# PROCESS CONTROL PROGRAM

FOR

CONSUMERS POWER COMPANY

MIDLAND NUCLEAR COGENERATION PLANT

February, 1983

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## REFERENCES

1. Werner & Pfleiderer, Topical Report, WPC-VRS-0001, "Radwaste Volume Reduction and Solidification System," Revised May 1978.

2. Werner & Pfleiderer, "Operating and Maintenance Manual," Volumes 1-16, Revision 2, June 26, 1981.

3. "Final Safety Analysis Report," Consumers Power Company, Midland Plant.

4. T S Boegli, R R Bellamy, W C Britz and R L Westerfield, "Preparation of Radiological Effluent Technical Specifications of Nuclear Power Plants," NUREG-0133 (October 1978).

5. Code of Federal Regulations, Title 49, "Transportation."

6. Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation."

## INTRODUCTION

The Process Control Program (PCP) is a supporting document of the Technical Specifications, Appendix A to the Operating License. As such, the PCP describes the systems, controls, and parameters to be used in the processing, packaging, and handling of various types of radioactive waste intended for shipment to offsite burial facilities. The intent of the program is to provide reasonable assurance of the complete solidification of liquid waste streams and that packages of solid waste contain no free standing liquids.

The PCP will be maintained at the plant for use as a reference guide and training document of accepted operating practice concerning processing, packaging, and handling of radioactive wastes with the solid waste systems. Changes in these operational methods will be incorporated into the PCP in order to ensure that the PCP represents the current operational methods in all applicable areas. Supporting plant procedures will be maintained current with the PCP.

## 1.0 SYSTEM FUNCTIONAL DESCRIPTION

### 1.1 General

The Midland Plant utilizes a Werner and Pfliederer vol[illegible]uction and solidification system (VRS) to process vario[illegible] liquid waste streams.

The process utilizes thermal energy [illegible]porate water from the radioactive wastes thus reducing was[illegible]me to anhydrous waste residue. This residue is then encapsulated in a thermoplastic matrix (asphalt).

The end product is a monolithic, freestanding solid with no free liquid. Fifty-five gallon drums are used to contain the encapsulated waste for temporary storage, transport, and burial.

A diagram of general system functions is shown by Figure 1.0-1 and 1.0-2.

### 1.2 Functional Descriptions

The VRS system is composed of several skid mounted subsystems and process peripherals necessary for process control and monitoring. These are:

#### 1.2.1 Control Hardware

The VRS is remotely controlled from the Solid Radwaste Building Control Room. The following control panels are located in this control room:

a. Solid Radwaste Control Panel;

b. CCTV/CRANE Control Panel;

c. Foxboro Nest Panel;

d. Reliance Automatic 31/32 Panel; and

e. Crane Control Cabinet.

The general layout of the control room is shown in Figure 1.0-3.

The Solid Radwaste Control Panel is a graphic control panel with front mounted indicators, recorders and controllers. These are all clearly identified as to function. An annunciator system is provided to identify system malfunctions. System feed rates, temperatures, pressures and other parameters are monitored and controlled from this panel.

The CCTV/Crane Control Panel is a freestanding enclosure with a sloping panel. Mounted on the panel are four (4) 14" diagonal TV monitors. Associated with each TV monitor is a 6 position Video Selector Unit which permits the operator to select any one of five (5) cameras throughout the system to be viewed on a particular monitor. Focus-Zoom-Pan/Tilt controls for 3 cameras are also provided.

The sloping panel contains all controls for the Solid Radwaste System Crane, such as bridge and trolley lights, hoist, trolley and bridge motions, etc. In addition, control switches and lights are provided for drum conveying and decontamination station operation.

The Foxboro Nest Panel contains electronics required for signal conditioning, alarm, and control necessary for proper system operations.

The Reliance Automate 31/32 Programmable Controller is designed to provide a solid state programmable replacement for electro-mechanical relays and timers. It consists of:

a. The Automate 32 chasis containing a processor, controller monitor, memory and serial I/O cards;

b. Power supply; and

c. Automate 31 I/O subsystem containing power supply, I/O drum, link card, inputs, outputs, timers, etc.

A cassette tape is provided which contains the program for the Reliance Automate 31/32 Programmable Controller based on elementary wiring diagrams of the total system. This tape shall be controlled pursuant to plant computer software control procedures.

The Crane Control Cabinet contains the control hardware required for operation (ie, relays, resistors, motor controllers, DC drive, etc) of the system crane.

1.2.2 Extruder Evaporator

The function of the extruder-evaporator is to receive simultaneous input from a radwaste feed source and an asphalt binding medium;

evaporate free water; mix and disperse the radioactive residues in the asphalt binder; and discharge the product into a 55 gallon steel drum. Volume reduction is achived by evaporation of water from the waste/asphalt mixture in a fluid state until discharged into a container. Cooling to ambient temperatures causes the waste/asphalt matrix to harden and form a freestanding monolith. The extruder-evaporator is shown in Figure 1.0-4. Its design data is given in Figure 1.0-7.

1.2.2.1 Twin Screw Principle

Asphalt (binder) and wastes fed to the extruder are conveyed along the length of the process section and mixed together by the twin screws. Two basic types of screw elements are provided: conveying elements and mixing/kneading elements. Positive conveying action is provided by self-wiping, intermeshing, 3-lobe screw elements. The mixing and kneading elements also provide conveying action, but their primary function is to generate intensive mixing. Due to brief residence time within the extruder-evaporator, water may be evaporated from thermally sensitive materials, such as resin beads, without causing unnecessary degradation of the resins. Screw conveyance of radwaste/asphalt is shown in Figure 1.0-4.

The 3 lobe screws (both conveying elements and mixing/ kneading blocks) are co-rotating and intermeshing with

self-cleaning capability. The root of a channel of one screw is constantly wiped by a crest of an adjacent screw; accordingly, the flight channel is cleaned. The material is constantly conveyed along the barrel wall and is transmitted from one screw to the other at the saddle point of the barrel.

Reverse conveying capability can be achieved through the use of left-handed screw elements. This principle is utilized at the extruder-evaporator outlet to assure the positive discharge of product material from the machine. It should be noted that the screws are operated with only partially filled flights in certain parts of the process section. This is important for removal of moisture which must diffuse from the matrix as the product approaches dryness. A narrow residence time distribution is important for uniform product quality and is of practical value when cleaning the machine for maintenance. This may be accomplished by running clean asphalt, without radwaste feed, through the machine. This prevents the need to dismantle the screw barrel for decontamination prior to maintenance. A typical screw configuration and the operation of the kneading disks are shown by Figure 1.0-5.

1.2.2.2 Support Plates for the Process Section

The barrel sections of the process are connected to the frame by a key and keyway in such a manner as to allow for the thermal growth of the process section in the longitudinal direction from the fixed tie-rod plate.

1.2.2.3 Modular Barrel Section

| Item | Barrel Number |
|---|---|
| A. 1 Feed Barrel | No 1 - 350 mm long |
| B. 2 Closed Barrels | No 2 and 5 - 360 mm long |
| C. 3 Vent Barrels | No 3, 4 and 6 - 720 mm long |
| D. 1 Discharge Barrel | No 7 - 720 mm long |

Each of these barrels possess a system of bored holes parallel to the screw bores for heating or cooling by steam or water, respectively. Each barrel section has provisions for installation of temperature elements.

The Feed Barrel has nozzles for the introduction of asphalt, resin and liquid waste concentrates to the extruder-evaporator. It is provided with independent systems of heating and cooling bores for respectively heating the process with saturated steam, and for cooling with isolated cooling water. One thermoelement fitting is provided for installation of a thermocouple.

The Closed Barrel does not have any process openings. It is used for introducing heat into the process, thereby evaporating water from the waste/asphalt mixture. This section is steam heated and has one thermocouple for temperature measurement.

The Vent Barrel is also steam heated and has a rectangular opening on top of the barrel for the removal of the volatiles (water vapor). Two thermocouple fittings are provided.

A Discharge Barrel is provided with heating and cooling capability similar to the inlet barrel. It has an opening facing downward through which the radwaste/asphalt is discharged into the waste container (55 gallon drum). Two thermocouple fittings are provided.

1.2.2.4 Asphalt Feed Nozzle

The asphalt feed nozzle is located at the top of the feed barrel. This connection is designed to accommodate a steamjacketed asphalt feed line. A flanged connection is provided for condensate removal.

1.2.2.5 Resin and Concentrate Feed Nozzles

The resin and concentrates feed nozzles are located on top of the feed barrel and are physically downstream of the asphalt feed nozzle.

1.2.2.6 Steam Domes

The steam domes are fittings on the top rectangular opening of each vent barrel. The water vapor escaping from the waste/asphalt matrix enters the steam domes and is condensed. The condensate is gravity drained to the distillate collection system. A typical steam dome is shown in Figure 1.0-6.

The steam domes are fabricated of stainless steel and consist of a vertical body with a pendent condenser section. To avoid premature condensation of vapor, the vertical body is steam jacketed.

Periodic inspection of the steam dome internals is accomplished by means of two sight glasses provided on the top of each dome. Illumination capability is provided by lighting operated by a local pushbutton. A dome boilout system is provided to periodically remove accumulated salt sediments.

1.2.3 Auxiliary Support Systems

1.2.3.1 Auxiliary Steam System

An electrically operated auxiliary boiler is provided to supply steam to:

a. Asphalt System Heat Tracing;

b. Extruder-Evaporator Barrels;

c. Extruder-Evaporator Vent Post Cleaning Nozzles;

d. Extruder-Evaporator Vent Dome Inspection Glass Cleaning Nozzles; and

e. Decontamination Station for Drums.

Chemical controls are specified and maintained on auxiliary boiler feedwater, by periodic chemical additions and blowdowns, for the purpose of corrosion control.

1.2.3.2 Isolated Cooling Water System

This system supplies cooling water to the following:

a. Extruder-Evaporator Inlet/Outlet Barrels;

b. Extruder-Evaporator Dome Cooling Units;

c. Lube Oil Heat Exchanger; and

d. Distillate Collection Heat Exchanger.

Chemical controls are specified and maintained on this system for the purpose of corrosion control.

1.2.3.3 Lube Oil System

This sytem supplies cooled filtered oil to the extruder-evaporator:

a. Reduction and distribution gears;

b. Thrust bearing; and

c. Shaft support bearings.

1.2.3.4 Distillate Collection System

This system recovers, cools and returns distillate, produced by the extruder-evaporator, to the Liquid Radioactive Waste System. A portion of this system removes organic impurities by special filtration.

1.2.3.5 Drum Fill Station

The container filling operation takes place in a shielded area to maintain the radiation exposure to the operator and other personnel ALARA. Filling is observed by the operator through shielded windows and/or a closed circuit television system. The operator can remotely monitor and control all aspects of filling from the Solid Radwaste Control Room. The fill station consists of the following equipment/components:

a. Turntable;

b. Drip Pan Mechanism; and

c. Vent Hood/Fans and Filter Train.

The turntable holds six 55 gallon steel drums. When signaled remotely to index, the turntable positions the next empty drum under the discharge port. It is also used for temporary storage of filled drums while cooling.

The drip pan mechanism collects the extruder-evaporator output during the index cycle of the turntable. The output is collected in a disposable tray which falls into the next drum when properly positioned for filling. This allows for continuous system operation.

The vent hood is provided for adequate ventilation of the fill station area and the distillate collection tank. Air is exhausted through HEPA and charcoal filters prior to introduction into the Auxiliary Building Ventilation Exhaust.

1.2.3.6 Drum Handling System

The system consists of two principal functional components:

a. The Empty Drum Conveyor; and

b. The Solid Radwaste Building Bridge Crane.

The Empty Drum Conveyor is utilized to transport empty drums from the area outside the west end fill station radiation shield, into the fill area. Empty drums are removed from the conveyor and set on the turntable by the

bridge crane. The bridge crane is used to retrieve filled drums from the turntable for placement in a temporary drum cooling area within the fill area east of the turntable.

1.2.3.7 Empty Drum Conveyor

This conveyor is a belt driven (via an electric motor), accumulating conveyor. It is capable of moving empty drums from a loading point, in the Empty Drum Storage Area, to the drum release point which is located in the fill station area. This conveyor has a zero-pressure accumulation feature which permits the conveyor to act as a magazine which can accumulate six (6) drums. This is equal to the turntable capacity. The conveyor is loaded manually at the loading point. Conveyor operations are controlled from panel OC-027 and consist of: motor start/stop and drum release.

1.2.3.8 Solid Radwaste Building Bridge Crane

This crane has a capacity of 7.5 tons and a 53 foot span bridge designed specifically for remote drum handling. Specialized features include:

a. Totally remote operation from a shielded control room;

b. Crane indexing system and container handling via closed circuit television;

c. Electrical interlocks to protect crane from overtravel (ie, bridge-east/west; trolley-north/south, hoist-up/down);

d. Microdrives on bridge trolley, and hoist to permit precise location of crane;

e. Independent drives and electrical systems on bridge, trolley, and hoist to permit removal of crane from areas of significant radiation exposure in the event of a single motor or electrical failure;

f. Interlock to prevent high speed motion of bridge or trolley unless the hoist is in the "full up" position. This prevents excessive container swing and prevents collisions of suspended loads with intermediate walls, etc;

g. Interchangeable drum grab and hook for specialized drum handling and general lifting;

h. Interlock to prevent raising drum unless "grab" jaws are fully engaged;

i. Remote location of electrical control hardware in low radioactive areas to simplify servicing and maintain operator exposures ALARA;

j. Interlock to prevent drum grab releases unless drum is set down;

k. Digital readout of drum vertical location; and

l. Use of a rotating block for added load handling flexibility.

Typical crane operations may include:

a. Loading empty drums on turntable from empty drum conveyor;

b. Removing filled drums from turntable to a cooling area;

c. Transporting drums to capping, contamination swiping and decontamination stations;

d. Transporting and indexing filled drums to the proper site within a storage cell; and

e. Removing drums from storage cells to the truck loading bay for loading into transporting cask or vehicle.

To aid the operator in locating drum positions, a system of target grids is provided on the ceiling of the Solid Radwaste Building. Each assigned drum storage position is provided with a "target" which is viewed by a CCTV camera mounted on the crane trolley. When the camera

"cross-hairs," as viewed on the monitor, coincide with the selected target, the drum grab is directly above the storage location. A "down-looking" CCTV camera is also provided on the trolley. This camera is used for surveillance of storage areas and in drum handling operations.

1.2.3.9 Seal Water System

The seal water system supplies cooled and clean water to lubricate and flush pump seals as shown in Figure 1.0-1. It also provides a back pressure to prevent process leakage into or through the seals.

1.2.3.10 Spent Resin Decant/Recirculation System

This system decants excess water from the resin slurry in the Spent Resin Decant Tank and maintains a homogeneous mixture of resin and water in the system.

1.2.3.11 Asphalt System

The asphalt system allows makeup to the Asphalt Storage Tank from an outside supplier through a fill line and strainer. It also stores, maintains the asphalt in a pumpable state and provides suction pressure to the Asphalt Metering Pump.

1.2.3.12 Radwaste Concentrate Feed System

Used to meter radwaste concentrates and resins to the extruder-evaporator. There are four feed streams:

a. Boric Acid Concentrates;

b. Liquid Radwaste Concentrates;

c. Chemical/Laundry Wastes; and

d. Spent Resin.

Each feed line contains metering pumps and flow controls to provide optimum feed flow to the extruder-evaporator for the type of radwaste being processed. Feed lines have flushing capabilities to clean lines at the end of each batch processed. A block diagram showing tank capacities and inputs are shown by Figure 1.0-1.

1.2.3.13 Capping and Swipe Station

The purpose of the capping station is to allow remote placement of a drum lid and crimping the lid to seal the drum for shipment.

The swipe station allows a remote swipe to be taken of the radwaste container after capping and crimping to determine the quantity of loose surface contamination present. A determination is then made as to whether decontamination is needed.

These stations are operated from outside a shielded room which maintains operator exposure ALARA.

1.2.3.14 Decontamination Station

The decontamination station is used to decontaminate radwaste containers that have loose surface contamination greater than site limits for such contamination. The drums are sprayed with high-pressure steam-heated water and air blown dry. This operation is conducted in a sealed enclosure within a shielded room.

1.2.3.15 Steam Dome Boilout System

The Steam Dome Boilout System supplies an exact amount of demineralized water through the respective port connection in the steam dome, for removal and cleaning of unwanted salt sediments which may accumulate in the steam dome.

1.2.3.16 Dry Waste Compactor

The dry waste compactor is used to compress low-level dry waste, such as cloth, paper, floor sweepings, plastic and the like into a container suitable for shipment to a burial facility or for on-site storage.

Because only low activity waste is compacted, and additional administrative controls are applied, the unit requires no shielding during operation. The compactor is

vented through HEPA/charcoal filters to the Auxiliary Building Ventilation Exhaust.

### 1.2.3.17 Liquid Filter Handling System

The filter handling system is utilized in removal, transfer and remote handling of plant liquid filter elements. A shielded cask, with remote handling tools, is provided to facilitate filter removal from system housings and transporting filter elements to the Solid Radwaste Building.

A special shielded cell, located in the Solid Radwaste Building, has been provided to allow draining and remote transfer of the element to a 55 gallon drum. The filter element is held suspended in the center of the drum by a support. The drum will then be placed on the extruder-evaporator turntable and encapsulated with asphalt.

SOLID WASTE SYSTEM ONE-LINE DIAGRAM

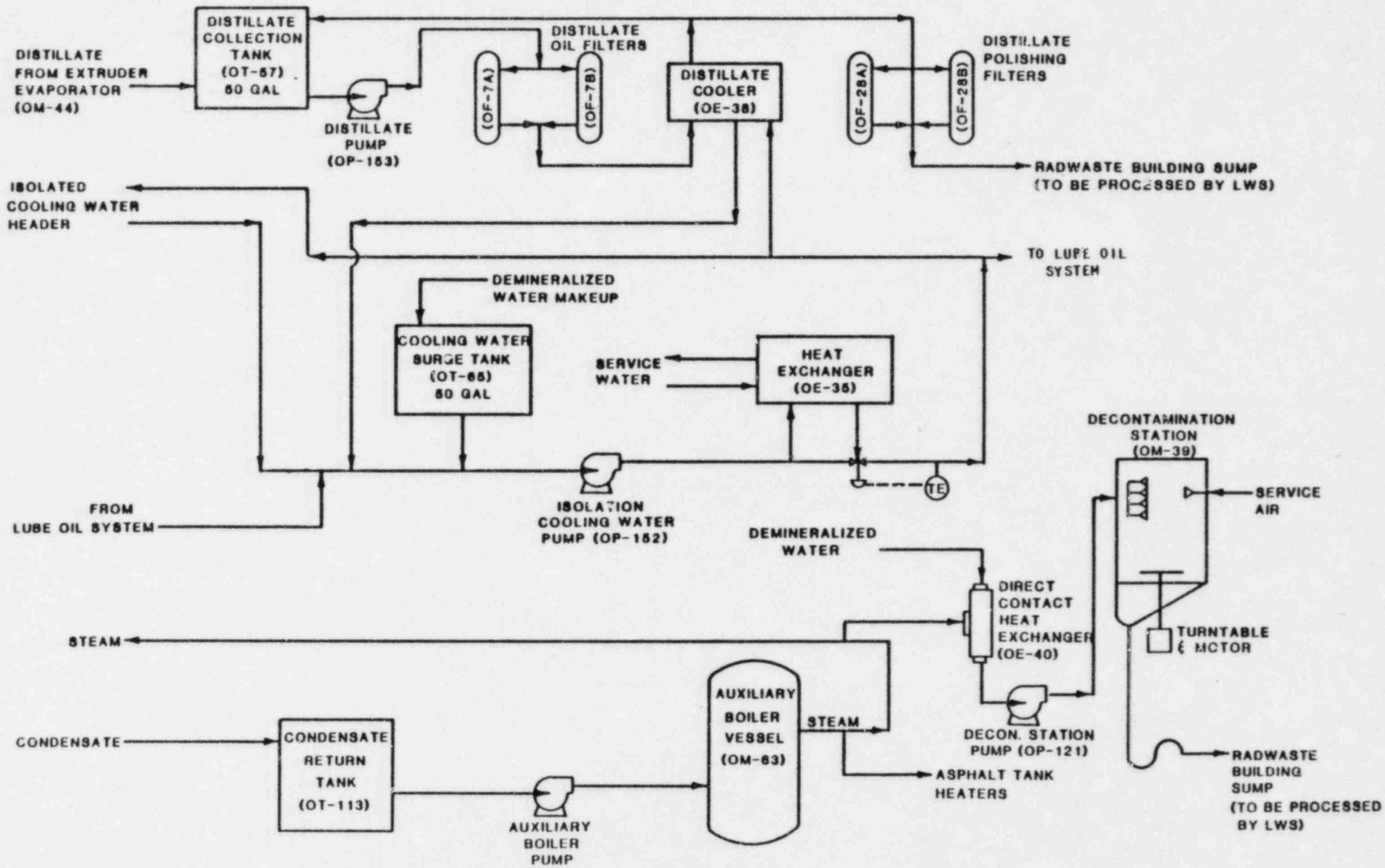



FIGURE 1.0-1

# SOLID WASTE SYSTEM ONE-LINE DIAGRAM

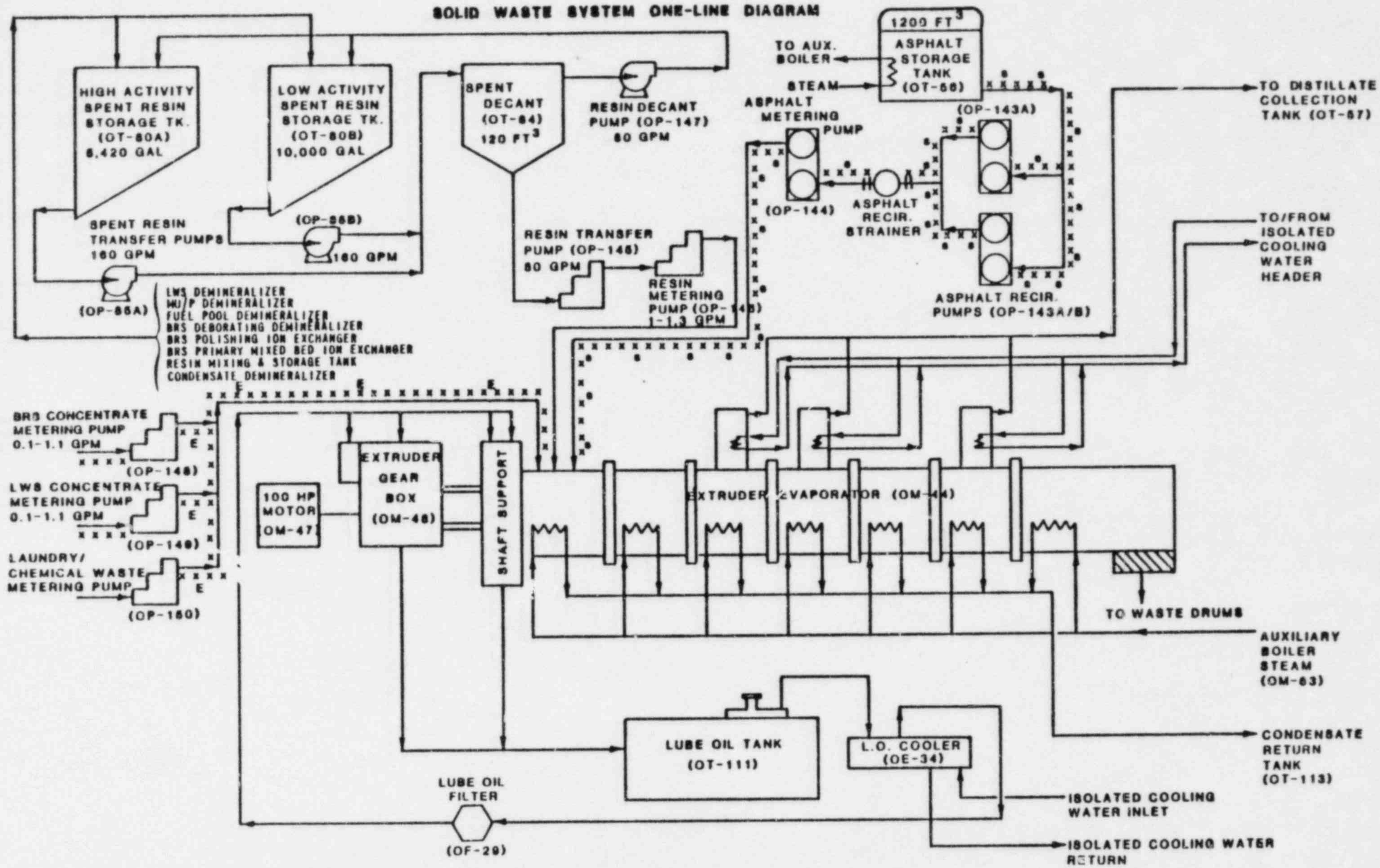



FIGURE 1.0-2

GENERAL LAYOUT CONTROL ROOM, EL 656' 6"

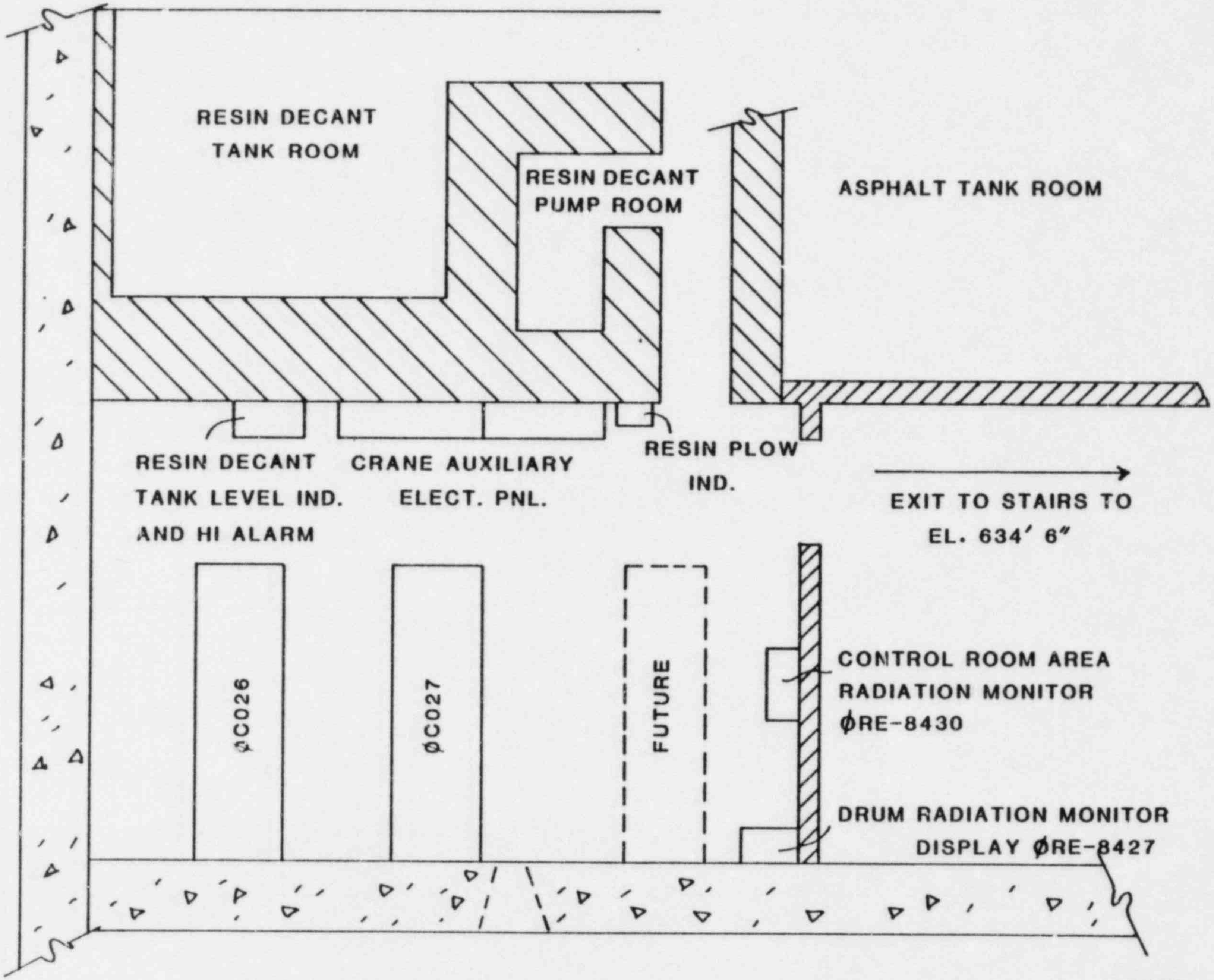



FIGURE 1.0-3

EXTRUDER EVAPORATOR

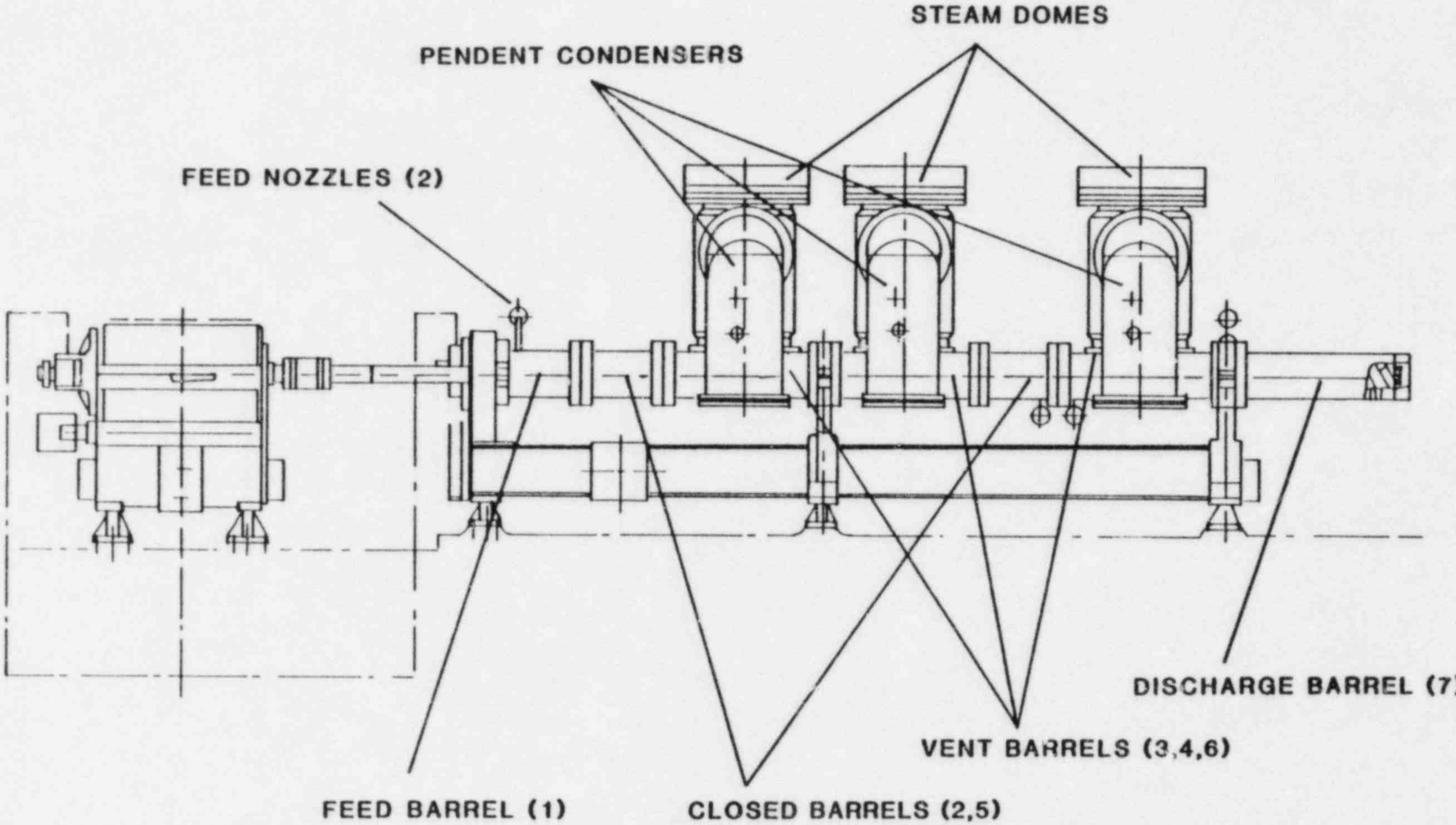
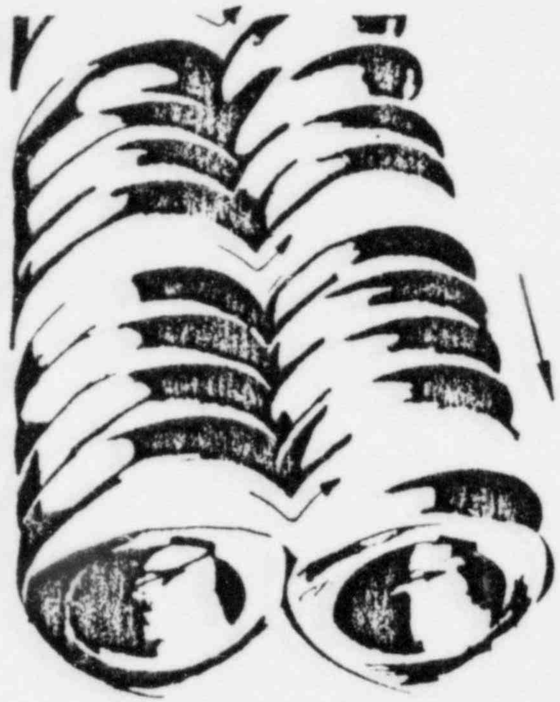
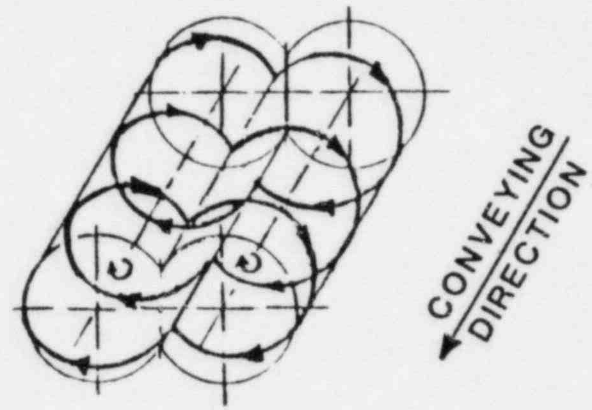


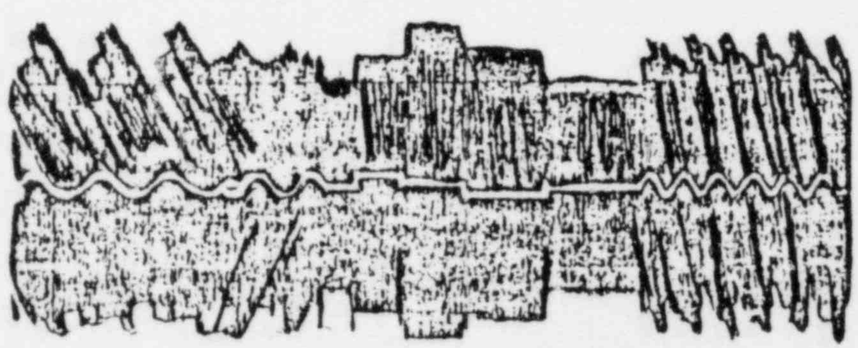

FIGURE 1.0-4

SCREW CONFIGU...TION
AND KNEADING DISKS

REPRESENTATION OF RADWASTE/ASPHALT
CONVEYANCE





TYPICAL SCREW CONFIGURATION

OPERATION OF KNEADING DISKS

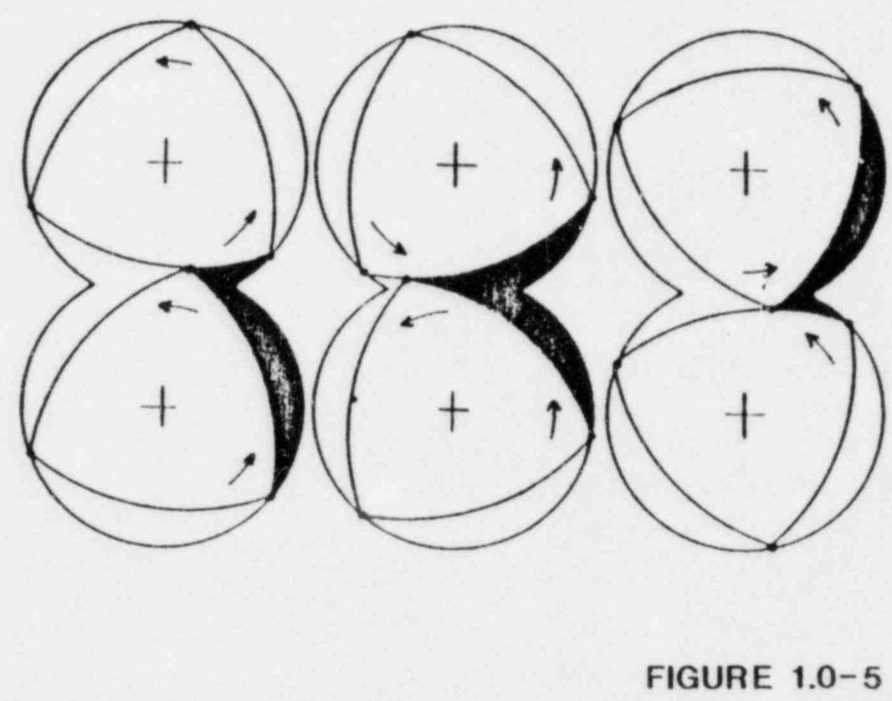


FIGURE 1.0-5

STEAM DOME ND PENDENT CONDENSER

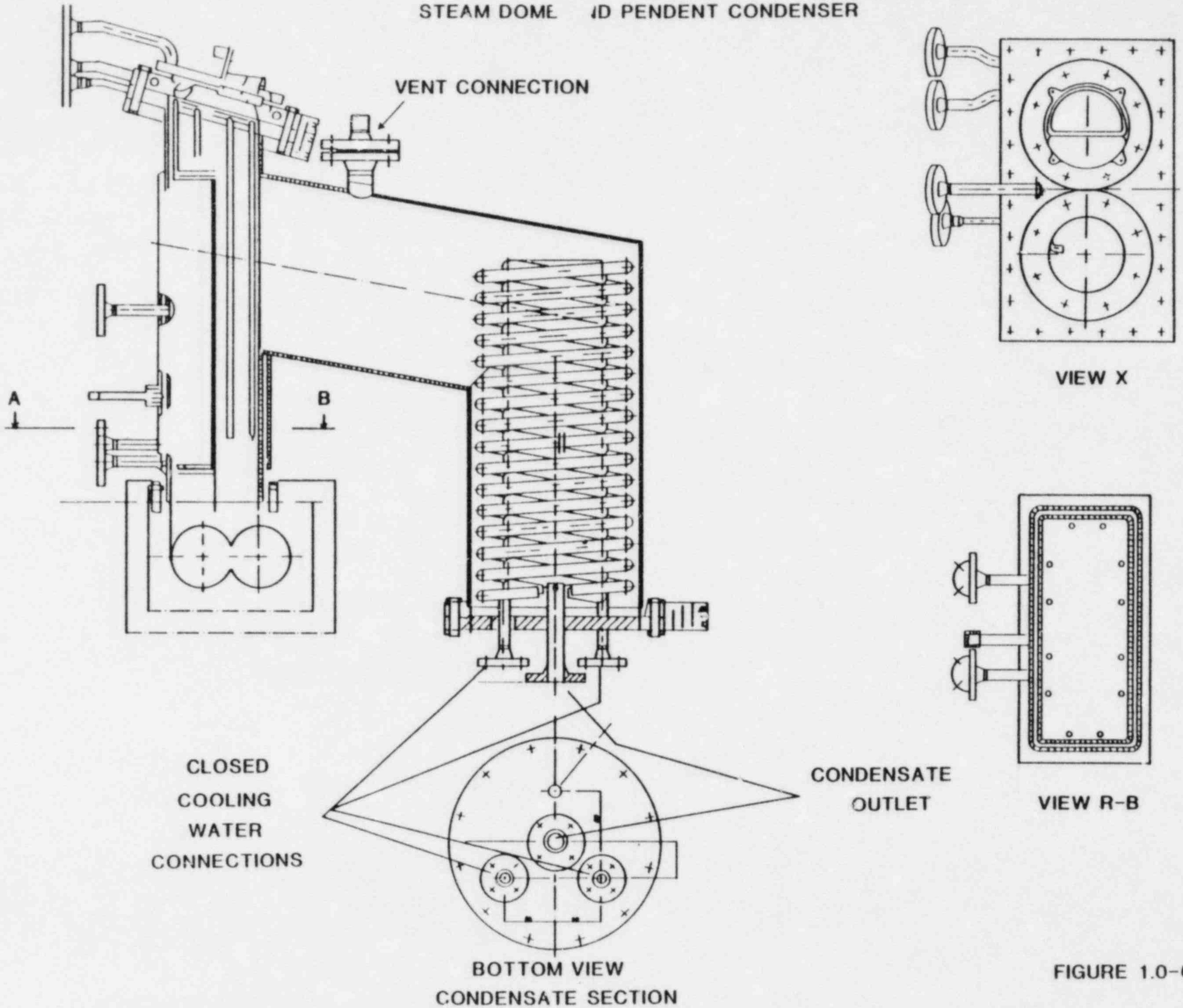



FIGURE 1.0-6

EXTRUDER-EVAPORATOR DESIGN DATA

Revolutions

| | Min | Max |
|---|---|---|
| Motor rpm | 180 | 1800 |
| Screw Shaft rpm | 30 | 300 |

Gearbox

Overall reduction ration between motor and screw shafts = 6.0 : 1.

Distributor and Reduction Gearbox

| | |
|---|---|
| Make | Kachelmann |
| Kind | Four Step Spur Gear |
| Type | 2 A 100 A |
| Ratio | 6 : 1 |
| Lubrication | Forced Feed Constant Circulation |
| Grade of Oil | Gear Oil SAE 90 EP |

| Designation | Abbreviation/ Dimension | Value |
|---|---|---|
| Outer Diameter of Screw Nitrided Elements | $D_a$ (mm) | 120 |
| Depth of Flight Nitrided Elements | h (mm) | 10.5 |
| Center Distance | A (mm) | 110 |
| Length of Process Part | L (mm) | 4240 |
| Length of Barrel Section | $L_G$ (mm) | 350/360/720 |
| Average Theoretical Residence Time in Process Part at 1 m Length and 100 l/h throughput | $t_m$ (min) | 0.86 |
| Screw Shaft Speed | n (rpm) | 30-300 |
| Drive Power | P (kW) | 7.5-75 |
| Total Length of Machine | $L_M$ (m) | About 6.21 |
| Width of Machine | B (m) | About 1.18 |
| Max Height of Machine | H (m) | About 1.76 |
| Weight of Machine | G (Mgm) | About 9.0 |

## 2.0 VARIABLES INFLUENCING SOLIDIFICATION

The purpose of this section is to identify and define those process variables which have a direct effect on the ability of the final product to form a freestanding monolith with no free liquid.

The following variables influence the properties and consistency of the final product:

a. Asphalt Type;

b. Waste chemical species used as feed;

c. Ratio of waste-to-asphalt; and

d. Process temperature.

### 2.1 Asphalt Type

Asphalt utilized in the system shall conform to ASTM-D-312-71, Type III. This is an oxidized petroleum-based asphalt, such as Witco Chemical Company's Pioneer 221. The specifications for this asphalt are provided in Appendix A.

This grade of asphalt has a low residual volatile content and a high molecular weight. At room temperature, and at all normal ambient temperature conditions, this material is a freestanding, monolithic, solid.

Utilization of an asphalt complying with ASTM-D-312-71, Type III, is the means by which process control of this variable is achieved.

## 2.2 Waste Chemical Species

The type and relative quantity (waste-to-asphalt ratio) of waste chemicals being incorporated into the asphalt matrix has a direct influence on the properties of the final product. Encapsulation of inorganic salts and solids typically "stiffen" and harden the end product, whereas organic liquids have the opposite tendency. When the specified ratio of waste-to-asphalt is maintained, final product properties for typical power plant wastes, are independent of the waste type.

However, certain chemical specifications are required as an outer bounds to limit end product tendencies to soften at lower temperatures.

A maximum limit of 1% oil by wieght will be applied to the waste feed streams. Most oils found in power plants are low viscosity fluids, which are liquid at room temperature. Based on calculations for a typical waste stream with 20% solids by weight and 1% oil by weight, Werner and Pfliederer has found the total concentration of oil in the end product would be approximately 2.5%. This would then lower the end product softening point by approximately 5°F, or approximately 2°F lower per percent of oil. This is within an acceptable range, and therefore, is the basis for the limit of 1% oil in the feed stream.

Other chemical specifications on feed streams are specified in Section 4.0. These are limited primarily for equipment protection and at typical plant levels will have no discernable effect on the end product.

## 2.3 Waste-to-Asphalt Ratio

The ratio of waste-to-asphalt contained in the end product has the most significant effect on the viscosity and physical consistency of that product. Process control is achieved by placing limitations on the range of waste-to-asphalt ratios allowable for each waste type.

Waste-to-asphalt ratios (mass) shall be maintained, for each waste feed, as specified below:

| Feed | Ratio of Waste-to-Asphalt In the End Product |
|---|---|
| 1. Boric Acid Concentrates | ≦ 50/50 |
| 2. LWS Concentrates: | |
| - highly borated (7-20 wt %) | ≦ 50/50 |
| - low to moderately borated (less than 7 wt %) | ≦ 60/40 |
| 3. Chemical/Laundry Waste | ≦ 60/40 |
| 4. Spent Resins | ≦ 50/50 |

Should the ratio of waste-to-asphalt be increased above the range specified in the foregoing table, the end product viscosity will increase and may exhibit a grainy texture. This could lead to "pyramiding" of the product in the container, thereby decreasing the container filling efficiency. In all cases, the product will cool to form a free-standing monolith. If lower than specified waste loadings are realized, the end product properties will approach that of pure asphalt. Again, solidification is assured; however, towards this end of the spectrum, economical volume reduction may not be realized.

Proper waste-to-asphalt ratios in the end product are automatically maintained by a coordinated proportioning feed system. Operator involvement is limited to setting the initial proportion of waste-to-asphalt flow. Figure 3.0-4, Concentrates-to-Asphalt Diagram shall be utilized to determine the proper feed control settings. Using the solids content of the waste feed from sample analyses.

The operator can also visually confirm that the quality of the end product is approximately being maintained. A CCTV camera "views" the discharge from the extruder-evaporator, and a TV monitor located in the Solid Radwaste Building Control Room allows the operator to observe the physical consistency of the product as it is discharged into the container.

## 2.4 Process Temperatures

A proper temperature profile along the length of the extruder-evaporator is required to provide adequate evaporative (process) capacity, and to assure that free water is not discharged from the machine.

Process temperature profiles for Midland waste types shall be maintained within (± (Later) °F) of the following:

| Waste Type | Process Temperature (°F) | | | | | |
|---|---|---|---|---|---|---|
| Zones: | 1 | 2 | 3 | 4 | 5/6 | 7 |
| Boric Acid Concentrates<br>LWS Concentrates<br>Chemical/Laundry Waste | 165° | 265° | 300° | 330° | 375° | 350° |
| Spent Resins | 165° | 265° | 280° | 300° | 310° | 310° |

Low Temperature alarms are provided to alert the operator to a low temperature out-of-specification condition which could potentially lead to the discharge of free water. If the out-of-specification condition persists for two (2) minutes, the extruder-evaporator is automatically tripped to prevent free water from being discharged into the container. Free water cannot be discharged in the interim, since the residual heat of the extruder-evaporator itself is sufficient to effect evaporation.

The foregoing controls/interlocks are provided to prevent the discharge of free water to the container. The temperature profiles specified above, have been proven by Werner and Pfleiderer to yield residual total moisture content in the product of less than 1% by weight for waste concentrates (inorganic salts), and less than 10% by weight for bead resins. This margin provides assurance that free water cannot be discharged under normal circumstances. Under out-of-specification conditions, discharge of free water is prevented by the low temperature process interlocks.

## 3.0 SOLID RADWASTE SYSTEM OPERATION

The solid radwaste system is designed to handle four distinct types of radwaste:

a. Liquid concentrates and resins;

b. Liquid radwaste system filters;

c. Compactible waste; and

d. Non-compactible solid waste.

The purpose of this section is to provide an operational overview of the methods to be utilized in handling each of these radwaste types.

Solid Radwaste system design data is provided in Appendix C and a general layout of the work area is shown in Figure 3.0-1.

### 3.1 Liquid Concentrates and Resin Processing

Liquid concentrates and resins are normally processed by the radwaste solidification system using the extruder-evaporator unit as described in Section 1.0. These feed sources are shown in Figure 3.0-1.

The liquid concentrates are supplied directly to the extruder-evaporator via a common feed line. Resin is fed to the extruder-evaporator through a separate line and metering pump directly from the Resin Decant Tank. High and low activity resin storage tanks are pumped to the decant tank, mixed, dewatered, and metered to the extruder-evaporator as required.

All feed to the extruder-evaporator shall be controlled utilizing the batch mode of operation. When a specific tank is at a level requiring processing, perform the following: (1) isolate the tank from further input, (2) recirculate mixture until a representative sample can be taken and analyzed, and (3) process at a pre-calculated mixing ratio until the batch is completed or terminated.

### 3.1.1 Sampling and Analyses

Prior to processing a tank, it is isolated and recirculated to obtain a representative sample. The objective of this sample is to:

a. Ensure the feed stream will comply with vendor chemical specifications,

b. Determine the setpoint for the feed flow rate controller which will result in the correct mixing ratio per Section 2.3 of this manual, and

c. Determine the radionuclide type and quantity for assessment of end product total activity and to allow proper completion of shipping documents.

A unique number, called the "batch number", is assigned to the volume to be processed so that control of each processing run is maintained. This number shall appear on all documentation associated with processing that volume. This will allow traceability from the end product to the source tank.

### 3.1.2 Determination of Processing Parameters

To calculate the feed flow rate which will yield the required mixing ratio of the end product, the following analytical results must be known:

a. Specific gravity of the feed, and

b. Solid content in weight percent.

In addition, the pH must be in the range of 7.5 to 10.0 and the oil content must be less than 1.0%.

The feed flow rate in gallons per hour may be determined as follows:

$$\text{Feed Rate (gal/hr)} = \frac{31.7}{(1.0 - \text{Solids Content})(\text{Sp Gravity})};$$

where 31.7 is the extruder-evaporator evaporative capacity in gallons per hour.

The mixing ratio for the type of feed in question must then be determined from the table of Section 2.3 of this manual.

If necessary, the ratio of concentrates-to-asphalt is now adjusted to reduce the solids content in order to reduce the radioactivity loading in the end product. This will reduce the dose rate on the exterior of the container to be filled for ALARA purposes.

Using the Concentrates Nomogram (Figure 3.0-3) or the Resin Nomogram (Figure 3.0-4), as appropriate, the feed flow rate in

pounds per hour and dry solids flow rate in pounds per hour is determined.

Finally, the asphalt fractional flow rate, where the feed flow rate equals 1.0, is determined. Then the appropriate nomogram (Figure 3.0-3 or 3.0-4) is used to determine the required asphalt flow. The flow controller setpoint is determined from:

$$\text{SETPOINT} = \frac{\text{Asphalt Flow Rate}}{\text{Feed Flow Rate}}$$

From the data previously determined, the distillate flow rate and the container (drum) filling time can be calculated.

### 3.1.3 Operation of the Extruder-Evaporator

Prior to operation of the extruder-evaporator, all auxiliary systems must be filled, vented, and brought to proper chemical specifications in accordance with vendor recommendations. These systems were functionally described in Section 1.0 and are shown in Figures 1.0-1 and 1.0-2.

The extruder-evaporator shall be brought to the correct temperature profile for the type of waste stream being processed. Required temperature profiles are presented in Section 2.4.

Feed flow shall never be supplied to the extruder-evaporator without asphalt flow. Asphalt flow to the extruder-evaporator shall be started prior to initiating feed flow and shall continue

to be supplied to the extruder-evaporator after feed flow has been stopped.

The feed line shall be flushed in accordance with vendor recommendations prior to shutdown of the extruder-evaporator. This will reduce radioactivity retained within the unit.

Containers shall not be filled to more than 90% capacity and shall be visually monitored periodically during filling to ensure proper operation of container level probes. Visual monitoring shall be by means of remote controlled television.

Steam domes and viewing ports shall be periodically cleaned in accordance with vendor recommendations.

3.1.4 Container (Drum) Handling Operations

Prior to being filled, each container shall be inspected to meet these minimum conditions:

a. No liquid should be present inside the container;

b. The container integrity is intact and no deformity, rust, or other damage is present which may compromise container integrity during handling or shipment; and

c. Container sealing surfaces are not damaged or deformed.

Each container shall be identified by an unique serial number affixed to the side prior to being used. This serial number,

along with the batch number described in Section 3.1.1, is used for traceability of the contents.

The containers are placed on a conveyor which transports them into the shielded area called the turntable room. The drums are then placed on the turntable by the remotely operated crane, as necessary. This unit holds up to six (6) drums for filling. One of the drums is always under the extruder-evaporator discharge except when the turntable is indexed (rotated) following completion of filling a drum. A "drip-tray" is automatically placed under the extruder discharge during the indexing operation. This "drip-tray" falls into the next drum positioned under the discharge.

When several drums have been filled, they are then removed from the turntable and placed in a "sit down" area next to the turntable for cooling.

Drums require several hours to cool sufficiently to allow capping. Figure 3.0-5 indicates the end product temperature as a function of time following completion of filling.

After cooling, the drum is remotely removed from the Turntable Room by the overhead crane and moved to the capping station. Here the drum is capped by a crimping machine which is operated remotely. This equipment is described in Section 1.0.

The drum is remotely moved to the swipe station for assessment of loose surface contamination levels on the drum exterior. Swipes

are taken by using a remote arm. A small turntable rotates the drum while a swipe paper is held against the drum by the remote arm. The swipe is then placed in a shielded drawer for removal to outside the shield where it is then counted.

If loose surface contamination above plant limits is found, the drum is then placed within the Washdown Station and cleaned by steam. After cleaning the drum is blown dry while still within the washdown enclosure. These operations are remotely performed. The drum will then be moved back to the capping/swipe area to confirm that loose surface contamination is below plant limits. The cycle will be repeated until decontamination is complete.

While inside the capping/swipe area, a radiation detector located in close proximity to the side of the drum, at approximately the center, will be utilized to evaluate the radiation levels on the drum. This detector may be read locally at the swipe station operating area outside the shielded enclosure, or in the Solid Radwaste Control Room.

3.2 Liquid Radwaste System Filters

The solid radwaste system includes facilities for remotely handling wet filters removed from nuclear plant auxiliary systems containing reactor coolant or radioactive waste. The system is described in Section 1.0.

A shielded cask and remote handling tools are utilized in removing a liquid filter from its system housing. This cask is then closed and moved to a decontamination room for draining of residual liquid. It is

then transported into the Solid Radwaste Building. Here the cask is placed in a shielded area and the bottom of the cask is removed. The top of the cask and the filter element are lifted over into a second shielded area and the filter element is then lowered remotely into a 55 gallon steel drum. A wire mesh retaining element receives the filter and holds it suspended in the center of the drum. The top portion of the cask is then returned to the first shielded area and the bottom is reattached for further use. The drum is then lifted by the overhead crane to the extruder-evaporator turntable room and placed on the turntable. It is subsequently encapsulated by asphalt/radwaste product.

Drums utilized in this process are serialized, inspected, and otherwise handled as described in Section 3.1.

3.3 Compactible Waste

Compacting of dry, solid waste will be performed in an area of the Solid Radwaste Building known as the Compacting Room. This room contains a locally read and alarmed radiation monitor, the compacting unit, an empty and full drum area and an area for holding bags of compactible waste.

Each drum will be inspected and numbered with a unique number as discussed in Section 3.1 of this manual prior to being used in compacting. These drums are then placed in the Compacting Room for use.

As part of a material control program, contaminated waste generated during work performed within radiologically controlled areas will be segregated at the work location, where practicable. Containers are provided at the work location which are marked for wet, non-compactible

or compactible material. Compactible material is normally placed in polyethylene bags. These bags are then transported to the Compacting Room.

Each bag should have been previously labeled with radiation survey information. The compactor operator will monitor each bag for radioactivity (dose rate) prior to handling.

Prior to compacting, the compactor operator shall inspect each bag, visually or by feel if this can be performed in a non-hazardous fashion, to verify that wet or non-compactible waste is not contained in the bag. Bags containing such material shall not be compacted. Consideration will be given to add small amounts of absorbants to collect free liquid which may escape inspection.

When ready to compact, the operator places an empty 55 gallon drum inside the compactor with the name in the "up" position. Surveyed and inspected bags of waste are inserted into the drum through the loading door. During compacting, radiation readings will be taken as necessary to maintain exposures ALARA. Efforts will be maintained to compact drums utilizing their capacity allowing for expansion. After reaching this level, the drum is removed from the compactor and a ring-clamp and gasket type lid is immediately used to cap the drum. Contamination and radiation surveys are performed on the drum and the results recorded. If contaminated, the drum is taken to the Washdown Station and decontaminated as described in Section 3.1. Subsequent surveys are remotely conducted from within this area as previously described.

The compactor is exhausted through HEPA and charcoal filters to the Auxiliary Building Ventilation Exhaust System. The Compacting Room also exhausts to this system.

Appropriate radiological safety procedures shall be followed during compacting to ensure the operator is properly protected from airborne and surface contamination and exposures are maintained ALARA. Procedures shall ensure that equipment and Compacting Room contamination levels are minimized.

### 3.4 Container Storage and Accountability

After containers have been decontaminated externally and surveyed for radiation and contamination levels, they are then ready for storage.

Midland Plant has two container storage cells designed to handle 55-gallon steel drums similar to USDOT Specification 17H. One cell is designated for High Activity Container Storage and the other is designated for Low Activity Container Storage. The activities are based on container radiation readings. Each storage cell is identical as to container capacity and method of storage. These cells are diagramed in Figure 3.0-6 and 3.0-7. Each cell has the capacity to hold 242 drums.

An indexing system is utilized to exactly locate a drum over a specific storage location. A "down-looking" video camera allows viewing the future location of the drum.

Drums shall be stored such that higher radiation level containers are placed toward the center of the appropriate cell. Prior to placing a

drum in a cell, the operator must review recorded data which shows the current status of each cell. From the radiation level, the operator determines the appropriate cell for the container. From the status data the operator then locates a vacant index position appropriate for the given radiation level. The drum is then positioned over the index location and set down. The operator then records the drum serial number and the storage location.

This tracking and accountability system is necessary because once the drums are placed in a storage cell the serial number can no longer be read visually until the drum is removed from the cell. In order to know the radiation conditions on a drum being removed from a cell, the location of each drum in the cell must be tracked. Drums will be removed from the cells periodically, loaded into appropriate shipping vehicles or casks, and shipped to a licensed burial facility for disposal. Drums shall be loaded according to radiation levels.

When shipped it is necessary to indicate the type and quantity of each radionuclide, the physical form, and the chemical form of the material in each container. The tracking system relates storage location, drum serial number, and batch number. The analytical data from the batch provides this information for the shipping paper. Containers are each surveyed for radiation and contamination prior to loading. Facilities have been provided for remote weighing of each container as required.

## 3.5 Non-Compactible Radwaste

Appropriate containers meeting the requirements of 49 CFR shall be procured for packaging and shipping materials which cannot be compacted. Procedures established shall insure proper packaging requirements (ie, bracing, filler material, closures, etc), weight limits, and material type specifications are complied with.

Containers shall be surveyed for radiation and contamination, weighted, etc, prior to shipment. Containers shall be serialized with a unique number for traceability and control.

## 3.6 Conclusion

The procedures described in Section 4.0 of this manual provide detailed administrative and operational instructions which control solid radwaste processing and container handling as described in general within this section.

Appendix B provides a listing of system alarms and a brief description of the parameter monitored.

The equipment, interlocks, alarms, and administrative controls described herein ensure the solid radwaste system produces an end product, for each type of solid radwaste, which is packaged consistent with Midland Plant Technical Specifications and appropriate Federal shipping regulations.

## GENERAL LAYOUT OF SOLID RADWASTE BUILDING

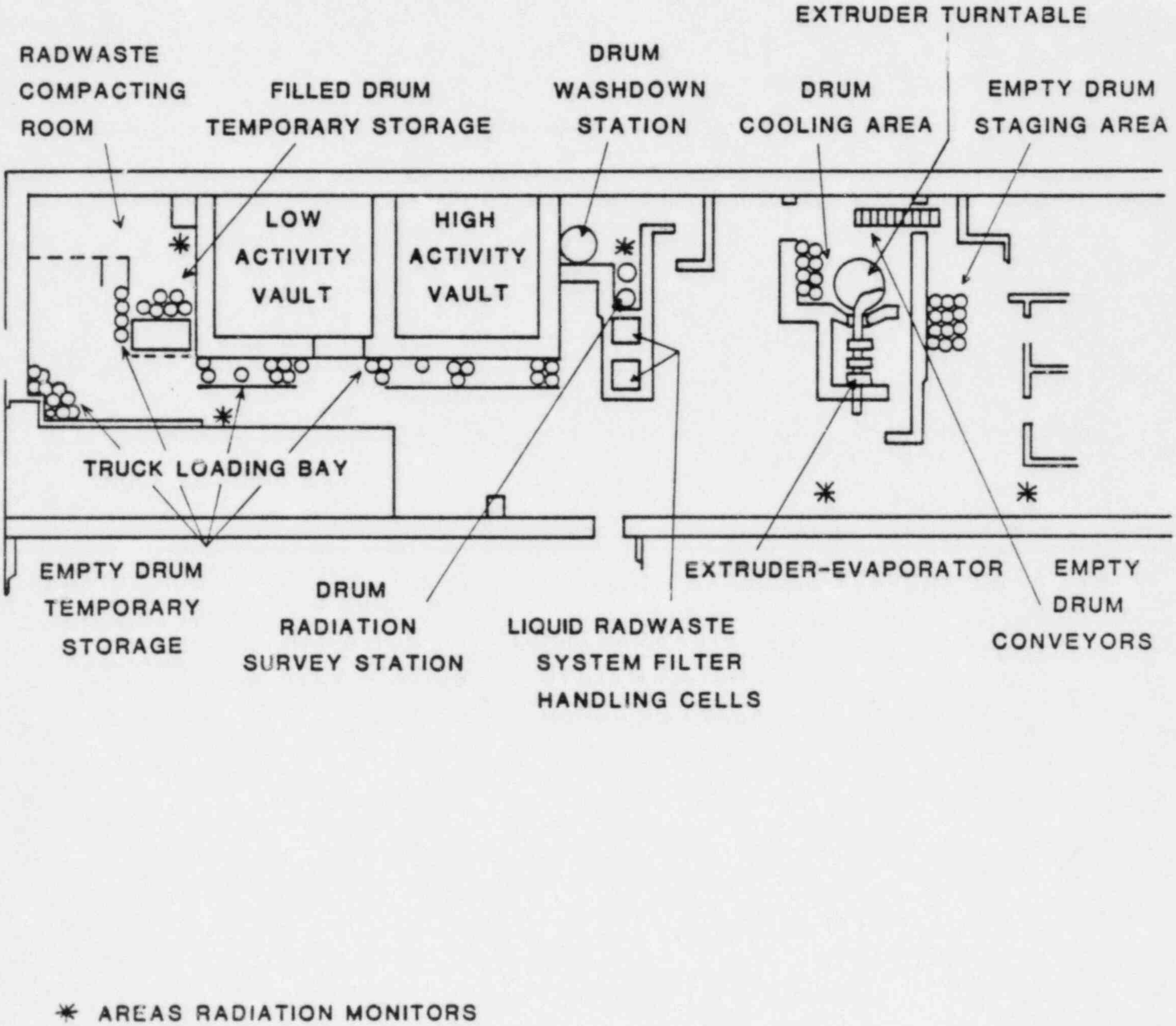



FIGURE 3.0-1

# SOLID RADWASTE SYSTEM OPERATIONAL DIAGRAM

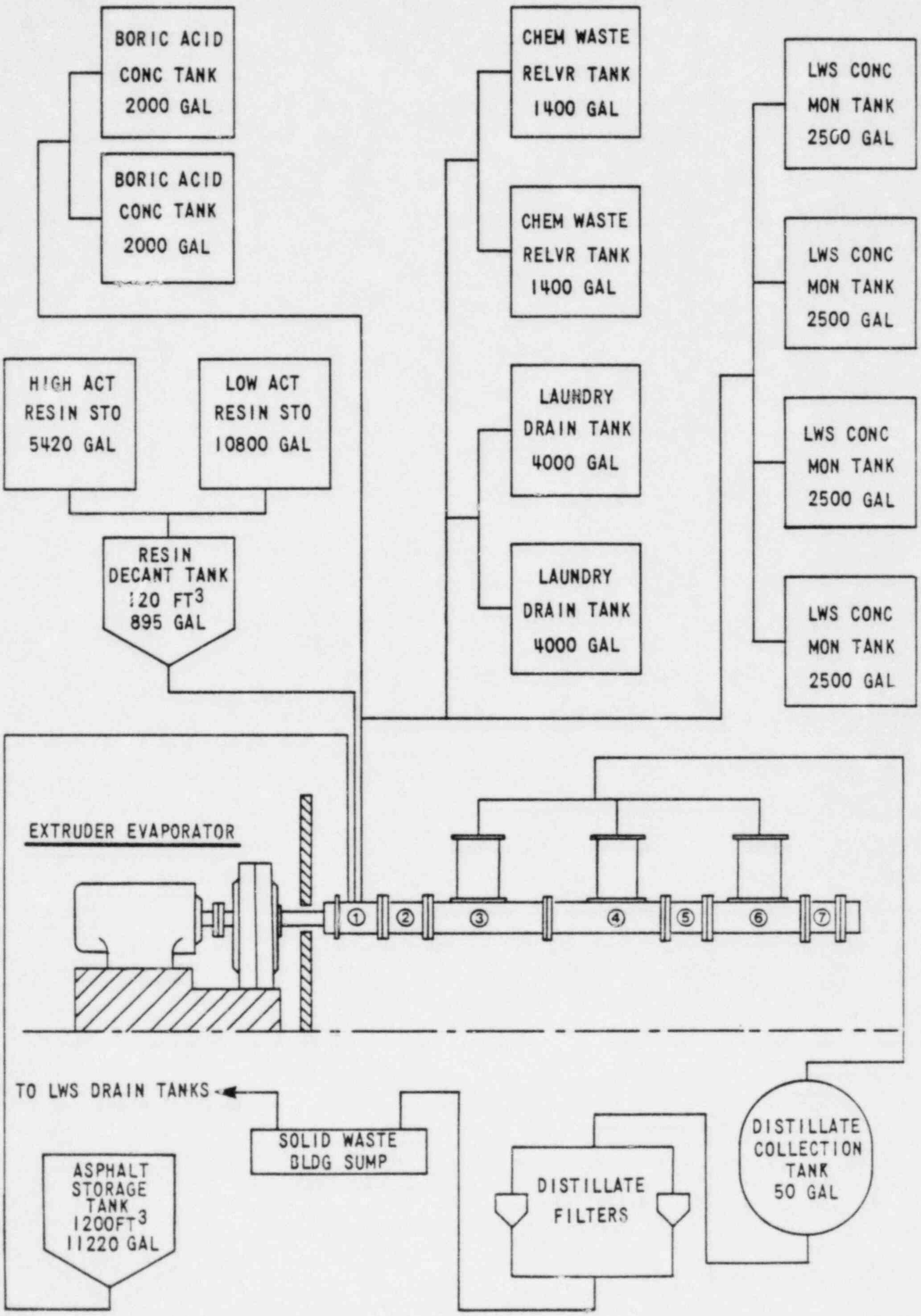



FIGURE 3.0-2

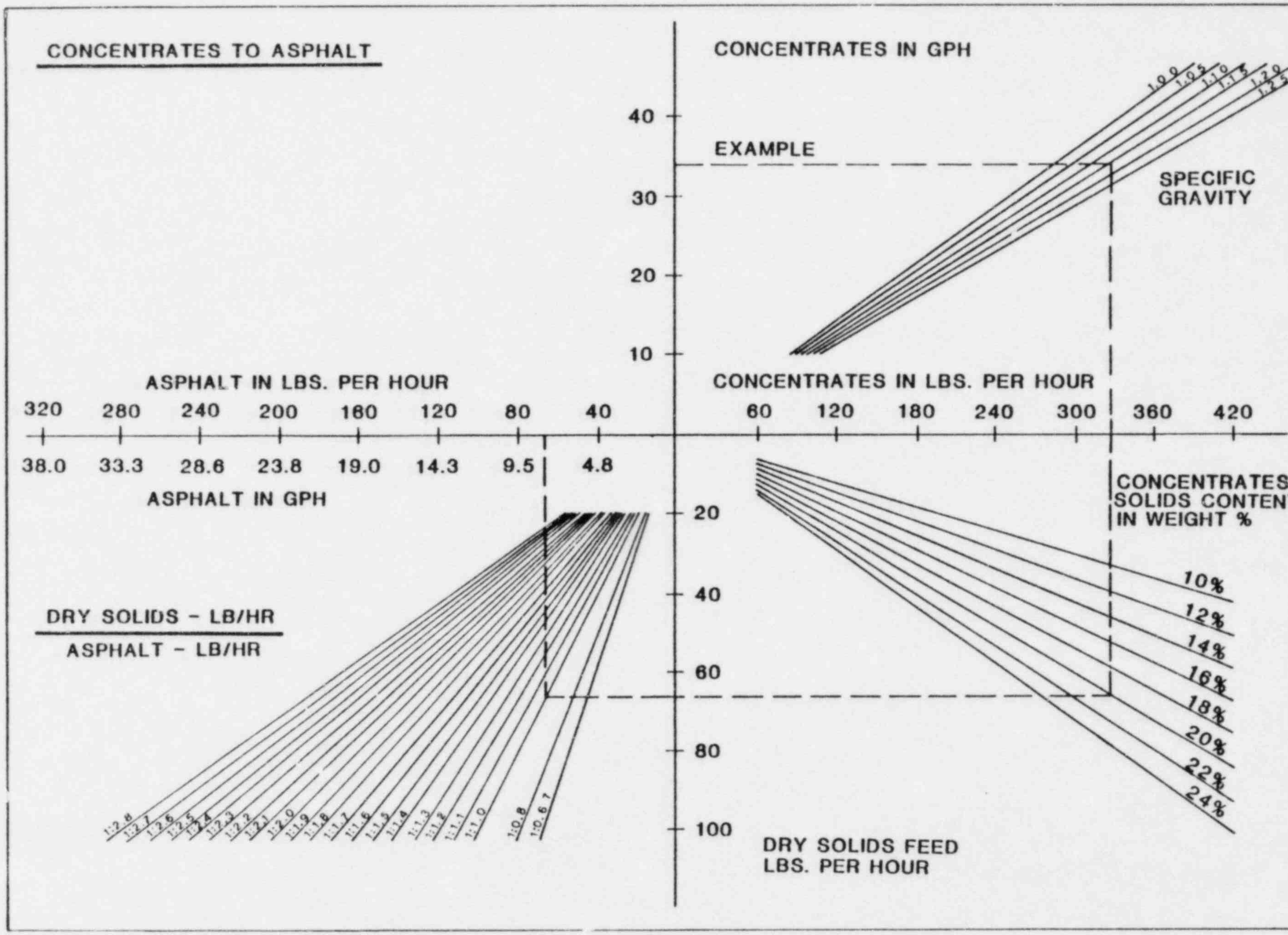

CONCENTRATES TO ASPHALT
CONCENTRATES IN GPH
EXAMPLE
SPECIFIC GRAVITY
1.00
1.05
1.10
1.15
1.20
1.25
40
30
20
10
ASPHALT IN LBS. PER HOUR
320
280
240
200
160
120
80
40
38.0
33.3
28.6
23.8
19.0
14.3
9.5
4.8
ASPHALT IN GPH
CONCENTRATES IN LBS. PER HOUR
60
120
180
240
300
360
420
CONCENTRATES SOLIDS CONTENT IN WEIGHT %
10%
12%
14%
16%
18%
20%
22%
24%
DRY SOLIDS - LB/HR
ASPHALT - LB/HR
1:2.8
1:2.7
1:2.6
1:2.5
1:2.4
1:2.3
1:2.2
1:2.1
1:2.0
1:1.9
1:1.8
1:1.7
1:1.6
1:1.5
1:1.4
1:1.3
1:1.2
1:1.1
1:1.0
1:0.8
1:0.67
20
40
60
80
100
DRY SOLIDS FEED LBS. PER HOUR

FIGURE 3.0-3

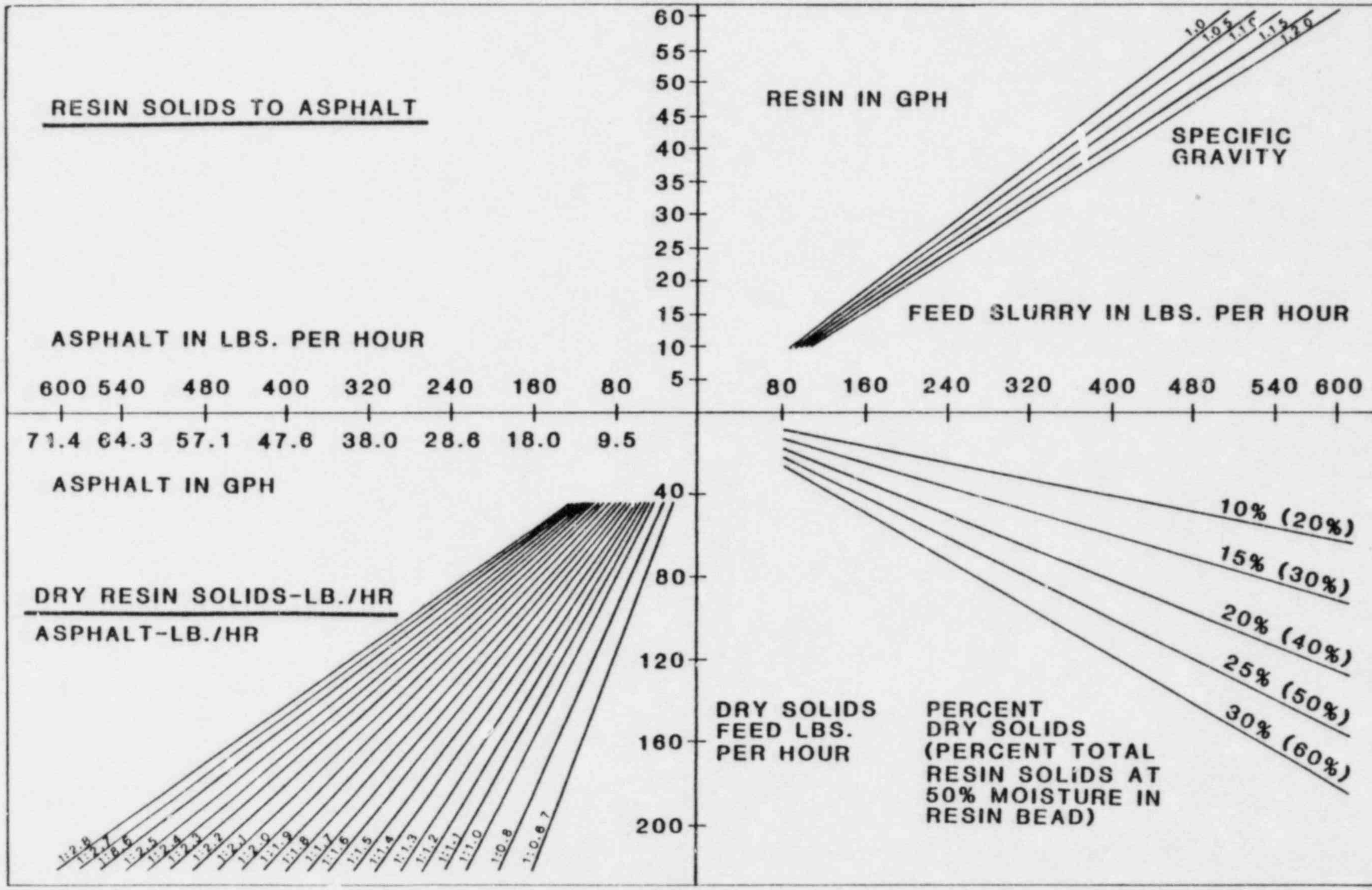
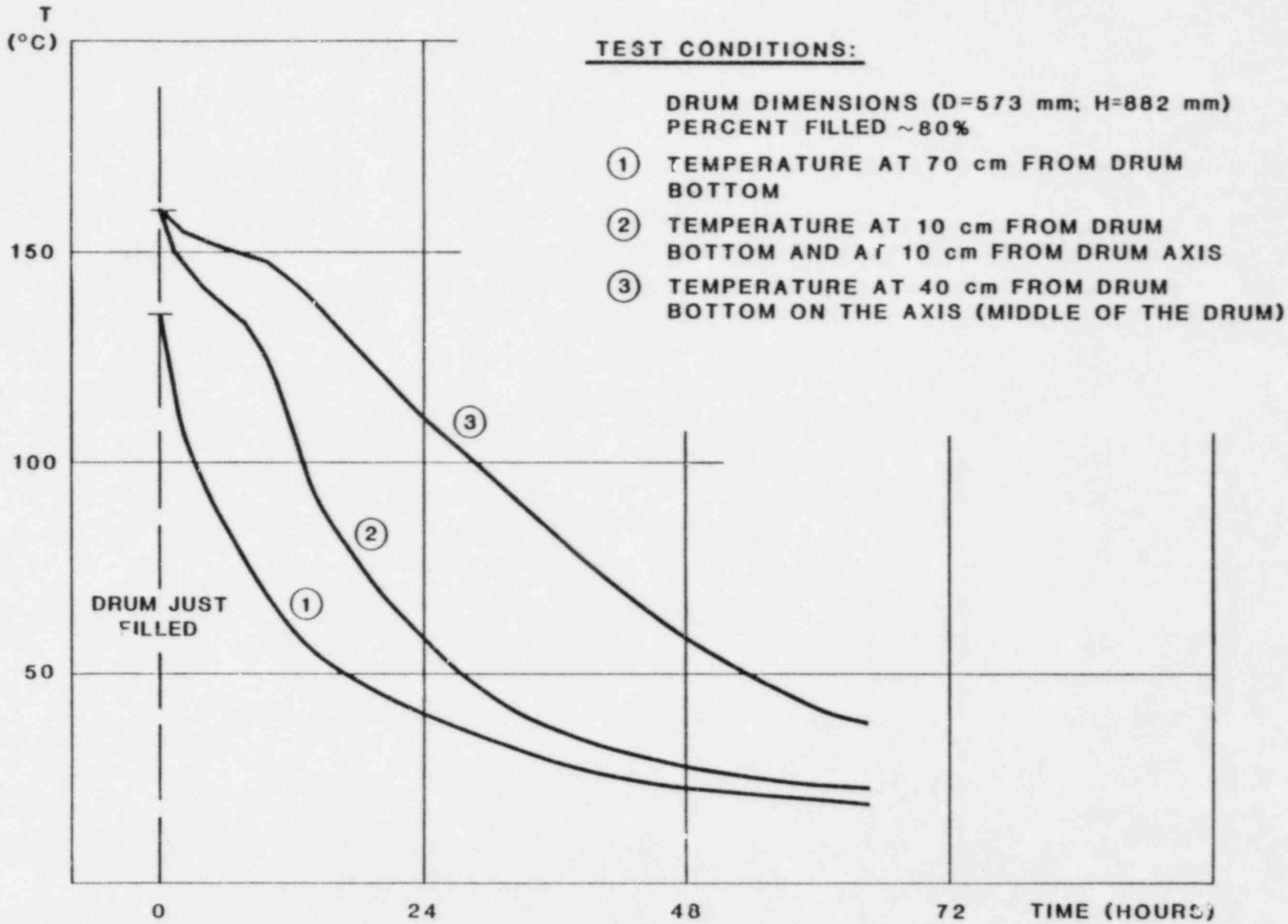

RESIN SOLIDS TO ASPHALT
ASPHALT IN LBS. PER HOUR
600 540 480 400 320 240 160 80
71.4 64.3 57.1 47.6 38.0 28.6 18.0 9.5
ASPHALT IN GPH
DRY RESIN SOLIDS-LB./HR
ASPHALT-LB./HR
1:2.8 1:2.7 1:2.6 1:2.5 1:2.4 1:2.3 1:2.2 1:2.1 1:2.0 1:1.9 1:1.8 1:1.7 1:1.6 1:1.5 1:1.4 1:1.3 1:1.2 1:1.1 1:1.0 1:0.8 1:0.67
RESIN IN GPH
60 55 50 45 40 35 30 25 20 15 10 5
SPECIFIC GRAVITY
1.0 1.05 1.10 1.15 1.20
FEED SLURRY IN LBS. PER HOUR
80 160 240 320 400 480 540 600
40 80 120 160 200
DRY SOLIDS FEED LBS. PER HOUR
PERCENT DRY SOLIDS (PERCENT TOTAL RESIN SOLIDS AT 50% MOISTURE IN RESIN BEAD)
10% (20%)
15% (30%)
20% (40%)
25% (50%)
30% (60%)

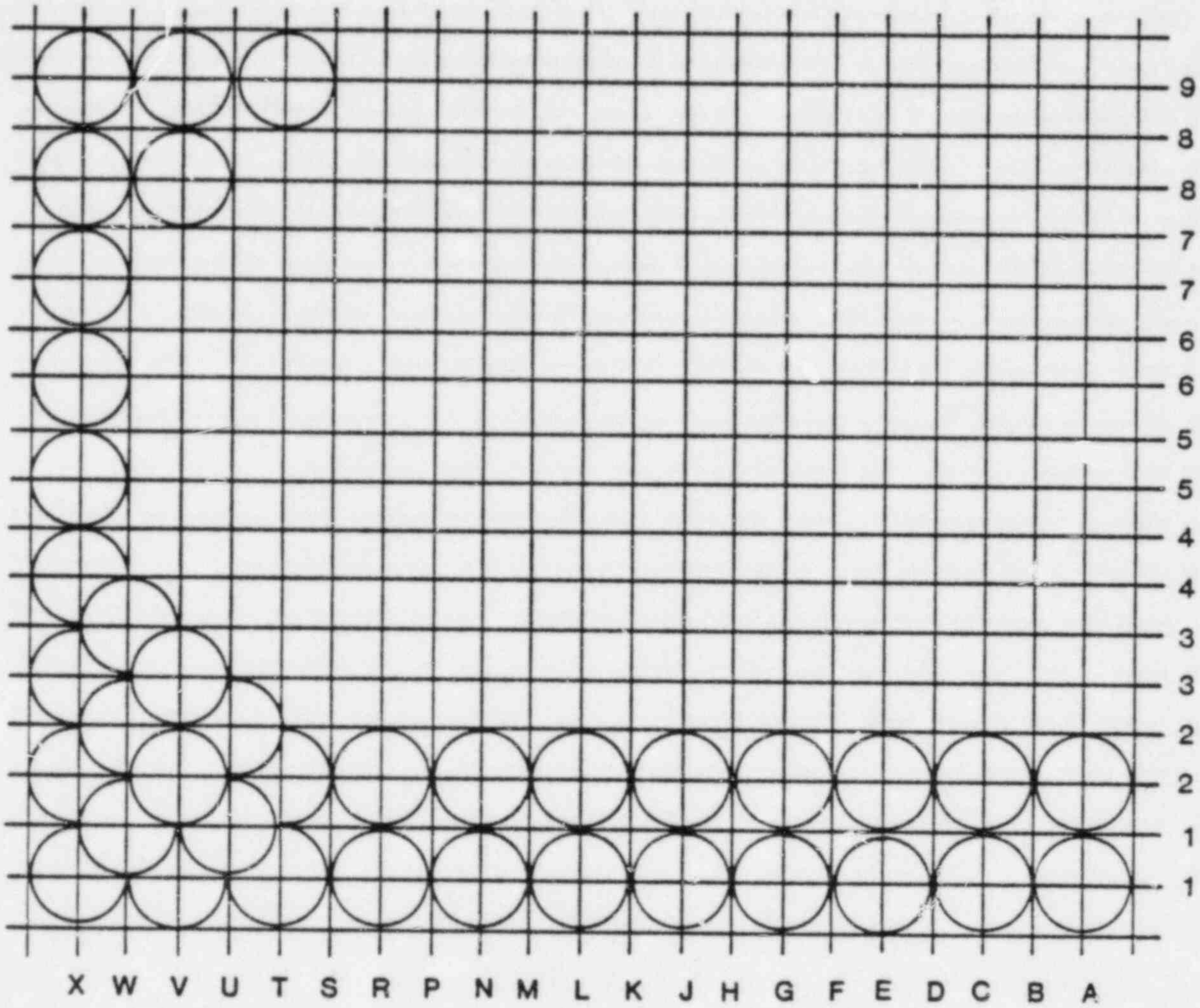
FIGURE 3.0-4




BITUMEN PRODUCT TEMPERATURE AS FUNCTION OF TIME

FIGURE 3.0-5

# STORAGE CELL GRID LOCATIONS




CAPACITY:

LEVEL 1 (9 x 11) = 99 (POSITIONS A-1 THROUGH X-9)

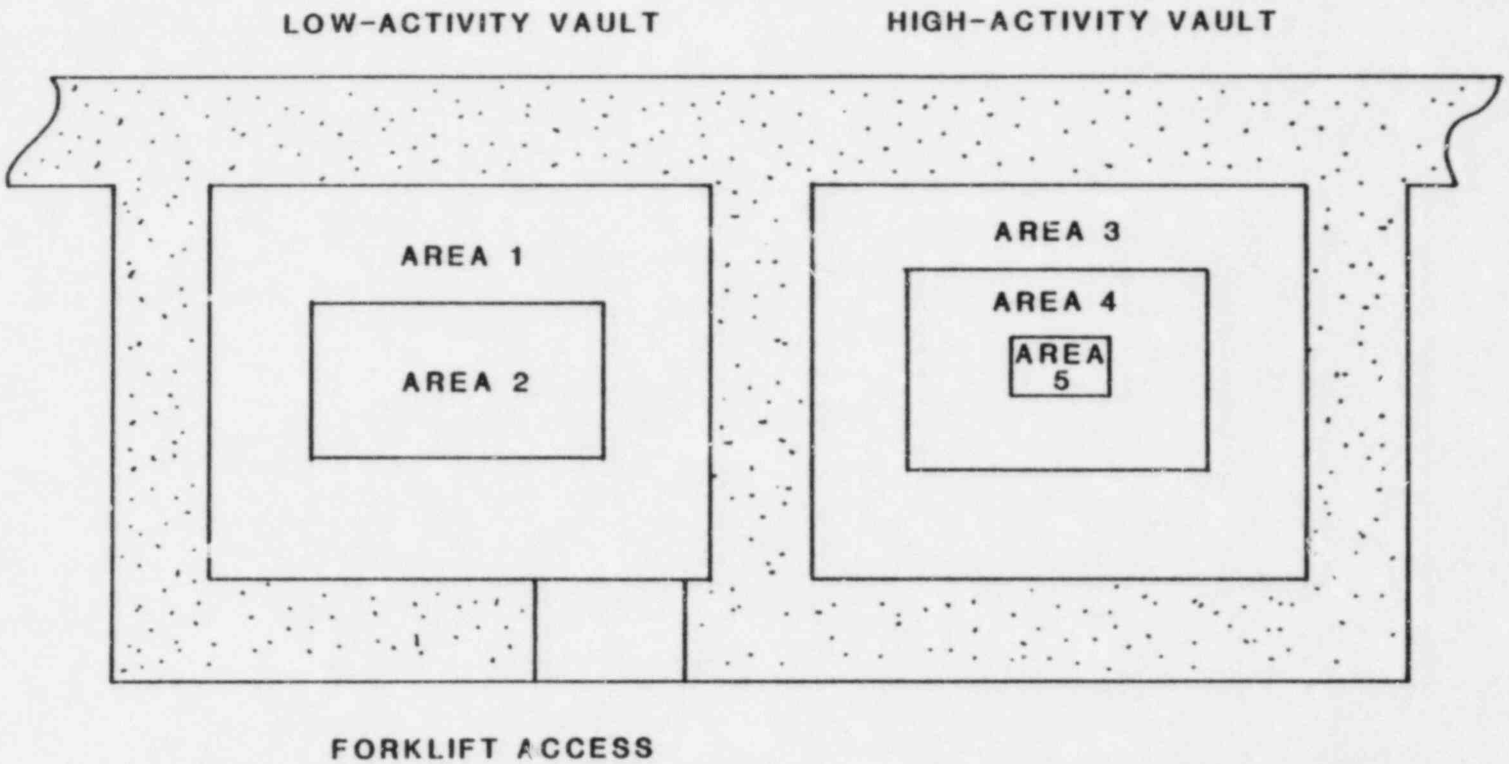
LEVEL 2 (8 x 10) = 80 (POSITIONS B-1 THROUGH W-9)

LEVEL 3 (7 x 9) = 63 (POSITIONS C-2 THROUGH V-8)

TOTAL 242 DRUMS

FIGURE 3.0-6

# DRUM STORAGE ZONES




| AREA | CONTACT READINGS |
|---|---|
| 1 | < 50 mr/hr |
| 2 | ≥ 50, <100 mr/hr |
| 3 | ≥ 100, <500 mr/hr |
| 4 | ≥ 500, < 5000 mr/hr |
| 5 | ≥5000 mr/hr |

FIGURE 3.0-7

## 4.0 IMPLEMENTING PROCEDURES

The Midland Plant will operate in accordance with administrative and operating procedures which implement the requirements of this Process Control Program and plant Technical Specifications 16.3/4.11.3, 16.6.8, 16.6.9.1.8, and 16.6.13.

### 4.1 Solid Radwaste Management (ST 1216.5)

This procedure establishes an overall management program setting the administrative requirements for handling, processing, packaging and tagging/labeling solid radwaste on-site.

The intent of this procedure is to establish guidelines for reducing and controlling solid radwaste generation.

### 4.2 Radwaste Solidification (PL 4250.1)

This procedure establishes the detailed administrative requirements for processing solid radwastes pursuant to the Process Control Program.

### 4.3 Solid Radwaste System Chemistry (PL 4250.5)

This procedure establishes sampling and analyses requirements for feed streams to the extruder-evaporator and for chemical control of extruder-evaporator auxiliary systems pursuant to the Process Control Program and Plant Technical Specifications.

4.4 Solid Radwaste System (OP 4250.1)

This procedure provides detailed valve lineups, equipment operating instructions, and required operating parameters pursuant to the Process Control Program, plant administrative procedures and Plant Technical Specifications.

4.5 Radwaste Container Storage and Accountability (PL 4250.2)

This procedure establishes administrative requirements for tracking container contents, both chemically and radiochemically, in a manner which assures correct documentation of transfer to another licensee (ie, shipment).

4.6 Container Nuclide Content (CH 4250.1)

This procedure contains methodology used to estimate the radionuclide quantities present in process containers.

4.7 Radwaste Compacting (PL 4250.3)

This administrative procedure is used to insure compacting operations are performed pursuant to the PCP and ALARA requirements.

4.8 Dry Waste Compactor (OP 4250.5)

This is the operating procedure for the waste compactor.

4.9 Filter Handling (OP 4250.6)

This is the operating procedure covering details of in-plant handling of liquid filters using the filter handling cask and transfer cells.

APPENDIX A

## ASPHALT TECHNICAL DATA SUMMARY

## WITCO CHEMICAL - PIONEER 221

1. Basic Constituent

   Pioneer 221 is an oxidized petroleum base asphalt. Oxidation is accomplished by air blowing at temperatures ranging from 200°C (392°F) to 300°C (572°F). Air blowing results in a product with minimum volatile content (0.1%), greater inertness and higher molecular weight.

2. Flash Point

   The Flash Point of Pioneer 221 is in excess of 288°C (549°F). The Flash Point is determined by the Cleveland Open Cup (ASTM D92-71) method. It is the lowest temperature at which surface vapors will momentarily ignite when a test flame is passed over the surface.

3. Fire Point

   The Fire Point of Pioneer 221 is in excess of 300°C (572°F). The Fire Point, like the Flash Point, is determined by the Cleveland Open Cup (ASTM D92-72) method. It is the lowest temperature at which the surface vapors will burn for at least 5 seconds before going out, the vapors being ignited as in the test for Flash Point.

4. Ignition Point

   The Ignition Point of Pioneer 221 is approximately 400°C (752°F).

   The Ignition Point is the lowest temperature at which the heat loss from the combustible mixture is exceeded by the heat produced in the chemical reaction. It is thus the lowest temperature at which combustion begins and continues in an air environment.

5. Softening Point

   The Softening Point of Pioneer 221 is in the temperature range of 88-94°C (190-201°F).

   The Softening Point is determined by the Ring and Ball method (ASTM D-36-70).

6. Viscosity

   The Viscosity of Pioneer 221 in the temperature range from 250°F to 400°F is presented in attached graph.

The graph is based on the following data from Witco Chemical:

Saybolt Furol Viscosity

| | |
|---|---|
| at 205°C | 54 sec |
| at 177°C | 161 sec |

7. Penetration

The Penetration of Pioneer 221 by ASTM Method D-5-73 for various temperatures is given below:

| | |
|---|---|
| 25°C (77°F) | 22-30 dmm |
| 46°C (115°F) | 40-60 dmm |
| 0°C (32°F) | 13-18 dmm |

The abbreviation "dmm" means one-tenth of a millimeter. The number of dmm's represents needle penetration under standard conditions of loading and time for a given temperature.

8. Specific Gravity

The Specific Gravity of Pioneer 221 is approximately 1.0 gram per cc.

Specific Gravity is determined by ASTM Method D-70-72, which employs a pyenometer. A pyenometer is a container of known volume which is weighed empty and filled with sample.

9. Solubility

Pioneer 221 may be considered to be entirely waterproof and insoluble in water. Pioneer 221 is soluble in petroleum solvents such as naphtha, mineral spirits and kerosene, in addition to carbon tetrachloride, carbon disulfide and trichlorethylene.

PIONEER 221 LAMINATING & INDUSTRIAL ASPHALT
PIONEER E-7465 FOR SALT CARTON MANUFACTURERS

Pioneer 221 is an all-purpose, tough, medium softening point asphalt for use in laminating paper, foil-to-paper, as a base pigment for paints and varnishes, or in the manufacture of sealers and adhesives.

Pioneer 221 complies with federal specifications set forth by the Food & Drug Administration for use in packaging and sealing food products and will not stain, or impart an odor or taste when used properly in connection with packaging products.

PHYSICAL CHARACTERISTICS

| | |
|---|---|
| Softening Point | 190-210°F |
| Penetration @ 77°F | 20-30 dmm |
| Ductility @ 77°F | 2.5 cms + |
| Solubility CCL | 99.0% + |
| Flash Point (C.O.C.) | 550°F + |
| Weight Per Gallon | 8.3 lbs |
| Use Temperature | 400°F ± 25° |
| Viscosity @ 400°F | .94 secs |
| Viscosity @ 375°F | .174 secs |
| Viscosity @ 350°F | .360 secs |

Packaging: Bulk - Tankwagon ( 5000 gal), tank car ( 10,000 gal)
Packages - 100 lb cartons

# VISCOSITY OF PIONEER 221 ASPHALT FROM WITCO CHEMICAL VS TEMPERATURE

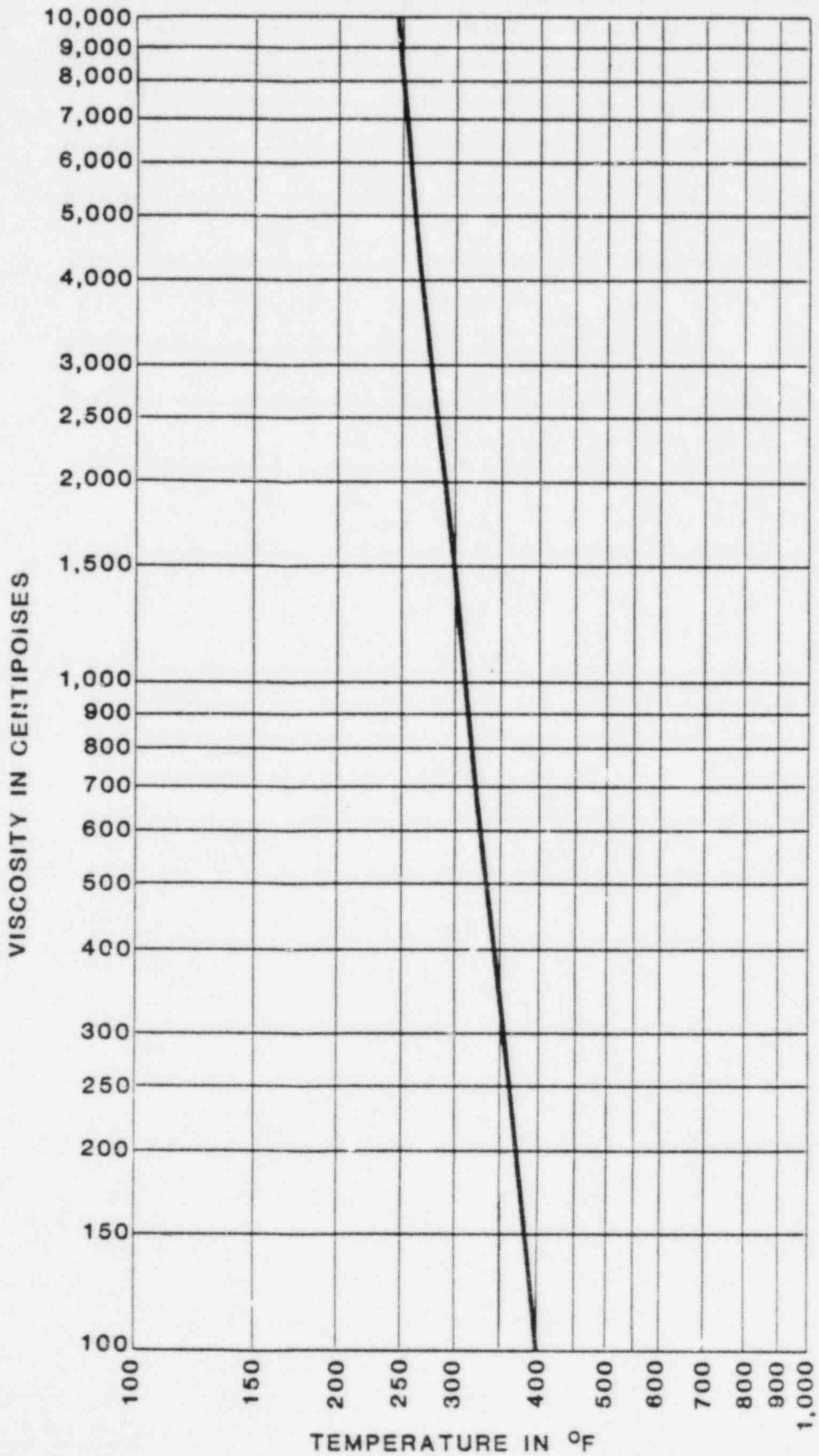



FIGURE A-1

APPENDIX B

## ANNUNCIATOR ALARM FUNCTIONS

Alarm Nos

100 Boric Acid Concentrates pH Hi

If Boric Acid Concentrates pH reaches hi level, alarm is sounded.

110 Boric Acid Concentrates pH Hi-Hi

If Boric Acid Concentrates pH reaches hi-hi level, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

120 Boric Acid Concentrates pH Low

If Boric Acid Concentrates pH reaches low level, alarm is sounded.

130 Boric Acid Concentrates pH Low-Low

If Boric Acid Concentrates pH reaches low-low level, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

140 Boric Acid Concentrates Pump (OP-148) Suction Pressure Low

If Boric Acid Concentrates Pump (OP-148) low suction pressure exists, and pump (OP-148) is running, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

101 Boric Acid Concentrates Pump (OP-148) Discharge Pressure Hi

If Boric Acid Concentrates Pump (OP-148) hi discharge pressure exists, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

111 Boric Acid Concentrates Flow Hi

If Boric Acid Concentrates hi flow exists, and metering pump (OP-148) is running, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

121 Boric Acid Concentrations Flow Low

When Boric Acid Metering Pump is turned on, and normal flow is not established within 5 seconds, alarm is sounded.

131 Boric Acid Concentrates Pump (OP-148) Motor Temperature Hi

If Boric Acid Concentrates Pump (OP-148) motor reaches hi temperature, alarm is sounded; Boric Acid Pump and Boric Acid Seal Water Valve trip and close simultaneously.

141 Boric Acid Discharge Valve Open/Metering Pump Not Running

If Boric Acid discharge valve is open and metering pump is not running, after a 30 second time delay, the alarm is sounded.

102 Liquid Waste Concentrates pH Hi

If Liquid Waste Concentrates pH reaches hi level, alarm is sounded.

112 Liquid Waste Concnetrates ph Hi-Hi

If Liquid Waste Concentrates pH reaches hi-hi level, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve trip and close simultaneously.

122 Liquid Waste Concentrates pH Low

If Liquid Waste Concentrates pH reaches low level, alarm is sounded.

132 Liquid Waste Concentrates pH Low-Low

If Liquid Waste Concentrates pH reaches low-low level, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve trip and close simultaneously.

142 Liquid Waste Concentrates Pump (OP-149) Suction Pressure Low

If Liquid Waste Concentrates Pump (OP-149) low suction pressure exists, and pump (OP-149) is running, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve trip and close simultaneously.

103 Liquid Waste Concentrates Pump (OP-149) Discharge Pressure

If Liquid Waste Concentrates Pump (OP-149) hi discharge pressure exists, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve trip and close simultaneously.

113 Liquid Waste Concentrates Flow Hi

If Liquid Waste Concentrates hi flow exists, and pump (OP-149) is running, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve close and trip simultaneously.

123 **Liquid Waste Concentrates Flow Low**

If pump (OP-149) is turned on, and normal flow is not established within 5 seconds, alarm is sounded.

133 **Liquid Waste Concentrates Pump (OP-149) Motor Temperature Hi**

If motor (OP-149) reaches hi temperature, alarm is sounded; Liquid Waste Pump and Liquid Waste Seal Water Valve trip and close simultaneously.

143 **LWS Discharge Valve Open/Metering Pump Not Running**

If LWS discharge valve is open and metering pump is not running, after a 30 second time delay, the alarm is sounded.

104 **Laundry/Chemical Waste pH Hi-Hi**

If Laundry/Chemical Waste pH reaches hi-hi level, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

114 **Laundry/Chemical Waste pH Low**

If Laundry/Chemical Waste pH reaches low level, alarm is sounded.

124 **Laundry/Chemical Waste pH Low-Low**

If Laundry/Chemical Waste pH reaches low-low level, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

134 **Laundry/Chemical Waste Pump (OP-150) Suction Pressure Low**

If Laundry/Chemical Waste Pump (OP-150) low suction pressure exists, and pump (OP-150) is running, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

144 **Laundry/Chemical Waste Pump (OP-150) Discharge Pressure Hi**

If Laundry/Chemical Waste Pump (OP-150) hi discharge pressure exists, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

105 **Laundry/Chemical Waste Flow Hi**

If Laundry/Chemical Waste Flow is hi, and metering pump (OP-150) is running, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

115 Laundry/Chemical Waste Flow Low

When Laundry/Chemical Waste Metering Pump is turned on, and normal flow is not established within 5 seconds, alarm is sounded.

125 Laundry/Chemical Waste Pump (OP-150) Motor Temperature Hi

If motor (OP-150) reaches high temperature, alarm is sounded; Laundry/Chemical Waste Pump and Laundry/Chemical Seal Water Valve trip and close simultaneously.

135 Laundry/Chemical Waste pH Hi

If Laundry/Chemical Waste pH reaches hi level, alarm is sounded.

145 Laundry/Chemical Discharge Valve Open/Metering Pump Not Running

If Laundry/Chemical discharge valve is open and metering pump is not running, after a 30 second time delay, the alarm is sounded.

200 Resin pH Hi

If Spent Resin pH reaches hi level, alarm is sounded.

210 Resin pH Hi-Hi

If Spent Resin pH reaches hi-hi level, alarm is sounded; Spent Resin Pump and Spent Resin Seal Water Valve trip and close simultaneously.

220 Resin pH Low

If Spent Resin pH reaches low level, alarm is sounded.

230 Resin pH Low-Low

If Spent Resin pH reaches low-low level, alarm is sounded; Spent Resin Pump and Spent Resin Seal Water Valve trip and close simultaneously.

240 Resin Metering Pump (OP-146) Suction Pressure Low

If Resin Metering Pump (OP-146) low suction pressure exists, and pump (OP-146) is running, alarm is sounded; Spent Resin Pump and Spent Resin Seal Water Valve trip and close simultaneously.

201 Resin Metering Pump (OP-146) Discharge Pressure Hi

If Resin Metering Pump (OP-146) hi discharge pressure exists, alarm is sounded; Spent Resin Pump and Spent Resin Seal Water valve trip and close simultaneously.

211 Resin Flow to Extruder Hi

When hi Resin Flow to Extruder exists, alarm is sounded.

221 Resin Flow to Extruder Low

When Spent Resin Metering Pump is turned on, and normal flow is not established within 5 seconds, alarm is sounded.

231 Resin Metering Pump (OP-146) Motor Temperature Hi

If motor (OP-146) reaches hi temperature, alarm is sounded; Spent Resin Pump and Spent Resin Seal Water Valve trip and close simultaneously.

241 Spent Resin Decant Tank (OT-64) Level Low

If Spent Resin Decant Tank reaches low level, and Spent Resin Transfer Pump is running, alarm is sounded.

202 Seal Water System Flow Low

If any one of Seal Water Valves opens, and its respective normal flow is not established within 5 seconds, alarm is sounded.

212 Seal Water System Flow Hi

If flow in any Seal Water System is hi, alarm is sounded.

222 Spent Resin Decant Tank (OT-64) Emergency Level Hi-Hi

If spent resins in Spent Resin Decant Tank reaches hi-hi level, alarm is sounded and Decant Tank Inlet Valve is closed.

232 Spent Resin Decant Tank (OT-64) Pressure Hi

If Spent Resin Decant Tank hi pressure exists, alarm is sounded.

242 Resin Decant Pump (OP-147) Discharge Pressure Low

If Spent Resin Decant Pump (OP-147) is turned on, and normal flow is not established within 5 seconds, alarm is sounded.

203 Resin Transfer Pump (OP-145) Suction Pressure Low

If Spent Resin Transfer Pump (OP-145) is running, and low suction pressure exists, alarm is sounded.

213 Resin Transfer Pump (OP-145) Discharge Pressure Hi

If Resin Transfer Pump (OP-145) hi discharge pressure exists, alarm is sounded.

223 Auxiliary Boiler (OM-63)

If water level in Auxiliary Boiler is low, and pump (OP-230) is not running, alarm is sounded.

233 Decant Tank Agitator Motor Overcurrent

If Agitator Motor current is hi, alarm is sounded.

204 Spent Resin Discharge Valve Open/Metering Pump Not Running

If Spent Resin Discharge Valve is open and metering pump is not running, after a 30 second time delay, the alarm is sounded.

214 Boilout Tank (OT-110) Level

When Boilout Tank level goes below "low", alarm is sounded. Alarm stays on until level goes above hi limit.

224 Radwaste Building Sump Level Hi-Hi

Alarm is sounded if contact from system is open.

234 Extruder Motor (OM-47) Temperature Hi

If Extruder Motor temperature is hi, alarm is sounded and extruder drive is shut down.

244 Extruder Motor (OM-47) Speed Low

If within 2 minutes from start-up of an extruder, operator does not bring extruder speed up above 15% of maximum speed, alarm is sounded, all feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down.

205 Extruder Motor (OM-47) Torque 105%

If Extruder Motor torque exceeds 105%, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down.

215 Extruder Motor (OM-47) Torque 115%

If Extruder Motor Torque exceeds 115%, alarm is sounded and extruder is shut down.

225 Extruder Barrel (OM-44) Temperature Low

If Extruder Barrels are at low temperature, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

235 Extruder Barrel (OM-44) Temperature Hi

If Extruder Barrels reach hi temperatures, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

245 Steam Header Pressure Low

If Extruder Steam Header Valve is open and Steam Header low pressure exists alarm is sounded.

300 Steam Dome "A" Temperature Low

If Steam Dome "A" low temperature exists, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

310 Steam Dome "A" Temperature Hi

If Steam Dome "A" reaches hi temperature, alarm is sounded.

320 Steam Dome "A" Level Hi

If asphalt in Steam Dome "A" reaches hi level, alarm is sounded.

330 Steam Dome "B" Temperature Low

If Steam Dome "B" low temperature exists, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

340 Steam Dome "B" Temperature Hi

If Steam Dome "B" reaches hi temperature alarm is sounded.

301 Steam Dome "B" Level Hi

If asphalt in Steam Dome "B" reaches hi level, alarm is sounded.

311 Steam Dome "C" Temperature Low

If Steam Dome "C" low temperature exists, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

321 Steam Dome "C" Temperature Hi

If Steam Dome "C" reaches hi temperature, alarm is sounded.

331 Steam Dome "C" Level Hi

If asphalt in Steam Dome "C" reaches hi level, alarm is sounded.

341 Cooling Water Surge Tank (OT-65) Level Hi

If water in Tank (OT-65) reaches hi level, alarm is sounded.

302 Cooling Water Surge Tank (OT-65) Level Low

If water in Tank (OT-65) reaches low level, alarm is sounded.

312 Cooling Water Flow Low

Alarm is sounded if normal flow is not established within 5 seconds after Isolation Cooling Water Pump (OP-152) is turned on.

322 Cooling Water Temperature Hi

If Cooling Water temperature is hi, alarm is sounded.

332 Asphalt Inlet Strainer Pressure Differential Hi

If differential pressure in Asphalt Inlet Strainer is hi, alarm is sounded.

342 Asphalt Storage Tank (OT-56) Temperature Low

If asphalt in Storage Tank (OT-56) is at low temperature, alarm is sounded.

303 Asphalt Storage Tank (OT-56) Temperature Hi

If asphalt in Storage Tank (OT-56) reaches hi temperature, alarm is sounded.

313 Asphalt Recirculation Pump (OP-143B) Suction Pressure Low

If Asphalt Recirculation Pump (OP-143B) low suction pressure exists, alarm is sounded and Recirculation Pump (OP-143B) is shut down. The Asphalt metering pump (OP-144) will trip from low suction.

323 Asphalt Recirculation Pump (OP-143B) Discharge Pressure Hi

If Asphalt Recirculation Pump (OP-143B) hi discharge pressure exists, alarm is sounded and Recirculation Pump (OP-143B) is shut down. The asphalt metering pump (OP-144) will trip from low suction.

333 Asphalt Recirculation Pump (OP-143A) Suction Pressure Low

If Asphalt Recirculation Pump (OP-143A) low suction pressure exists, alarm is sounded and Recirculation Pump (OP-143A) is shut down. The asphalt metering pump (OP-144) will trip from low suction.

343 Asphalt Recirculation Pump (OP-143A) Discharge Pressure Hi

If Asphalt Recirculation Pump (OP-143A) hi discharge pressure exists, alarm is sounded and Recirculation Pump (OP-143A) is shut down. The Asphalt Metering Pump (OP-144) will trip from low suction.

304 Asphalt Recirculation Strainer Pressure Differential Hi

If Asphalt Recirculation Strainer hi differential pressure exists, alarm is sounded.

314 Asphalt Metering Pump (OP-144) Suction Pressure Low

If Asphalt Recirculation Pump (OP-143A) or (OP-143B) is running, and Asphalt Metering Pump (OP-143A) or (OP-143B) is running, and Asphalt Metering Pump (OP-144) low suction pressure exists, alarm is sounded. Low suction pressure shuts down Asphalt Metering Pump (OP-144). All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

324 Asphalt Metering Pump (OP-144) Discharge Pressure Hi

If Asphalt Metering Pump (OP-144) hi discharge pressure exists, alarm is sounded and pump (OP-144) is shut down. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

334 Asphalt Storage Tank (OT-56) Level Low

If Asphalt Storage Tank (OT-56) low asphalt level exists, alarm is sounded.

344 Asphalt Storage Tank (OT-56) Level Hi

If Asphalt Storage Tank (OT-56) hi asphalt level exists, alarm is sounded.

305 Asphalt Flow Hi

If Asphalt hi flow exists, alarm is sounded.

315 Asphalt Flow Low

If asphalt normal flow is not established within 5 seconds after pump (OP-144) is turned on, alarm is sounded. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

325 Asphalt Metering Pump (OP-144) Motor Temperature Overload

If asphalt metering pump (OP-144) motor hi temperature exists, alarm is sounded and pump (OP-144) is shut down. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder is also shut down. If this condition exists in the extruder shutdown mode, the extruder cannot be restarted.

345 Radwaste Building Truck Bay Sump Level Hi

Alarm is sounded if contact from system is open.

400 Lube Oil Temperature Hi

If lubrication oil reaches hi temperature alarm is sounded and extruder drive is shut down.

410 Lube Oil Tank (OT-111) Level Low

If oil in lube oil tank (OT-111) reaches low level, alarm is sounded and lube oil pump (OP-154) is shut down. All feed metering pumps are shut down, and after a 2 minute time delay, the extruder drive is also shut down.

420 Lube Oil Filter (OF-29) Pressure Differential Hi

If hi differential pressure in lube oil filter (OF-29) exists, alarm is sounded.

430 Lube Oil Pressure Low

If lube oil normal pressure is not established within 5 seconds after lube oil pump (OP-154) is turned on, alarm is sounded. Extruder drive cannot be started unless lube oil pressure is normal.

440 Lube Oil Flow Low

If lube oil normal flow is not established within 5 seconds after lube oil pump (OP-154) is turned on, alarm is sounded. If lube oil low flow condition develops during extruder operation, all feed metering pumps are shut off, and after a 2 minute time delay, the extruder is shut down.

401 Vent Hood Filter Pressure Differential Hi

If vent hood filter hi differential pressure exists, alarm is sounded.

411 Fill Station Drum Level "A" Hi

If asphalt in fill station drum reaches hi level, alarm is sounded. This alarm is also initiated at panel (OC-188).

421 Fill Station Drum Level "A" Hi-Hi

If asphalt in fill station drum reaches hi-hi level, alarm is sounded. This alarm is also initiated at panel (OC-188).

431 Fill Station Drum Level "B" Hi

If asphalt in fill station drum reaches hi level, alarm is sounded. This alarm is also initiated at panel (OC-188).

441 Fill Station Drum Level "B" Hi-Hi

If asphalt in fill station drum reaches hi-hi level, alarm is sounded. This alarm is also initiated at panel (OC-188).

402 Vent Hood Exhaust Fan (OM-121) Stopped

If vent hood exahust fan stops, alarm is sounded.

412 Indexing Malfunction

If the indexing cycle is not completed within 10 seconds, alarm is sounded All feed metering pumps are stopped, and after a 2 minute time delay, the extruder drive is shut down.

422 Distillate Collection Tank (OT-57) Level Low

If water in Distillate Collection Tank (OT-57) reaches low level, alarm is sounded.

432 Distillate Collection Tank (OT-57) Level Hi

If water in Distillate Collection Tank (OT-57) reaches hi level, alarm is sounded.

442 Distillate Pump (OP-153) Discharge Pressure Low

If a normal discharge pressure is not established in 5 seconds after Distillate Pump (OP-153) is turned on, alarm is sounded and above pump is shut down.

403 Distillate Oil Filter (OF-7A/B) Pressure Differential Hi

If a Distillate Oil Filter (OF-7A/B) hi differential pressure exists, alarm is sounded.

413 Distillate Cooler (OE-38) Outlet Temperature Hi

If Distillate Cooler (OE-38) Outlet reaches hi temperature, alarm is sounded.

423 Distillate Pump Motor (OP-153) Failure

If motor starter for Distillate Pump Motor (OP-153) is not energized, alarm is sounded.

404 Decontamination Station Booster Pump (OP-121) Suction Pressure Low

If Decontamination Station Booster Pump (OP-121) low suction pressure exists, alarm is sounded and above pump is shut down.

414 Decontamination Station Booster Pump (OP-121) Discharge Pressure Hi

If Decontamination Station Booster Pump (OP-121) hi discharge pressure exists, alarm is sounded.

424 Turntable Motor (OM-49) Not Running

If extruder drive is on and turntable motor (OM-49) is not running, alarm is sounded.

434 Cooling Water Pump (OP-152) Discharge Pressure Low

If a Cooling Water Pump (OP-152) normal discharge pressure is not established within 5 seconds after above pump is turned on, alarm is sounded and pump (OP-152) is turned off.

444 Heat Tracing Failure

Alarm is sounded if contact from system is open.

415 Reliance Automate 31/32 Malfunction

If Reliance Automate 31/32 fails, alarm is sounded.

APPENDIX C

# SOLID RADWASTE SYSTEM DATA

## High Activity Spent Resin Storage Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, gal | 5,420 |
| Fluid | Water and spent resin |

## Low Activity Spent Resin Storage Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, gal | 10,800 |
| Fluid | Water and spent resin |

## Clean Resin Transfer Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, $ft^3$ | 125 |
| Fluid | Water and new resin |

## Spent Resin Decant Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, $ft^3$ | 120 |
| Fluid | Water and spent resin |

## Asphalt Storage Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, $ft^3$ | 1,200 |
| Fluid | Asphalt Witco Pioneer 221 or equivalent |

## Extruder Distillate Tank

| | |
|---|---|
| Number | 1 |
| Type | Horizontal |
| Capacity, gal | 50 |
| Fluid | Water |

Cooling Water Isolation Surge Tank

| | |
|---|---|
| Number | 1 |
| Type | Vertical cylindrical |
| Capacity, gal | 50 |
| Fluid | Water |

Extruder-Evaporator

| | |
|---|---|
| Number | 1 |
| Type | Twin Screw |
| Design temperature, °F | 300 |
| Feed flowrate, gpm | |
| Radwaste | 0-1 |
| Asphalt | 0.1-0.6 |
| Product flowrate, gpm | 0.25 |

Extruder Motor

| | |
|---|---|
| Number | 1 |
| Type | Variable speed dc |
| Horsepower | 100 |

Extruder Gearbox

| | |
|---|---|
| Number | 1 |
| Type | Speed reduction, dual reduction drive |

Solid Waste Shipping Drums

| | |
|---|---|
| Size, gal | 55 |
| Type | 17 H |
| Weight empty, lb | 70 |
| Weight full, lb | 550 |

Six Drum Turntable

| | |
|---|---|
| Number | 1 |
| Type | Remote controlled |

Drum Capper

| | |
|---|---|
| Number | 1 |

Empty Drum Conveyer

| | |
|---|---|
| Number | 1 |
| Type | Roller |

Electric Auxiliary Boiler

| | |
|---|---|
| Number | 1 |
| Type | Resistance |

Dry Waste Compactor

| | |
|---|---|
| Number | 1 |
| Type | Hydraulic |
| Filter type | 0.3 micron HEPA |
| Ram travel, in | 44 |
| Ram clearance above drum, in | 26 |
| Drum type | 55 gallon |

Compactor Ventilation System

| | |
|---|---|
| Prefilter efficiency | 40% |
| HEPA filter efficiency | 99.97% (particles .3 micron and larger) |

Minimanipulator

| | |
|---|---|
| Number | 1 |
| Type | Slave |

Decontamination System

| | |
|---|---|
| Number | 1 |
| Type | Steam/water |

Filter Handling System

| | |
|---|---|
| Number | 1 |
| Type | Portable shield |
| Shield thickness, in | 9 (steel) |
| Window thickness, in | 8 (leak glass) |
| Hoist capacity, tons | 1 |

Filter Transfer Shield Casks

| | |
|---|---|
| Number | 2 |
| Type | Bottom opening lead cask |
| Weight, lb | 5,500 |
| Dimensions, in | |
| Diameter | 21 |
| Height | 48 |
| Shield thickness, in | 6 (lead) |