. Summer responsibility.

IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

3. N.A. V. C. Summer responsibility.

4. N.A. V. C. Summer responsibility.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Additional Information for the
U-Form Radwaste Solidification System

360.1 a) Provide a list of equipment, solidification components and process chemicals which are within your scope of supply.

Answer: The generic system consists of a waste blending tank with accessories, two chemical addition tanks, a catalyst solution tank, a urea formaldehyde concentrate (UFC) tank, a radwaste pump, a catalyst pump, two chemical addition pumps, a recirculating pump, a UFC pump, and associated valves, flow detectors, plus the control console. In general all items shown in Figure 1-5 of the reference topical report are supplied by Teledyne Energy Systems. In some cases the users may select to provide tanks, pumps, etc. of their own choosing.

Components which are supplied for solidification include disposable containers, sparging apparatus, flexible hoses, level indicators, flow indicators, radiation detectors, etc., and T.V. monitoring stations.

Teledyne Energy Systems does not supply chemicals. Users are required to purchase chemicals from the appropriate chemical suppliers.

360.1 b) Provide a list of interfaces between the U-Form Radwaste Solidification System (UFRSS) and the required plant services.

Answer: The interface connections required for operation of the UFRSS are:

1. A resin input line which delivers a resin slurry to the waste blending tank. Pumping power to be supplied by user.

2. A radwaste liquid line (evaporator bottoms, floor drains, filter aids) which delivers radwaste to the waste blending tank. Pumping power to be supplied by user.

3. A flush water input line which delivers non-contaminated water to the UFRSS. Pumping power and water to be supplied by user.

4. An air line input which delivers air to the sparging system at 50 psig. Pumping power and air to be supplied by user.

5. Ventilation air for the radwaste room not part of UFRSS.

6. Electrical power (nominal 115, 230, 460 V AC 3 phase) is required at various locations to power pumps, valves, detectors, control console etc. Electric power to be supplied by user.

R"FERENCE: REPORT PPD-TR-7701
Rev. 1

7. Output drain lines are required for the UFRSS. User provides sumps and/or lines which return liquids to their radwaste holding tanks.

8. Output air vent lines are required for the UFRSS. User provides vent ducts which collect UFRSS vented air for controlled monitoring and release through plant system.

9. Output flush water lines are required for the UFRSS. User provides lines to return water to their radwaste holding tanks.

10. Output of radwaste liquids, e.g., spent resin dewater liquid lines are required for UFRSS. User provides lines to return radwaste liquid to their radwaste holding tanks.

360.1 c) What plant services are required for waste input, transfer liquid return, flush water, overflow, drainage, compressed air, ventilation air, electric power and waste transfer to a truck?

Answer: See part b) above "interfaces." Transfer of waste to truck normally accomplished by crane and/or a type of fork lift truck. Transfer function of casks, drums, liners, etc. normally selected by user.

360.2 a) Provide the processing capacity of the UFRSS and compare it with the expected total waste input to the system for both PWR's and BWR's with a rating of 3400 MWt.

Answer: The UFRSS can comfortably process 200 ft^3 of radwaste per shift based on a two hour cycle per 50 ft^3 liner. An average yearly output from Oconee, Brunswick, Calvert Cliffs, Dresden, Farley, Indian Point, Millstone, Oyster Creek, Palisades, Pilgrim, Salem and Zion is about 17,000 ft^3 of radwaste with a maximum of 48,000 ft^3 for Brunswick and a minimum of 2,500 ft^3 for Calvert Cliffs. Thus for the average of 17,000 ft^3 per year the UFRSS would be used on 85 shifts or 8 percent of a total of 1,095 shifts per year. (The "expected" waste volumes from a given plant are usually much lower than the actuals due to problems encountered in normal operation of a nuclear facility, thus we have selected the comparison based on actual waste production as reported by the facilities listed above.)

360.2 b) Clarify whether the UFRSS can handle solidification of the slurry of depleted resins arising from backwashes of condensate demineralizers?

Answer: Yes, slurries can be solidified in the same volume ratio as resins. The purpose of dewatering is to reduce the volume of radwaste to be shipped to burial sites. It is economical to return the resin carrier water back to the resin holding tank of the user.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.3 Explain how the air sparger can ensure adequate mixing of the waste in the waste container.

Answer: Earlier designs of the UFRSS used mixing blades with a mixer motor mounted on the liner for blending the radwaste and binder chemicals. This technique proved inadequate (mainly due to operator attention to procedures, condition of mixer blades, etc.). The system was then engineered for an air sparger technique which was interfaced with the control system to provide the proper timing of the mix cycle and was proven to provide a more homogenous mixture of the radwaste and chemicals prior to solidification. With mixer blades, dead spots were found to exist in corners of the liner; with the sparger system the mixing flow pattern sweeps out all areas of the liner including corners. The advantage of sparging is most effective when mixing resins which tend to stay trapped in the liner corners when blades are used to mix the radwaste.

360.4 Clarify the following items relating to the piping and instrumentation diagram, Figure 1-5 of the report.

a) What do "BDTS", "LWPS" and "DW" stand for?

Answer: BDTS and LWPS stand for two types of resins used in one UFRSS system in Spain. As an example, the V.C. Summer facility in South Carolina might label the lines Resin Tank 1 (for a Westinghouse Nuclear Systems Resin - WNES/ATRS) and Resin Tank 2 (Nuclear Blow Down Resins - XTK-108-NB). These input lines and their nomenclature are site specific. For the purpose of this report consider them as Tank 1 and Tank 2 for two types of resins as required.

DW stands for dewater line which is located at the liner or radwaste disposable container.

b) Do the waste inputs shown in the figure include condensate polishing demineralizer resins?

Answer: Input lines to the Waste Blending Tank can range from one to many depending on the user's desires. In the figure, five input lines are shown: 2 resins, 1 evaporator bottom, 1 drain and 1 for filter aids. This is a site specific item and the UFRSS has no restriction on the number of lines the user may have to deliver radwaste to the system. Note Valve MOV 4 is the single point input for radwaste to the waste blending tank. MOV 4 is the interface point between the UFRSS and the introduction of user radwaste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.4 c) Correct the discrepancies in the capacities of the various tanks given in Figures 1-4 and 1-5.

Answer: Delete gallon labels on Figure 1-4. This was a simple block diagram to show relationships of the UFRSS tank subsystem. Tank gallon labels were a carryover from a prior presentation slide. Tank capacities are not germane to operation of the UFRSS system but are sized for user convenience and cost considerations for storage capacity, chemical delivery schedules, etc. Each radwaste system will vary in tank size depending on user preference.

360.5 Clarify the following items relating to flush water.

a) What water is used as flush water?

Answer: Flush water is supplied by the user. It can be tap water or demineralized water but should not be contaminated.

b) How is flush water in the waste container ultimately disposed?

Answer: Flush water in the waste container can be pumped through the dewater line to the spent resin storage tank, or drained through the container bottom plug into an acceptable radwaste room drain collector, or pumped (with a portable pump) to any appropriate contaminated water holding tank including the Waste Blending Tank. Flush water is ultimately recycled for solidification through the Waste Blending Tank under normal operation.

c) What effect will flush water have on the solidification process.... and is there a limit on the quantity of flush water which the waste container can accept?

Answer: Flush water has no effect on solidification, except to say a few more gallons of water must be processed than if one didn't flush when the system was through with a solidification cycle. The limit of flush water the waste container can accept is equal to the size of the waste container. If one fills the waste container full of flush water, that water must be recirculated and solidified, which obviously yields two containers of solidified waste.

d) In Section IV under step 25 (pg. 55) it has been stated that the liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner. Explain this statement.

Answer: Refer to Figure 1-5 and note that flush water is introduced into the liquid waste discharge line at valve MOV 3. The flush water, when introduced, goes in two directions: (1) back up the line to the Waste Blending Tank and (2) forward in the line to the Radwaste Pump and Disposal Container or liner. This then cleans the waste discharge line from the WBT all the way through the flexible hoses attached to the liner.

REFERENCE: REPORT PPD-TR-77 1
Rev. 1

360.6 In Section IV of the report (pg. 67) reference has been made to some parameters such as temperature profiles, hardness, dryness and uniformity for waste samples. State criteria for acceptability of these parameters.

Answer: Sample verification test parameters are as follows:

1. Take a radwaste sample ~100-300 cc.

2. Add catalyst in proportions given for the boric acid, sodium sulfate or resin formulae.

3. Stir until the catalyst is completely mixed with the radwaste.

4. Adjust temperature of sample to between 110-120°F (43-49°C).

5. Add UFC in proportions given for the radwaste being sampled.

6. When UFC is added observe and record temperature as it increases.

7. Stir sample continuously until temperature from the exothermic reaction reaches 30°F (17°C) ± 3% higher than the reading after UFC was added. Normal time to reach +30°F is about 8-15 minutes. Stop stirring sample (this corresponds to sparging cut off on large drums or liners).

8. Continue measuring temperature increase until temperature levels out at about 150°F (66°C) which indicates the solidification reaction has been completed.

9. Let sample cool and vent till condensation beads are no longer formed and/or are present.

10. Remove billet from sample container and inspect for uniformity and hardness. Hardness should be equal to that of chalk with no gradation in uniformity. Typical readings of hardness should be >80 on a Durometer A scale.

360.7 Provide information on the following:

a) The operating parameters required for successful solidification of cation and anion resin beads, powdered resin systems, and precoat filters.

Answer: All of the above must be chemically adjusted in the Waste Blending Tank prior to solidification. Adjustment means "spending" the resins, etc. so they do not take up acid necessary for the U-F reaction. Thus 10% sulfuric acid is added to the resins until a pH increase of one unit is observed on the pH meter. At this point the resins, powders, etc. will be "spent" and should not affect the solidification step when U-F and the

REFERENCE: REPORT PPD-TR-7701
Rev. 1

and the catalyst react to form a solid mass.

b) The pre-treatment limits and adjustments for specific gravity, anti-foaming agent and high oil content for the various types of wastes for successful solidification of the wastes (see pg. 84 of the topical report).

Answer: The specific gravity of the wastes is not a factor in determining the pre-treatment limits for those wastes described in the report, i.e., boric acids, sodium sulphates and resins and powders.

Anti-foaming agents are added to the wastes only if during actual operation it is found necessary to use them. The anti-foam agents would be added to the waste in the Waste Blending Tank and their addition would not affect the solidification cycle since only a fraction of a percent is required to control foaming. The use of foaming agents is a site specific operation.

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In all cases mentioned above, it must be remembered that the sample solidification will dictate whether the radwaste needs to be adjusted for pH, dilution of oils, etc.

360.8 Where should the waste be sampled and whose responsibility is the sampling system? Also describe how the waste radioactivity concentrations and identification of radionuclides will be determined and recorded if sampling is within your scope of responsibility.

Answer: A sample outlet, recirculating line, and associated valves are provided with the system. Details of sample handling, measuring for radioactivity etc. are the responsibility of the user.

360.9 In your report, youhave provided a summary table of recent tests (pg. 85) using U-Form process. Provide the following additional information.

a) Give full scale solidification testing results for each type of waste or simulated waste.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 Answer:

1. 12 ^{w}/o Boric Acid @ ratios of 1.25:1
   Billet Size: 50 cu. ft.
   No. of billets: 5
   All were dry after initial solidification

2. Dewatered Resin Beads (Anion & Cation)
   in Ratio of 1.5:1
   Billet Size: 55 gal. drum
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   in 12 ^{w}/o Boric Acid solution 1.35:1 ratio
   Billet Size: 55 gallon drum
   No. of billets: 1
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4. Sodium Sulfate 22.9% @ ratio of 0.8:1
   Billet Size: 55 gallon drum
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   Billets dry after initial solidification

b) Include pre-coat filters in the summary table if the system will be used for that purpose.

Answer: Pre-coat filters have only been solidified in small samples. The reactions were similar to resin beads. Full scale testing for pre-coat filters would be conducted during facility checkout forany user desiring to solidify pre-coat filters.

c) Clarify whether the dewatered resin beads listed in the summary table include cation and anion beads and all kinds of powdered resin systems; if they do not include these as separate items.

Answer: Resins, cation and anion, have been solidified in large billets as a 50-50 mixture. Small scale testing on one or the other, and powdered resins, have been solidified in test sample size billets. No differences in the final solidified product were noticed between small samples of one resin versus large billets of both resins. We conclude that large billets of a single resin, cation or anion, will perform the same as the 50/50 mixtures tested.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

360.9 d) For each of the waste streams, include test results on amounts of free standing water after normally expected storage period, and transportation to assure that lifting, vibration, heat, freezing, jolting, and motion of the waste containers will not release liquid from the solidified mass in excess of applicable burial ground license requirements prior to arrival of the wastes at the burial site.

Answer: A 50 cu. ft. billet was shipped from Teledyne Energy Systems, Timonium, Maryland to Barnwell, South Carolina and back again to determine if real transportation activities would cause free water to be released. The result of the test was that no water was released during transportation.

Long term storage (>9 months) also showed no generation of free water under temperatures of less than 80°F. If billets are subjected to temperatures greater than 80°F for long periods of time, weep water is produced at the bottom of the liner. Tests were conducted at Teledyne to determine these weep rates. The results are as follows:

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Temperature held for 24 hours	Days allowed for transportation
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During these weep tests, the test billets were static loaded with an equivalent of 50 feet of U-F. No significant change in weep rate was noted between loaded and unloaded billets. Thus we conclude only temperature can effect the weep rate production of free water. (Cooling even to freezing has shown weep water to be reabsorbed into the billet.)

REFERENCE: REPORT PPD-TR-7701
Rev. 1

As a result of the above, we recommend users schedule shipment of the radwaste billets to minimize the time on the road in the hot sun. Once billets are buried no weep water is produced and in fact, that which was produced during transportation will be reabsorbed in the cool ground.

360.9 e) Include test results to show that residual liquids, if any, are compatible with the container materials, etc.

Answer: Weep water produced in the U-F system has a pH of 3 to 5, i.e., it is acidic. The liners (containers) to be used for the U-F solidification process have been internally coated with a 1/4" coal-tar epoxy specifically to prevent any weep water or low pH condensate water from attacking the steel portion of the liner. Further, now that a High Integrity Container has been approved which will be immune to attack by U-F, we recommend all users of U-F systems incorporate the new HIC liners in their operation plans. Tests results are available from the HIC supplier, e.g., Chem-Nuclear, to show its resistance to low pH liquids.

360.10 Clarify whether each of the liners and containers will be provided with bottom drains to facilitate easy examination of free standing water in any container when it is needed.

Answer: Disposable liners (containers) used for solidification of radwaste include two inspection ports, one at the upper lid assembly and one at the bottom of the liner in the form of a drain plug.

360.11 Provide tables comparing the features of UFRSS with the applicable positions of Regulatory Guide 1.143, July 1978, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" and Branch Technical Position, ETSB BTP 11-3 (Rev. 1), "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

Answer: (A) Regulatory Guide 1.143

1. Systems Handling Radioactive Materials in Liquids

   1.1.1 UFRSS was designed and tested to meet this paragraph. All approvals were made by Gilbert Associates, Architects and Engineers for V. C. Summer Facility.

   1.1.2 Material Certs etc. approved by Gilbert Associates and V. C. Summer.

   1.1.3 N.A. V. C. Summer responsible for structures.

REFERENCE: REPORT PPD-TR-7701
Rev. 1

1.1.4 UFRSS equipment not designed for seismic criteria as stated in 1.143.

1.2.1 All tanks of the UFRSS monitor level and activate alarms.

1.2.2 N.A. V. C. Summer responsibility

1.2.3 N.A.. V. C. Summer responsibility

1.2.4 N.A. V. C. Summer responsibility

1.2.5 N.A. V. C. Summer responsibility

2. Gaseous Radwaste Systems

N.A. UFRSS System not to be used for gases.

3. Solid Radwaste Systems (Resins)

3.1.1 Same as 1.1.1 above

3.1.2 Same as 1.1.2 above

3.1.3 Same as 1.1.3 above

3.1.4 Same as 1.1.4 above

4. Additional Design, Construction and Test Criteria

4.1 ALARA Exposure: UFRSS designed in cooperation with Gilbert Associates and V. C. Summer to achieve this goal.

4.2 All QA approved by Gilbert Associates

4.3 All TES weldings done to ASME specs.

4.4 N.A. System check out V. C. Summer responsibility

4.5 N.A. System check out V. C. Summer responsibility

5. Seismic Design

N.A. for UFRSS components

6. Quality Assurance for Radwaste Management Systems

Reference Topical Report Appendix for QA Manual

REFERENCE: REPORT PPD-TR-7701
Rev. 1

Answer: (B) ETSB 11-3 (Rev. 1)

I. Process Requirements

1. Dry Waste N.A.

2. Wet Waste

a) UFRSS complies with U-F system

b) Filter elements to be sclidified in liner by standard U-F process

II. Assurance of Complete Solidification

1. Process Control Program

a) Solidification agents and waste test required prior to solidification. Ratios, pH, temperature, etc. must be adjusted to proper level prior to solidification.

b) Solid waste processing (Same as above)

c) Operator Assurance

See V. C. Summer operating plan

2. Free Liquid Detection

Top and bottom inspection ports provided in liner.

III. Waste Storage

1. N.A. V. C. Summer responsibility.

2. N.A. V. C. Summer responsibility.

3. N.A. V. C. Summer responsibility.

IV. Additional Design Features

1. UFRSS has heat tracing where required.

2. UFRSS has flushing capabilith where required.

3. N.A. V. C. Summer responsibility.

4. N.A. V. C. Summer responsibility.