Nuclear

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4410-89-L-0038/0455P

US Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Processed Water Disposal System Technical Evaluation Report

Attached is GPU Nuclear's responses to your request for additional information regarding the Processed Water Disposal System Technical Evaluation Report, dated February 16, 1989.

Sincerely,

M B Roche

M. B. Roche
Director, TMI-2

JJB/emf

Attachment

cc: T. A. Moslak - Acting Senior Resident Inspector, TMI
W. T. Russell - Regional Administrator, Region I
J. F. Stolz - Director, Plant Directorate I-4
L. H. Thonus - Project Manager, TMI Site

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ATTACHMENT
4410-89-L-0038

NRC QUESTION 1

Foaming and spraying will be used to ensure good heat transfer in the evaporator (page 7). They will also affect the decontamination factors (DF) achieved by the evaporator. Describe your process control program (PCP) and your control operating parameters (i.e., level, flow rate, spray rate) to assure good heat transfer and the design objective DF's. If the PCP is still under development, describe how your test data will be used to develop an acceptable PCP.

GPU NUCLEAR RESPONSE

The LICON evaporator is designed to operate under varying conditions of foaming in the boiling liquid. As can be seen by reviewing the system diagram on Figure 4 of the Technical Evaluation Report, the boiling action takes place in the shell of the horizontal shell and tube heat exchanger portion of the evaporator. The liquid level is controlled in this section to assure sufficient wetting of the tubes yet low enough to prevent flooding of the vapor dome. The end of the heat exchanger contains a 24 inch diameter plexiglass viewing window. Thus, the water level as well as the boiling action can be seen by the operator. In addition, the evaporator is also designed so that the liquid entrained with the rising vapors drains from the vapor dome to the suction of the recycle pump. The drain line contains a sight flow indicator which permits the operator to see the quantity of liquid draining from the vapor dome. Further, under unexpected conditions of extremely high liquid carryover, the liquid level would rise in the vapor dome causing an automatic shutdown of the evaporator. This high level trip is discussed on page 20 of the TER. The evaporator liquid level controller has been preset at the manufacturer's facility during system testing with surrogate accident generated water feed solutions. The level controller can be easily reset in the field by the operator if conditions warrant. The operator will be sufficiently trained and experienced to make these adjustments. Adjustment of the level controller will be controlled by operating procedures.

Liquid entrained in the vapor stream leaving the vapor dome will also be removed through the vapor compressor's liquid seals. As shown on Figure 4 of the TER, water is injected through valves V-46 and V-10 into the compressor suction duct. This water desuperheats the vapors and provides a liquid seal on the compressor lobes. Excess water is removed at the compressor discharge duct by eductor E-1. The system has been modified since submittal of the TER so that the eductor E-1 and the vacuum pump discharge into a contaminated distillate tank. Most of the liquid carryover in the vapor stream will thus be collected in the contaminated distillate tank and will be reprocessed by its use as reflux spray to the vapor dome. The reflux spray is a new addition that quenches the volatilized boric acid back into the boiling liquid. Additional controls on the system include conductivity monitors in the process streams that would detect upset conditions causing large quantities of liquid carryover.

As can be seen from the foregoing discussion, the evaporator is specifically designed to operate with potentially foaming waste water solutions with minimal liquid carryover. Regardless of the other operating parameters, the primary system parameter of interest is the concentraton of contaminants in the vaporizer feed stream. Vaporizer feed concentrations (or evaporator discharge concentrations when operating in coupled mode) of less than 1/1000th of "base case" concentrations will assure compliance with estalished release rates. These concentrations will be periodically determined by the sampling program specified in our PCP.

As stated in the TER, the primary method of control will be liquid sampling. Distillate samples will be withdrawn at a frequency to be specified in the PCP. The samples will be analyzed for boron and the System DF computed by comparison of the boron concentration in the feed to the boron concentration in the distillate. The DF determined for boron will used to estimate a conservative concentration of radionuclides in the effluent during the interval between radionuclide analyses. Other analyses, as specified in the PCP, will also be performed, but the constituent in the AGW used for DF calculation is boron as it is volatile when in the form of boric acid and will provide the most conservative (i.e., the lowest indicated) measure of DF. If sample analysis shows that the required DF is not being achieved, the process will be adjusted accordingly. If necessary, the atmospheric discharge from the vaporizer can be terminated and the evaporator distillate routed to CC-T-1 for interim staging, returned to a PWST, or directly recycled back to the evaporator feed. Also, the evaporator may be shut down. Short term (i.e., between sample intervals) operation with a DF of less than required is not considered a major upset as our stated effluent release limits are based on quarterly averages. The instantaneous release limit is governed by present Technical Specifications and release rates approaching 25% of that value will cause the vaporizer to shutdown automatically.

A Process Control Plan (PCP) will be developed for this system. The purpose of this PCP, as with any PCP, is to assure that the requirements of 10 CFR 20.311(d)(1) are met. It will specify the sampling program necessary to assure compliance with our operating limits and the methods of calculating the final wastes's radionuclide concentration as a function of influent radionuclide concentration and total dissolved solids concentration. This will require a knowledge of the specific gravity and packing density of the final dry waste produced. This will be determined by on-site testing using surrogate solutions. This is discussed further in Responses 2, 4, 17, and 18. The PCP will not specify system operating parameters such as temperatures, levels, pressures, and flowrates as those parameters do not directly relate to the system DF. These will be specified in operating procedures. The PCP will specify the effluent limits from the vaporizer and the evaporator influent limits necessary to assure that the effluent limits are not exceeded based on the DF determined during testing and operation.

NRC QUESTION 2

Provide the maximum quantity of radionuclides and maximum volume of solution that will be present in liquid evaporator bottoms at any time during evaporation. Be sure to include solutions that might result from using the evaporator in lieu of ion exchange pre-treatment.

GPU NUCLEAR RESPONSE

The volumes of liquid solution that will be present in the evaporator system are as follows:

a. The VC-300 evaporator shell has a volume of about 145 gallons if completely flooded. During normal operation it will contain on the order of 50 to 90 gallons of liquid.

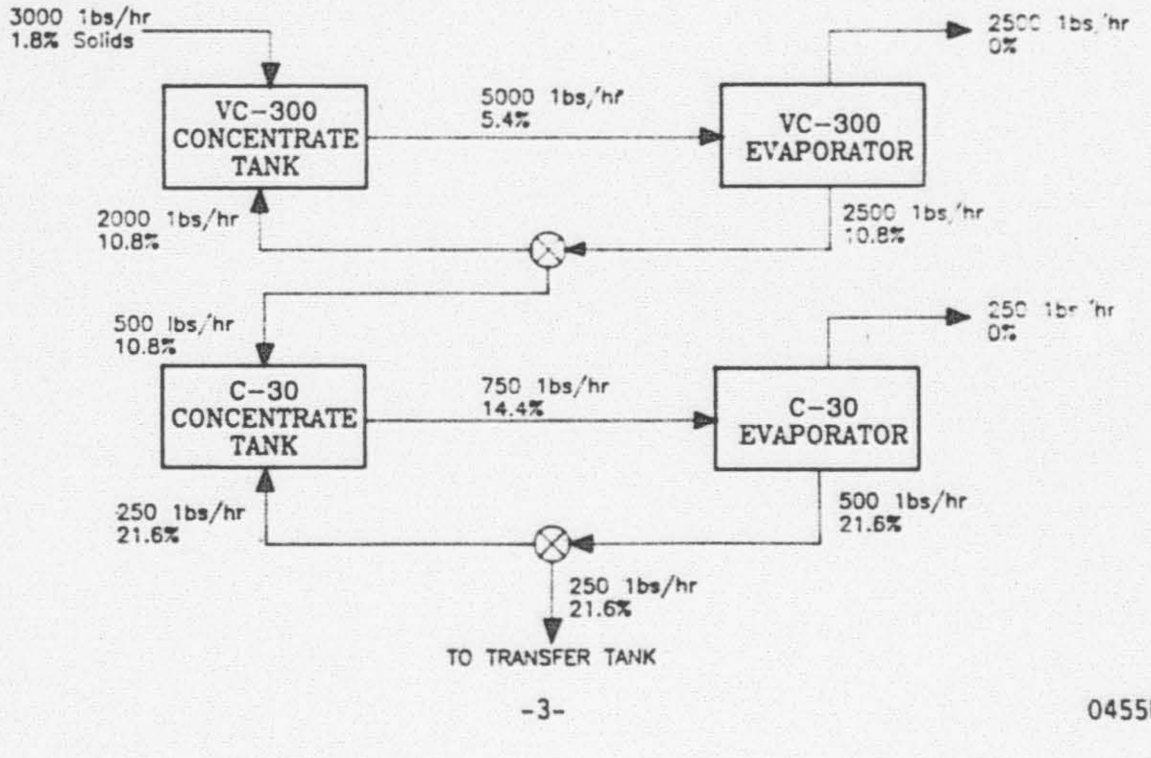
b. The VC concentrate tank has a volume of about 75 gallons. Its normal operating level is 50 to 65 gallons.

c. The C-30 evaporator shell has a flooded volume of about 8 gallons with an operating level of 5 to 6 gallons.

d. The C-30 concentrate tank has a volume of about 35 gallons with an operating level of about 25 to 30 gallons.

e. The transfer tank has a volume of 130 gallons with an operating level of 40 to 90 gallons.

The following simplified process flow diagram shows the flowrates and projected total solids concentrations at the key points in the system:



This is based on processing "Base Case" water. Thus, the radionuclide concentrations in the liquid bottoms are as follows:

- VC Concentrate Tank: about 3 times "Base Case"
- VC Evaporator Shell: 5 to 7 times "Base Case"
- C-30 Concentrate Tank: about 8 times "Base Case"
- C-30 Evaporator Shell: 10-12 times "Base Case"
- Transfer Tank: 10-12 times "Base Case"

These concentrations will produce an LSA, Class A waste form.

If operating the system in a closed cycle to preprocess water by evaporation in lieu of ion exchange, the system influent limits will be set based on total dissolved solids concentration of the feed so that the radionuclide concentration in the dry solid waste will be within Class A burial limits and LSA transportation limits. The influent can exceed "base case" concentrations since the distillate will be staged for further processing rather than being vaporized to the atmosphere. The influent limit must be calculated in accordance with our Process Control Plan for each batch of water and will vary depending upon the radionuclide mix. For example, if a batch of water contained only Sr-90, the controlling criteria would be the Class A burial limit of .04 curies per cubic meter. If the water contained boron and sodium concentrations to yield a total dissolved solids concentration of about 2 percent by weight, then a Sr-90 concentration of 7.1 E-4 μCi/ml in the feed would yield a concentration of .04 Ci/m^3 in the dry solids. If operating with a feed concentration of about 2 percent total solids and a Sr-90 concentration of 7.1 E-4 μCi/ml, the concentration of Sr-90 at various points in the system would be as follows:

- VC Concentrate Tank: 2.1 E-3 μCi/ml
- VC Evaporator Shell: 3.5 E-3 to 4.9 E-3 μCi/ml
- C-30 Concentrate Tank: 5.7 E-3 μCi/ml
- C-30 Evaporator Shell: 7 E-3 to 8.5 E-3 μCi/ml
- Transfer Tank: 7 E-3 to 8.5 E-3 μCi/ml
- Dry solids: .04 Ci/m^3 or .036 μCi/gm

This will be calculated for each batch based on the radionuclide mix. This example calculation is based on a dry solid waste specific gravity of 1.12. Field testing of the system with surrogate solution will determine the proper specific gravity to use in the PCP calculations. Sr-90 concentrations were used in this example as Sr-90 would be the most severe case for off-site dose consequences of a major spill. Similar calculations can be performed for other nuclides or mixes of nuclides.

NRC QUESTION 3

Describe what actions have been taken to prevent premature solidification of the evaporator bottoms in the concentrate tank and associated piping and describe how you plan to redissolve prematurely solidified bottoms.

GPU NUCLEAR RESPONSE

The most likely cause of unintended premature precipitation of solids in the process stream is a loss of electrical power to the system. As discussed briefly in section 4.2.1 of the TER, if excess precipitation occurs, the material will be redissolved by dilution with clean water. In addition, if the normal electric power source is lost, an emergency power feeder is capable of providing about 100 amps at 480 volts to selected loads in the system. Use of the emergency power feeder will be procedurally controlled to assure appropriate operating loads to allow prompt dilution of the process streams as the system cools. In addition, as shown on the system P&ID, the concentrated bottoms transfer tank is provided with a 9 KW electric heater to preclude excessive crystallization.

During normal operation of the system, the concentrate from the VC-300 or main evaporator subsystem will have a total solids concentration of about 10%. If the solids were pure boric acid, they would be completely soluble down to a temperature of about 120° F. Further, the presence of sodium hydroxide in the solution greatly enhances the solubility of the boric acid. Thus, very little, if any, precipitation is expected in the VC-300 system.

The concentrate from the C-30 subsystem will have a total solids concentration of about 20%. As pure boric acid, this would be completely soluble at temperatures above 180°F. Thus, if no or very little sodium hydroxide was present in the feed solution, there would be some precipitation in the concentrates. This is anticipated and is intended by the design of Licon Aquavap system. In some other commercial applications of the system, the C-30 concentrate is fed directly to a filter press for removal/recovery of the precipitate.

Inadvertent crystallization from overconcentration is possible as a result of operator error. The consequences of such an event are mitigated by the thermal design of the Licon Aquavap system. The heating loop on the VC-300 generates excess heat which is rejected to the VC-Distillate tank via the desuperheat spray. This excess heat is the source of energy (supplemented by electric heaters) to the C-30 evaporator. The C-30 evaporator operates at a lower temperature and higher concentration than the VC-300. Thus, plugging of the flow paths and fouling of heat transfer surfaces will occur first in the C-30. As heat transfer is reduced by fouling in the C-30 the VC-Distillate tank temperatures will increase causing higher temperature water to the desuperheater sprays. This will eventually lead to high temperature shutdown of the VC-300 vapor compressor. In addition, as the VC-Distillate temperature increases, the efficiency of the eductors and vacuum pump will decrease as the distillate is the motive force for the eductors and seal water for the liquid ring vacuum pump. This could lead to reduced vacuum, flooding of the distillate side of the VC-300 and resultant cessation of boiling in the

VC-300. If this occurred, the major plugging would be in the small C-30 system and would be on the shell side of the heat exchanger rather than the tube side as in many conventional boric acid evaporators. During one test run of the evaporator, GPU Nuclear engineers requested that the LICON operators attempt to overconcentrate to the point of plugging. The C-30 was concentrated to the point where the shell was about half full of crystallized boric acid. The system was shut down, diluted with clean water, and reheated. The crystallized boric acid redissolved readily and the system resumed normal operation.

In the unlikely event that extreme plugging did occur, the C-30 tube bundle can be easily removed, the exterior surfaces of the tubes cleaned, and the bundle reinstalled. The C-30 shell is 8 inches in diameter, about 5 feet long, and has 25 one inch OD tubes. Refer to the responses to questions 2 and 4 and note that, with the radionuclide concentrations that will exist, such a maintenance activity is well within the capabilities of nuclear power plant maintenance technicians. Although considerably more difficult and time consuming, the VC-300 tube bundle can also be removed for cleaning if necessary.

Process tie-in piping is protected from both freezing and solidification of boric acid solution by heat tracing and insulation.

NRC QUESTION 4

Provide the anticipated maximum quantity and radionuclide content of a batch of solids from the blender/dryer before it is transferred to the pelletizer.

GPU NUCLEAR RESPONSE

The presently planned sequence of operations is that a single blender/dryer cycle will include the transfer of five (5) 90 gallon batches of concentrate from the transfer tank prior to discharging the blender/dryer's contents to the packaging system. This is 450 gallons of liquid with a dissolved solids concentration of about 20% or about 750 lbs. of dry solid waste. The radionuclide concentrations of this waste are as described in response number 2.

NRC QUESTION 5

Provide the maximum individual dose and population dose that could result from a transportation accident involving the waste evaporator bottoms in the form in which they will be shipped. Include a description or reference for your model and assumptions.

GPU NUCLEAR RESPONSE

Evaporator bottoms will be shipped in accordance with the DOT and, if applicable, NRC regulations. It is currently anticipated that a maximum of 14 shipments consisting of 78 17C drums[1] will be shipped from TMI. Each drum will consist of pelletized waste; however, for purposes of the transportation accident analysis, the waste form is assumed to behave as if it were a dry powder, which has a higher propensity to become airborne. Even under worst case accident scenarios, only a portion of the pellet would be powder. The evaporator bottoms are also highly soluble and if precipitation was occurring, the airborne release fraction would be significantly reduced. The total curies of Sr-90, Cs-137, Cs-134, Sb-125, and Co-60 involved in this shipping campaign is assumed to be a factor of 2.9 higher than anticipated to conservatively account for additional isotopes (i.e., Ni-63, Tc-99, C-14). The population dose resulting from an accident during these shipments has been calculated with the aid of the RADTRAN III[2] model.

The route selected from TMI to Hanford, WA, was based upon the INTERSTAT (incorporated into RADTRAN III) least-risk route. The population density along the route is integrated to obtain the population. Dose to the population can occur through any of the following mechanisms: groundshine, cloudshine, inhalation (internal from aerosolized material and inhalation of resuspended material), and ingestion. RADTRAN III uses eight categories for accident severities with the eighth being the most severe. The corresponding values for the four quantities (i.e., severity fraction, release fraction, aerosolization fraction, and respirable fraction) that define the population risk are as follows:

> Severity fraction is a three dimensional array which defines the probability of accidents in each of the three different population zones for each severity category. These values range from a high of .58 for an urban category 1 to a low of 9.9 E-7 for an urban category 8.
>
> Release fraction - 0.1, 0.1, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
>
> Respirable fraction - 0.5 for all categories
>
> Aerosolization fraction - .001, .001, .01, .01, .01, .01, .01, .01

The resulting expected value (i.e., probability times outcome) of population dose from this shipping campaign is 2.0 E-3 person-rem.

The dose received by the maximally exposed individual, who is a teen with bone as the critical organ, from the postulated truck accident has been conservatively calculated to be 322 mrem. This dose assumes that an accident has occurred and the accident is serious enough to affect all drums. This would be a low probability event. The dose was calculated using a breathing factor of 1.25 m^3/hr from Reference 3; inhalation dose factors for Sr-90, Cs-137, Cs-134, Co-60, Sb-125, Ni-63, Tc-99, and C-14 from Reference 4; an airborne release fraction of .001, dispersion into immediate area of vehicle and a two-hour stay time. It is assumed that the least amount of shipments (i.e., the maximum amount of curies per shipment) is progressing and an accident occurs in which 100% of the contents of all drums were available to go airborne with 50% of the airborne particles assumed to be respirable. It should be noted that transportation of Class A, LSA waste is a standard event governed by applicable regulations.

FOOTNOTES

1. A specification 17C steel drum has a 55-gallon capacity and is approximately 23 inches in diameter and 35 inches high. The body and heads are constructed of 16-gauge low carbon, open hearth or electrical furnace steel. The heads are double-seamed to the body with a non-hardening seaming compound; the side seamed is welded. Two rolling hoops are located on the body. Specification 17C drums are constructed according to ANSI MH 2.4-1979 and must meet the design criteria of 49 CFR 178.115.

2. RADTRAN III Sandia Report SAND 84-0036 TTC-0407, February 1986.

3. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," Revision 2, June 1974.

4. NUREG 0172, "Age-Specific Radiation Dose Commitment Factors for a One-Year Chronic Intake," November 1977.

NRC QUESTION 6

Describe the mechanisms that would mitigate the affects of a failure of the HEPA filters on the package enclosure. Estimate the worker exposure for workers in the building and the environmental releases.

GPU NUCLEAR RESPONSE

While it is normal practice to route a HEPA exhaust to the building exhaust ventilation ductwork, venting the exhaust to the work space within the building is an acceptable practice when airborne radioactivity consequences are not anticipated to be significant. The influent to the HEPA filters on the package enclosure is not expected to be significantly contaminated due to the low specific activity of the dry product. As a result, exhausting the blower exhaust to the work space is an acceptable design for this operation. In addition, these blowers will be equipped with gauges to monitor filter loading and, when necessary, the filters will be changed out and tested in accordance with station operating procedures. Based on our extensive experience with the use of HEPA filters, we are confident that this program will minimize the potential for HEPA filter failure.

In the unlikely event that a filter failure does occur, worker exposure and environmental releases would be low. This is illustrated as follows:

Assumptions

Based on our experience with airborne dusts, dust comming out of the blower discharge would be visible at a minimum concentration of 10 mg/cu m.

The worst case specific activity of the dry product is .04 uCi/cc (10 CFR Part 61 Class A waste limit for Sr-90).

The density of the dry product is 1.12 g/cc.

Based on the total inventory of activity in the water to be processed, the Cs-137/Sr-90 ratio is 0.33.

If the operator saw visible dust coming out of the blower discharge, the exhaust unit would be secured. Making the conservative assumption that the airbone dust level had to reach 10 mg/cu m before it was visible, the worst case airborne activity in the exhaust would be:

(10 mg/cu m)(.04 uCi/cc)(1 cc/1.12g)(1 g/1000 mg)(1 cu m/1E+6 cc)

= 3.6E-10 uCi/cc Sr-90 or 0.36 MPC

(3.6E-10)(0.33) = 1.2E-10 uCi/cc Cs-137 or 0.01 MPC

If the operator had to enter the building without respiratory protection for 15 minutes to shut down the blower, his resulting exposure would be less than 0.1 MPC-HR.

In terms of an environmental release, the consequences of a HEPA failure would also be small. Making the conservative assumption that the operator did not notice visible dust coming from the blower for 1 hour, using the same airborne dust concentrations assumed previously, the maximum release rate from the building would be:

(3.6E-10 uCi/cc)(250 cu ft/min)(2.83E+4 cc/cu ft)(1 min/60 sec)

= 4.2E-5 uCi/sec Sr-90

(4.2E-5)(0.33) = 1.4E-5 uCi/sec Cs-137

The total release for 1 hour would be:

(4.2E-5 uCi/sec)(3600 sec) = 0.15 uCi Sr-90

(0.15)(0.33) = 5.0E-2 uCi Cs-137

The resulting dose at the site boundary would be:

1.6E-5 mrem whole body dose

6.3E-5 mrem bone dose

These calculations are conservative in that the assumed concentrations of radionuclides is the final waste form exceed the 10 CFR Part 61 Class A waste limits commited to by GPU Nuclear for evaporator operation.

NRC QUESTION 7

We note that the evaporator building atmosphere may be as much as 25 percent of the occupational MPC value (page 10). List the radionuclides that are expected to be most significant. Based on our preliminary calculations, if the building atmosphere is 25 percent of the occupational MPC for soluble Sr-90 and the building is exhausted at 2500 cfm through an unfiltered exhaust, the release rate from the building will be 3.0E-4 µCi/sec or approximately four times the particulate release rate from the evaporator operated at 5 gpm and a DF of 1000. Describe the filtration and monitoring systems planned for the building exhaust.

GPU NUCLEAR RESPONSE

A continuous air monitor will be located in the building to provide monitoring of airborne contamination for occupational radiation protection. In accordance with station procedures, the alarm setpoint is based upon being able to detect radionuclide concentrations of 25% MPC in the period of a working shift. However, these concentrations are not anticipated to be reached.

Based on the maximum specific activity of the dry product which could be released into the building, airborne activity concentrations in the building could only be a small fraction of the 25% MPC referenced. This is illustrated below:

Assumptions

Assume that a dry product leak rate as high as 5 lbs/hr would go unnoticed by the operator for a one hour time period.

The worst case specific activity of the dry product is 0.04 uCi/cc (Class A limit for Sr-90).

The density of the dry product is 1.12 g/cc, thus the specific activity in terms of mass is 0.036 uCi/g.

The partition factor is 1E-3.

Based on the total inventory of activity in the water to be processed, the Cs-137/Sr-90 ratio is 0.33.

During an undetected dry product leak rate of 5 lbs/hr, the steady state airborne activity in the building would be:

$$\frac{(5\ \text{lbs/hr})(454\ \text{g/lb})(1\text{E-}3)(0.036\ \text{uCi/g})}{(60\ \text{min/hr})(2500\ \text{cu ft/min})(2.83\text{E+}4\ \text{cc/cu ft})}$$

= 1.9E-11 uCi/cc Sr-90 or less than 2% MPC

(1.9E-11)(0.33) = 6.3E-12 Cs-137 or less than 0.1% MPC)

The release rate would be:

(1.9E-11 uCi/cc)(2500 cu ft/min)(2.83E4 cc/cu ft)(1 min/60 sec)

= 2.25E-5 uCi/sec Sr-90

(2.2E-5)(0.33) = 7.3E-6 uCi/sec Cs-137

The resulting dose at the site boundary for the one hour release would be:

8.3E-6 mrem whole body dose

3.3E-5 mrem bone dose

The same conservatism discussed in response to Question 6, regarding the Sr-90 and Cs-137 concentration, also applies here. Obviously, 5 lbs/hr is a very large leak rate and would be detected within a very short period of time. Upon detection the system would be shut down until the leakage is repaired. However, even under such exaggerated conditions, the release rate from the building would be less than 40% of the particulate release rate from the evaporator system when operated at 5 gpm with a DF of 1000. Under normal operation, the release rate from the building would be a small fraction of the evaporator release rate. In addition, a continuous air monitor with alarm capability and strip chart will be in operation in the facility to provide early indication of airborne activity increases. The sample collected from this monitor will be routinely analyzed to allow for trending of airborne activity in the building. Based on this criterion, no filtration or monitoring system is planned for the building exhaust.

Further, as stated in the response to Question 11, if unacceptable radiological working conditions occur in the evaporator building, action will be initiated to protect the operators, the system will be placed in a safe shutdown condition, and all processing activities will be terminated until the radiological problems are corrected. In addition, the building ventilation will be shutdown to terminate any unplanned airborne release to the environment.

NRC QUESTION 8

The packaging system will be kept under negative pressure (page 9). Indicate what negative pressure will be maintained, identify where will it be measured and describe the alarm and control system.

GPU NUCLEAR RESPONSE

The drum enclosure in the packaging system will be kept under a negative pressure of at least 0.1 inches of water when drum filling operations are in progress. The drum enclosure is equipped with two differential pressure gauges. One measures pressure drop across the HEPA filter, the other measures the differential between the enclosure's internal and external pressures. There are no control and alarm functions, these parameters are periodically monitored by the operator.

The enclosure exhaust fan is rated at 250 SCFM. With the drum enclosure door open during drum removal (door will be closed during drum filling) the fan will provide an air velocity of about 30 feet per minute into the enclosure.

NRC QUESTION 9

Indicate if the ambient air sampler in the evaporator building will be a continuous air monitor with an alarm. Describe how this or another device will be used to control airborne radioactivity to less than 25 percent of MPC and less than 50 percent of MPC for an hour.

GPU NUCLEAR RESPONSE

As stated in the response to NRC Question 7, even under conservative worst case conditions, the steady state airborne activity concentration would not exceed 2% MPC. Leakage from the system would be plainly visible far before airborne concentrations approached 25% MPC. The continuous air monitor in the building will be equipped with an alarm; however, due to the low specific activity of the material in the building, it is anticipated that its major use would be to trend any airborne activity in the building.

NRC QUESTION 10

We calculate that if the boric acid is uniformly associated with the Strontium-90, then air that contains 25 percent of occupational MPC for Strontium-90 will also contain 35 mg/m^3 boric acid. The ACGIH occupational limit for "nuisance dusts" is 10 mg/m^3 and for sodium salts of tetra borates is 1 or 5 mg/m^3, depending on the hydration. Describe your program for worker protection from borates.

GPU NUCLEAR RESPONSE

As described in the response to NRC Question 7, airborne activity concentration in the evaporator building could only be a small fraction of 25% MPC (e.g., <2% MPC). In any event, we can monitor boric acid/sodium tetraborate levels both directly and indirectly (from MPC values). Air samples will be collected according to NIOSH methods 0500 and 0600 for total and respirable dusts (which would include any borates present in the atmosphere), respectively, both inside and outside the building for comparison. If airborne concentrations exceed 1 mg/m^3, workers will be adequately protected by prescribing filtered particulate respirators.

Please note that concentrations of 1 mg/m^3 and, thus, the need for respirators is unlikely. Sound industrial process principles have been applied to the design and operation of the evaporator. The designed 2500 cfm ventilation system is adequate to control dust levels for this building. The system is designed to be tight, leaks will be quickly isolated and cleaned up. Maintenance will be performed as necessary to minimize the leakage from the system. The drum packaging area, which is the largest dust generator, will be isolated in a HEPA filtered enclosure and good housekeeping will also help minimize dust loading in the building.

In addition, please note that boric acid is not a nuisance dust. While its TLV is also 10 mg/m^3, it is a mild irritant to the eyes, nose, mouth, throat, and skin. Sodium tetraborate is a moderate skin irritant with a lower TLV of 1 mg/m^3. These stated TLVs are 8-hour time-weighted averages. Our goal is to maintain concentrations well below levels that could result in the TLV being exceeded.

All persons working inside the evaporator building will be informed of the hazards of the different liquid concentrates and solids. Methods for safely containing and cleaning up spill/leaking material will be planned. Training will include these items.

NRC QUESTION 11

Page 10 indicates that if acceptable radiological conditions cannot be achieved in the evaporator building within one hour evaporator operation will be terminated. Indicate if this is intended to include either closed or open cycle evaporation, operation of the vaporizer section and operation of the packaging unit. Indicate if there is any intention to shut down building exhaust during any such conditions.

GPU NUCLEAR RESPONSE

If unacceptable radiological working conditions occur in the evaporator building, action will be initiated to protect the operators, the system will be placed in a safe shutdown condition, and all processing activities will be terminated until the radiological problems are corrected. In addition, the building ventilation will be shutdown to terminate any unplanned airborne release to the environment.

NRC QUESTION 12

Provide the basis for the apparent assumption that building exhaust monitoring is only needed if building air concentrations exceed 25 percent of the occupational MPC.

GPU NUCLEAR RESPONSE

As illustrated in the responses for Questions 6 and 7, the reason that building exhaust monitoring is unnecessary is that there is such a low potential for airborne activity in the building. Airborne activity is not expected to approach 25% MPC.

NRC QUESTION 13

We note on page 10 that the evaporator system building will be placed on a curbed pad that will be of sufficient size to contain the entire volume of liquid that could be contained in the system. Provide the estimated volume. Describe the shut-off mechanisms that will be installed to discontinue feed to the system in the event of a malfunction.

GPU NUCLEAR RESPONSE

The slab on which the system equipment will be mounted has a curbed volume of approximately 2200 gallons. The flooded volume of all the processing equipment on the slab (including the solids handling equipment and exhaust stack) is approximately 1650 gallons.

There are two (2) liquid "feed" lines into the evaporator building: one for chilled (non-radioactive) water and one for radioactive water feed to the evaporator and/or vaporizer. The chilled water system is a closed loop containing approximately 100 gallons. A flow switch is provided in the closed loop to shutdown the chiller and the recirculation pump should the liquid inventory be lost.

The radioactive water feed line, which may be routed to either the evaporator or the vaporizer, also contains a shutoff mechanism. Shutoff of feed to the evaporator is provided by a high-level switch in the VC concentrate tank which automatically closes a feed solenoid valve (V-62). Feed to the system can also be quickly isolated by closing manual valves in the feed piping. These valves are located inside the evaporator building and an operator will usually be present to monitor the system.

There are a number of other automatic mechanisms regarding the evaporator or vaporizer feeds. For example, liquid radiation monitor PWD-RML-1 will shutdown the vaporizer upon detection of high radioactivity in the vaporizer's feed (i.e., evaporator discharge). Also, any sizable leak of feed (or other process liquid) will sound the evaporator building sump high level alarm to warn the operator.

NRC QUESTION 14

Isolation of source and staging tanks is discussed on page 12. Indicate if isolation will be single or dual barrier. Describe how you will assure the absence of through-valve leakage.

GPU NUCLEAR RESPONSE

Isolation of source and staging tanks will be dependent on the exact process scheme which is planned or underway. In addition, isolation will depend on exactly which tanks are in service. (Note that CC-T-1 is to be both a feed tank for the vaporizer and a distillate staging tank for the evaporator.)

Feed tanks which are not in service will be isolated from the evaporator and vaporizer feed flow paths and from other sources of TMI-2 water by at least a single barrier and, where possible, a double barrier.

Feed tanks which are in service will be isolated from other sources of the TMI-2 water by at least a single barrier and, where possible a double barrier.

At this time only one tank, CC-T-1, has been identified as a distillate staging tank. It is presently planned that evaporator distillate will only be staged to CC-T-1 when the vaporizer is not operating (i.e., there are no plans to route evaporator distillate to CC-T-1 while simultaneously drawing vaporizer feed from CC-T-1 as if CC-T-1 were a surge tank). CC-T-1 will be isolated by double valves from the evaporator feed line regardless of whether or not it is in service as a staging tank. CC-T-1 will be isolated from other sources of TMI-2 water by at least a single barrier and, where possible, a double barrier -- regardless of whether or not it is in service as a staging tank.

Through-valve leakage will be monitored by several mechanisms. First, feed and staging tank levels will be monitored periodically by the system operators. Two (2) flowmeters with totalizers are provided on both the evaporator and vaporizer feed lines. These flowmeters and totalizers will be monitored by system operators. A deviation in flow rates or totals would warn the operators of the system of possible through-valve leakage. Also, where possible, flow volume-to-tank level mismatches are another potential warning of through-valve leakage. As has been done for the TMI-2 cleanup for many years, operators will be instructed to monitor tank levels and flowrates closely during liquid radwaste transfers. (It should be noted that volume-to-tank level mismatches will be difficult to discern in some of the proposed transfers for the evaporator system flow . This is because the evaporator flow rate is small relative to the size of the feed tanks. For example, the level change is one inch of tank height per approximately 1250 gallons while the evaporator runs at 5 GPM, and the feed tank is a PWST.)

In addition, the probability of through valve leakage is minimized by the in-service leak tests of boundary isolation valves performed during construction in accordance with ANSI B31.1.

The best method for monitoring of through-valve leakage is via sampling and analysis; GPU Nuclear intends to undertake such a program. Feed tanks to be used to supply batches to the evaporator or vaporizer will be isolated, recirculated, and sampled prior to start of any batch. During the subsequent operation of the evaporator or vaporizer, feed supply line samples will be grabbed and analyzed. Any significant discrepancy between the samples taken from the feed tank and the feed supply line would be an indication that some outside source is contaminating the feed. Similarly, samples will be taken at various points in the process stream to ensure that the evaporator/vaporizer system is both functioning properly and not subject to through-valve leakage.

NRC QUESTION 15

When the evaporator and vaporizer are coupled, describe how you will accommodate mismatches in throughput.

GPU NUCLEAR RESPONSE

There are numerous methods by which both evaporator and vaporizer throughput rates may be adjusted to achieve a balancing of flows between these two phases of the system. Among the methods which can be used to adjust flows are:

- changing feed rates
- adjusting vaporizer blowdown rates
- adjusting heating or cooling rates
- adjusting thermostat setpoints.

In addition, the vapor separator flash tank provides a sufficient surge capacity between the evaporator and the vaporizer processes to accommodate small mismatches in flows between the two processes.

Shop testing of the actual evaporator and vaporizer to be used at TMI-2, while operating in the coupled mode, indicates that there should be little or no problem in balancing the flow between these two (2) processes.

NRC QUESTION 16

Describe and indicate the location of rupture disks or relief valves in the system and identify where they relieve to.

GPU NUCLEAR RESPONSE

There are only two (2) rupture disks and one (1) vacuum relief valve on the evaporator, vaporizer, and solids handling portions of the system. The first rupture disk is located on the steam line from the vaporizer's flash tank to the exhaust stack. This 2 inch rupture disk is designed to break at a 15 psi pressure differential. The "discharge" of the rupture disk is routed to atmosphere through a vent duct in the roof of the evaporator building.

The second rupture disk is on the blender/dryer shell. Like the first, this 2 inch rupture disk is rated for 15 psi. The "discharge" of this rupture disk is routed to the building sump.

The shell of the blender/dryer is provided with a vacuum relief to protect the unit during cooldowns. This 1 inch vacuum relief valve opens at a 3 psi differential pressure.

NRC QUESTIONS 17 AND 18

Indicate the maximum time between chemical and radiochemical sample collection (page 13) and having the results available to the operating staff.

List the isotopes that you will analyze for in the coupled and decoupled modes. Provide the sensitivity of these analyses.

GPU NUCLEAR RESPONSE

As stated on page 13 of the TER, "the primary control over environmental effluents will be established by strict control over the process influents. The body of water to be processed will be isolated from all other sources of contamination, the source tank will be recirculated to assure homogeniety and then sampled. A chemical and radiochemical analysis for the principal radionuclides will be performed as presently done on-site and the analytical results compared to the influent criteria discussed in section 3.3".

This verification of the influent water chemistry is a prerequisite for processing a source tank and is applicable whether processing in coupled or decoupled mode. The analyses to be performed include a gamma scan, gross alpha, determination of Strontium-90, Carbon-14, Tritium, pH, conductivity, boron concentration, and sodium concentration. The length of time necessary to obtain the analytical results is irrelevant to system safety as comparing the results to the influent criteria is a prerequisite for processing. The laboratory techniques used will be such that concentrations listed in the table of "base case" nuclides can be detected for the analyses performed.

Once processing from a PWST has begun, a sample of the water will be collected from that tank after every 100,000 gallons of processing. The tank will be recirculated periodically to prevent stratification. If processing from a smaller tank (e.g., CC-T-1), samples will be taken at approximately every 20% of tank volume but not more often than daily. These samples will be analyzed for pH, conductivity, sodium, boron, gross alpha, gamma scan, and strontium-90. The sensitivity for these analyses will be as previously stated and the analytical results will generally be available to the operations staff in 4 to 12 hours after sample collection.

During processing, the evaporator distillate will be sampled and analyzed for boron concentration every 12 hours. The sample results will generally be available within about 4 hours and will be used to calculate the evaporator's decontamination factor. The boron analysis can detect boron concentration down to a level of 1 ppm. In addition, a sample of the vaporizer feed will be collected every 2 days. If operating in coupled mode, this is the evaporator distillate. If operating the vaporizer in decoupled mode, the evaporator will be shutdown and this sample is from the vaporizer feed sample valve. These samples, taken every two days, will be analyzed for Strontium-90 (LLD <1.1 E-7), Carbon-14 (LLD <1.0 E-7), and Cesium-137 (LLD <3.7 E-8). The analytical results will generally be available within about 12 hours. In addition, GPU Nuclear is also planning to add a sampling station to the vapor stack discharge.