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August 31, 1983
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TMI Program Office
Attn: Mr. L. H. Barrett
Deputy Program Director
US Nuclear Regulatory Commission
c/o Three Mile Island Nuclear Station
Middletown, PA 17057-0191

Dear Sir:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Makeup and Purification Demineralizer Resin Removal - Technical Plan

In accordance with GPUNC's commitment in GPUNC Letter 4410-82-L-0052 dated November 18, 1982, from Mr. B. K. Kanga to Mr. L. H. Barrett, attached is the subject Technical Plan (5 copies). This plan describes the activities and systems required to remove and dispose of the contents of the Makeup and Purification Demineralizers. The Plan utilizes the Submerged Demineralizer System (SDS), in-plant let down, and spent resin systems with some additions and modifications.

The attached Technical Plan relies on the study of system options reported in HEDL-7377, "Planning Study, Resin and Debris Removal System, Makeup and Purification Demineralizers: TMI-2".

If you have any questions on this Plan, please contact Mr. J. J. Byrne of my staff.

Sincerely,

B. K. Kanga

B. K. Kanga
Director, TMI-2

BKK/EDF/jep

Attachments

CC: Dr. B. J. Snyder, Program Director - TMI Program Office

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GPU Nuclear
TMI-2 DIVISION

TECHNICAL PLAN

MAKEUP AND PURIFICATION DEMINERALIZERS RESIN REMOVAL

Prepared by:
TMI-2 Technical Planning Department
GPU Nuclear, Inc. - Bechtel National, Inc.

TPO/TMI-072

TPO/TMI-072
Revision 0
August 1983

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TECHNICAL PLAN

MAKEUP AND PURIFICATION DEMINERALIZERS RESIN REMOVAL

Technical Planning Department

Approval ____________________
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ACKNOWLEDGEMENT

The content of this plan represents the work and cooperation of many individuals. Considerable input from persons in Engineering, Operations, Safety Review, Radcon, and several Department of Energy (DOE) contractors is gratefully acknowledged.

SUMMARY

This plan describes the activities and systems required to remove and dispose of the contents of the makeup and purification demineralizers. The plan utilizes the submerged demineralizer system (SDS), in-plant letdown, and spent resin systems with some additions and modifications.

The plan is presented in three major phases: Phase I -- the removal of soluble radioactivity prior to transferring any solids; Phase II -- the modification of the spent resin system and design and installation of a solidification system, if necessary; and Phase III -- the actual resin transfer and solidification. Phase I and Phase II can proceed in parallel.

The preparation of the resins for offsite shipment is scheduled for the end of 1984, consistent with GPU Nuclear's commitment to the Nuclear Regulatory Commission. Based on ORNL analyses, success in performing these operations on schedule is likely.

The final resin waste form is a major issue that must be resolved because the quantities of waste and number of shipments will vary greatly between disposal at commercial sites versus DOE destinations. This also applies to any SDS vessels generated as a result of liquid radwaste processing. This plan assumes that solidification of the makeup and purification demineralizer resins is required.

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SECTION 1.0

INTRODUCTION

1.1 OBJECTIVE

This plan addresses the removal, transport, and disposal of the contents of the demineralizers in the Three Mile Island Unit 2 (TMI-2) makeup and purification system. The purpose is to present the selected technical methods for removal and waste processing.

1.2 BACKGROUND

The demineralizers in the TMI-2 makeup and purification system accumulated significant quantities of fission products and fuel debris during and subsequent to the March 1979 accident. Except for the reactor systems, the demineralizers contain the greatest amount of contaminated material at TMI-2. Until recently, the physical condition of the demineralizers and their contents were unknown. The radiation and thermal exposure to the installed resins were sufficient to cause severe degradation. (The "B" demineralizer resin sample did not show significant damage, however, the "A" demineralizer requires further characterization.) There was also concern that the demineralizer vessels contained large quantities of fuel. (We now know there are less than 4 kilograms of fuel in both vessels; Reference 1.) Thus a significant effort was conducted to determine the state of the demineralizer contents and to develop this plan. This effort is now completed.

Operations to decontaminate the demineralizers will be complex because of the degraded condition of their contents and the high radiation levels in the demineralizer cubicles. The demineralizers and components within the cubicles are not available for personnel access. If these resins were to be transferred by normal procedures, other plant areas and systems normally used for resin disposal would see radiation levels in excess of design.

The demineralizer characterization project is reported in References 1 through 4. The characterization project started in May 1982 and was completed in June 1983. The results of that effort provide the bases for this plan. Summaries of the characterization project results are in Appendices A and B.

System options are reported in Reference 5. The selected system approach is presented in this plan.

1.3 SCOPE

This plan addresses removal and disposal of the contents of the demineralizers in the makeup and purification system.

Decontamination of the demineralizers after contents removal and decontamination of the upstream and downstream portions of the makeup and purification systems are not in the scope of this plan. These activities are covered in the Integrated Plan for AFHB Characterization/Stabilization/Decontamination, TPO/TMI-049 (Reference 6).

1.4 CRITERIA

The criteria for this project are:

- Maximize use of existing systems to the extent practicable
- Minimize the possibility of creating new hotspots while transferring demineralizer contents
- Maximize use of remote operations techniques for high radiation areas to the extent practicable
- Provide operational decoupling among major project phases to allow operational flexibility and plan modifications to suit actual results achieved.

1.5 APPROACH

The plan is presented in three phases:

Phase I: Rinsing and eluting the demineralizer contents without moving solids (Section 3.1)

Phase II: Modifying the spent resin system, and sluicing and solidifying normal resins for a system test (Section 3.2)

Phase III: Sluicing, solidifying, and disposing of the purification demineralizer contents (Section 3.3).

Phases I and II can proceed in parallel. Completion of both is a prerequisite for Phase III.

There are schedule and system interfaces of this project with the auxiliary and fuel handling building (AFHB) system decontamination effort. There are also interfaces with the processing for disposal of other in-plant resins and sludges.

Section 2.0 of this plan presents systems descriptions required for completing the phases of the project. Section 3.0 is a work sequence for the project. Section 4.0 describes the project's interface with other projects.

SECTION 2.0

SYSTEMS DESCRIPTIONS

The makeup and purification demineralizer removal activity has been separated into three phases as shown in Figure 2-1. This figure shows that Phase I and Phase II must be completed before Phase III is begun. These prerequisite phases can proceed in parallel if resources are available. The following section describes each phase in more detail.

2.1 SYSTEM DESCRIPTION FOR PHASE I

In Phase I, soluble radioactivity (primarily cesium 137) will be removed from the resins and processed by the SDS system. This will reduce the dose rate in the demineralizer cubicles and sluice path to the spent resin system, and will minimize the handling problems caused by radiation of the sluiced demineralizer contents.

The activity will be removed by rinsing and eluting the resins. The flow path for this phase is shown in Figure 2-2. The resins will be rinsed by batching borated water into the demineralizer vessels, fluffing the resin, and decanting the water. Essentially the same operation will take place during eluting, however, chemicals such as sodium hydroxide and sodium borate will be added to the flush water to further displace the radioactive isotopes.

For these operations, the flow rate will be maintained between one and five gallons-per-minute to minimize the carryover of suspended solids. The resulting velocity through the demineralizers will be between 0.1 and 0.6 inch-per-minute. These velocities are capable of suspending resin particles of 8 to 20 microns and fuel particles of 1 to 3 microns. To guard against particle carryover and operational upsets, a guard filter will be installed.

The total flow required through each demineralizer is estimated to be 3000 gallons. This estimate is based on three volume exchanges for rinsing and three for elution. The anticipated procedure is to batch feed about 250 gallons, soak, fluff, settle, and decant. As the cesium concentrations are

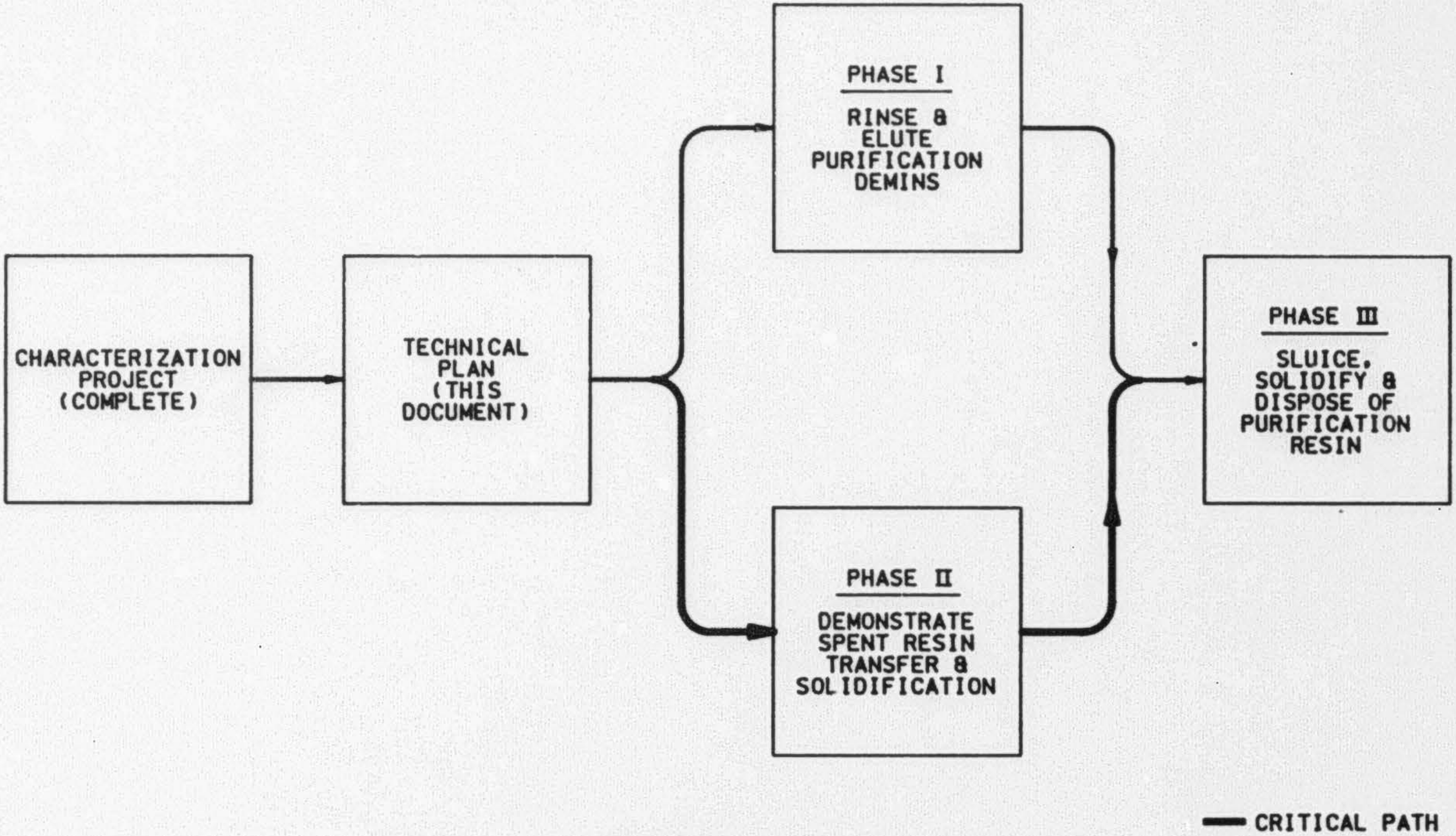


FIGURE 2-1

MAKE-UP AND PURIFICATION DEMINERALIZER RESIN REMOVAL PLAN OVERVIEW

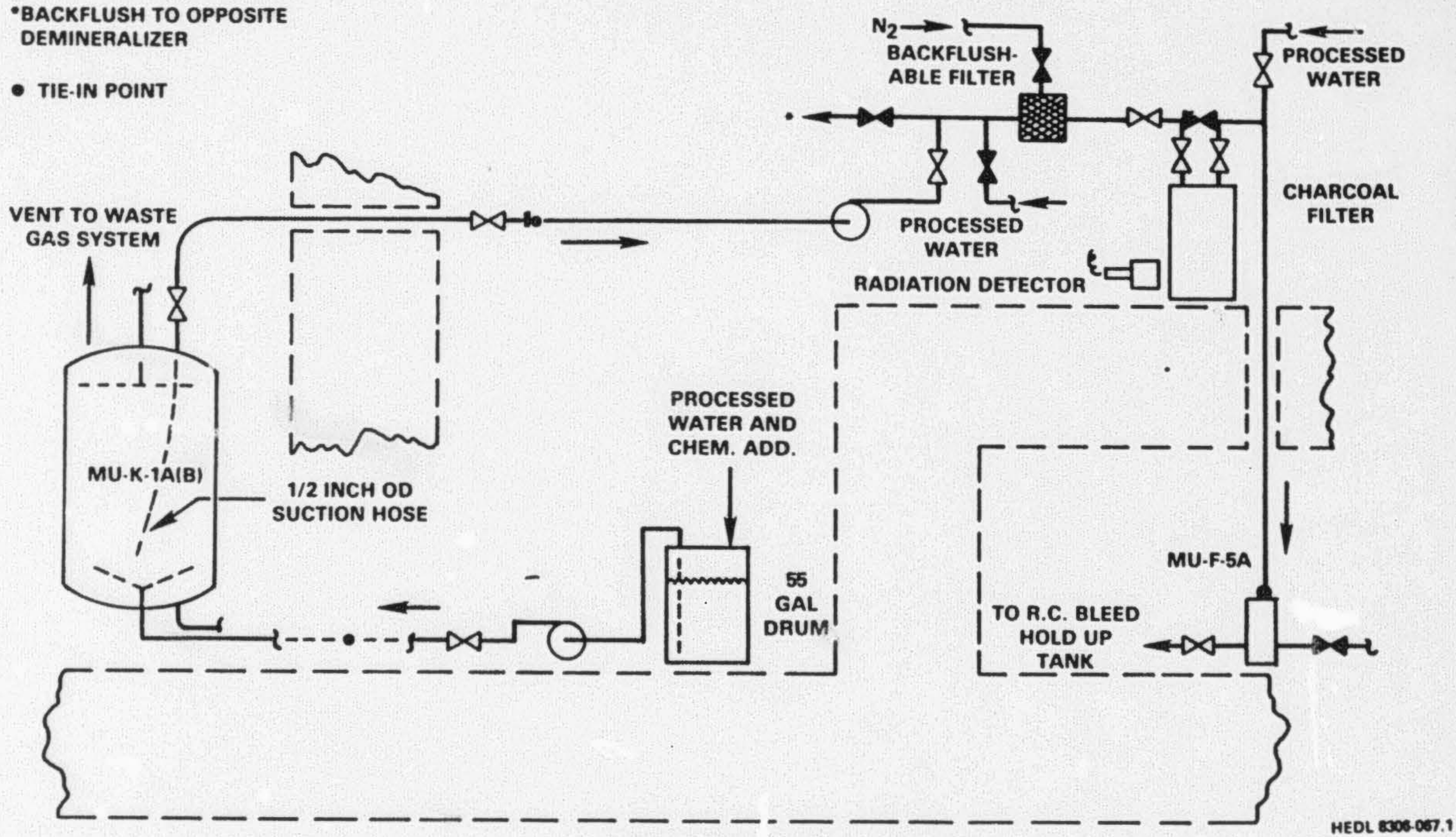


FIGURE 2-2
SCHEMATIC FOR RINSE AND ELUTION

expected to be very high, the discharge stream will be diluted with additional process water immediately downstream of the filter. These steps can be repeated more than three times if it appears that further removal of soluble radioactivity will be accomplished.

2.1.1 Equipment Description

For the most part, Phase I will use existing in-plant systems with the addition of a skid for water and chemical addition and for filtering and diluting the demineralizer effluent. A remote control tracked vehicle (LOUIE) will be used for radiation and video monitoring in the demineralizer cubicles.

The locations of these hardware additions are shown in Figure 2-3. They are individually discussed below.

2.1.1.1 Rinse Water Supply and Eluting Chemical Addition

A water feed is required to rinse and elute the demineralizer contents. This will be accomplished by connecting a process water supply, via hoses, to the existing connection for demineralized water addition. Alternatively, the water may be batched through the resin fill line. This modification is necessary because rinse water will be borated processed water and not plant demineralized water. A small batch tank will be required for chemical addition during elution steps. The water addition control station is conceptually shown in Figure 2-3 as being located in the Hayes gas analyzer room. This location allows both the dilution/elution feed and decant operations to be controlled from this room.

2.1.1.2 Effluent Filtration of Organics

Degradation of the resins within the demineralizer has resulted in organic compounds that will become suspended in the rinse and elution water. It is preferred that these compounds not pass into other portions of the letdown system or to the SDS. (It should be noted, however, that absolute filtration

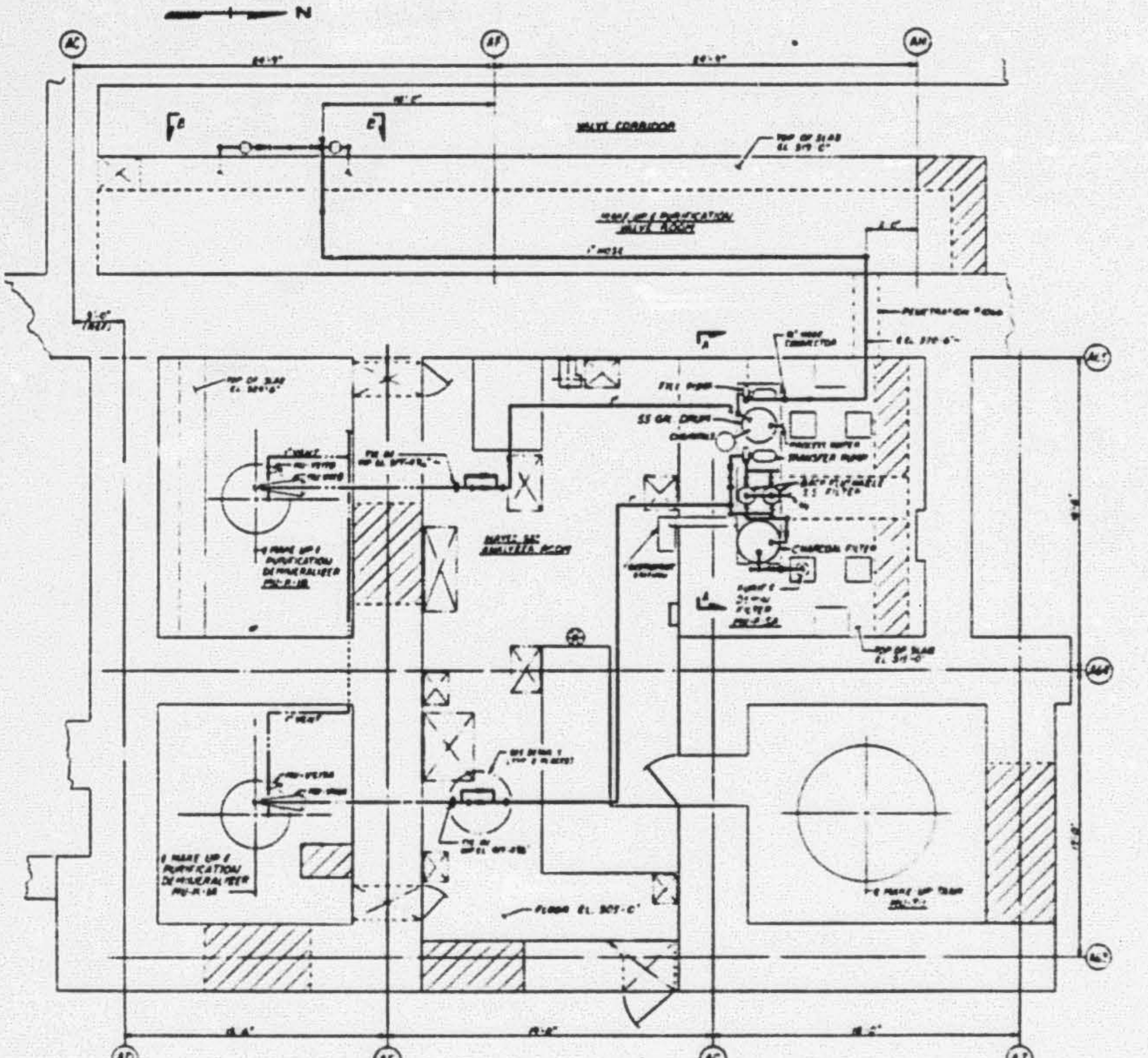


FIGURE 2-3
LOCATION SKETCH FOR RINSE AND ELUTION

of organics is not a requirement). To remove organics, a charcoal filter will be installed on the mezzanine of the Hayes gas analyzer room. The filter will be tied into the resin fill lines for the inlet and into the top of MUF-5A housing for the outlet. The filter will be housed in its own shielding and will be removed as a unit after the organics removal is complete.

2.1.1.3 Guard Filter For Particulates

A guard filter will be placed in the effluent line ahead of the organics filter. This guard filter has three purposes:

- To guard against the transfer of bulk solids out of the demineralizers that might be caused by flow transients during rinsing and elution

- To prevent resin and fuel fines transfer into the letdown piping and bleed tanks

- To prevent loading the organics filter with radioactive particulates, which would create a potential disposal problem.

Conceptually, the guard filter will be a sintered metal backwashable unit. The backwash flow path goes to the demineralizer opposite the one being pumped out. The backwash capability prevents this filter from becoming abnormal waste containing high TRU content and alleviates any plugging problems.

2.1.1.4 LOUIE

LOUIE is an existing remote control tracked vehicle that will be provided by the DOE for this project to obtain radiological information and data from within the demineralizer cubicles during the various operations. Similar information may also be required in the spent resin tank rooms during Phase III. In addition to radiation data, video inspection for suspected leaks and to verify valve operation will be useful tasks for LOUIE.

2.2 PHASE II SYSTEM DESCRIPTION

Phase II activities prepare the spent resin system for handling the sluiced demineralizer contents and provide for removing the material from the plant. This phase also demonstrates complete spent resin and solidification systems operation with material that is not as radioactive as the purification demineralizer contents.

A flow diagram for the sluicing and solidification process is shown in Figure 2-4.

2.2.1 Equipment Description

To a large extent these processes will use existing systems; however, some significant modifications and additions are planned. The modifications required to support demineralizer sluicing and solidification are individually discussed below. The locations of hardware additions are shown in Figure 2-5.

2.2.1.1 Spent Resin System Tie-ins to Solidification Skid

The existing spent resin pump discharge and the recirculation return line were installed to connect to TMI-1 systems. They wind their way beneath the El. 305' floor to the northwest corner of the auxiliary building at El. 305'. To minimize the runs of such pipe and to minimize uphill sluicing, the solidification process equipment will be located adjacent to the spent resin transfer pump cubicle, as shown in Figure 2-5. As a result, the existing pump discharge and return piping will be cut and a short recirculation loop will be installed, as shown in Figure 2-4. This addition will be permanent and should meet Regulatory Guide 1.143 design specifications. It will allow connection, by hoses, to the temporary solidification unit.

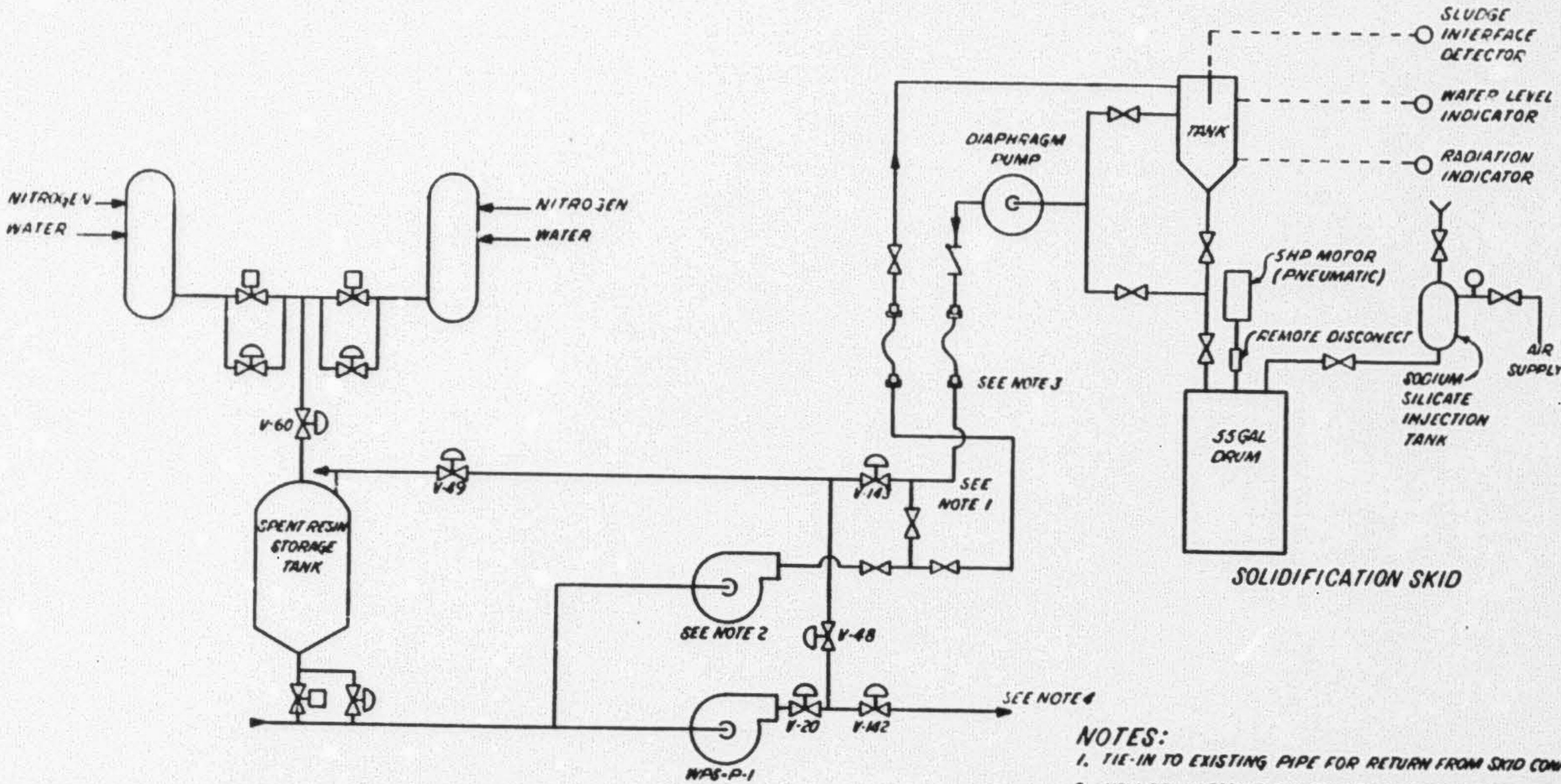


FIGURE 2-4
SLUICE AND SOLIDIFICATION SCHEMATIC

NOTES:
1. TIE-IN TO EXISTING PIPE FOR RETURN FROM SKID CONNECTORS
2. NEW PROGRESSING CAVITY OR PNEUMATIC DIAPHRAGM PUMP AND CONNECTING PIPE.
3. NEW CONNECTIONS FOR SOLIDIFICATION SKID.
4. TIE-IN TO EXISTING PIPE FOR DEWATERING LINE TO A RECEVING TANK.

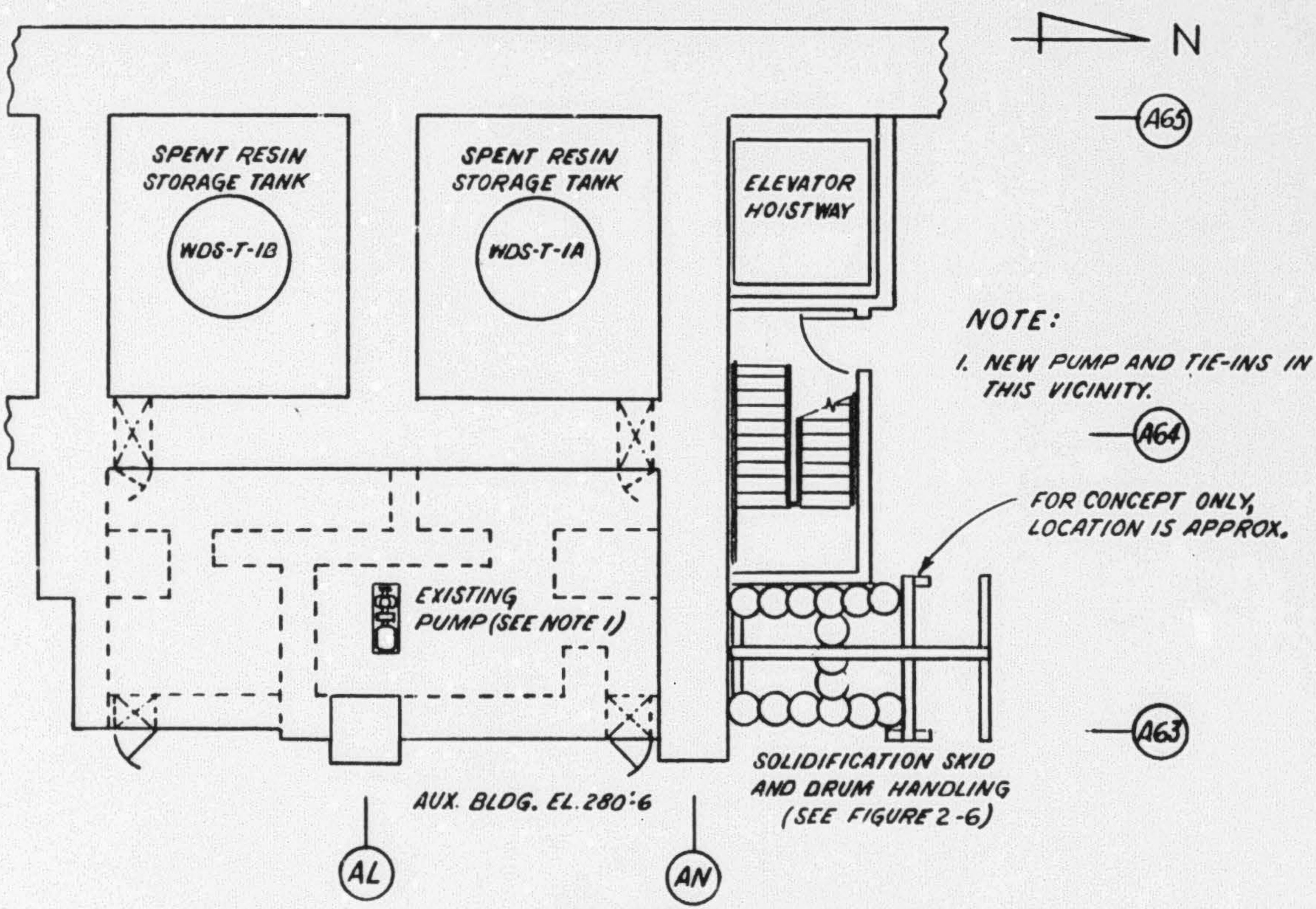


FIGURE 2-5
LOCATION SKETCH, SPENT-RESIN SYSTEM

2.2.1.2 Transfer Pump Addition

The installed resin transfer pump is a a centrifugal pump designed for low solids concentration water. A progressive cavity or pneumatic diaphragm pump more suitable for dense slurries should be installed in parallel with the existing pump.

The existing pump should not be removed because it will be useful for pumping water during dewatering and decanting operations when there is no need to move solids. If the installation of the additional pump creates undue difficulties with regard to piping and valve installation, then consideration can be given to replacing the existing pump.

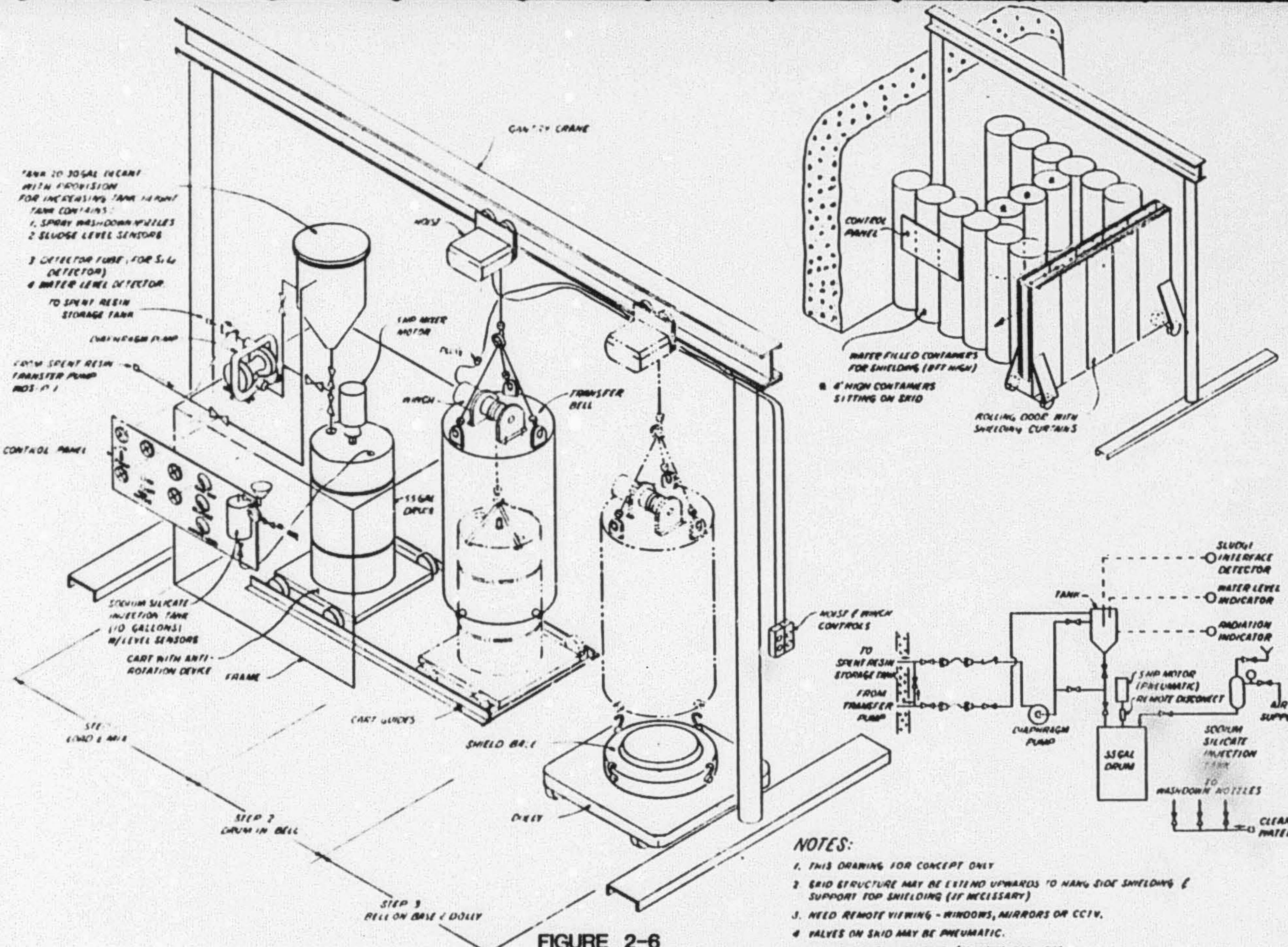
2.2.1.3 Spent Resin Tank Dewatering Pipeline Connection

The current method for dewatering spent resin tanks is to drain them through a sparging line to the floor drain in the cubicle. To avoid recontaminating the auxiliary building sump, this method will be replaced. A dewatering line will be added that will allow water to be pumped to a tank such as the reactor coolant bleed tank B, from which it can be processed with SDS or EPICOR II.

2.2.1.4 Solidification Skid

A conceptual sketch of the solidification skid is shown in Figure 2-6. The solidification skid consists of a waste batch control tank, solidification equipment, and handling equipment including a transfer bell.

The focus of the skid will be a cone-bottomed batch control tank (20 to 30 gallons per batch) with appropriate radiation, solids, and water level instrumentation. The batch tank will be located immediately above the waste drum. This will allow operators to adjust the amount of waste to be solidified prior to dumping it into the solidification container, thereby insuring that disposal regulations are met. It will also prevent drum overfilling.



NOTES:

1. THIS DRAWING FOR CONCEPT ONLY
2. SKID STRUCTURE MAY BE EXTEND UPWARDS TO HANG SIDE SHIELDING & SUPPORT TOP SHIELDING (IF NECESSARY)
3. NEED REMOTE VIEWING - WINDOWS, MIRRORS OR CCTV.
4. VALVES ON SKID MAY BE PNEUMATIC.
5. SUITABLE AREA MONITORS & ALARMS REQUIRED.
6. SUITABLE VENTILATION & FILTERING REQUIRED.

FIGURE 2-6

SOLIDIFICATION SKID CONCEPT

The system will use 55-gallon drums with a sacrificial mixer. This size was chosen to simplify the handling of solidified waste from El. 280' to El. 305' for transfer to interim storage. The drums will be loaded with cement prior to receiving waste material.

A pump and several valves will also be required, as will drum positioning, anti-rotation, and indexing features. Shielding will, for the most part, be portable; however, it will be an integral part of the design. There will be several cleanout water flush points, valved and manifolded to a common connection point.

2.2.1.5 TRU Detection System

One possible process control parameter would be the radiation of the batch control tank on the solidification skid. The feasibility of the detecting TRU quantities in this manner is currently being investigated by DOE. If feasible, a detection system will be included with the skid.

2.2.1.6 Drum Handling

Once solidified, the drummed waste will be transferred to storage awaiting shipment. A shielded handling system including a transfer shield will be integrated with the skid design. The system is shown in Figure 2-6.

2.3 PHASE III

Phase III is the actual sluicing, solidification, and disposal of the purification demineralizer resins. Phase III uses the equipment installed in Phase II.

SECTION 3.0

WORK SEQUENCE DIAGRAM

The work sequence is shown on three seperate diagrams representing the Phase I, Phase II, and Phase III activities. These are Figures 3-1, 3-2, and 3-3, respectively.

3.1 PHASE I ACTIVITIES

Steps 1-33 are required to complete the work defined as Phase I. The lead for several of these activities will be assumed by off-island DOE contractors and is indicated on the figures by heavy outlining.

3.1.1 Letdown System Operability (Steps 1-5)

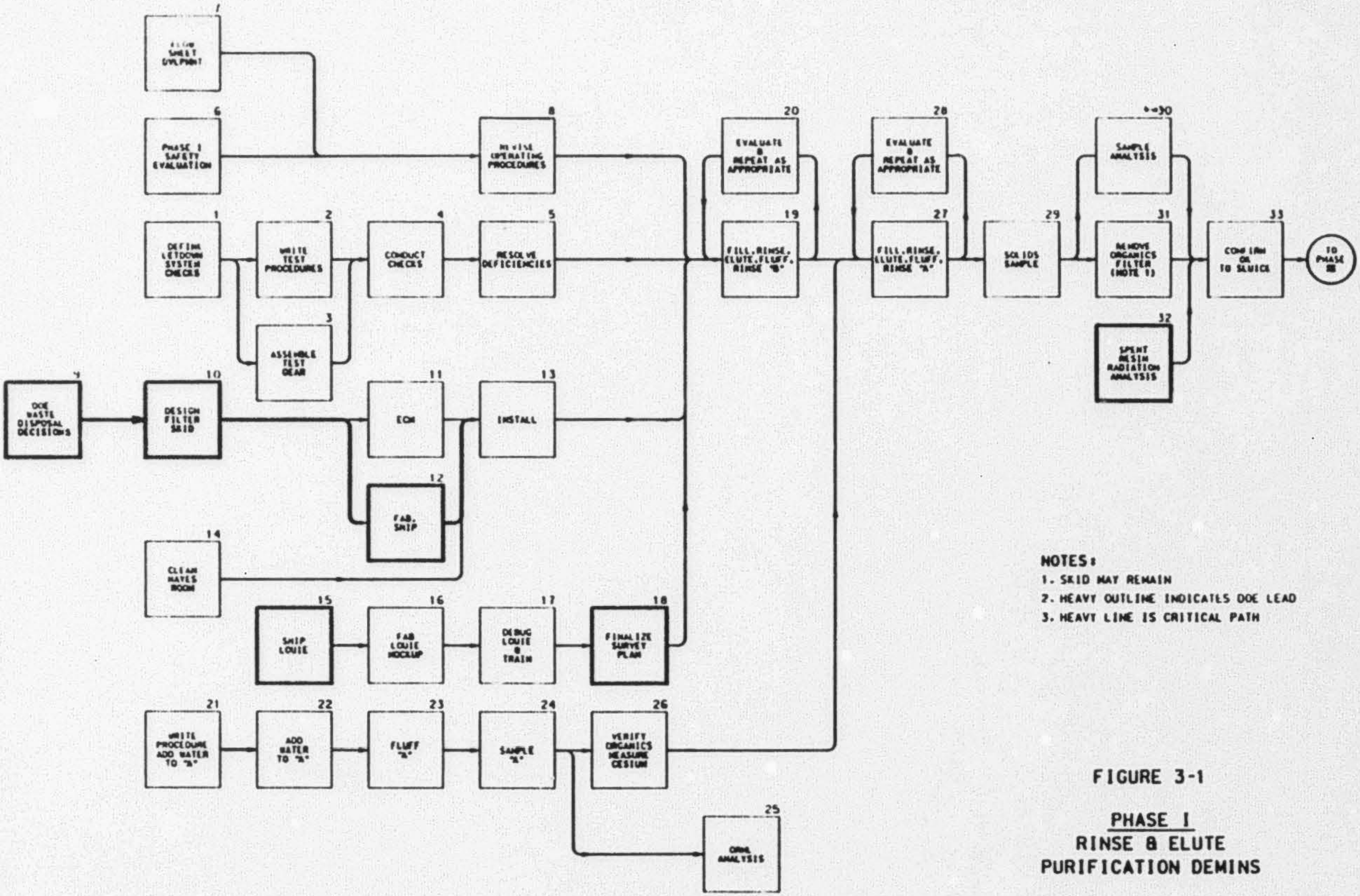
Steps 1-5 of the sequence verify letdown system operability to allow filling and emptying of demineralizers by backwards flow via the letdown line and demineralizer bypass to a radwaste tank, which will be a batch feed tank for the SDS. Flow should be avoided to portions of the letdown piping upstream of the bypass line as well as to the fill lines, sluice lines, and other connected systems.

Check the new filter installations for tightness and the ability to remove them. Operability test procedures should be written.

The assembly of test gear, Step 3, is potentially a time-consuming activity due to limited access to many areas.

3.1.2 Safety Evaluation and Procedures (Steps 6-8)

Procedures will be required for filling, rinsing, fluffing, and eluting the demineralizer contents, which will be conducted in accordance with the process flow sheet specifications. The review of these procedures will include a safety review.

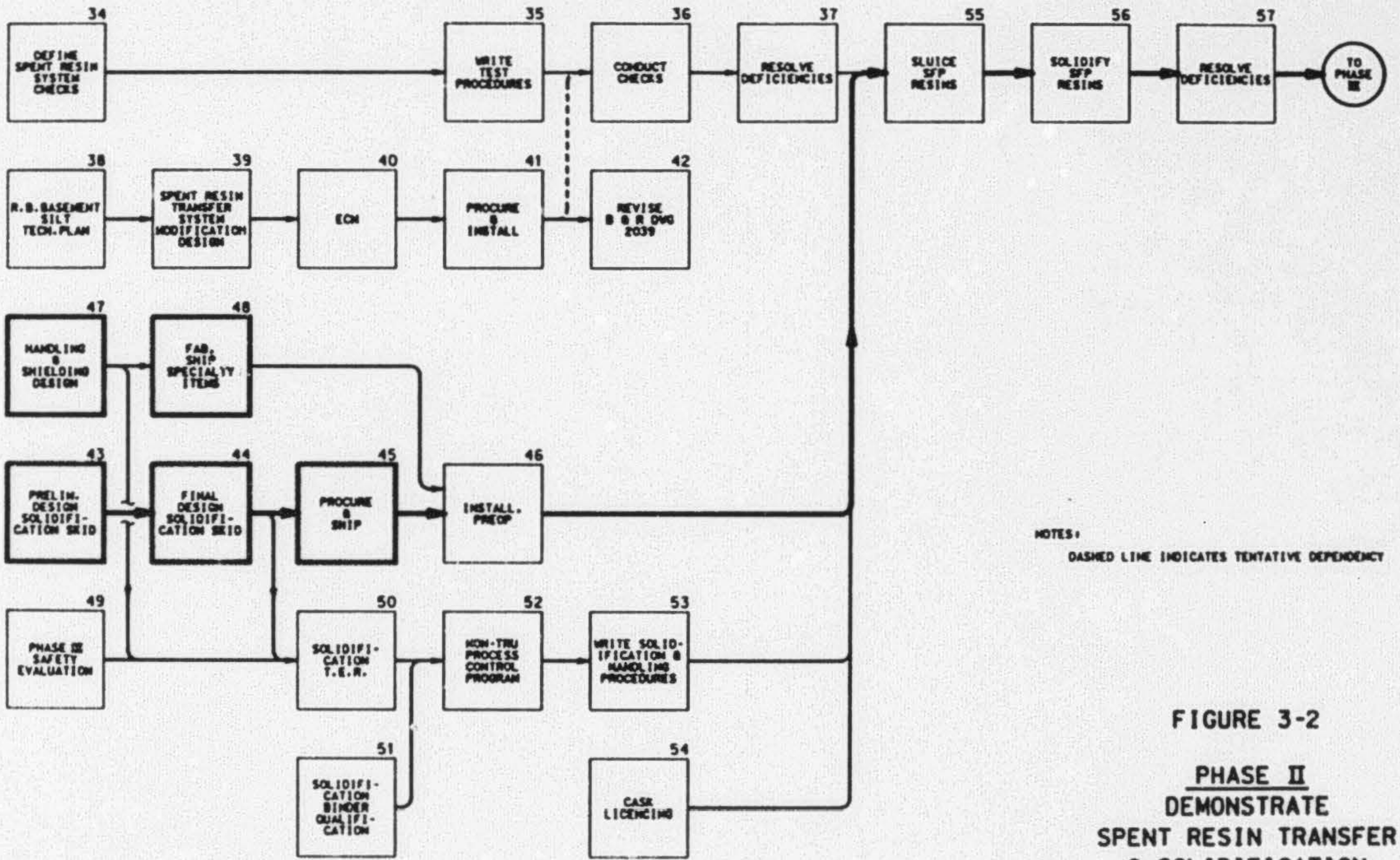


NOTES:

1. SKID MAY REMAIN
2. HEAVY OUTLINE INDICATES DOE LEAD
3. HEAVY LINE IS CRITICAL PATH

FIGURE 3-1

PHASE I
RINSE & ELUTE
PURIFICATION DEMINS



NOTES:

DASHED LINE INDICATES TENTATIVE DEPENDENCY

FIGURE 3-2

PHASE II

DEMONSTRATE SPENT RESIN TRANSFER & SOLIDIFICATION

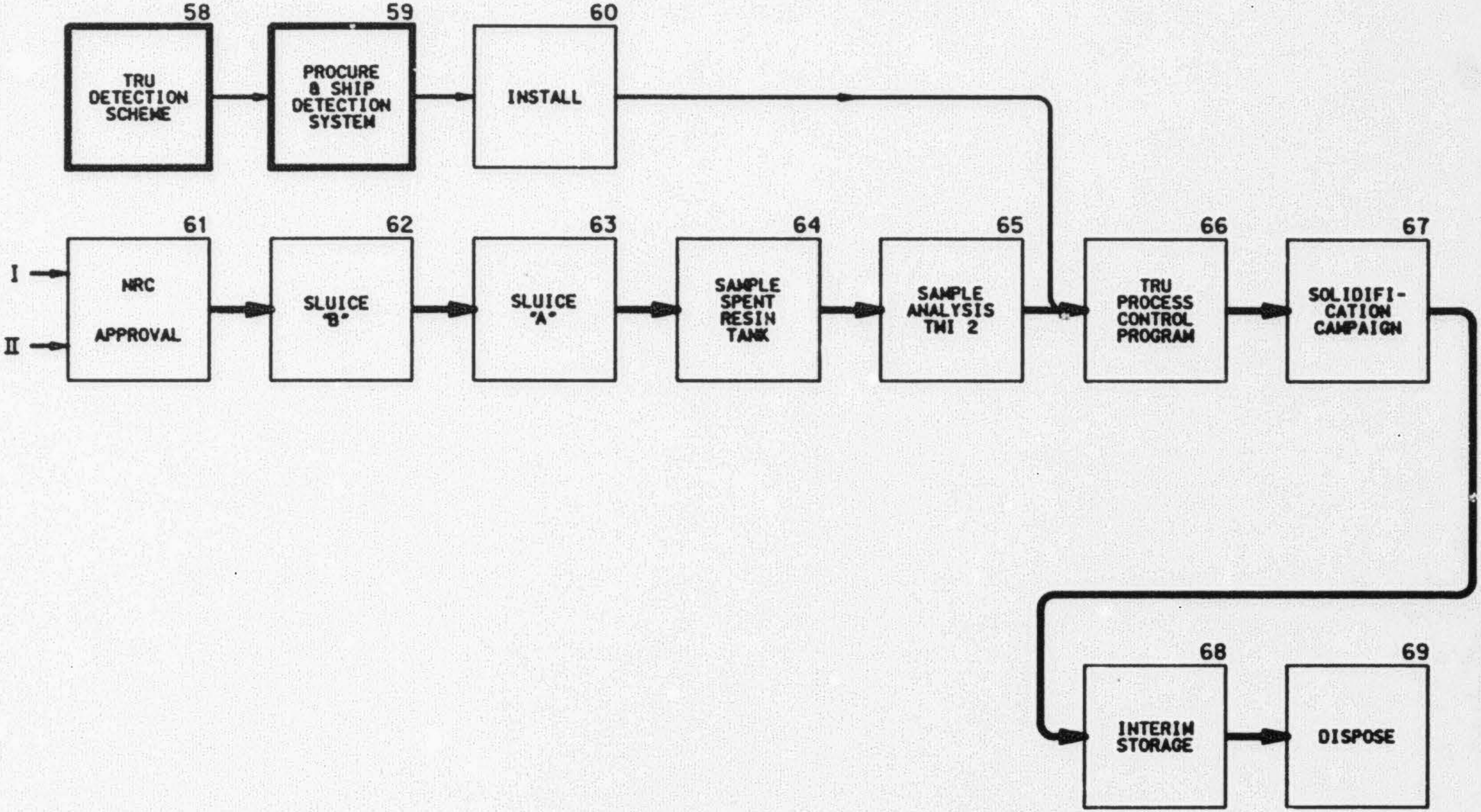


FIGURE 3-3

PHASE III

SLUICE, SOLIDIFY & DISPOSE OF PURIFICATION RESIN

3.1.3 Waste Disposal Decisions (Step 9)

The quantities of solidified waste for various disposal scenarios are presented in Table 3-1. As can be seen, minimum volume disposal as TRU waste results in significant savings of operational effort and can result in significant savings in disposal cost if DOE, in accordance with the abnormal waste Memoranda of Understanding, can quote a reasonable disposal price.

A similar situation exists for SDS processing of the soluble activity. There are approximately 15,000 curies of Cs-137 in the two demineralizers. From a system performance standpoint, this activity can be deposited in one or two SDS vessels. However, commercial waste disposal limits (10 CFR 61) would limit this to about 1,000 curies per vessel, this results in about 15 vessels.

The waste disposal destination is therefore an issue that should be addressed soon in order to establish firm processing plans.

TABLE 3-1
PURIFICATION DEMINERALIZER RESIN
WASTE VOLUME BASED ON 4kg FUEL*

LIMITING FACTOR	DRUMS
1. Current U. S. Ecology License	200
2. 10 CFR 61 (Category C)	25
3. Max Solidifiable Conc. (Approximate)	15
4. Unsolidified	7

* Assumes cesium will be mostly removed during rinse and elution.

3.1.4 Filter Skid Sequence (Steps 10-13)

The design, fabrication, and delivery of the organic and particulate filters (see Sections 2.1.1.2 and 2.1.1.3) will be handled by DOE. Installation includes checkout of spent filter handling as well as installation in the system flow path.

3.1.5 Hayes Room Cleanup (Step 14)

The Hayes gas analyzer room requires several actions before proceeding. For example, the valves installed for the characterization project leak and must be fixed, the temporary cubicle entry doors must be removed, the radioactive gas sample rack will probably have to be relocated to make room for the filter skid installation, and the makeup filter cubicle must be decontaminated.

3.1.6 LOUIE (Steps 15-18)

The remote control transport vehicle is described in Section 2.1.1.4. As with the characterization project where SISI was used, a floor plan mockup should be constructed for exercising LOUIE and for operator training. The survey plan will specify the observations and data to be taken and should be used for training. No formal written procedures are required for LOUIE, as it is not a part of installed systems and there are no safety consequences in the event of its failure. In the event of failure, other remote devices such as FRED may be used.

3.1.7 "B" Operations (Steps 19-20)

The initial rinsing and eluting will be carried out on the "B" demineralizer. The "B" demineralizer will be filled, rinsed, eluted, fluffed, and re-rinsed before this process is begun on demineralizer "A". Although the "B" demineralizer contains more radioactivity than the "A" demineralizer, it contains less fuel, remains wet, and is better characterized by direct sample analysis results.

3.1.8 Fill and Resample "A" (Steps 21-26)

Because of sampling difficulties, the "A" demineralizer conditions are not as well know as those in demineralizer "B" even though the "A" demineralizer has been more extensively characterized by non-destructive techniques. A repeat of the previous sampling procedure is not planned before proceeding because there is no reason to believe that it will be any more successful. Therefore, it has been decided to partially fill "A" with water in an attempt to dissolve any crust and to wet the resin.

A sample of the "A" demineralizer will be drawn to verify the organics filter design and to obtain some idea of the amount of soluble cesium in the demineralizer.

3.1.9 "A" Operations (Steps 27-28)

Following the removal of soluble radioactivity from the "B" demineralizer, a similar procedure will be performed on the "A" demineralizer. These steps are a repeat of Section 3.1.7 but are for the "A" demineralizer. The degree of success with "B" and the results of the "A" water sample will provide information for processing "A".

3.1.10 Sample Demineralizer Contents (Steps 29-30)

After the elution of "A", the solids in both demineralizers will be sampled to determine the amount of radioactivity remaining. This will define the quantity of resin to be sluiced to the spent resin tanks.

3.1.11 Remove Organics Filter (Step 31)

After rinsing and eluting both demineralizers, there is no longer a need for the organics filter and thus it may be removed so it will not interfere with future resin sluicing operations.

The water addition and guard filter portions of the skid, however, may remain to support sluicing and later decontamination efforts.

3.1.12 OK To Sluice (Steps 32-33)

After the rinse and elution steps are conducted, the adequacy of existing shielding in the spent resin transfer system will be evaluated. To support this evaluation, an analysis will be conducted to predict the expected dose rate in various areas, particularly the spent resin tank cubicles, as a function of the radioactivity remaining in the demineralizers. The results of this analysis can be compared with the original shielding design basis.

The results of this comparison will determine whether the demineralizer contents should be sluiced and solidified in smaller batches than currently planned or whether additional shielding is required. After plan modification Phase I will be complete.

3.2 PHASE II ACTIVITIES

Steps 34-57 define the activities required to complete Phase II. Phase II prepares the spent resin system for handling the sluiced demineralizer contents and provides for removing the material from the plant. This phase also includes a demonstration run of the entire spent resin transfer system and solidification system by sluicing the spent fuel pool resins to the spent resin tanks with subsequent solidification. Like the particulate and organics filter skid in Phase I, the design and formation of the solidification and organics filter will be by a DOE contractor.

The detailed requirements for this phase are discussed in Section 2.2. A more detailed discussion of the logic sequence in Figure 3-2 follows.

3.2.1 Spent Resin System Operability (Steps 34-37)

This sequence is functionally the same as for the purification letdown system (Section 3.1.1). However, in this case there will be several modifications to the spent resin system, and therefore Figure 3-2 shows that these should be installed before the checks. In actual practice, it may be possible to conduct much of the testing before some of the modifications. These are operational decisions and beyond the scope of this plan.

3.2.2 RB Basement Silt Removal Technical Plan (Step 38)

A technical plan for removal of the reactor building basement silt is scheduled. This silt will likely require solidification prior to disposal. Therefore, this step identifies the need to investigate the potential for using the spent resin tanks and the make-up and purification solidification skid for the silt. Due to the different handling characteristics of the silt, some additional modifications are likely. These modifications must be identified and accommodated prior to contaminating the transfer and solidification system with the make-up and purification demineralizer resins.

3.2.3 Spent Resin Transfer System Modifications (Steps 39-42)

As described in Section 2.2, some hardware modifications to the spent resin system will be required. As these will be permanent changes, an engineering change memorandum (ECM) is required.

In addition to the ECM sketches, this plan calls for a revision of the P&ID for the spent resin system as a minimum. This is because this drawing will be necessary for operation of the system. It would also be prudent to revise the consolidated P&ID that was drawn for this project (Dwg. No. 2E-533-21-001), as it shows the purification demineralizers and spent resin system on one sheet and will be very useful for operators.

3.2.4 Solidification Skid (Steps 43-46)

The solidification skid described in Section 2.2.1.4 is required before any resins are sluiced. This sequence could possibly be the most limiting critical path for this project because considerable work is required.

3.2.5 Handling and Shielding (Steps 47-48)

The removal of the solidified drums from the solidification skid will require handling equipment and special shielding. This activity should be coordinated with the solidification skid design. This equipment may include transfer bells, hoists, and dollies. These are described in Section 2.2.1.6.

3.2.6 Solidification Operational Preparation (Steps 49-53)

The solidification skid is a new system. Although it is temporary, it is expected to stay in place for an extended period of time. Thus the development of operational procedures for solidification will be preceded by a technical evaluation report (TER) and associated safety review. Before the TER can be completed, the skid, shielding, and waste handling designs must be available.

A process control program (PCP) will be required for solidification batch control to ensure that solidification requirements are met and transportation and disposal limits are not exceeded. The demonstration operations in Phase II are not expected to create TRU contaminated waste because they will be conducted with pre-accident resins. Therefore, the PCP need not address TRU concentrations during Phase II operations.

Step 53 recognizes the Technical Position on waste form recently issued by NRC (Reference 7). This step is the test required to qualify the selected solidification binder.

3.2.7 Amend Cask License (Step 54)

A cask license may be required to ship the TRU contaminated waste. For example, if the CNS-113-C cask were to be used, it would have to be licensed for 200 grams of fuel.

3.2.8 System Demonstration (Steps 55-57)

These steps call for sluicing of the spent fuel pool cleanup system resins to demonstrate the operation of the modified spent resin system and the new solidification skid. These resins are mildly radioactive and should indicate any system deficiencies without risk of significant contamination or personnel exposure. When deficiencies are resolved, these systems should then be ready to process the purification system demineralizer contents.

3.3 PHASE III ACTIVITIES

Phase III involves the removal and disposal of the purification demineralizer solids. If significant radioactivity is removed in Phase I, then sluicing should be a routine operation. The system requirements for this phase are discussed in Section 2.3.

3.3.1 TRU Detection Scheme (Steps 58-60)

Because there is some fuel and thus TRU isotopes in the demineralizers, the concentration of this material in the final waste will have to be closely controlled to ensure burial limits will not be exceeded. Thus, a method of measurement is required for the final PCP. The feasibility of direct measurement of gamma activity to infer the TRU concentration is currently being investigated. For this project, since the soluble cesium will be removed before the solids are sluiced, insoluble cesium as well as cerium may be an acceptable measurement isotope. Should neither prove feasible, then direct control of solids quantity will be required (and difficult).

The TRU measurement hardware will be coordinated with the solidification skid design. It will not be necessary to have it in place for the Phase II demonstration, although this would be preferable.

3.3.2 Sluice Campaign (Steps 61-63)

It is anticipated that NRC concurrence will be required before sluicing the resins from the purification demineralizers. Phase I and II completion should provide sufficient assurance of safety to obtain this approval.

This plan calls for sluicing both demineralizers into one spent resin tank. This will "homogenize" the contents of both demineralizers, minimizing the sampling requirements consistent with ALARA principles. These samples will be used for solidification media proportioning to keep the final radioactive concentrations below disposal limits. As discussed previously, if the rinse and elution steps are not sufficiently effective in removing cesium, then these operations may be carried out individually for each demineralizer and possibly for smaller batches. This will complicate the PCP because several samples will probably be needed.

3.3.3 Solidification and Disposal Campaign (Steps 64-69)

The Phase II PCP will be revised for TRU control for the solidification campaign. The PCP revision will depend on the method for relating radiation to solids quantities, the results of a sample of the contents of the spent resin tank, and waste disposal destination decisions that will affect allowable concentrations (see Section 3.1.3). Sufficient samples will be taken to assure good waste characterization. These samples in combination with external radiation measurements will be used to define the quantity of waste in each drum.

The material will be solidified in 55-gallon drums that can be staged in the auxiliary building or individually transported to interim storage prior to shipping for disposal.

3.4 MILESTONE SCHEDULE

An overview milestone schedule for the previously described project activities is shown in Figure 3-5. This schedule shows that the commitment to the NRC to have material ready for shipment by the end of 1984 is achievable. Engineering is working on a detailed schedule.

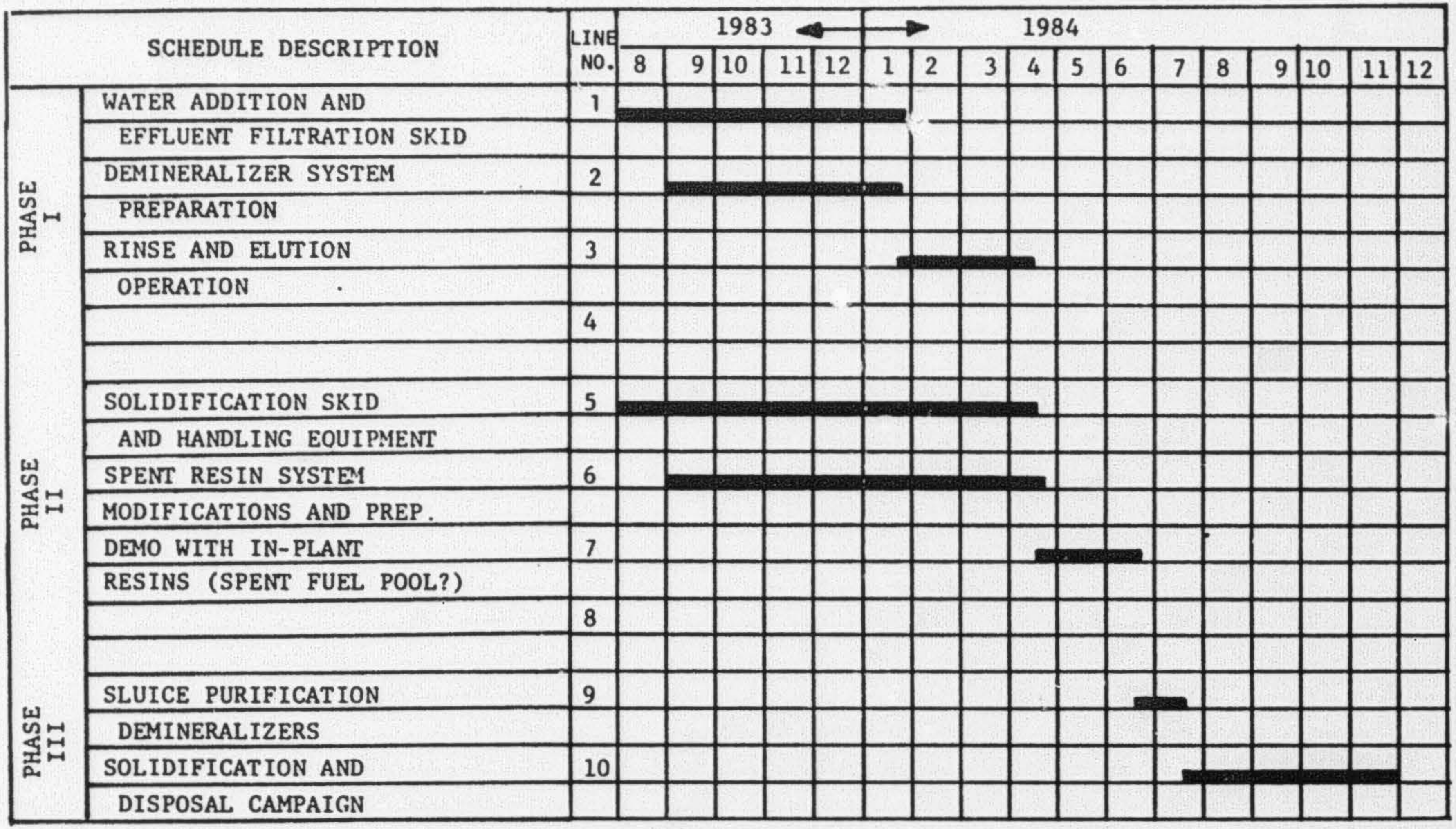


FIGURE 3-4

SCHEDULE OVERVIEW

SECTION 4.0

INTERFACE WITH OTHER PROJECTS

4.1 INTERFACE WITH SYSTEMS DECONTAMINATION

4.1.1 Schedule Interface

The goal of the project is to have the resin from the makeup system demineralizers ready to ship by the end of 1984. Plans for decontamination of all systems outside the scope of this plan are delineated by the Integrated Plan for AFHB Characterization/Stabilization/Decontamination, TPO/TMI-049, (Reference 6). The relationship between the implementation of these two plans will be shown on Recovery Programs Integrated Intermediate Schedules. Implementation of both activities is expected to begin in 1983. AFHB decontamination operations are expected to extend over a significant period of time. However, it is clear that the demineralizers must first be emptied before decontamination or removal of the debris and their associated piping is attempted. These decontamination activities may have to be rescheduled if the demineralizer project is not completed.

4.1.2 Isolation Boundaries

Establishing the boundaries for the demineralizer processing project is not prescribed here and is left as an operational decision.

4.2 INTEGRATION WITH OTHER DEMINERALIZER RESIN DISPOSAL

The activities sequence diagram shows sluicing of spent fuel cleanup demineralizers as a prerequisite to purification demineralizer sluicing. The purpose is to first "test" the system with less radioactive waste.

Other in-plant resins can be processed in the campaign with the spent fuel cleanup and the purification demineralizer resins for operational efficiency. Resins that have been identified as candidates are cleanup demineralizers and evaporator condensate.

4.3 INTEGRATION WITH REACTOR BUILDING BASEMENT SILT PROCESSING

A technical plan for processing the reactor building and AFHB silt is currently being written. It will recommend that the silt be pumped to the spent resin tanks for settling. The solidification skid also would be used for basement silt since the same problem of controlling TRU concentrations also applies in this effort. Use of the spent resin tanks for this purpose will require some modifications. These modifications should be accomplished, if possible, prior to sluicing of purification demineralizer resins. These modifications are not yet fully investigated, however, they are expected to be:

- A method to decant water from a spent resin tank
- Additional agitation features to break up consolidated silt at the tank bottom
- Additional instrumentation to determine silt quantities and concentration

REFERENCES

1. HEDL-7285. "Fuel Content of the TMI-2 Makeup Demineralizers"

2. Letter to G. Quinn, EG&G/TMI from A. P. Malinauskas, ORNL, dated June 13, 1983.

3. LASL-Q-4183-317. "NDA Measurements of the Demineralizers at TMI-2".

4. HEDL-7335. "Resin and Debris Removal System Conceptual Design."

5. HEDL-7377. "Planning Study, Resin and Debris Removal System, Makeup and Purification Demineralizers: TMI-2."

6. Technical Planning Department. Technical plan for the integrated plan for AFHB characterization/stabilization/decontamination. TPO/TMI-049. Revision 0. June 1983.

7. NRC Technical Position on Waste Form, May 1983.

APPENDIX

SUMMARY OF CONTENTS
OF MAKEUP AND PURIFICATION DEMINERALIZERS

Resin Scoping Tests

A series of scoping tests were run at Pacific Northwest Laboratories (PNL) in an attempt to simulate the radiation and thermal degredation of the resins in the makeup and purification system. PNL irradiated a sample of IRN-150 mixed bed resin (similar to those used at TMI-2) to an accumulated dose of 1.7 x 10 rad with an external ^{60}Co source. The estimated cumulated doses experienced by the makeup and purification resins was between 1 and 5 x 10^9 rad. The results of these tests indicated a significant loss in resin volume and a corresponding increase in resin density. Samples of the resin were also heated to various temperatures and studied for degradation effects and products. Samples subjected to both radiation and heating showed significant weight loss (50-60%) and loss of functionality but remained sluicable up to 750°F. The estimated maximum temperature experienced by the resins in the makeup and purification system was 360°F. The gases released during the radiation and heating processes were sampled and analyzed. The major gas generated was hydrogen (80-90%).

In-Cell Surveys

A number of in-cell surveys were performed to determine the quantity of fission products and fuel in the demineralizers. Westinghouse Hanford Corporation (WHC) provided a small robot equipped with a TV camera and a dose rate monitor for the initial surveillances inside the cubicles. Gamma dose rate profiles augmented by TLD vertical dose profiles were also performed in the "A" demineralizer cubicle. Uncertainties involved in the interpretation of these data for assaying the quantity of fuel present in the demineralizers led to the performance of several additional in-cell surveys using more sophisticated non-destructive assay techniques.

Solid State Track Recorders (SSTR) were used to assess the neutron flux at the "A" demineralizer tank surface, thereby determining the quantity of fuel present. The SSTR data confirmed the tank was dry above the 309' elevation and estimated the quantity of fuel to be 1.7 ± 0.6 kg U.

The second technique for fuel measurement involved the scanning of the gamma spectrum from the "A" demineralizer tank using Si(Li) compton recoil spectrometry. Using equipment supplied by WHC, a scan of the "A" demineralizer tank through an existing penetration yielded the quantity of ^{144}Ce and ^{137}Cs present in the tank. From these data, an estimate of fuel of 1.3 ± 0.6 kg U was obtained.

The third technique applied to the fuel assay of the demineralizer resins was the use of a Be (γ,n) spectrometer system supplied by Los Alamos National Laboratory (LASL). The results of these scans showed the "A" demineralizer fuel content to be 2-7 kg and the "B" demineralizer to be ~0.7 kg of U.

A summary of the data concerning the demineralizers known prior to sampling is given in Table I. It can be seen from the data in this table that the best estimate of conditions in the demineralizers are:

1. The resins have shrunk and settled
2. There is only a small volume of liquid in the tanks
3. More fuel and core debris are in the "A" demineralizer
4. Neither demineralizer has a significant quantity of fuel
5. The "B" demineralizer has more Cs activity
6. Piping and equipment in cubicles are in satisfactory condition

TABLE I

Estimated Demineralizer Loadings
Based NDA Characterizations

	Initial	A Vessel	B Vessel
1. Resin			
Volume, ft^3	50	22	22
Weight, lb	2,139	1,025	1,025
^{137}Cs, Ci	0	3,500	7,000
^{134}Cs, Ci	0	270	540
2. Liquid			
Volume, ft^3	44	3	3
Weight, lb	2,746	193	193
3. Debris			
U, lb		5	1
Core Debris, lb		95	19
^{137}Cs, Ci		177	35
^{134}Cs, Ci		16	3
^{106}Ru, Ci		21	4
^{144}Ce, Ci		28	5
^{125}Sb, Ci		116	23
TRU, Ci		0.5(a)	0.1(a)
4. Gas			
Volume, ft^3		54	54
Temp, °F		80	80
Pressure, psig		11	10.5

(a) α activity only

GAS SAMPLING

With the results of the resin scoping tests and non-destructive assay measurements in hand, sampling of the demineralizers began. The first task was to sample, depressurize and purge each demineralizer of its trapped gases.

This was accomplished by modifying the instrument lines leading to the Barton differential pressure gauge (MUDPAH-4517) located in the Hays Gas Analyzer Room. The installation of a temporary gas line to permit venting to the waste gas decay tanks was installed with the capability of adding diluent gas (nitrogen). After clearing of liquid in the instrument lines, samples of the gases were taken and analyzed on-site and at an off-site laboratory (WHEDL). The results of these analyses are summarized in Table II.

TABLE II

Analysis Results of Makeup and Purification Demineralizer Gas Samples Taken During Venting

	Results		
Analysis	Sample 1 A-demin	Sample 2 A-demin	B-demin*
Kr (ppm)	<6	<6	<6
Xe - 136 (ppm)	0.8	0.8	2
Xe - 134 (ppm)	0.6	0.7	1.5
Xe - 132 (ppm)	0.7	0.8	1.8
Xe - 131 (ppm)	8	7	19
Xe - 129 (ppm)	0.2	0.3	0.6
CO_2 (mole %)	0.47	0.44	2.75
Ar (mole %)	0.10	0.01	0.03
O_2 (mole %)	<0.01	0.02	<0.01
N_2 (mole %)	91.6	91.4	8.69
CO (mole %)	<0.2	<0.2	<0.2
He (mole %)	<0.01	<0.01	<0.01
H_2 (mole %)	7.59	7.15	81.3
CH_4 (mole %)	0.21	1.02	7.28
Kr - 85 (UCi/cc)	0.043	0.043	0.20

* No D_2, He - 3 or HT detected

Using gauges installed in the temporary gas venting system, the best estimate of the initial gas pressures on the demineralizers were 8 psig on the "B" demineralizer and 4 psig on the "A" demineralizer. The "A" demineralizer was diluted with nitrogen gas during the liquid clearing operations. It can be seen from these analyses that the principal gas was hydrogen with some nitrogen and very little oxygen. This suggests that oxygen scavanging is occurring thus preventing the build up of a potentially explosive atmosphere. The demineralizers were vented and purged with nitrogen to less than 2% residual hydrogen.

Resin Sampling

Following the safe venting and purging of the demineralizers, modifications necessary to sample the resins in the tanks were begun. Sampling was accomplished by cutting the resin fill line in the Hays Gas Analyzer Room and installing a new ball valve on the 3" lines for each demineralizer. Special sampling tools, designed and fabricated by NUS Corporation, were used to obtain samples of the material in both tanks with minimum contamination and exposure to personnel. Samples were obtained by probes inserted through the diaphragm valves in the resin fill lines and into the resin beds through the top of the tanks. The "A" demineralizer sample was very difficult to obtain due to the presence of a crust over the resin which was later confirmed by a visual fiberscope survey. The "B" demineralizer was found to contain a layer of water covering the resin. Two samples of the "B" demineralizer were obtained. The results of the analyses of these samples performed at ORNL are shown in Table III. The conclusions that can be drawn from these results are:

TABLE III
Analytical Results for TMI - Columns A & B

		April 1983		May 1983		
Units	El.	B-Solution	B-Solid	B-2 Liq.	B-2 Solid	A Solid
ppm	B	3000		3000	>200	>200
	C	1000 ppm		900 ppm	>10%	>10%
ppm	Na	7000		~10,000	>1000	>1000
ppm	Mg	<1		<1	2	5
ppm	Al	10		10	70	50
ppm	Si	<3		<3	<5	<5
ppm	P	0.1		0.1	<1	4
ppm	SO_4	9600		6000	15,000	10,000
ppm	Cl	5		20	30	20
ppm	K	3		0.8	4	4
ppm	Ca	20		10	30	50
ppm	V				1	<0.1
ppm	Cr	0.3		0.6	5	<1
ppm	Mn	0.2		0.1	5	10
ppm	La				3	~1
ppm	Ba				<1	40
ppm	Cs*	30		30	100	100
ppm	129-I*					100
ppm	Te*	<1		<1	30	10
ppm	Sn				~2	
ppm	In	0.2		0.3	30	300
ppm	Cd	<1		<1	60	1000
ppm	Ag	0.4		2	30	600
ppm	Rh				≤3	≤3
ppm	Mo					200
ppm	Nb	<.1		<.1	<1	1
ppm	Zr	1		1	6	500
ppm	Sr*	1		<1	1	4
ppm	Rb*	6		4	15	15
ppm	As	<.5		<.5	<1	2
ppm	Zn	<.2		0.2	<1	<1
ppm	Cu	1		0.3	<1	2
ppm	Ni	0.5		0.6	40	100
ppm	Co	<.1		<.1	<1	3
ppm	Fe	10		10	200	700
ppm	U	0.064	1620	0.109	283+	1250
ppb	Pu	0.72	3550	0.64	787+	3520
μCi/g	134Cs	0.181E3	0.778E3	0.101E3	1.13E3	15
μCi/g	137Cs	2.64E3	11.2E3	1.48E3	16.9E3	220
μCi/g	90Sr	0.014E3	0.49E3	9.46	0.88E3	200
μCi/g	60Co					1.98
μCi/g	125Sn					7.4
μCi/g	144Ce					9.9
	pH	5.7		5.3		

*Fission Product + normal.
+ = Values suspect - rechecks in progress.

TABLE III (Continued)

Units	El.	April 1983 B-Solution	April 1983 B-Solid	May 1983 B-2 Liq.	May 1983 B-2 Solid	May 1983 A Solid
At %	234U	0.022	0.023	0.023**	.026	.022
At %	235U	2.23	2.46	2.5**	2.17	2.35
At %	236U	0.128	0.072	~.1**	0.10	0.072
At %	238U	97.62	97.45	97.5**	97.70	97.55
At %	238Pu	≤0.07	<.05	<.1	<.1	<.1
At %	239Pu	87.85	91.0	84.4	82.88	89.87
At %	240Pu	10.29	7.6	13.8 -	13.25	8.75
At %	241Pu	1.79	1.4	1.82	3.87 +	1.38
At %	242Pu	<.05	<.05	<.1	<.1	<.1

Original Sample

R at contact (110 Liq. & Solid) (7)

Insoluble Residue ~20 mg/ml ~500 mg/ml (dry)

**Small aliquot.

+ = values suspect - rechecks in progress.

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1. The "A" demineralizer contains more fuel and core debris.
2. The "B" demineralizer liquid contains at least 500 Ci ^{137}Cs.
3. The "B" demineralizer resin is sluicable.
4. The "A" demineralizer sample may not be representative of resin.
5. The "A" demineralizer resin has a crusted appearance and severe channeling exists.
6. The "A" demineralizer is dry.