STOCK EQUIPMENT COMPANY SOLID RADWASTE SYSTEM TOPICAL REPORT

REPORT NO. SRS-001-NP
MARCH, 1979

PREPARED FOR
OFFICE OF NUCLEAR REACTOR REGULATION
DIVSION OF PROJECT MANAGEMENT
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

284 247

7907030482 B

STOCK EQUIPMENT COMPANY
16490 CHILLICOTHE ROAD
CHAGRIN FALLS, OHIO 44022 TELEPHONE (216) 543-8211

STOCK EQUIPMENT COMPANY

SOLID RADWASTE SYSTEM

TOPICAL REPORT

Prepared for

Office of Nuclear Reactor Regulation
Division of Project Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Stock Equipment Company
16490 Chillicothe Road
Chagrin Falls, Ohio 44022
(216) 543-8211

284 248

STOCK EQUIPMENT COMPANY
SOLID RADWASTE SYSTEM
TOPICAL REPORT

TABLE OF CONTENTS

284 249

284 250

284 251

284 252

284 253

POOR ORIGINAL

I. INTRODUCTION/ABSTRACT

This Topical Report is being presented to the U.S. Nuclear Regulatory Commission, Division of Project Management, Office of Nuclear Reactor Regulation, for the evaluation of the Stock Equipment Company Solid Radwaste System for use in nuclear power plants. The information contained herein has been provided to describe this system and indicate its design and operating features.

The first S-E-Co. Solid Radwaste System was sold for installation at Public Service Electric & Gas Company's Salem Station which has recently started-up. Prior to shipment, the Salem equipment was installed in S-E-Co.'s plant for approximately two years where it underwent exhaustive full-scale testing. Test data obtained from this system, coupled with additional field information, have been incorporated into the design of the system being presented in this topical report. This system represents over ten years of continuing research, development, and engineering, and has presently been sold for installation in twelve nuclear power plants to service twenty-two units. A listing of these installations is given at the end of this section.

Stock Equipment Company is a leading designer and manufacturer of specialized quality equipment of the power industry. Stock's experience in this field now trancends a period of fifty years; and realizes that in order to provide reliable equipment, meeting service and environmental requirements, equipment design must be directed specifically at application criteria. The S-E-Co. Solid Radwaste System has been designed and developed over the past ten years according to this fundamental concept. It features 40 year service life, maximum reliability and safety, and minimizes possible radiation exposure to plant personnel (ALARA).

This Topical Report has been prepared to familiarize the reader with the S-E-Co. Solid Radwaste System. Although this discussion has been presented in a non-proprietary version, patents have been issued and others are pending covering original ideas presented.

284 254

STOCK EQUIPMENT COMPANY

NUCLEAR EQUIPMENT CUSTOMER LIST

	CUSTOMER	STATION	ORDER DATE	SCOPE
1.	Detroit Edison	Enrico Fermi 1	1961	Remote Double Removal Valves for Sodium Overflow Pump
2.	Pub. Serv. El. & Gas	Salem 1 & 2	1970	Solid Radwaste System
3.	Pub. Serv. El. & Gas	Salem 1 & 2	1971	Evap. Bottoms System
4.	Phil. Electric	Limerick	1971	Remotely Operated Transfer Cars for Solid Radwaste System
5.	Pub. Serv. El. & Gas	Salem 1 & 2	1973	Filter Handling System
6.	Comm. Edison	La Salle	1973	Solid Radwaste System
7.	Comm. Edison	Byron	1975	Solid Radwaste System, Filter Handling & Transfer Cars
8.	Comm. Edison	Braidwood	1975	Duplicate of Byron Station
9.	Comm. Edison	Dresden 2 & 3	1975	Retrofit of Solid Radwaste System
10.	So. Cal. Edison	San Onofre 2	1975	Dry Waste Compactor
11.	Ontario Hydro	Bruce	1975	Dry Waste Compactor
12.	Texas Utilities	Comanche Peak	1976	Dry Waste Compactor
13.	Arizona Pub. Serv.	Palo Verde 1,2,3	1976	3 Dry Waste Compactors
14.	Comm. Edison	Zion	1976	Cement Filling Station
15.	Kansas G. & E. & Kansas City P. & L.	Wolf Creek	1976	Solid Radwaste System
16.	Northern States Power	Tyrone	1976	Solid Radwaste System
17.	Rochester G. & E.	Sterling	1976	Solid Radwaste System
18.	Union Electric	Callaway 1	1976	Solid Radwaste System
19.	Union Electric	Callaway 2	1976	Solid Radwaste System
20.	Carolina P. & L.	Shearon Harris 1,2,3,4	1977	Solid Radwaste System

284 255

251

NUCLEAR EQUIPMENT CUSTOMER LIST

CUSTOMER	STATION	ORDER DATE	SCOPE
21. Consumers Power	Midland 1 & 2	1977	Dry Waste Compactor
22. Niagara Mohawk	Nine Mile Point	1978	Dry Waste Compactor
23. Duquesne Light	Beaver Valley	1978	Solid Radwaste System
24. Commonwealth Edison	Dresden	1978	Dry Waste Compactor

284 256

II

DESIGN OBJECTIVES AND MAJOR FEATURES

A. General

1. The system and its major components are designed specifically for nuclear power plant use, 40 year service life, minimum radiation exposure to operating and maintenance personnel, maximum reliability and minimum maintenance attention.

   S-E-Co. designs and builds most major components because experience has shown that equipment designed for other specific uses or for general use will not normally meet these design criteria.

2. To ensure reserve emergency capability, the system's capacity is at least three to five times the average disposal requirement for light water reactors. The variation depends upon the size and type of nuclear system involved.

3. The S-E-Co. equipment forms a complete system requiring minimum engineering effort by the customer or his engineers. Components are shipped assembled, prewired, prepiped, and factory-tested. Electrical cables connecting the controls with the processing equipment and crane are cut to length, equipped with plugs and receptacles, and factory-tested.

4. The equipment is designed to occupy minimum plant space. The arrangement of the equipment and location of the control room are very flexible to fit individual plant requirements.

5. The use of a standard 55-gallon drum with a 4" threaded cap used in conjunction with the S-E-Co. System has the following advantages to the operator.

   a. Use of a closure that permits simple, consistent capping and uncapping in a totally remote operating mode.

   b. Use of a low-cost container ($2.35 to $2.60 per cubic foot) which is readily available and competitively priced and which fully meets the DOT 7A Specification. A closed-top drum is stronger than an open-top drum.

   c. The ability to remove and replace the cap remotely at any time as a means of inspecting the contents of the drum for free water, if ultimately required.

284 257

d. The ability to re-enter a drum after solidification to improve leachability characteristics, if required.

e. The ability to double-fill a drum as the larger closure accommodates the dual-nozzle assembly. This permits placing more waste in each container and filling the drum with two or more waste streams for radiation control of the shipping container.

f. The ability to provide additional assurance of external drum cleanliness since tht vent connection can be placed inside the shipping container with the nozzles during filling.

6. The S-E-Co. System is designed to maintain area and drum cleanliness, thereby minimizing time required for housekeeping. Drum washdown, if required, is accomplished with a remotely operated spray within the drum processing enclosure.

7. Maintenance safety is assured because substantially all equipment requiring maintenance is located in safe areas or may be remotely moved to safe areas.

8. All components containing waste liquids or slurries may be remotely emptied, washed down, or flushed internally. All equipment may be decontaminated by hosing externally.

9. All equipment is designed to "fail safe" upon loss of system power, water, or air supply.

10. The system may be operated and controlled by one operator from a safe area. Control console instrumentation provides complete status information.

11. If smear testing, labeling and measuring of the radiation level of drums is required, this may be accomplished safely from behind a shield wall, which has been designed specifically for this purpose, prior to truck-loading.

12. Remote handling of drums via the bridge crane permits accurate stacking of drums, hence, full utilization of decay pit storage capability.

13. Interfacing with liquid radwaste equipment is straightforward, flexible and simple.

    Interfaces with advanced volume reduction equipment such as fluid bed dryers or crystallizers can be handled by S-E-Co.

14. To help ensure meeting technical solidification requirements at lowest cost, S-E-Co. conducts detailed solidification tests tailored to each station's individual requirements. Pretested solidification formulas and a process control program are provided.

15. Remotely operated cartridge filter handling equipment can be supplied to interface with the solid radwaste equipment.

16. All drives utilize gear transmissions designed and built by S-E-Co. for 40-year life. In S-E-Co.'s opinion, this is the most reliable, maintenance-free drive available.

17. Cement and waste fill nozzles enter the shipping container prior to filling, and appropriate vent connections collect displaced air, dust, and vapor from inside the drum.

    The objective is to keep the exterior of drums clean to avoid the necessity of cleaning and smear testing later.

18. All cable located in radiation zones meets stringent fire (IEEE-383-74) and radiation resistant standards.

B. Drumming and Decanting Stations

1. These two stations are designed to place all motors, air cylinders, controls, limit switches, remotely controlled valve operators, electronic components, and most gear transmissions on the safe side (side opposite the processing equipment) of a 12" thick steel shield wall.

   The shield walls are 5' wide x 10' high. All equipment, pipes, and wires are installed and tested prior to shipment. S-E-Co. supplies machined steel support frames for installation in the area's concrete shield walls for support of the drumming and decanting stations.

   The machined shield walls serve as accurate equipment foundations connecting driver and driven components which helps assure the accuracy required for 40-year life. Penetrations in the shield walls are stepped, as necessary, to eliminate direct radiation paths from the processing side to the maintenance side of the walls.

2. The shipping container is within the drum processing enclosure during cap removal, filling, cap replacment and mixing. While the equipment is designed to avoid spills, if a spill should occur, it is isolated from station environment, thereby

284 259

avoiding possible airborne contamination resulting from these operations.

The enclosure is equipped with washdown sprays, drain, and radioactive vent connections.

3. All components are designed to minimize crevices, crud traps, or equipment contamination. For example:

   a. All pipe welds are consumable insert butt welds.

   b. All valves are full-flow plug-type with liners to eliminate crud traps.

   c. The decant tank internal surfaces are polished to a No. 4 finish.

   d. Flanges are used only where necessary for possible maintenance convenience and speed.

   e. Low carbon stainless steel is utilized for all surfaces wetted by radwaste effluents.

4. Evaporator concentrates and slurries may be measured into shipping containers separately or mixed in 1/2 gallon increments for radiation level control of the containers. This helps match containers with shipping cask capability and lowers burial cost.

   A radiation measuring device reads the slurry radiation level in the decant tank. A second device measures container radiation level after processing.

   The S-E-Co. "double-filling" technique permits maximum utilization of shipping container volume.

5. A 500-gallon decanting tank, mixer, and instrumentation are provided to ensure that the solid/liquid ratio of slurries is consistent as pumped to the shipping containers. It also ensures that the minimum amount of water is disposed of. This equipment has no filters or screens to change or to plug.

   Other than heavy stainless steel mixer blades, no equipment (sensors, etc.) is submerged in the slurry. Decontamination sprays are provided.

   The atmospheric pressure tank is built to the ASME Code to ensure highest quality and total system integrity.

284 260

All periodic maintenance can be accomplished without entering the tank.

6. The solidification agent, slurry, and evaporator concentrates remain separated until after they are in the shipping container. This has the following advantages:

   a. Ensures that no solidification will occur outside of the shipping container.

   b. Minimizes the use of flush water.

   c. Avoids the possibility of jelling slurries in tanks at elevated temperatures. (Concentrate lines and tanks are heat traced. It is not desirable to heat trace slurry lines and tanks.)

   d. Provides the capability of accurately measuring each constituent separataly for consistent solidification control.

7. A remote-reading solid state scale is provided to measure drum weight after processing.

8. Automatic safety devices prevent drum overfilling and decant tank overfilling.

9. Two single-acting, positive displacement metering pumps, designed specifically for their service, accurately measure waste to the shipping container. They are large, slow-moving piston pumps to ensure long life and avoid vapor-binding when pumping hot liquids.

   a. The pumps have multiple valves which may operate as either suction or discharge, therefore, material may be pumped in either direction in the same pipe. For example, drums may be filled or material may be returned to the liquid system tanks.

   b. A third valve permits flushing in any direction through the pump.

   c. Tests indicate that the pump can clear plugged lines and that the pump helps to eliminate pluggage when pumping slurry.

   d. A dead-end seal water system prevents recycling of waste due to pump leakage.

284 261

10. A specially designed progressive cavity pump is utilized for pumping decanted water.

11. The dual fill nozzle assembly (one for slurries and one for concentrates) is equipped with plug valves, backing up the metering pump valves for shutoff after filling.

    Flushing may take place through the pump prior to valve shutoff or downstream after valve shutoff or both. This flexibility is built in to ensure the absence of radioactive dripping that could contaminate the exterior of the shipping container.

    Flush water is a measured quantity which is considered in the pretested solidification formulas, hence, flushing does not create a separate waste problem. Depending upon the flushing mode, the amount of flush water will vary from 1/2 pint to 1/2 gallon per drum.

12. High quality, stainless steel, full-flow plug valves are used for all radwaste and water control valves. Remotely operated valve operators designed, built, and tested by S-E-Co. for 40-year life are supplied with all plug valves.

13. The drum processing enclosure is equipped with two spray systems, one for decontamination of the drum if a spill should occur and one for decontamination of the interior of the enclosure.

    If a drum should become contaminated during processing, it will show up on the drum grab TV monitor prior to the drum's being removed from the enclosure. The drum may be tumbled and sprayed prior to removing it from the enclosure. Cleaning while the spill is wet increases cleaning efficiency.

14. Air exhaust piping is piped through an oil collector to remove oil mist.

15. Piping is built to ANSI B31.1 power piping code.

C. Bridge Crane

1. Dual electrical circuits and drive motors ensure continuity of operation, servicing in a safe area, and precise low-speed operation.

2. Low speed operation is 2.5 fpm to provide safe, accurate locating capability.

284 262

3. A target grid system (located above the crane) and companion TV camera cross hairs provide remote accurate location capability. The crane grab may be easily located within 1/2 inch which enhances safety and prompt remote operation.

4. Two bridge-mounted surveillance cameras with remote tilt control and one drum-grab-mounted TV camera provide overall area surveillance, verification of crane location, and remote inspection capability. The high quality cameras:

   a. Have been tested to 10 G shock load and are designed for severe duty applications.

   b. Will focus within three inches of the camera lens.

   c. Are automatic, requiring only focus adjustment by the operator.

   d. Are state-of-the-art solid state components.

   e. May be rebuilt in less than one hour.

   f. Permit clear observation with as little as five lumens in the field of view.

   g. Have non-browning radiation resistant lenses.

   h. Require only five wires from the control room to the cameras.

5. Lifting capability of the drum hoist is 7-1/2 tons. The drum grab jaws will handle loads up to one ton and auxiliary hooks are provided to handle loads up to the maximum hoist capacity.

6. The crane is of dual girder construction with large, hardened, cast steel wheels and rails to ensure safety and rigidity. Rail ends are machined to promote long rail and wheel life.

7. The drum cannot be released from the grab while the drum is suspended.

8. A grab elevation readout is provided for use in conjunction with the TV. This tells the operator the elevation of the grab in inches above the floor and shows positive vertical motion when in operation.

9. Antiswing guides are provided to prevent swinging of the drum during high speed operation. For high speed operation, the

284 263

load and grab must be in the full up position where the guides prevent swing and the load will clear all permanent obstructions under the crane.

10. Special cable handling equipment is provided to ensure long cable life. Rails for cable handling equipment are supplied.

11. The crane is equipped with high pressure sodium lights to permit observation of all crane functions. Lights in decay pits and other radioactive areas are not required for normal operations. Lights are redundant and are on separate circuits.

12. Four jaws are used to pick up a drum with the drum grab. Each jaw is capable of holding the drum. The operator has positive indication from the grab TV camera that the jaws are open or closed or, when lifting, that each jaw is in fact clamped on the drum.

13. For safety, bridge and trolley motion is limited to low speed when the load is in excess of one ton.

14. Redundant limit switches, which cut power, prevent the operator from running the crane into bridge or trolley stops. Shock-absorbing bumpers prevent damage if the redundant limit switches fail.

15. The crane is designed to be washed down if necessary for decontamination.

16. The drum grab will handle both closed-top drums (used for solidified products) and open-top drums (used for compacted dry waste) without adjustment.

17. The grab can pick up and locate drums when stored in a pattern touching each other. It is not necessary to widely separate drums in storage to permit remote handling.

D. Compactor

1. The low pressure (780 psi) hydraulic system helps ensure minimum maintenance.

2. A large hydraulic system reservoir avoids the necessity of having oil cooling equipment. Increased lubricity is obtained by the use of fire-resistant phosphate ester for the hydraulic fluid to reduce wear on seals and sliding surfaces.

3. The hydraulic system will stall out at maximum eccentric loading rather than damage the platen, cylinder rod, or other

284 264

260

components. The hydraulic circuit is of the high-effeciency, regenerative type.

4. The loading table facilitates loading of the drum, assists in maintaining good housekeeping, and helps avoid drum rim distortion.

5. The drum extension guides waste into the drum even when a drum is almost full. This assures a full drum and permits compacting a stack of waste 60" high. It also permits compacting 60" wide rolled paper or felt that has been placed in the drum vertically without further contact by the operator. Paper of this type is normally used when servicing radioactive equipment or during fuel changing. This material may be rolled up, placed in the drum, the drum placed in the compactor, the drum extension doors closed, and the material compacted into the drum.

   The drum extension doors have been provided for operator safety and to assist in dust removal with the ventilation system when compacting.

6. The drum extension permits filling a drum in less time and with fewer strokes of the machine.

7. The lower drum head is supported by a formed plate to avoid drum head damage and to ensure drum alignment.

8. The drum support plate is moved out of the frame by a hydraulic cylinder to allow drum handling by overhead hoist or by lift truck.

9. Ample roughing and HEPA filters with high capacity fan ensure that radioactive dust will be captured without danger to operating personnel. A minimum negative 1/2" water pressure is maintained within the compaction chamber even when filters are dirty.

10. The 30,000 pound compacting force will give more densely packed drums, and it will permit crushing of HEPA filters and other items having some strength which is not possible in lighter machines.

11. Servicing the built in filters can be accomplished without having to touch the dirty filters. Dirty filters are deposited directly into a drum to be compacted with the next batch of waste.

12. All operating cylinder motions are interlocked with limit switches so that the ram cannot be operated unless the drum

284 265

is all the way in or out of the compacting position and the drum extension door is closed. Further safety is provided by deadman controls on the hydraulic cylinders.

13. Oil level gauge, pressure gauges, indicator lights, etc., are all located to be conveniently observed.

14. The compactor is designed for 40-year life in nuclear power plant service.

15. Construction will permit washdown without damage for decontamination purposes, if necessary.

16. A pilot operated check valve is used to hold the ram in the UP position when the unit is not in operation.

E. Cement Filling Station

1. Solidification agent is placed in each shipping container per pretested formulas prior to the container entering a radioactive zone.

   Sufficient agent is added to ensure solidification regardless of malfunctions that may occur within radioactive zones.

2. The equipment is designed to eliminate cement dust in the plant. This feature is not available with commercially manufactured equipment.

3. Cement is accurately weighed into the drum with a S-E-Co.-designed solid state scale. Weighing is necessary to obtain consistent solidification results. (A minimum error of 10% to 20% can be expected if volumetric measurement is used due to moisture and particle size variation.)

4. The equipment will store a minimum of two truckloads of cement to ensure adequate material for emergencies.

5. Porous stainless steel airslides are used within the storage tank to ensure that the tank can be emptied even after long outages. A low pressure blower is supplied to deliver air to the airslides to ensure that water or oil from the plant air system does not enter the cement equipment. The compressor operates only during drum filling (normally only 20 to 30 minutes per shift).

6. The cement fill nozzle and vent annulus (connected to a dust collector) promote external drum cleanliness and maintain a slight vacuum on the drum during filling.

284 266

7. Solid state controls permit the operator to record gross and tare weights and preset the quantity of cement to enter each drum. Filling is automatically stopped when the preset weight of cement is reached.

8. A roller conveyor is provided to conveniently supply empty drums to the filling equipment. A gravity-type conveyor is provided for storing cement filled drums prior to processing and for delivering drums to the crane pick-up location.

9. A dust-tight dust collector collects dust when filling the tank or drums. Discharge from the dust collector complies with EPA regulations and is exhausted to the outside of the building.

10. High level alarms are provided in the storage tank and day tank. A safety valve is provided to prevent damage in case of overfilling.

11. Positive, dust-tight screw conveyors are supplied to deliver cement from the day tank and dust collector hopper to the fill nozzle.

12. A bell valve at the fill nozzle seals the fill nozzle after filling, thereby eliminating dribble.

F. Drum Inspection and Labeling Station

1. Drum inspection and labeling are accomplished by an operator from behind an 8-inch thick steel shield wall.

2. In the unit, the drum is supported on three points of a "spider" so that all surfaces of the drum, including the lower chine, may be reached for smear testing.

3. The drum support spider and drum may be rotated permitting access to all drum surfaces by means of a built-in motor and gear transmission operated from the safe side of the shield wall.

4. Access for hand-held tools is provided through full height access openings, approximately 8" wide on each side of the 8-inch thick steel shield wall.

5. The operator may observe the drum from a safe area through stainless steel mirrors supplied with the unit.

6. The unit is equipped with lights on the hot side of the wall, a drain connection for periodic washdown, and hand-held tools

284 267

for smear testing and labeling purposes.

7. The unit is designed to be installed within concrete or cement block shield walls. A steel structure surrounding the unit eliminates the need for internal forms.

8. The equipment is prewired requiring only 460 volt power supply by the customer.

G. Controls

1. Controls for the drumming station, decanting station, and bridge crane are integrated into a complete remote control package.

2. Major control items are the best quality items available, designed and built by S-E-Co., using solid state digital components in conjunction with electrical mechanical devices.

3. Normal operations of the drumming station are automatic. This helps ensure accurate repeatability, frees the operator for other tasks, and simplifies training.

4. All functions are interlocked to prevent malfunction or spills due to operator error.

5. A graphic panel is supplied to show the operator processing equipment, pipe, and valve status.

6. A record board is included to show the location of all drums under the remotely-operated crane and guide the operator to each location.

7. The controls and their interlocks are designed to ensure quick, simple operator training.

8. Major instrumentation, sensors, and limit switches in radioactive areas are redundant.

9. Television equipment is the best quality equipment available, is easy to maintain, and is shake-tested to 10 Gs to ensure reliable operation.

10. Control cabinets are completely assembled and tested with the equipment prior to shipment.

    Cabinets are ruggedly designed and built for power plant applications.

284 268

11. All power, control, and TV cables are furnished from the control room to the processing equipment and remotely-operated crane.

Only 460 volt power supply is required by the customer. If preferred, two separate power supplies may be installed.

284 269

III.
PROCESS DESCRIPTION

A. Process Flow

The Process Flow Diagram, shown in the Appendix, depicts the general processing sequence of the S-E-Co. Solid Radwaste System.

At the start of the process, 55-gallon DOT 17C drums which have been supplied with a 4-inch screwed opening are withdrawn from storage and inspected for physical damage. A drum number for process control is assigned and added to the top head of the drum to allow for positive identification and location with remotely operated T.V. cameras. The drum is then moved via a roller conveyor to the cement station where the 4-inch cap is removed and a mixing weight is added. The mixing weight speeds mixing operations and helps ensure that the contents are homogenous after processing.

The cement station has been provided with a control console which allows operation of all equipment necessary to fill drums with pre-determined amounts of cement in accordance with the Process Control Program. The quantity of cement to be added to each drum is based on pre-tested solidification formulas for the waste streams to be processed. With this information, the operator moves the drum from the roller conveyor onto an electronic scale-lift assembly and programs the weighing circuit to automatically fill the drum with the desired quantity of cement. The operator then initiates the left mechanism to elevate the drum to insert the fill nozzle and starts the automatic fill operation. The fill nozzle contains an integral suction connection which is piped to a dust collector to prevent dust from being discharged to the atmosphere. After filling, the drum is lowered and the cap is replaced by hand. The drum is then rolled down the roller conveyor with gravity assist to a section of the conveyor which serves as an in-process storage area.

The remotely operated crane is then used to transport the drum to the load platform on the drum processing enclosure which is located on the radioactive side of the drumming station shield wall. Once drumming operations are to be initiated, the remotely operated crane is used to lower the drum through a hatch opening and onto a positioning platform (drum cradle) inside the processing enclosure. After the drum has been loaded onto the drum cradle, the crane's drum grab is raised out of the enclosure. This allows the operator to remotely actuate closure of the hatch, thereby isolating the drum from the station environment during processing.

Operation of the crane and processing operations for filling and mixing drums with radwaste effluents are controlled remotely at a control station. The control station has been provided with a free-standing, desk-type console upon which all the controls and indicating devices required for remote operation of the crane, the decanting and the drumming stations, are located. Crane operation is assisted with a closed circuit television system and an over-head target grid system which allow precise positioning of the crane in the radwaste processing areas.

Prior to drumming radioactive evaporator concentrates, the feed system (not normally S-E-Co. supplied) to the solid radwaste system is set up to feed the S-E-Co. metering pump. The operator programs the control of this pump to deliver the correct amount of waste to be processed in the drum in accordance with the Process Control Program. After this has been accomplished, the pumping operation becomes a part of the automatic cycle.

Prior to processing slurries such as bead resins, Powdex and diatomaceous earth, the S-E-Co. 500-gallon decant tank is filled from the liquid system storage tank. During the filling operation, a mixer in the decant tank is used to ensure that the slurry will settle at a uniform level bed-of-solids after filling. Upon completion of the filling operation, the mixer is stopped to allow separation of solids and water. Once this settling period has elapsed, the water level and water-solid interface level are accurately measured with sonic sensors. These readings are displayed on the control console and inform the operator as to whether excess water is to be removed or water is to be added to the decant tank. This is done in accordance with the Process Control Program, in order to achieve the correct solid/water ratio consistent with the pre-tested solidification formula for the waste stream. Excess water is removed with decanting equipment and returned to a liquid system tank by means of a specially designed decanting pump in order to minimize the amount of water requiring disposal.

After the decant tank has been prepared with the correct solid/water ratio, the mixer is then automatically turned on and operates for a pre-determined period of time to ensure that the slurry is again homogeneous. While the slurry is being mixed, the operator is then able to approximate the radiation level of the slurry to be processed. This is accomplished with a radiation sensor mounted at the decant tank which has its readings displayed at the control console.

A S-E-Co. metering pump is used to transfer decant tank slurries to the drumming station for drum processing. This pump and its controls are identical in operation with that of the concentrated waste metering pump, and allow the operator to program the pump to deliver the correct amount of waste to be processed in each drum. Once programmed, the pumping operation becomes a part of the automatic cycle.

284 271

Fill nozzle flushing is accomplished automatically after each filling operation whether concentrated waste or decant tank slurry. Measured quantities of flush water is used and is considered in the pre-tested solidification formulas. Since flush water is delivered to the drum prior to mixing, no separate disposal situation is required.

With the metering pump and the appropriate feed controls set-up for the correct quantities and selections of waste, drum processing can then be initiated. The movement of the drum through the drumming station cycle is automatic, once the drum has been loaded into the drum processing enclosure and the hatch has been closed. The drum is uncapped, filled, recapped, clamped, tumbled and unclamped. This operational sequence may be repeated in the automatic cycle to permit the drum to be filled twice. The S-E-Co. double-filling technique repeats the filling and mixing operations in order to solidify the maximum amount of waste in each drum. Additionally, this allows evaporator concentrates and slurries to be processed and solidified in any proportion within the same drum. Combinations of these wastes are based on the solidification formulas, as dictated by the Process Control Program, and provides radwaste management of drum radiation levels. This feature has significant advantages from the standpoint of economics in terms of shipping and burial costs.

Upon completion of the automatic process cycle, the drum is returned to the load/unloading position. The operator then opens the hatch and lowers the crane's drum grab into the enclosure. The drum grab is equipped with a downward viewing camera, which allows the operator to inspect the drum for any possible contamination prior to removing it from the enclosure. Should any be detected, the drum can then be washed down inside the enclosure. During this operation, the drum is blasted with sprays of water. Although the system has been designed to preclude such occurances, this safety feature has been incorporated to assure containment of radioactive contamination from the station environment.

After the operator has verified that the top head of the drum is free of contamination, he then raises it out of the drum processing enclosure and positions it upon the scale platform. Once released by the crane, the drum's weight and radiation level are then measured and recorded. This information is used to decide the decay pit and location at which the drum should be stored. In addition, this information is used to assure that the filling process was accurate and in accordance with the Process Control Program. The amount of cement added per the pre-tested formulas is selected to ensure that all waste capable of being placed in the container will solidify. Error, if any, would be a reduction in the quantity of waste added. Radiation levels above or below that desired for a process average may be ascertained at this time, and indicate whether a change in the mixture, as permitted by the Process Control Program, is needed in order to obtain the desired ratiation level.

284 272

The operator then moves the drum with the crane to the appropriate decay pit for storage prior to shipment. There are usually multiple decay pits separating high and low level waste. Time in storage will depend upon desired decay time, the quantity of drums in storage, and transportation logistics. The S-E-Co. crane is capable of stacking drums five or more high in decay pits, providing that sufficient head room is available. Tests with DOT 17C drums in conjunction with crane hoist speed indicate that drums are strong enough to be stacked twenty high without incurring physical damage. Reference the Appendix for test details. However, S-E-Co. recommends that under normal conditions, stacking should not exceed two or three high. The additional storage height can then be reserved for abnormal or emergency conditions.

Prior to shipment, each drum may be placed in a shielded drum inspection and labeling station for smear testing, labeling, and radiation level measuring. At this station, the crane is used to deposit the drum upon a turntable. The operator, standing behind an 8-inch thick steel shield wall, can then rotate the drum with the controls provided, and with the built-in mirrors and light system inspect the drum surface. The station has been equipped with a drain should wash-down of the enclosure or the drum be required for decontamination. Hand tools have been provided to allow the operator to reach the drum's surfaces through access openings for performing smear testing and labeling operations, and measuring radiation levels without receiving direct-line radiation exposure. This provides a safe means of assuring drum compliance with shipping regulations and provides a safe, convenient means of collecting information necessary for shipments.

After completion of operations at the drum inspection and labeling station, the drum is then transported with the crane for truck loading or truck-cask loading, as may be required. The crane may be utilized for the removal and installation of cask lids by attaching a lifting fixture to the crane's drum grab. Crane hoist capacity is 7 1/2 tons.

Compressible dry wastes such as paper, rags, glass and clothing which require disposal are processed at the S-E-Co. dry waste compactor. This unit has been designed for safe, convenient operation by a single operator for packing materials of very low radioactivity requiring no radiation shielding. The operational sequence at this unit begins with placing an open top 55-gallon drum onto the drum support platform which has been contoured to fit the bottom of the drum. This allows not only accurate alignment, but also distributes compressive forces rather than allowing them to be localized at the drum rim during compaction. The support platform is then hydraulically retracted into the compactor and the loading table is locked closed. The loading table locks the upper portion of the drum in a stable position and facilitates drum loading. Wastes can then be loaded into the drum, up to a height of 60" with the assurance of compaction. Drum extension

284 273

guides have been provided to assist in waste loading operations. After the waste has been loaded, the two inlet section safety doors are closed and locked. This allows the operator to initiate compaction operations. Controls and indicating devices are located at the side of the compactor. They have been positioned to provide ease of operation, safety, and inform the operator as to system status. An air filtration system which includes a roughing filter and two parallel HEPA filters has been provided with a connection for attaching it to the plant's radioactive vent system. Once the drum has been compacted, the safety doors and the load table can then be opened. This allows the operator to extend the load platform and remove the drum. The S-E-Co. crane can be utilized for drum loading and removal of the drum from the platform. After the top head of the drum has been installed, the crane can then be used to transport the drum for storage or shipping operations.

B. Feed Control

Slurries and evaporator concentrates are measured through individual single-acting, piston-type metering pumps. The pumps are slow speed pumps designed specifically for this service. They deliver 1/2 gallon per stroke and 15 gallons per minute at rated air pressure to assure that cavitation or flashing does not occur and to give long life. The amount of material delivered to the container is determined by measuring the pump strokes through a S-E-Co.-designed solid state electronic control. The operator preselects the quantity to be delivered to each drum from his pretested formulas and sets the quantity into the control. The pump will automatically deliver this quantity of waste to each container.

A digital readout is supplied on the control console which allows the operator to monitor the quantity of material being delivered to each container. The operator may cancel feed at any time.

Mounted in the fill nozzle, which is located inside the drum during filling, is an emergency sonic sensor to shut down filling at a predetermined level before the drum can overflow.

Quantities of water for flushing the fill line and/or fill nozzle are predetermined based on a timing cycle and are considered in the pretested formulas.

At the cement station, cement is weighed into a drum by use of a solid state (load cell) scale connected to S-E-Co. designed solid state circuitry. Again, in this case, the operator preselects the quantity of cement to be added to the container in the solid state control. Once this weight is obtained, filling is automatically cut off.

284 274

For process control, the drum weights of each container are logged in at various steps using each individual drum number. A drum is weighed remotely after filling and mixing and the final weight compared with the pretested formula weight to ensure that the pretested formulas have been followed or to determine any error.

C. Filling and Mixing (Level Control)

S-E-Co. supplies to each customer solidification formulas which have been tested both on laboratory and full scale basis for the waste stream(s) to be processed. These formulas are used in conjunction with the Process Control Program to dictate the quantities of cement and waste(s) required to assure compliance with solidification criteria.

The amounts of cement and waste(s) added to each drum are metered as described under Feed Control. Filling operations are automatic with controls provided for operator over-ride. Digital readouts are utilized for monitoring filling progression and with the electronic (load cell) scales allow the operator to assure that the correct quantities have been added. Prior to drumming slurries, the decant tank is filled from the liquid radwaste system. During this operation a sonic sensor mounted on the tank is used to indicate waste level. In addition, this sensor provides high and low level alarms at preset tank levels. Level readings and high level alarms are annunciated at the control console. Alarm circuitry is used to close inlet line valves to the decant tank and may be utilized as interlocks for liquid radwaste transfer pumps. High level trip points are pre-set to alarm prior to slurry levels reaching the inlet of the over-flow pipe provided with decant tank. The low level alarm is used to prevent the start-up pumping operations from the decant tank to the drumming station. This has been provided to preclude incomplete drum filling.

During the decant tank filling operation, a mixer is used to ensure that the contents of the tank are homogeniously dispersed. Once the filling has been completed, the mixer is stopped to allow the slurry to settle at a uniform bed-of-solids. Sonic sensors on the decant arm are then used to accurately measure the water and the water-solid interface levels. Digital readouts at the control console display these readings and inform the operator as to whether excess water is to be added to the tank or removed as dictated by the Process Control Program. This is done in order to achieve the correct solid/water ratio consistent with the pretested solidification formulas. Excess water is removed with and returned to a liquid system tank by means of a specially designed decanting pump.

As described earlier, slurries and concentrated wastes are pumped through S-E-Co. metering pumps into 55-gallon drums prefilled with cement as part of the automatic cycle. Pump controls allow the

284 275

operator to program the correct quantity of waste to be added to each drum. A sonic sensor mounted in the drum fill nozzle has been provided as an emergency safeguard to stop pump operation should a malfunction occur prior to drum overflow. In addition, the quantity of cement specified in the solidification formulas are based on the maximum quantity of waste capable of being filled into a drum to assure complete solidification of the waste.

Upon completion of each filling operation, the drum is capped and tumbled as part of the automatic processing cycle. The mixing speed and time have been selected for optimum results.

D. Positioning and Drive

The shipping container is the main element of movement inside the drum processing enclosure. Once the bridge crane positions the container on a platform inside the drum processing enclosure and the hatch is closed, the container moves by automatic sequence to the capper for cap removal, to the fill nozzle, to the tumbling position, etc. The platform rotates on an arc from a vertical shaft. The platform is also elevated and lowered by means of the same shaft. The rotation and elevating motors are located on the safe side of the shield wall and drive through a common gearbox, designed by S-E-Co. for this purpose. The gearbox is located at the upper end of the vertical shaft. Redundant limit switches and a programmed controller are used for positioning the container at the various work stations. Mechanical guides are used for final location at the capping and uncapping positions and at the fill nozzle. This combination of controls allows the capper to remove and replace a cap even if the cap is off center in the container as much as 1/2 inch (approximately eight times normal drum manufacturing tolerances).

The fill nozzle is located at a fixed position. There is no mechanical seal to the drum. The fill nozzle is inserted into the drum prior to filling by elevation of the container with the positioning platform. Interlocks prevent the metering pumps from starting if a container is not in the proper position.

The capper, designed specifically for its purpose, is essentially a complex gear transmission. The collet is rotated by a motor on the safe side of the shield wall and is clamped and unclamped by an air cylinder located on the safe side of the shield wall operating through a rack and pinion drive. In operation, the drum is located in the proper position by the vertical shaft and its separate drive. This automatically informs the capper that the drum is in position to have the cap removed. The capper collet is rotated down a lead screw having the same pitch as the threads in the cap. Limit switches sense the cap position when the collet is located inside the cap; the air cylinder then expands the collet; and rotation is reversed to remove the cap from the container. The automatic sequence is stopped by a limit switch actuator located in the center of the collet, if a cap should not be in the drum. When the sequence stops, a "trouble light" informs the operator of the difficulty.

284 276

Tumbling of the drum end over end for mixing is accomplished by means of a motor and gear transmission located on the safe side of the shield wall which rotate clamp arms inside the drum processing enclosure.

E. Capping

The 55-gallon drums used with the S-E-Co. System have only one opening. The opening is a nominal 4-inch diameter cap located in the center of the top head of a DOT 17C container. The cap is inserted in the drum with a threaded connection and gasket. Flanges, gaskets, and caps are supplied to drum manufacturers by S-E-Co. so that S-E-Co. may maintain quality control.

For either cap insertion or cap removal, the container is located at the capping work station as described in 2.3 above. The capper is used for removing a cap or inserting a cap into a container within adequate tolerances while the container is in a known location. The capper itself is a compound gear box having, in essence, three drives.

1. A motor-driven rotating motion working through a lead screw which has the same pitch as the threads in the cap. This drive raises or lowers a machine tool-type collet utilized for clamping the cap. The lead screw ensures that the cap is taken out on the same helix as the cap threads to avoid any possibility of cross-threading or damage. The upper and lower positions of the capper collet are controlled by means of limit switches.

2. Once the collet is inside the cap, an air cylinder-driven rack and pinion clamps the cap and rotation of the lead screw is reversed to remove the cap.

3. A mechanical limit switch operator located in the center of the collet will stop automatic operation and alarm the operator if, for some reason, a container was placed inside the drum processing enclosure without a cap.

The motor for rotation, the air cylinder for clamping, and the limit switch safety device are all located on the safe side of the shield wall.

F. Radiation Monitoring

The S-E-Co. System has three positions for measuring the radiation level of containers.

1. A radiation sensor is located at the decanting tank and is shielded from other sources. This device is intended to determine the approximate radiation level of material in the decanting tank to help determine how much should be placed in each container for container radiation control. With the S-E-Co. double-filling technique, slurries, which will normally be of a higher radiation level than evaporator concentrates, can be mixed with evaporator concentrates in the same container for container radiation control. The process 284 277

control plan recommends that the radiation level of the decanting tank be measured after removal of excess water and when the material is homogenized in the tank by the built-in mechanical mixer.

2. A second radiation measuring device is located on the outgoing scale to measure the radiation level of a shipping container after filling and mixing. This permits the operator to be assured that his blends have been correct for radiation control and, if not, lets him know this so that he can make adjustments upstream. Knowing container radiation level also helps him decide in which decay pit to place the container and, perhaps, the length of time he wishes the container to remain in storage prior to shipment.

   S-E-Co. does not supply a means of measuring the radiation level of evaporator concentrates. This level is best measured upstream of the S-E-Co. System, if required. Evaporator concentrates do not normally attain as high a radiation level as resins or slurries, hence, there is little use for process control of this material from a radiation standpoint.

3. The drum inspection and labeling station provides plant operators a shielded position from which to measure the radiation level of a shipping container prior to truck loading and from which to smear test a container to ensure that the outside of the container is not contaminated.

G. Flushing, Cleaning and Decontamination

The S-E-Co. System is designed to keep the outside of a container clean. It is also designed such that the operator may determine whether the outside of a container is contaminated and clean it, in the event that it is found to be contaminated, prior to the time that the contamination would dry. This decreases the difficulty of cleaning. Various features of the S-E-Co. System designed with this in mind are:

1. Pretested formulas and accurate means of measuring quantities of materials placed in containers.

2. Insertion of the fill nozzle in the container prior to filling with either solidification agent or waste.

3. Vent connections at both the cement filling station and waste filling locations that maintain a vacuum on the interior of the drum. The vent connection located inside the container has the capacity not only to collect the air displaced during drum filling, but also to sweep air into the container thereby sweeping the drum head to avoid any minor puffs which could possibly contaminate the drum head.

284 278

4. The waste fill nozzle is equipped with automatically operated, plug-type shutoff valves to back up the pump valves and minimize the possibility of dripping. The fill nozzle proper may be flushed in three different operating modes, if contamination should become a problem, to ensure that the piping downstream of the shut-off valve is free of radioactive contaminant. The plug valve may be closed after which the downstream portion is flushed. The fill nozzle may also be flushed from the metering pump with the shut-off valve open. The third possibility is a combination of the two.

5. If contamination is present, it is most likely to occur inside the drum processing enclosure during the filling, capping, and mixing operation. The downward viewing TV camera, located on centerline of the crane's drum grab, will focus within three inches and is used as an inspection tool to determine if any contamination is on the drum head when the operator lowers the grab inside the unit to remove the drum after filling and mixing. Should the drum head appear to be contaminated, the operator would remove the crane grab, put the controls in "manual", return the drum to the tumbling mode, and actuate drum cleaning sprays which cover the entire periphery of the drum while it is tumbling. The drum would tumble for a few minutes after the sprays cease. This permits as much water as possible to be thrown from the drum. The drum would then be removed from the drum processing enclosure and placed in storage.

6. In addition to the spray system for drum washdown operations, the drum processing enclosure and the decant tank are both equipped with spray systems for cleaning their interiors. These spray systems allow dirt, crud or possible contamination constituents to be flushed from both units and returned to the liquid radwaste system. Both units are constructed of 304L stainless steel, and employ continuous welds in their interiors to minimize possible crud traps and facilitate cleaning. Additionally, the decanting tank is polished to a number four (4) finish throughout its interior to facilitate cleaning.

7. The S-E-Co. metering pump is a single-acting piston pump with multiple valves. With flush water connected to the pump, any other pipe line which it serves can be flushed. A test report in the appendix indicates the excellent performance of this pump for clearing any pipeline pluggage. Please note that no by-pass valves are necessary. The pump can pump in either direction through the same pipeline. The pump will also empty the decanting tank and return the slurry to its original liquid system storage tank or other location deemed desirable by the customer.

284 279

8. S-E-Co. uses 304L and 316L stainless steel for piping used for slurry and evaporator concentrates, respectively. Pipe fabrication utilizes consumable insert butt welding to minimize crud traps. All valves are full-ported plus valves having no crud traps.

9. If it should become desirable, flush water systems could be switched to hot water, or decon solutions could be added by modifying the piping in a safe area.

10. The drum inspection and labeling station provides a work area where drums may be inspected for possible contamination prior to shipments. The interior of the enclosure is capable of being washed down and has been supplied with a bottom drain connection to allow for decontamination operations.

11. The S-E-Co. bridge crane is capable of being washed down in case of radiation buildup or for normal house cleaning purposes. This crane has incorporated integral design construction to minimize crud traps and components have been selected which resist cummulative gamma radiation buildup of 10^7 RADS.

H. Instrumentation and Controls (Alarms & Interlocks)

The S-E-Co. Solid Radwaste System incorporates instrumentation and the controls which have been designed to allow for simplicity of operation, system reliability, and safety. Relay logic is used for general machine control, and solid state equipment is used for instrumentation and digital control.

For clarification, this discussion is divided into five (5) major categories, those being: Cement Filling Station, Bridge Crane, Drumming and Decanting Stations, Drum Inspection and Labeling Station, and Dry Waste Compactor.

1. Cement Filling Station

Stock Equipment Company provides two types of cement filling stations, one utilizing an indoor main storage tank and the other with an outside main storage tank. Each of these stations are provided with a control console which allows operation of all equipment necessary for unloading, storing feeding, conveying, and weighing cement into 55-gallon drums. The control console is located adjacent to the drum filling equipment and includes push-buttons, spring-return toggle switches, light indications, and digital readouts for controlling and monitoring system operations. The controls and indicating devices are located on the control console for ease of operation and are clearly identified for operator awareness as to their function and status.

284 280

The main storage (inside and outside installations) is filled with cement via the standard blowers supplied on cement delivery trucks. In order to preclude over filling operations, a sonic sensor is mounted in the top of the main storage tank. This sensor is pre-set to detect cement levels which approach tank capacity. Alarm circuitry is provided to annunciate high level conditions at the control console and may be utilized for remote indications and audible alarms.

Cement stored in the main storage tank is delivered to the day tank via the conveying equipment supplied with the cement station. In order to assist in the removal of cement from the main storage tank to the conveying equipment, fluidizing systems have been provided to aerate the cement and promote flow. For this purpose, indoor main storage tanks have been equipped with an air slide system which covers the bottom of the tank. The air slides are divided into four (4) sections and are supplied with low pressure, high volume air from a motor driven rotary blower. Controls for operating this system are provided at the control console. Upon operator initiation, air from the rotary blower is supplied to individual sections of the air slides through an automatic sequencing distributor valve. Outdoor storage stations utilize a fluidizing system which consists of small jet-pulse air vibrators, which are located at the conical section of the main storage tank. This system is activated automatically once the conveying system has been energized by the operator.

The conveying system used to fill the day tank for indoor storage stations consists of a bucket elevator system. Operation of the bucket elevator is controlled by the operator from the console and is interlocked with a sonic sensor which is mounted in the top of the day tank. This sonic sensor is used to detect high level conditions within the day tank, and has been provided with alarm circuitry to annunciate the high level condition at the control console and to automatically stop the bucket elevator to prevent over-filling. Outdoor storage systems utilize a pneumatic conveyor system to fill the day tank from the main storage tank. This system is controlled by the operator and operates automatically. The pneumatic conveyor system consists of a receiving tank, and pressure regulated solenoid valves which allows the conveyance of cement to the day tank on a batched basis with air. Operation of the pneumatic conveyor system is automatically stopped once a high level condition has been sensed in the day tank.

In order to help promote cement flow, a fluidizing air system has been supplied for the day tank. This fluidizing system is controlled by the operator from the control console and consists of small, jet-pulse type air vibrators which are located at the bottom hopper of the day tank to fluidize the cement being discharged.

284 281

Controls provided with the console allow the operator to fill drums with cement either automatically or manually. Automatic filling operations are operator initiated and controlled through an electronic weighing system. This system allows the operator to program the required quantity of cement for each drum and automatically stops the filling operation once this quantity has been added. The quantity of cement selected is specified by Process Control Program to assure solidification. The filling operations consist of the operator moving an empty 55-gallon drum which has had its cap removed and a mixing weight added onto the scale lift assembly. Load cells from this assembly provide weight signals to solid state equipment which measures the weight of the drum. The tare weight measurement is then displayed with a digital readout on the console and locked in a memory circuit of the weighing system. A thumb wheel switch located on the console is used by the operator, to pre-set the system for the required quantity of cement. With the weighing system programmed, the drum is then elevated to insert the fixed fill nozzle. With the drum located at the fill position, the operator then initiates the filling operation (either automatic or manual). Operation selection and start controls are interlocked with a push button fill permissive. This permissive is a maintain type control, which allows the operator to stop the operation upon release. Once the filling operation has been started, the shut-off valve on the fill nozzle is opened, the screw conveyor is started, and the dust collection system is energized. Cement is then transported from the day tank and deposited into the drum. The weighing system monitors filling progression and displays the weight of cement being added at the console. Once net weight of cement coincides with the pre-set quantity, the weighing system automatically stops the fill operation. Thumb-wheel switches provided with the solid state equipment allow for system dribble compensation to bias the weighing system for variations in cement. A clear tare push button has been provided, which allows the operator to remove the original tare reading from the electronic memory circuit, add it to the net weight of cement added to the drum, and display the total weight of the drum with cement. Manual operations allow the operator to fill drums without automatic stopping by the weighing system. A scale zero push-button has been provided on the console to accurately zero the weighing circuitry.

In order to assure dust free operations, the cement station has been provided with a dust collection system. This system may be energized at any time by the operator, but operates automatically whenever filling operations are initiated. The dust collection system includes a motor driven ventilation fan which provides vacuum conditions within the day tank, conveyor section, and at the vacuum plenum on the cement fill nozzle. Any dust which is generated when performing filling operations is drawn through this system by the vent fan to an

284 282

exhaust air filter assembly. Dust is captured on the filter element of this system and the filtered air passes out through the blower to exhaust system and the filtered air passes out through the blower to exhaust piping. Individual filter elements for the dust collection system are cleaned automatically and alternately. During this cleaning operation, a solid state control timer automatically selects the element to be cleaned and activates a solenoid controlled air valve. Once the solenoid has been activated, the air valve opens and allows a pulse of compressed air (low volume, high pressure) to pass through the selected filter element from the inside outward removing dust from its surface. Purged dust then drops into a receiving hopper (inside cement station) or into the day tank (outside stations) and is utilized for drum filling. A safety valve guards all components against overpressure.

In addition to the controls, instrumentation, and indicating devices discussed thus far, all motors have been provided with status indicating lights. These lights are located on the access door to the electrical cabinet which houses the motor starters, and indicates stop, run or overload trip conditions.

2. Bridge Crane

The traveling bridge crane is operated remotely from the control console which is supplied with the control station. Crane controls include selector switches and spring-return control switches which are centrally positioned on the vertical face and desk top of the control console. These controls have been located for ease of operation and incorporate positive operator initiated actions. Also located on the control console are television monitors, the grab elevation display, and illuminating indicator lights which provide the operator with visual contact and awareness of crane operations and system status.

The crane has been provided with two separate electrical power and control circuits with separate high and low speed drive motors for crane operation. This dual circuit concept has been utilized to assure that electrical failure in any one circuit will not prevent remote completion of an operation and movement of the crane to a maintenance area. The motor starters and associated electrical components are located in weatherproof electrical cabinets on the crane's bridge and trolley assemblies. The relay logic associated with crane operation is located in electrical cabinets provided with the control station.

Selector switches provided on the control console allow the operator to energize the parallel power and control circuits either separately or simultaneously (normal operation). Dual

284 283

circuit controls are also provided for operation of the grab jaw and the grab light system.

Individual spring-return, toggle type operating switches mounted on the control console have been provided for operation of the bridge, trolley, and hoist. High speed, low speed, and direction of travel are selected by moving the control handles to their appropriate operating mode. These controls can be used individually or simultaneously for movement of the crane to its desired position. Upon release, each control returns to the neutral position and stops operation.

In order to provide smooth transitions from high speed to low speed operation, motion monitors have been provided in the control circuits for the bridge and trolley drives. These monitors sense their respective driveshaft speeds and when the driveshaft speed is at or below the respective low speed drive motor speed, the motion monitor operating through an electric clutch allows the low speed motor to be engaged.

The television system provides the operator with visual control when operating the crane. The power supplies utilized for this system are located in the back of the control console. The monitors are arranged symmetrically on the vertical face of the control console and permit viewing of the Radwaste area and accurate positioning of the crane. The monitors have been provided with their own horizontal hold, vertical hold, contrast, and brightness controls. Located next to the monitors are toggle switches which are used for camera focusing. The cameras themselves are located on the crane. Two cameras have been supplied on the bridge structure and are mounted on the motor driven actuators. Controls for these actuators have been provided on the control console which allow the operator to adjust the tilt of the camera for viewing the Radwaste area and monitoring operations. An upward viewing camera has been mounted on the trolley, which is used to view an overhead target grid system. Each individual target of this system contains an alpha-numeric designation which, with a drum record board referencing these designations, allows the operator to accurately ascertain the position of the crane within the Radwaste area. A downward viewing camera has been supplied on the drum grab's center line to assist the operator when lowering the drum grab and when operating the drum grab jaws. In addition, this camera is utilized by the operator as an inspection tool for the top heads of drums to check for possible contamination and drum identification.

Crane operation is also aided with a grab hoist elevation reading which is displayed on the control console. This elevation display

284 284

is a digital readout which references the height of the drum grab in inches with respect to the Radwaste area. Instrumentation for this display consists of S-E-Co. design solid state equipment which drives a digital elevation display in conjunction with raising and lowering operations of the hoist. The elevation instrumentation is reset by a limit switch supplied on the trolley whenever the drum grab has been raised to its full-up position. This has been incorporated to ensure accurate elevation tracking of the system. A pre-set elevation control has been incorporated into the grab elevation system to allow setting a minimum elevation to which the hoist can lower the drum grab. This has been provided to prevent the hoist from playing out cable in excess of system capacity.

In addition to the pre-set elevation control, gear limit switches have been provided on the hoist system which are used for setting limits for hoist motor operation. These switches are incorporated into the control system to set high speed up, low speed up, low speed down, and high speed down hoist drive limits.

Also incorporated with the hoist system are load sensing switches which are attached to the hoist rope. These switches are integral mechanical load cell and limit switch assemblies which are preset to sense specific loads on the hoist system. They are used in control circuitry to annunciate slack cable, load on hoist and over 1 ton conditions at the control console.

The load sensing switch used for detecting loads in exce[illegible] one ton is utilized to limit all drive motor operations to the low speed mode whenever operating in this condition. A limit switch on the trolley limits operation of the bridge and trolley to the low speed mode unless the drum grab has been raised to its "full-up" position. In the "full-up" position, the drum grab is supported to eliminate drum swinging and the drum has been raised between the bridge beam and will clear all obstructions within the radwaste area. These items have been incorporated into the circuitry for safety and to assist in positioning accuracy.

The load switch used for the slack cable indication is used in the drum grab circuitry to prevent grab jaw operation unless the drum grab is being firmly supported. This has been provided to prevent the possibility of the grab jaws being opened when loads are suspended. Grab jaw open and closed conditions are displayed at the control console with light indications.

In addition to being supplied with energy absorbing compression type bumpers, redundant limit switches are provided to stop high and low speed drive motor operation of the bridge and trolley should an obstruction be encountered. Audible alarms on the bridge assembly are sounded to alert personnel in the Radwaste area of bridge and trolley movements.

284 285

3. Drumming and Decanting Stations

The drumming and decanting station are controlled by the operator from the control console supplied with the control station. The controls and indicating devices used for operation of these stations consists of selector switches and push-buttons along with indicating lights, digital displays, gages, and an illuminating graphic display. They have been located on three panels mounted on the vertical face and desk top of the control console and have been arranged for ease of operation and to aid the operator in his control of the stations.

The illuminating graphics display panel provides a visual process flow schematic of operations and includes both the decanting station and drumming station. This display is a representation of the process system and indicates feed flows, valve positions, equipment status (i.e. run or stop), and the process operation being performed at that time.

Located immediately below the graphic display package is a process selection panel. This panel consists of selector switches which allow the operator to select the desired feed to the decant tank, the operation to be performed at the decant tank, and the operation to be performed with the concentrated waste metering pump. The decant tank feed select switch consists of selections for filling the decant tank and a selection for returning waste from the decant to a liquid system storage tank. Upon selection with the switch, the correct solenoid controlled air actuators open valves as required for the particular feed selection. The status of these valves is displayed on the graphics display panel to allow the operator to verify proper feed set-up or return set-up. The decant tank operation select switch is a multiple position switch which allows the operator to select the required operations to be performed at the decanting station. Operations which may be selected are decanting, filling, pumping to the drumming station, or returning decant tank contents to the liquid system. Upon a particular operation selection, this switch allows valves to be open with the solenoid controlled air actuators, control relays to be energized, and system circuitry to be set up for operation start by the operator, as required. The concentrator waste operation select switch is a two position switch which allows the operator to set up station controls to pump concentrated waste into drums.

Located next to these process control switches, are four gages which are used to indicate decant tank waste in gallons, machinery air pressure, flush water pressure, and concentrated waste feed temperatures. The input to the decant tank gallon gage is supplied from a sonic sensor mounted on top of the decant tank. Only the sender and receiver for this sensor are mounted on the decant tank with its associated electronics located on the back of the decanting station shield wall and at the control console.

284 286

Pressure transmitters have been supplied for the flush water pressure reading and for the equipment air pressure readings. These transmitters are not only used to drive their respective gages, but provide alarm inputs and interlocks in the event that the system requirements are not met. A thermal couple located at the incoming concentrator waste line is used to monitor temperatures and is also interlocked and incorporated into control circuitry in the eventuality that system parameters are not met.

Located below the process selection panel is a panel which is used for system status displays and operational control. On this panel are digital displays which are used to indicate decant tank status. These status displays consist of decant arm position, water level, and waste level within the decant tank. The decant arm position display is a continuous readout, to the nearest 10th of a degree, and indicates the relative decant arm position within the tank. The readout range for this display is 0-99.9 degrees which corresponds to the travel limits of the decant arm drive. A digital display located below the arm position is used for indicating the water level within the decant tank. This display is given in degree readings and is locked in, once a sonic sensor located on the decant arm nozzle detects the water level within the decant tank. The display remains locked in until such time as the decant arm has been reset by raising it to its full-up position and energized downward again. A digital display is also used for indicating the relative solid waste level in the decant tank after this slurry has settled. This display reads to the nearest 10th of a degree and is displayed when a sonic sensor located on the decant arm nozzle detects the solid waste to water interface level. The display remains locked in until such time the decant arm has been raised to its full-up position and energized downward again. The sonic sensor used for indicating this level is also used to stop decant arm downward motion. Located next to these displays are controls and digital displays for the operation of the decant tank metering pump and the concentrated waste metering pump. The controls for operating the metering pumps consists of sets of thumb wheel switches which allow the operator to program the pump to meter the required quantity of waste to be filled in each drum. The operator may program not only the quantity of waste, but the filling operation (single or double fill) to be used from either pump or a combination of both. Once programmed, pumping operations become a part of the automatic processing sequence. Digital readouts are supplied, which display in half gallon increments the amount of waste which has been pumped and allow the operator to monitor pumping progression and verify that the correct amount of waste has been supplied. Also located on this panel are drum status

284 287

displays. These displays consist of a digital radiation level readouts which display the relative radiation level of the drum after it has been filled and mixed and of decant tank contents. The drum radiation reading is taken after the drum has been raised out of the drum processing enclosure and positioned onto a scale assembly, which is located on top of the enclosure with a radiation dector. A spare detector has been provided, which only requires electrical connection at the control station for usage, should the other fail. A similar arrangement has been provided at the decant tank to measure radiation levels after the correct solids/water ratio has been obtained and the slurry mixed. Weight readings from scale assembly are displayed on the console. This is a digital readout which indicates drum weight in pounds and is used by the operator for filling verification as indicated by the Process Control Program. Located below the weight reading is a zero scale push button which allows accurate zeroing of the weighing system.

Located on the desk top of the control console is an operations panel. This panel contains push buttons and illuminating push button combinations for control of processing operations. The panel is divided into decant station and drumming station operations. Controls associated with the decant station include an operational set-up push button which allows the operator to verify that feed and operation selections have been made. A separate push button control has been provided for operation set-up and initiation. Controls are interlocked to prevent starting operation without set-up verification. A push-button is also provided to stop operations. Two push buttons have been provided for raising and lowering the decant arm. These controls are interlocked with a settling timer to allow decant tank slurries to settle at a uniform bed of solids. The controls for raising and lowering the decant arm are utilized in conjunction with the decant tank status displays to allow the operator to assertain the water level and solid water interface level within the decant tank. Once these have been determined, the operator then refers to the Process Control Program to decide whether or not the proper solids to water ratio exists in the decant tank, whether water is to be removed from the tank by decanting, or whether water is to be added to the decant tank. A separate control has been provided for adding water to the decant tank in order to obtain the required slurry to water ratio. This control allows flush water to be added to the tank as long as the operator maintains switch contact. A push button control has also been provided to allow tank wash-down operations. This operation is automatic upon initiation and directs flush water through spray nozzles to clean all inside surfaces of the tank.

Controls for operating the drumming station are located next to those for the decanting station. Included with these controls are push-buttons which allow fill line flushing, concentrated waste feed line flushing, drum process enclosure wash-down and drum wash-down operations. These controls open the appropriate valves required to initiate the selected flush operation. Located next to these are push-button controls for opening and closing the hatch to the drum processing enclosure. Limit switches are used to annunciate hatch open and hatch closed conditions and utilized to prevent drumming operation start unless the hatch is closed. Controls for initiating the automatic drum processing operation, for manual advancing of the processing sequence, and for skipping operations and emergency stop are also provided on this panel. Once this station has been set up with the hatch closed, the operator depresses the automatic start push button to initiate drumming operations. The drum is uncapped, filled, recapped, clamped, tumbled, and unclamped. Programming the metering pump controls for second fill operations repeats this sequence of operations for double filling mixing times are controlled through timers to assure homogenous mixing. Limit switches and relay logic are utilized as interlocks for operation verification and advancing the automatic sequence programmer. Operations are visually indicated on the graphic display panel for operator awareness.

In addition to the status indications already discussed, additional alarms and indications are provided at the top of the console. These alarms are grouped together and are provided with each set of drumming and decanting combinations. Located underneath the desk top of the control console are three push buttons; to test alarm circuits, acknowledge fault, clear and reset alarm circuitry. Should any of these indications be annunciated they will alarm and cause an audible signal to be turned on. System functions monitored with these light indications include; flush water pressure, machinery air pressure, decant tank high level, select decant tank feed, motor overload trip, drum process cycle complete, no cap in drum, no fill selection, drum overfill, and drum process fault.

<u>Flush Water Pressure</u> is alarmed if water pressure drops below or rises above recommended pressure. Recommended water pressure for system operation is 50 psig ($\pm$ 5 psig) with low and high alarm conditions given should pressure exceed 60 psig or drop to 40 psig. Should either of these conditions occur, a pressure transmitter located in the system line will initiate alarm circuitry. In addition, this fault will cause drumming station operations and decanting station operations except decant tank filling to be stopped. Once the alarm condition has been corrected, operations can then be re-initiated.

284 289

Machinery Air Pressure is monitored with a pressure transmitter located near an air regulator used for controlling air pressure for operation of the valve actuators and metering pumps. This transmitter has been set to energize alarm circuitry should air pressure supplying the equipment exceed 100 psig or drop below 60 psig.

The alarm circuitry is interlocked with station controls to stop drumming station and decanting station operations except decant tank filling. Once the alarm condition has been corrected, station operations can then be re-initiated.

The Decant Tank High Level alarm indicates high level waste conditions within the decant tank. This alarm is controlled by a sonic sensor mounted at the top of the decant tank which is pre-set to annunciate a high level condition prior to waste being spilled over into the overflow pipe. Instrumentation supplied with this sensor allows for two high level set points in order to provide advance annunciation to the operator of the approach of an overfilling condition, and to automatically close valves to stop filling. In addition, contact initiations are provided which may be utilized by the customer for incorporation into control circuits for liquid system pumps feeding the decant tank.

Select Decant Tank Feed annunciations are alarmed should the operator fail to select a feed stream for filling the decant tank.

Motor Overload alarms are annunciated should any of the following motors have an overload trip: decant mixer drive motor, decant arm drive motor, decant pump motor, pivit drive motor, lift drive motor, clamp drive motor, capper drive motor, and tumble drive motor. In addition to the console alarm display, each motor has been provided with status indications on the electrical cabinet doors where their respective motor starters are located. These status indications display whether a run, stop, or motor overload condition exists. This allows the operator to quickly and positively identify which motor has tripped.

No Cap in Drum is annunciated whenever the drumming process has gone through the uncapping sequence and no cap has been detected by the capper. Should this condition exist, the automatic process sequence will stop and not advance to the next operation.

284 290

No Fill Selection is annunciated should the operator fail to select the amount of waste to be pumped into the drum with metering pump control switches. Should this condition occur, the automatic processing sequence will stop until the alarm condition has been corrected.

Drum Overfill is annunciated whenever drum pumping operations approach an overfill condition. A sonic sensor mounted in the fill nozzle for the concentrated waste and the decant tank slurries at the drumming station is used to detect drum content levels and is pre-set to initiate alarm circuitry prior to spillage conditions. Circuitry automatically stops pumping before overfilling occurs.

Drum Process Fault is annunciated whenever a problem in the drum processing program exists. The alarm is given in coincidence with all other alarms. Timing relays and interlocks are used in conjunction with the automatic sequence program for drumming operation to verify that operations automatically advance as programmed.

4. Drum Inspection and Labeling Station

The drum inspection and labeling station is operated from a control panel mounted on the front shield wall of the unit. The control panel is mounted on an electrical cabinet which houses the electrical equipment and motor starters utilized for operating the turntable assembly and light system. The controls provided allow the operator to energize the station, to turn the light system on and off, and to rotate the turn table in both directions.

5. Dry Waste Compactor

The dry waste compactor is operated from a control panel located on the side of the unit. Controls include push buttons, toggle switches, indicating devices, gauges. Separate controls have been provided for starting and stopping the unit for drum slide extension and retraction and for ram operation.

Operation of the air filtration system and the hydraulic system are interlocked with the start controls. They are energized and operational whenever the start push button has been depressed.

Operation of the drum slide is interlocked with limit switches for the ram and loading table. These switches prevent operation of the slide unless the ram is in the full-up position and the table has been opened.

Operation of the ram is interlocked with limit switches located on the drum loading cable, and the extension doors. These limit switches will prevent operation of the ram unless the

284 291

loading table and the extension doors have been closed.

Light indications are located with the controls to inform the operator of ram and drum slide status. In addition, located above the control panel are gauges for monitoring ram thrust,pressure differential accross the roughing filter, and pressure differential across the HEPA filters. Pressure transmitters and pressure switches are used for monitoring these functions. The air pressure gauges are maked to inform the operator of ruptured, normal, and blocked conditions of the air filters.

I. Piping and Instrumentation Diagram (P & ID)

Piping and instrumentation diagrams as shown in the Appendix indicate interfaces between the S-E-Co. Solid Radwaste System, the liquid radwaste system, and other plant systems. These diagrams identify piping and instrumentation with their nomenclatures, and S-E-Co., and customer identification numbers (if available). Physical characteristics such as line size, pressure, temperature, flow rates, etc. are indicated on the diagrams at points of interfacing.

284 292

IV.

PROCESS CONTROL PROGRAM

A. GENERAL

Branch Technical Position ETSB 11-3 requires reasonable assurance that the waste material as mixed with solidification agent has, in fact, solidified prior to shipment off site. It suggests that solidification formulas be pretested prior to actual use in order to verify that solidification results in a free-standing mass (if the container were to be removed) without free liquid. It also suggests that "administrative controls" be established for operating the radwaste equipment giving reasonable assurance of compliance with the requirements of pretested solidification formulas. ANSI Draft Standard N 198 suggests this same control.

Stock Equipment Company's solidification program has investigated the usage of cement as a solidification agent for various types of wastes generated from typical nuclear power plants. Results of this program have indicated that proper solidification, meeting the requirements of ETSB 11-3, may be achieved, however, the amount of cement utilized will vary widely dependent upon the waste stream to be solidified and its chemical and physical properties. Consequently, solidification formulas are necessarily site-sensitive.

Stock Equipment Company provides the use of its solidification laboratory and its personnel to develop pretested formulas for use at each individual station as a part of the equipment-purchase contract. The solidification formulas are based upon information provided from the station as to the types of wastes to be encountered and their physical and chemical characteristics and constituents.

Adjustments or modifications to pretested solidification formulas based on actual operating conditions may be required to maximize processing efficiency. In all cases solidification formulas provided by Stock Equipment Company will be directed at the following:

1. Formulas will meet technical solidification criteria within known operating parameters of the plant.

2. Where possible, formulas will provide a means for establishing control of the radiation level of solidified drums in order to match them with their intended method of shipment (example: shipping casks).

3. Formula specifications per Item 1 will be directed at maximizing operating efficiency at minimum cost.

284 293

The discussion which follows has been provided to indicate those factors affecting solidification, process parameters controlled by S-E-Co. equipment, and suggested measures to assure compliance with sol..ification criteria. Information presented is of a general nature and is not intended to be site-specific or restrictive to alternate methods which meet governing guidelines for solidification.

B. FACTORS AFFECTING SOLIDIFICATION

1. Type of Cement

Solidification characteristics vary greatly with the type of cement used. There are variations in the particle size and constituents of each that provide unique characteristics. The three most available types are:

a. Type I - The common grade available in building supply houses. It is best described as the basic cement used for most tasks from si ewalks to brick walls. It is currently used at most nuclear stations for solidification.

b. Type II - Developed as a sulfate-resistant cement having much lower exothermic properties than Type I. Its main commercial use is for pouring heavy structures such as dams or nuclear power plants.

c. Type III - Best known as "high-early-strength" cement.

Type III cement has advantage when solidifying acids. Type II cement is much better than Type I for sulfate wastes. There are trade-offs in the selection of ce ent for radwaste use. The S-E-Co. formulas have been pretested for each individual station's specific waste streams. If the correct type of cement is not utilized, proper solidification may not occur.

2. Amount of Cement and Waste in Each Container

The amounts of various constituents selected in the pretested formulas were chosen to give solidification in a reasonable length of time. While a contingency factor is built into the formulas, significant variation from the formulas may cause unsatisfactory solidification results.

284 294

The S-E-Co. equipment measures the cement, waste, and flush water entering the container within the accuracy required by the pretested formulas.

3. Cement to Water Ratios

One of the chemical reactions occurring during solidification is that the cement's chemical constituents combine with molecules of water (hydration) to form a solid. A given quantity of cement is capable of combining with a specific quantity of water. If there is too much water, free water will result; if there is insufficient water, not all of the cement will hydrate. A proper cement to water ratio is necessary to achieve solidification and to obtain free-standing strength.

The S-E-Co. decanting tank and its equipment are used to control the amount of water (required for a given pretested formula) entering the shipping container when drumming slurries. When drumming evaporator concentrates, the percentages of dissolved solids and water are controlled by the operation of the liquid radwaste system equipment. It is important that the solids to water ratio from the liquid system be maintained within the prescribed limits of the pretested formulas.

4. Temperature

During hydration, cement has an exothermic reaction, meaning that the mass increases in temperature. The amount of heat generated varies with the type of cement used. In general, increases in temperature, within limits, speed the solidification process. The temperatures generated are considered when selecting pretested formulas. However, too high a temperature can hinder proper solidification in extreme cases. For example, if the waste temperature is too high, this, combined with the natural exothermic reaction of the cement, may heat the mass above the boiling temperature of water. If this occurs, part of the water will turn into steam and pressurize the container. Bubbles can also form in the mass which can weaken the final structure. Pressurization of containers can be dangerous, and drums can be deformed to the point that the remote handling equipment cannot pick them up. When formulas specify temperature limits on evaporator concentrates, drumming should not be attempted with fluids above that temperature.

The S-E-Co. unit has a thermocouple which is used to measure concentrates temperature in the concentrates piping and as an interlock and system alarm for concentrates metering pump operations.

5. Chemical Constituents of the Waste

Various chemicals react differently with cement. In general, acids retard solidification while some other chemicals enhance solidification. Contaminants such as petroleum products in the waste stream may also impact solidification results. Pretested formulas have been tested to provide acceptable technical results based on the type(s) and concentration(s) of the various constituents of the waste. Variations from the pretested formulas may result in unacceptable results. Chemical constituents are neither measured nor controlled in the S-E-Co. equipment.

6. PH of the Waste Stream

As previously indicated, acids tend to retard the set of cement. Since the natural pH of cement is approximately 10, waste streams which have a pH less than 10 are usually sensed as an acid. In general, the lower the pH, the smaller the amount of waste which can be solidified with a given quantity of cement. In addition, some high-acid resins, when placed in a basic environment, exhibit swelling characteristics. Should swelling occur as a result of mixing with cement, swelling may weaken the mass while solidification is in process.

In some cases (as indicated above), specific waste types may require pH adjustment in order to achieve the acceptable technical results required for solidification. In these cases, pretested formulas would specify limits for pH control. PH is neither measured nor adjusted in the S-E-Co. equipment.

7. Time

Solidification is not an instantaneous occurrence. As solidification occurs and the mass ages, the strength of the mass increases. It is well known that 14-day strength and 28-day strength figures are common measurements for construction work. For radwaste use, a strength of a few pounds per square inch is satisfactory and will form a free-standing mass. Pretested formulas establish minimum set times during which the solidified waste should be considered as "in process". Set times are necessarily a function of the specific waste stream solidified and the particular solidification formulas used.

8. Mixing

The mixing method and time utilized do affect solidification results. S-E-Co.'s equipment provides a mixing method which testing has demonstrated does provide a uniform distribution of waste and cement. Equipment controls have been provided to adjust mixing times as prescribed by pretested formulas.

284 276

C. OPERATIONAL CONTROL

OPERATIONS COMMON TO DRUMMING SLURRIES AND EVAPORATOR CONCENTRATES

1. Drums should be ordered to tolerances and information supplied with the Operating and Maintenance Manual. For solidified waste, S-E-Co. recommends the use of a new DOT 17C, 16-gauge, closed-head drum with a special 4-inch screwed cap located in the center of the top head.

   The remotely operated processing equipment will handle drums which deviate from these tolerances. However, because most drums are built for commercial usage, it is possible to obtain drums with excessive deviation, making it impossible to handle them remotely in the processing equipment

   Drum tolerances should be verified upon receipt of drums.

2. A log should be established to record the drum number, inspection points, and contents of each drum processed through the solid radwaste system.

3. Waterproof numbers should be placed upon the top head of each drum. The numbers should be at least three inches high. This allows the operator to verify that the correct drum is being processed by utilizing the crane's surveillance and/or drum grab TV camera at each processing step. In addition, the assignment of drum numbers allows the operator to identify the location and status of each drum with the drum location board.

   (LOG ENTRY - Check off point)

4. After a drum is placed on the cement filling station's roller conveyor (prior to filling), remove the cap with the hand tool provided. During this operation, cap threads can be inspected and it can be assured that a gasket is, in fact, installed. Each drum should be visually inspected to ensure that the drum has not been damaged. Major dents could cause sufficient deforming to prevent processing in the remotely operated equipment. Any hole is reason for rejection.

   (LOG ENTRY - Check off point)

5. Move the drum onto the scale and measure the empty weight of the drum.

   (LOG ENTRY - Drum Weight)

6. Insert the mixing weight in the drum.

   (LOG ENTRY - Drum and Mixing Weight Total)

284 297

7. Preset the cement filling station controls to the quantity of cement required per the pretested formula for the waste stream to be solidified. Start the equipment and fill the drum with cement. (The controls automatically stop filling when the preset quantity has been added.)

(LOG ENTRY - Gross and Net Weight of Drum)

8. Replace the cap in the drum. This may be done by hand. Finger-tight is sufficient for cap reinsertion.

NOTE: The cement filling station is designed to avoid spilling cement on the exterior of the drum. If cement spills on the drum exterior, due to malfunction or operator error, it is recommended that the drum be cleaned prior to further processing. This may eliminate or simplify the cleaning of the radioactive drum required in order to meet shipping regulations.

9. With the remotely operated crane, move the drum to the platform adjacent to the drum processing enclosure hatch. Utilitize the drum grab TV camera to verify the drum number and to assure that the cap has been reinserted in the drum after filling with dry cement.

10. Set the liquid radwaste system controls to deliver waste to the solid radwaste system per manufacturer's instructions. If evaporator concentrates are to be drummed, check the temperature against the pretested formula.

(LOG ENTRY - Evaporator Concentrates Temperature)

OPERATIONS 11 to 14 ARE TO BE FOLLOWED WHEN DRUMMING SLURRIES

11. Fill the decanting tank per S-E-Co. instructions in the Operating and Maintenance Manual.

When filling the decanting tank, the mixer will run continuously to ensure a uniform mix. After filling, the mixer automatically stops to allow the slurry to settle to a level bed-of-solids. A timed settling period is built into the controls. It prevents further mixer operation or processing within the timed settling period. Settling times are indicated with the pretested formulas supplied by S-E-Co.

(LOG ENTRY - Settling Time)

12. After the mixer-off-delay (settling time), activate the decant arm

284 298

to lower it into the fluid. Solid state digital readouts will show arm position, liquid level, and solid-liquid interface level. The arm motion will automatically stop when the arm sensor reaches the solid-liquid interface level.

(LOG ENTRY - Liquid Level, Solid-Liquid Interface Level)

13. Refer to the table provided by S-E-Co. to determine the correct decant arm position for decanting. It is important to ensure that the arm is set to the correct position prior to decanting because this will determine the solid to liquid ratio of the remaining material in the tank.

(LOG ENTRY - Correct Decant Arm Position from S-E-Co. Table)

14. Start the decanting pump. This pushbutton starts the following automatic sequence.

    a. The decanting pump starts and continues pumping until the water has been reduced to the correct level.

    b. The pump stops.

    c. The decant arm returns to its storage position in the top of the tank.

    d. The mixer starts and runs for a predetermined time to ensure that the contents are uniform (about the same solid to liquid ratio) throughout the tank.

    e. The mixer time-delay will then permit drumming if other controls are properly set.

NOTE: If the tank contains a relatively small amount of solids after Steps 11 - 14, due to a small percentage of solids in the liquid system feed line, it may be desirable to repeat Steps 11 - 14 to make a larger batch of waste prior to drumming.

---

15. Set the metering pump control counters. The slurry metering pump and the evaporator concentrates metering pump may be controlled to pump either or both materials into the drum (per pretested formulas) in 1/2-gallon increments. Presetting of the pump controls will automatically permit drumming to proceed at the correct time in the processing cycle when other interlocks are satisfied.

(LOG ENTRY - Required Filling Quantities from Pretested Formulas)

284 299

16. The drum is automatically filled.

(LOG ENTRY - Actual Quantity Pumped to Drum from Digital Pump Readouts)

NOTE: A sensor located in the fill nozzle prevents drum-overfilling due to operator error or malfunction. In addition, the quantities of cement specified in the pretested formulas will solidify as much waste as can be placed in a drum.

17. The drum is automatically tumbled a predetermined length of time for mixing.

(LOG ENTRY - Preset Mixing Time Required for the Waste)

18. Remove the drum from the drum processing enclosure with the remotely operated bridge crane. Place it on the drumming station scale. Compare the actual weight with the pretested formula. Advise the supervisor if in error.

(LOG ENTRY - Final Drum Weight, Drum Radiation Level, Date and Time)

NOTE: Observe the drum head with the drum grab TV camera prior to removing the drum from the drum processing enclosure. The equipment is designed to keep the exterior of the drum clean. If, through malfunction, there is water or crud on the drum head, wash per S-E-Co. instructions in the Operating and Maintenance Manual prior to removal of the drum from the drum processing enclosure.

19. Place the drum in the appropriate storage location.

20. Fill in the tag for the drum location board (drum number, date, weight, and radiation level) and hang it at the correct alpha-numeric location on the board.

(LOG ENTRY - Alpha-Numeric Location of Drum in Storage Area)

D. PROCESS PARAMETERS

1. Cement Type

The type of cement prescribed by the pretested formulas will be specified for specific waste stream. Measures should be established to assure that the type of cement to be utilized conforms to the requirements of the pretested formulas.

Various tests have evolved to differentiate types of cement from one another should the identity of the type of cement be unknown. These tests range from simple bench tests to more involved tests using

284 300

various chemicals as shown in the following table. Should identification be accomplished utilizing the technique indicated by this table, S-E-Co. recommends that Type II be differentiated from Type I by using Tests 4 and 5 and that Type III be differentiated from Types I and II by using Tests 1, 2, 3, and 5.

(See chart on following page.)

2. PH of Waste Stream

Should pH control of specific waste streams be required, the pretested formulas would prescribe limits for acceptability. Treatment, sampling, and pH testing, when required, should be accomplished prior to the transfer of the waste to the S-E-Co. Solid Radwaste System.

S-E-Co. solidification tests, involving pretreatment of strong acidic radwastes and high acid resins which exhibit swelling characteristics, have been accomplished with NaOH (50% concentration by weight). However, the particular agent and method to be employed for pretreatment should be evaluated on an individual basis prior to implementation.

3. Concentration and Type of Radwaste

The identities of solids, dissolved solids, and their concentrations transferred to the solid radwaste system are usually ascertained and controlled by the liquid radwaste equipment and its operation. In the case of slurries, the decanting tank is used to control solids concentration prior to drumming. Evaporator concentrates should be sampled, as required, to determine the concentration of waste constituents deemed important in the pretested formulas. This ensures that actual drumming is consistent with these formulas.

COMPARISON OF CEMENT PROPERTIES
A.S.T.M. (C150) Type Cement

	I	II	III
1. Appearance (Color)	Light greyish brown	Medium greyish brown	Light brownish grey
2. Median Particle Size (Microns)	200	300	60
3. Consistency at:			
water/cement = 0.45	Beef gravy	Beef gravy	Stiff mortar
water/cement = 0.3	Thick mortar	Dry mortar	Dry and crumbly
4. Cup (Loose) Density (gm/cm) (Per ASTM C188-78)	1.16	1.04	0.93
5. Formulation by Weight: 33% of 12% boric acid (pH=10) + 58% of cement + 9% of sodium carbonate			
Consistency	Thin crack filler	Thick beef gravy	Soupy mortar
Set Time	4 days	1 hour	10 minutes
6. Chemical Test Examples			
Tricalcium Aluminate	7 - 14%	4 - 7%	7 - 14%
Dicalcium Silicate	15 - 24%	23 - 33%	10 - 22%

Typical concentration values are given below:

WASTE	CONCENTRATION OF SOLIDS (By Weight)
a. Bead Resin	33%
b. Diatomaceous Earth	25%
c. Powdered Resin	25%
d. Solka-Floc	17%
e. Sodium Sulfate	25%
f. Boric Acid	12%

NOTE: Acceptable variability is + 10%.

4. Settling Time (Decanting Tank)

In order to allow slurries to settle at a uniform bed-of-solids in the decanting tank, adjustable timers have been provided at the control station to set settling times. Settling times given below have been selected to assure obtaining the correct slurry concentration and to minimize the recycling of "fines" to the liquid radwaste system during decanting.

SLURRY	TYPICAL SETTLING TIME (Minimum)
a. Bead Resin	1 hour
b. Diatomaceous Earth	4 hours
c. Powdered Resin	3 hours
d. Solka-Floc	3 hours

5. Temperature of Evaporator Concentrates

Evaporator concentrates should be maintained within a temperature range conducive to good processing and solidification. A temperature range of 140° F to 160° F generally provides adequate hydrodynamics and precludes possible overpressurization of containers. Concentrates piping supplied with the drumming station is provided with a thermocouple to monitor concentrates temperature. In the eventuality of excessive temperature conditions (typically 180° F),

284 303

alarm circuitry is activated.

6. Mixing Time

In order to assure uniform mixing of the radwaste with cement, adjustable timers have been provided at the control station to adjust mixing times.

Typical Mixing Times are:

a. Single Fill Operation - 8 minutes

b. Double Fill Operation - 5 minutes - first fill
3 minutes - second fill

7. Solidification (Set) Time

Solidification formulas are designed to produce timely solidification to minimize the storage required prior to shipping. Typical minimum set-times which assure complete solidification are indicated below.

WASTE	SET TIME (Days)
a. Slurries	1
b. 25% Sodium Sulfate	1
c. 12% Boric Acid	7

8. Solidified Strength

Solidification formulas are pretested to assure that the solidified strength (drum quantity) is free-standing and in compliance with NRC and DOT regulations and guidelines.

9. Contaminants

Contaminants such as petroleum products may affect solidification results. The impact which contaminants may have will depend upon the contaminant's particular type and concentration. S-E-Co. solidification tests involving typically encountered oil types indicate that 2% concentrations (by weight) do not adversely affect solidification results. Some types of oil, in concentrations up to 25%, have been solidified.

Measures should be established for monitoring and adjusting the Process Control Program to prevent contaminants from affecting solidification results.

284 304

300

10. Formulation Loadings

The solidification formulas have been pretested to assure solidification within the parameters discussed in this section. Solidification produces a free-standing mass containing no free liquid with the radwaste uniformly dispersed.

During system operation variations in cement or radwaste loadings may not affect solidification with all other specified requirements being met. Typical limits of acceptability follow:

	Acceptable Variation
a. Slurries	± 10%
b. Solutions	± 5%
c. Cement	± 5%

NOTE: Should variation in waste and cement occur for the same drum, the limits of acceptability indicated above are half of that specified.

11. Solidification Verification

In order to assure compliance with solidification criteria and to verify that process parameters are within prescribed limits, sampling and testing of waste streams may be required. The methods and procedures utilized for obtaining samples and testing should follow accepted practices and techniques. The frequency and scope of sampling and testing should be commensurate with that required for ensuring process control and as may be required by governing regulations.

If laboratory-scale samples are used to verify solidification and the pretested formula used, a sampling and testing procedure should be developed in order to meet the requirements of the Process Control Program. An example of a procedure for preparing labo[illegible]ory-scale solidification samples for testing and verifying result[illegible] follows:

a. Obtain sufficient radwaste sample material from the storage tank of the type of waste being drummed to make three, 200 gram solidification samples.

b. In each case prepare mixes of the radwaste with the type of cement being used and with any additive being used in exact proportion to formulations being used full-scale.

c. A record should be kept of the actual weights used, for verification that proper proportions are being used, both laboratory-scale and full-scale.

284 305

d. The approximately-600-gram mix is placed in three sample containers for solidification. These containers should be approximately 2" high x 2" in diameter, capped on both ends. (These can be made from acrylic tubing pieces, nominal 2-1/4" I.D. and 2-1/2" O.D. with EC-40 Caplug bottom and 2-1/2 EC Caplug top.) Labels on the top cap are required for later certification and should contain the date and time mixed, reference formulation number, etc.

e. Observation is made of the set time for comparison to that expected for the formulation being used.

f. Note should be made of any free liquid (after one day, two days, etc.) and any gas evolution during mixing or solidification.

g. The solidified samples may be further verified by compression-strength testing in comparison to the value expected for the formulation. In this case an average value for the three samples is used.

h. Another confirming test is to ascertain the specific gravity of the sample. This is obtained by measuring the final solidified sample's height and weight:

$$\frac{\text{Weight (grams)}}{\text{Height (centimeters)} \times 25.8064}$$

Comparison is made to the value expected for the particular waste formulation being tested.

i. If the laboratory-scale samples verify solidification and the properties expected, the full-scale mixing formulation is considered verified by pretested formulation, and full-scale drumming of the waste may proceed.

If the laboratory-scale samples fail to verify solidification, a review of the situation must be conducted. The following steps should be followed, in order, until proper corrective action has been determined.

1) Review and verify sampling and testing procedures. If an error is found, correct and verify results with additional solidification samples.

2) If sampling and testing procedures are correct, additional waste samples should be taken from consecutive batches of the same waste until five consecutive test specimens demonstrate solidification. Process parameters should be adjusted as required to assure solidification.

284 306

12. System Operability

The establishment of routine inspection, lubrication, and calibration schedules, as recommended by the Operating and Maintenance Manual, will help ensure equipment availability. In addition, functional checks and operational records may be required as directed by specific Process Control Programs and/or governing regulations for verifying equipment availability.

284 307

TYPICAL FORMULATIONS FOR BWRs & PWRs

Radwastes	Drum Quantities: Radwaste (Gallons)	Radwaste (Pounds)	Cement (Pounds)	Total Weight (Pounds)
1. 33% Bead Resin*	42	385	220	605
2. 25% Diatomaceous Earth	44.5	440	165	605
3. 25% Powdered Resin	44	405	175	580
4. 25% Sodium Sulfate	36.5	380	355	735
6. 12% Boric Acid*	22.5	199	365	564

*Notes:

a. Pretreatment to pH of 10 ± 1 for boric acid, strong acid cation bead resin, strong acid cation Powdex, acidic lab floor drain waste, and PWR chemical regenerative waste.

b. S-E-Co. double-fill technique assumed in all cases.

c. Evaporator concentrates temperature is 140°F to 160° F.

d. The above formulations may use either Type II or Type III cement with the exception of boric acid which requires Type III.

284 308

V.

EQUIPMENT

A. Scope

It is the objective to supply a complete Solid Radwaste System, consistent with the normal and emergency throughput of each individual station. Dependant upon whether the station is a single or double unit, the S-E-Co. System will consist of one or two drumming - decanting station units, respectively. A single drumming - decanting station unit provides a processing capability of 2-3 drums per hour. This allows processing an average of 67 to 100 gallons per hour of typically encountered radwastes. Based upon specifications received for individual stations, this is usually three or more times the normal waste generation rate. The quantity of equipment supplied is based upon specifications received for individual stations. Components that may be utilized are listed below.

1. Cement Filling Station

   Equipment to accurately measure solidification material into each shipping container. Additional functions normally performed at this work station include adding an identification number to the drum, adding a mixing weight, recording the amount of solidification material added to each container, and inspecting the empty drum for damage prior to use. Processing time - 2 to 5 minutes per drum.

2. Shield Walls

   The 12" thick steel shield walls, supplied assembled with both drumming and decanting stations, essentially shield drives and controls from the processing equipment and serves as the foundation connecting driven and drive components. These walls provide radiation shield equivalent to 39" of concrete.

3. Drumming Station(s)

   Equipment to accurately measure evaporator concentrates into the container, fill, mix, decontaminate (if required), weigh the filled drum, and measure its radiation level. Processing time - 15 to 30 minutes per drum.

4. Decanting Station(s)

   Equipment to accurately determine solid/liquid ratio of slurry-type waste, return excess water not needed for solidification to liquid system, measure the radiation level of the slurry, and accurately measure dewatered slurry into the container. Batches of waste up to 500 gallons maximum can be handled. Processing time will vary from 1 1/2 to 7 hours per batch.

284 309

5. Piping and Control Valves

All required piping, valves, and remotely operated valve operators preassembled with the drumming and decanting station shield walls.

6. Remotely Operated Material Handling Equipment

a. Bridge Crane

Normal mode consisting of crane, beams, rails, cable handling equipment, target grid system, grab, and four TV systems used for locating, surveillance, and inspection purposes.

b. Fixed Bridge Crane

Essentially the same as (a) but motion of container is limited to one horizontal axis.

c. Drum Handling Lift Truck

Utilized to handle empty drums or dry waste filled drums of low activity in safe areas. In some cases, such as in conjunction with a filter handling system, remote control may be added.

d. Rail Mounted Transfer Cars

Normally used only when processing and storage areas are widely separated or building restrictions or building restrictions do not permit all handling of radioactive material with above listed equipment. This equipment is remotely controlled.

7. Drum Inspection and Labeling Station

Normally provided to safely inspect, smear test, label and measure radiation level of drums as required prior to truck loading. May be modified to transfer cartridge filters from transfer casks to cement prelined drums for shipment.

8. Compactor

A 15 ton unit designed to compact dry waste into 55-gallons DOT 17 H drums.

9. Controls

Complete remotely operated controls are provided for drumming station(s), decanting station(s), and material handling equipment. Local controls are provided for cement filling station, compactor, and drum inspection and labeling station.

284 310

A record board to show drum inventory under the crane(s) is provided as part of the control package.

10. Shield Wall Support Frames

Structural steel frames to support the drumming station, decanting station, and drum inspection and labeling station shield walls are supplied.

B. Equipment Description and Operation

1. Cement Filling Station

The cement unloading, storing, feeding, weighing, and conveying equipment is used to load 55-gallon drums with the correct weight of cement. This system has been designed for dust-free operation with tight joints, special shut-off and control valves, and a dust free nozzle. Controls and interlocks are provided to assure vacuum conditions within the storage tank, conveyor, filter and fill nozzle points at all times when operating, so that dust cannot enter the plant's atmosphere or deposit on the outside surface of the drum. The cement storage tanks are statically grounded. The Kamlock fitting provided on the fill line will fit a standard four inch, bulk delivery truck hose. The fill line pipe connects to a diffuser box at the top of the main storage tank. Cement is conveyed to the top of the tank through the fill line pipe using air supplied by the standard blowers normally installed on cement delivery trucks.

Cement filling stations may be provided for inside or outside installation of the main storage tank. Inside installations utilize a main storage tank which has a cement capacity of 1240 cu. ft.. It is fabricated with 1/4" steel plate with corrugation of the side and back panels to provide structural rigidity. The tank bottom is made up of air slide panels which are used to fluidize the cement for discharge. Air utilized for this fluidizing system is supplied from a positive displacement rotary blower. This blower supplies high volume, low pressure air through an automatic sequencing distributor valve to individual sections of the air slide system. Cement is discharged from the front of the tank into a bucket elevator which is used to convey the cement to fill the day tank. The manhole at the top of the tank and a ladder inside allow entrance for maintenance work. Access doors in the lower section of the tank allow maintenance personnel to have access to air piping supplying the air slide system. Dust-free operation has been ensured with tight joinings, and caulked seams. A sonic sensor

284 311

mounted at the top of the tank is utilized to monitor filling operations and to alarm prior to overfilling.

Cement stations utilizing an outdoor main storage tank have a storage capacity of 2400 cu. ft. of cement. This storage tank is cylindrical with a conical discharge section. It is fabricated from 1/4" steel plate and has been supplied with similar features as the indoor main storage tank. The fluidizing system utilized for cement discharge is located in the conical section and consists of small jet-pulse type air vibrators. Operation of this fluidizing system is automatically controlled when conveying cement from the main storage tank to the day tank. The conveying equipment utilized for day tank filling is a pneumatic conveyor system. This system consists of a receiving tank, and pressure regulated solenoid valves which allow cement to be conveyed through a fill line to the day tank on a batch basis with air. Located at the top of the main storage tank is a sonic sensor which is used to monitor filling operations to preclude over filling, and a dust collector which collects any dust generated during operation of the air conveyor system. Access to the top of the tank has been provided with a ladder. Hand rails and a steam shield located on the top of the tank have been supplied for personnel safety.

The day tank is fabricated from 1/4" steel plate and has been provided with a fluidizing system to assist cement removal. This fluidizing system consists of small jet-pulse type air vibrators which fluidizes the cement upon operator command. A sonic sensor mounted at the top of the day tank is used to guard against overfilling. This sensor is interlocked with system controls and is used for alarm indication and to automatically stop the conveying equipment supplying the day tank with cement. Cement from the day tank is discharged into a screw conveyor system which transports the cement to the fill nozzle for drum loading.

The drum loading system consists of a control console with a slanted top for controls and readouts. Located adjacent to this console is an elevating mechanism with an electronic scale which is used to raise the drum to the fill position. The fixed-height fill nozzle is surrounded by a dust plenum which is connected to an air filter system to ensure that no cement dust escapes the atmosphere during the filling operation. The elevating mechanism has a conveyor section that aligns with the roller conveyor provided for drum handling. As the drum is raised with the elevating mechanism to the fill nozzle, a centering device aligns the drum opening with the fill nozzle. A thumb wheel switch provided with the console controls is used for presetting the quantity of cement to be loaded into the drum. Digital readouts are displayed on the console which indicate the tare weights (empty drum and drum with mixing weight) and the weight of cement added to it.

284 312

This second readout also provides visual indication of filling progression. Controls for operating the elevating mechanism are also located at the control console and are used for raising and lowering the drum to the fill nozzle. When the drum has been positioned at the fill nozzle, the operator can then initiate either automatic filling operations or manual filling operations. Once the filling operation has been started, the shut-off valve on the fill nozzle is opened, the screw conveyor is started, and the dust collection system is energized. Cement is then transferred from the day tank and deposited into the drum. The weighing system monitors filling progression and displays the weight of cement added at the control console. Once the net weight of cement coincides with the filling operations unless in the manual mode. Thumb-wheel switches provided with the solid state equipment allow for dribble compensation to bias the weighing system for variations in cement. A clear tare push-button has been provided which allows the operator to remove the original tare reading from an electronic memory circuit and add it to the net weight of cement. This weight is then displayed on the control console and indicates the total weight of the drum and cement. A scale zero push-button has been provided on the console to accurately zero the weighing circuitry. The electronic weighing system has a 999.9 lb. capacity.

The dust collection system may be energized at any time by the operator but operates automatically whenever filling operations are initiated. This system includes a motor driven ventilation fan which provides vacuum conditions within the day tank, conveyor section, and at the vacuum plenum on the fill nozzle. Any dust which is generated when performing filling operations is drawn by this system with the vent fan to an exhaust air filter assembly. Dust is captured on the filter elements of this system, and the filter air passes out through the blower to exhaust piping. Individual filter elements of the dust collection system are cleaned automatically and alternately. During this cleaning operation, a solid state control timer automatically selects the element to be cleaned and activates a solenoid controlled air valve. Once the solenoid has been activated, the air valve opens and allows a pulse of compressed air (low volume, high pressure) to pass through the selected filter element from the inside outward removing dust from its surface. Purged dust then drops into a receiving hopper (inside cement stations) or into the day tank, (outside stations). Dust deposited into the receiving hopper is conveyed with a separate screw conveyor to be utilized for drum filling. Safety valves guard all components against overpressure.

Once the drum has been filled with cement, the operator then uses the controls for the elevating mechanism to lower the drum, manually replaces the cap, and moves the drum on the roller

284 313

conveyor to a staging area for a crane pickup.

In addition to performing drum filling operations, the cement station provides a work area where drums may be inspected for damage, where the drum cap may be inspected for proper threading where the mixing weight may be added, and for making log entry as dictated by the Process Control Program.

Numbering on the drum head is recommended to facilitate viewing by means of the crane grab T.V. and surveillance cameras. Lables or stencils (if used) should be water-proof and resistant to damage from radioactivity. They should be pre-numbered with letters of sufficient size and contrast to permit reading from a considerable distance above the drum. Numbering of the drums allows for positive identification of the drums and facilitates drum process control.

2. Shield Walls

Each shield wall is 5' x 10' x 12" thick. The shield wall is arranged to bolt to a machined steel support frame that is inserted into the concrete shield wall prior to pouring. It forms a rectangular frame, measuring 4' wide and 9' tall, around the equipment on the safe side of the wall.

The shield wall consists of a steel plate, machined on all six sides, through which a number of penetrations are made for operating shafts and other items. The various plugs which fit into the penetrations, as well as the operating shafts, are stepped to prevent radiation's streaming to the safe side of the shield wall. The service pipes or tubing and electrical wires are passed from the safe side to the hot side of the wall through plugged and stepped penetrations.

The shield wall support frames consist of heavy angle iron frames machined after welding on the surfaces which contact the shield wall. To the forward face and angle of the frames are welded 1/4" plates which project forward to form the inside of the Purchaser's concrete walls. Suitable anchors are provided which may be tied to the concrete rebars. The 12" thick shield wall overlaps the support frame structure 6" on all sides to prevent radiation's passing around the wall to the safe side.

In addition to providing a radiation shield, the wall serves the additional function of equipment foundation, permitting factory assembly of driver and driven components. This serves to increase service life due to factory controlled equipment alignment.

284 314

310

3. Drumming Station

The drumming station is a compact assembly of components to drum radioactive slurries and solutions in 55-gallon drums with a solidification agent. For safety in operation and for maintenance, the equipment is attached to both sides of a 12" thick steel shield wall. On the safe side are mounted all motors, 4-way air valves valve operators, and as many of the gear reducers as is practical. On the hot side of the wall are the pumping end of the metering pump and the drum processing enclosure. This is the side which is an unsafe location for the operators or maintenance personnel when drums are being handled. Personnel can be present on the safe side of the wall during operation for maintenance or other purposes without danger of radiation exposure.

The drumming station is supplied preassembled with the metering pump, drum processing enclosure and associated equipment attached to the shield wall. It is piped and wired to minimize field assembly. A description of the drumming station components follows:

Drum Processing Enclosure

The drum processing enclosure is an assembly provided for cap removing, liquid waste filling, cap reinserting and tumbling (mixing) of 55-gallon drums. The assembly is completely enclosed to prevent any escape of radioactive liquid or gas.

The enclosure is attached to the radioactive side of the steel shield wall, with drive motors, limit switches, and controls on the opposite, safe, side of the shield wall. The enclosure is stainless steel. Internal surfaces are as free of crevices as is possible to limit potential radioactive particle hideout.

Two platforms are mounted on the opposite sides of the hatch. One platform is a set-down position to facilitate loading the drum processing enclosure. The second platform is equipped with load cells for weighing filled drums plus two radiation detectors for measuring drum radiation level. This arrangement of loading and unloading platforms minimizes drum processing enclosure loading and unloading time. The scale and radiation detectors are connected to digital solid state readouts on the control console. The second detector tube is a spare component. If the first tube becomes inoperative, the second tube may be used simply by switching lead connections at the control console.

284 315

As a drum is lowered into the drum processing enclosure, it comes to rest on a transfer platform supported by a vertical shaft designed to transport the drum from the loading position to the capping and uncapping, filling and mixing positions within the drum processing enclosure. This platform moves in an arc perpendicular to the shield wall. Two drive motors are located on the safe side of the shield wall for moving the platform horizontally to each work station and for elevating the drum and platform at the filling and capping positions. Limit switches, also on the safe side of the shield wall, stop the platform at each of the working positions. When in the mixing location, the drum is clamped and the platform is retracted to a rest position. The drum is then free to rotate end over end for mixing purposes, again with separate drives located on the safe side of the shield wall. A mechanical locating unit assures final precise positioning at the capping position and at the filling position.

To operate the drum processing enclosure, the operator first determines the effluent to be drummed and sets the counter on the pump for the quantity he wishes to place in the drum. The pump selector switch is next set to the proper mode. A drum is then loaded into the enclosure using the overhead crane, and the hatch closed. The operator then presses the start button to start the automatic cycle. The drum is uncapped, filled, capped and mixed after which the drum returns to the load-unload position and the automatic cycle stops. For safety reasons, opening and closing of the hatch is not a part of the automatic cycle.

To allow for out-of-location tolerances at the capping position, the drum is retained on the transfer platform by means of a spring-loaded base. The final drum position at the capper is assured by a mechanical device which guides the cap flange into the proper position. This device allows the cap to be out of position as much as 1/2" (approximately eight times quoted location tolerances for drum manufacture). A limit switch notifies the control system that a cap is in the correct position for removal. If there should be no cap in the drum, or if the drum is out of position, the automatic cycle stops. When in position, the capper inserts the collet into the cap, expands the collet with sufficient force for the cap removal, reverses direction and turns the cap out of the drum on the same helix as the threads in the drum cap. The motor for rotating the collet, the air cylinder

284 316

for expanding the collet, and the limit switch are all located on the safe side of the shield wall.

After the cap has been removed, it is held by the capper collet and the drum is lowered and moved to the fill nozzle position.

The drum is raised until the filling nozzle is inside the drum cap fitting before filling starts. Limit switches will not permit flow until the drum is in the proper position. The drum is filled with the quantity of waste which has been preset by the operator on the pump automatic stroke counter.

A measured amount of clean water flush occurs automatically after the pumping cycle, to clear radioactive material from the fill nozzle. After each drum filling, a pause occurs to permit dribble to enter the drum before the drum is disengaged from the filling nozzle. A shut-off valve is located above the fill nozzle to eliminate dribble as much as possible. A sonic-type overflow sensor is located in the filling nozzle to prevent spills or excessive liquid in the drum due to automatic control failure or operator error.

Air displaced during filling is vented through an annular passage around the nozzle to the radioactive vent line. A flange is provided for connection to the station radioactive vent system.

After the fill operation is completed, the drum and carriage are moved to the cap position, and the drum cap is replaced.

The drum is then clamped firmly to preclude movement during tumbling of the drum. When clamped, the drum transfer platform is retracted away from the carriage to permit clearance for the drum to be tumbled end over end. Mixing cycle time is controlled by an adjustable timer and when complete, the drum is again stopped in an upright position, the drum transfer platform returned to position, and the drum unclamped. The carriage then returns the drum to the unload position and the automatic cycle ends. The operator may then open the hatch by means of a push button and move the drum to the out-going scale platform with the overhead crane. After recording gross weight and radiation level as displayed on digital readouts, he may transfer the drum to the proper decay pit or directly to a truck.

284 317

The operating cycle can be changed from manual to automatic and automatic to manual at any time. All motions are interlocked to ensure correct sequencing. Status lights at the control console apprise the operator of drum processing operation. If malfunction occurs, the operator can quickly troubleshoot and decide whether to clear the fault or proceed under manual control. Automatic sequencing is locked out until the malfunction has been corrected.

Cycle time is approximately five minutes for uncapping, filling and recapping. Mixing time may be varied, depending on the mix proportions of solution or slurry and cement. A normal mix time would be eight to ten minutes.

Two spray systems are provided for emergency or routine decontamination purposes. One is capable of washing down the complete internal surface of the drum processing enclosure. The second is designed to wash down the exterior of a drum during mixing. Drum washdown will not be a normal function. If required, drum drying may be accomplished by tumbling the drum while clamped in the mixing position.

A drain connection is provided on the bottom of the drum processing enclosure. This drain will be connected to the plant equipment drainage system or other tankage as desired by the utility.

Positive Displacement Metering Pump

The pump is used to pump and measure the quantity of evaporator concentrates delivered to the drum filling nozzle in the drum processing enclosure. It may also be used to flush radioactive pipelines with water and return radwaste to the Purchaser's holding tanks.

The metering pump is designed specifically for this application. The design stresses on component parts are low, and operating speeds are moderate, providing long life.

The pump is comprised of an actuator assembly attached to the safe side of the shield wall, a piston rod passing through a plug in the shield wall, and a piston and valve assembly located in the radiation zone. The pump piston is single-acting with seal water retained within packing at the periphery of the piston. Seal water pressure is above the maximum working pressure of the pump so that any leakage occurs from the seal water into the pump chamber. Seal water is also applied to the valve operating rods. The rear portion of the pump jacket provides a pump to collect any seal water leaking past the piston seals

284 318

to the rear of the piston and return it to the equipment drain. A doubleacting air cylinder actuator drives the pump piston. Displacement is 1/2 gallon per stroke. The delivery rate is 15 gpm maximum and the pump can deliver approximately 100 psi discharge pressure with an 80 psig air supply.

The multiple poppet-type valves are operated by single-acting 2-1/2" diameter air cylinders. Springs return the valves to their seats and will hold the valves closed against a 100 psi differential pressure. Stroke length of the valves and main piston is controlled by stops in the air cylinders. This arrangement prevents pounding and wearing of pump components located in the radiation area. Sealing of the external pump housing is by means of "grafoil" gasket, and sealing of the pipe flanges is by means of stainless steel gasket. All construction materials are corrosion resistant stainless steel or bronze. Hard chrome plate over stainless steel is used to protect wear surfaces of the cylinder and operating rods. Valves are equipped with replaceable hardened seats.

Air valves for the actuator assembly are manifolded so that cylinder lubrication oil can be separated from the exhaust air before it is discharged.

Wearing components of the actuator air valves, limit switches and cylinders can all be serviced from the safe side of the shield wall. The pump piston and valve assembly on the hot side of the shield wall are designed to facilitate flushing for decontamination prior to servicing. Piston and valve packings, guides, seats, cylinders, cylinder rods, and valve stems are reached for service by removing the cylinder head while the pump housing remains attached to the shield wall plug.

The main pump air cylinder is mounted on a subplate attached to the wall plug. The subplate and cylinder are unbolted from the plug to provide access for uncoupling the main piston rod. The pump air cylinder is a double rod type to accommodate limit switches.

Control of the pump is accomplished from the control console by means of a selector switch, a digital fluid volume readout and start-stop buttons. The selector switch permits the operator to conveniently select the operation to be accomplished. The selector switch actuates the pump valve controls in proper sequence to automatically ensure that the correct suction and discharge valves are used for the planned operation. The readout circuit contains a control that permits the operator to preselect the volume of liquid to be pumped. The pump will automatically stop after delivery of the preselected volume. For example, to fill drums from the decanting tank, the operator turns the selector switch to "Fill drum from decanting tank" and sets the counter to the desired quantity of material to be pumped. The pump then delivers the required quantity, when required, in the automatic uncap, fill, cap and mix cycle.

The pump is extremely flexible due to the integral valves which operate either as suction or discharge. The pump is used to pump and measure the quantity of evaporator concentrates or other concentrated liquid wastes delivered to the drum filling nozzle in the drum processing enclosure. Since one of the connections to the pump is a clean water supply, the pump may be used to not only return radwaste to a Liquid System holding tank, but also to flush return and feed lines.

4. Decanting Station

The decanting station is a compact assembly of components to remotely decant slurries. For safety in operation and for maintenance, the equipment is attached to both sides of a 12" thick steel shield wall. Mounted on the safe side of the wall are all motors, 4-way air valves, air cylinders, controls, and as many of the gear reducers as is practical. On the hot side of the wall are the decanting tank and the pumping end of the metering and decanting pumps. No preventive maintenance is required on the hot side of the shield wall.

The decanting station is supplied preassembled with the decanting tank, metering and decanting pumps and associated equipment attached to the shield wall. Components are factory piped and wired to minimize field assembly. A description of the decanting station components and their operation follows:

Decanting Tank

The 500 gallon (working capacity) decanting tank accurately proportions solid waste and water to ensure the proper proportions for solidification. It is a closed 304L stainless steel cylindrical vessel, approximately 4'-6" diameter x 5' high, with semi-elliptical upper head and conical lower head and is designed and built to ASME Code Section VIII. It includes a movable decanting nozzle, sensors and a mechnical mixer.

The decanting tank is attached to its shield wall by four bolts extending through the wall and by two dowel pins which facilitate engagement of the bolts. The entire assembly is designed to be installed or removed from the shield wall in a minimum of time, if it should become necessary, to reduce radiation exposure of maintenance personnel.

The tank is filled from the top with a 1-1/2" line coming from the valve manifold. A connection for 284 320 emergency overflow is located at the top of the tank. The overflow can be connected to the plant drain line or trap. The tank can be drained through the pump to the manifold and returned to the proper liquid system tank. A vent nozzle is provided. This will guide the air displaced during filling of the tank to the station's radioactive vent line.

A decanting arm is mounted near the top of the tank. Water is decanted off through the arm itself, which is a pipe. The arm is raised or depressed by a positioning motor which is mounted on the safe side of the shield wall. The motor drive extended shaft connects to the decanting arm at the tank shell by means of a sealed rotating joint. This sealed rotating joint is of sufficient length to assure proper alignment of the mechanism. Mechanical limit switches prevent overtravel of the decanting arm. The arm is equipped with instrumentation to indicate its position. Two ultrasonic sensors are located at the enlarged intake end. One of these detects liquid and liquid-slurry interface level. The other detects final desired water level and causes the decanting pump to shut off. The arm position is continuously displayed at the control console with a solid state digital readout. The level sensors activate electronic equipment located on the safe side of the shield wall to determine levels for display at the control console on two additional solid state readouts indicating water level and solids level and to provide a means of decanting pump shut off.

The decanting tank mixer is operating when filling with slurries and provides a homogenous mixture when filling drums from the tank. A motor located on the safe side of the shield wall drives the mixer by means of a right angle gear drive. The mixing shaft is provided with three cast stainless steel propellers and a precision manufactured rigid coupling. Extensive testing at C-E-Co. has shown that the slurry discharged from the decanting tank is reasonably uniform throughout the entire discharge period. Uniform mixing is essential to the accurate proportioning of the ingredients for waste solidification.

A radiation sensor is mounted on the decanting tank to determine the approximate radiation level of slurries to be drummed, either separately or with evaporator concentrates, for the purpose of normalizing the radiation level of shipping containers. This would normally be measured during mixing, but after decanting is complete.

Decanting Pump

The decanting pump is used to remove excess liquid from the decanting tank. It is an 18 gpm progressive cavity-type, positive displacement pump driven through the shield wall by reduction gearing and a 1 hp motor. Pump rotor speed is 387 rpm.

The motor and gear box are located on the safe side of the wall to facilitate servicing. All of the pump moving parts: screw, universal joints, seals, bearings, gearing and motor can be removed from the safe side of the wall. The stator assembly is held to the pump housing by only four bolts for rapid disassembly, when required, and is the only component not removable from the safe side of the shield wall.

The entire pump is designed and manufactured by S-E-Co. except the rotor and stator which are standard "Moyno" components furnished by Robbins and Myers. The helical rotor is chrome plated stainless steel. The double helical stator is a radiation and abrasion resistant elastomer. The pump housing is of stainless steel designed and fabricated by S-E-Co.

The pump shaft is sealed at the pump inlet end with a double-faced type seal supplied with demineralized water. Seal leakage inward and outward is harmless non-radioactive water. Seal leakage outward is piped to the equipment drain system.

The deep groove ball bearings which support the shaft and the precision cut reduction gearing run in oil. The drive and reduction gearing on the safe side of the shield wall can be serviced without removing rotating components which pass through the shield wall.

Positive Displacement Metering Pump

The metering pump is designed by S-E-Co. specifically for its application. The design stresses on component parts are low, and operating speeds are moderate, providing long life.

The pump is extremely flexible due to the integral valves which operate either as suction or discharge. The pump is used to pump and measure the quantity of evaporator concentrates or other concentrated liquid wastes delivered to the drum filling nozzle in the drum processing enclosure. Since one of the pump valves is connected to a [illegible]er source, it may also be used to fl[illegible] radioacti[illegible] pipelines with water and return r[illegible] waste to the Purchaser's holding tanks. 284 322

The design of the pump is as described previously in the Positive Displacement Metering Pump Section under Drumming Station.

Operating of Decanting System

Incoming spent demineralizer resins or other waste feed slurries enter the decanting tank from the top with the tank mixer operating. When the tank is full, the mixer is stopped and the slurry is allowed to settle. The decanting arm intake nozzle is positioned at the top travel position above the liquid surface. After the solid contents have settled, the arm is lowered until the ultrasonic sensor located at the intake nozzle contacts the liquid surface. This level is displayed and held on a S-E-Co. solid state digital readout at the control console. The arm continues down until the ultrasonic sensor contacts the liquid-slurry interface. The arm then stops. This level is displayed and held on a second digital readout.

After observing the two level displays, the operator raises the arm, by means of remote controls on the control panel, to the correct position for decanting as determined from tables supplied by S-E-Co. Excess water is drawn off by the decanting pump and discharged to the liquid system waste water tank. When the water level in the tank uncovers the upper ultrasonic sensor, the decanting process stops automatically. The arm is then raised into the top of the tank and the mixer is started automatically. After a mixing delay period to ensure a uniform material, the metering pump draws the slurry from the tank and meters it into 55-gallon drums through the fill nozzle on the drum processing enclosure.

A manifold located at the top of the tank provides water to spray heads. When turned on by the operator, the sprays wash all surfaces inside the tank to prevent buildup of solid material and reduce radioactivity to a minimum for maintenance. If necessary, the sprays may also be used to add water to the decanting tank. The interior of the tank is polished to a No. 4 microfinish to assist decontamination.

5. Piping and Control Valves

All required piping, valves, and remotely operated valve operators are also preassembled with the drumming and decanting station shield walls.

Process and flush water piping is 1" to 2" diameter 316L stainless steel for concentrate service or 304L for slurry and flush water service. All welding is consumable insert butt welding. Flanges are used only at customer interface points and connecting piping to equipment that may periodically require removal for maintenance. Air piping is

284 323

Schedule 40, 304 stainless steel piping or stainless steel tubing, depending upon size, space, and application.

All valves on the hot side of the shield wall are nonlubricated, sleeved plug valves. These valves were chosen as standard after S-E-Co. tests because they seem to be the best available for this service. They provide tight shut off, no crud pockets, full throat opening, external adjustment of seat and seals, and a high molecular weight polyethylene sleeve which does not lose its resilience with age. The sleeve may be replaced without removing the valve from the line and is protected from fluid errosion. Metal backup seats are provided.

The valve operators mounted on the safe side of the shield wall are designed and manufactured by S-E-Co. The rack and pinion designed operator, which is operated by an air cylinder, is designed to be fail safe (closed) with air or power supply failure. Valve operators are also provided with wrench connections to open or close the valves from the safe side of the shield wall. A feature permits separating the gears during maintenance for safety purposes. The valves are equipped with limit switches in a watertight cavity to give visual position indication on the semigraphic panel in the control room.

6. Remotely Operated Material Handling Equipment

   a. Bridge Crane

      The bridge crane is designed and constructed for precise, remote handling of radioactive materials. The crane has a 7-1/2 ton hoist and the bridge span is variable to suit individual stations. It includes a specially designed grab for handling 55-gallon drums. It is operated from the control room with the aid of TV cameras. Lights for the TV cameras are on the crane which permits bulb changing in a relatively safe area. The crane is built to the CMAA #70 specification and is designed for use in radiation areas. Structural, mechanical and electrical equipment is capable of being washed down in case of radiation buildup or for normal housecleaning purposes. Two electrical circuits are provided for the trolley, bridge, grab, and hoist, one for the high-speed and one for the low-speed motors. This ensures that electrical failure will not prevent remote removal of the crane from a radiation zone nor completing the operation in process at time of failure.

      The bridge assembly consists of twin, wide-flanged beams attached to end trucks with high strength bolts. Beam and end truck welds are continuous to eliminate potential dust traps. Bridge drives, motor starters and shock absorbing bridge stops are mounted on the bridge. Drive gearing is totally enclosed, running in oil. End truck wheels are hardened, cast steel, running on hardened steel rails. Two TV cameras, each with remote adjustable title, downward viewing, are mounted on the bridge for area surveillance. Area lighting mounted on the bridge beams is high pressure sodium and is of sufficient brightness for the TV cameras.

The trolley carries the 7-1/2 ton drum grab hoist and trolley drive motors, transmission, enclosed motor starters, upward viewing TV camera and lights (to illuminate the locating grid mounted on the ceiling) and shock absorbing trolley stops.

In addition to shock absorbing stops on bridge and trolley, each unit is equipped with limit switches to shut off first high speed and then low speed power as the unit approaches the stops.

The drum grab handles open and closed top drums. It is supplied with multiple clamping jaws for sure grip and redundant motor operated jaw actuator for positive load release control. Downward viewing TV camera on the grab centerline and incandescent lights provide a view of the top of the drum on a control console monitor to aid the operator. This TV is also utilized as a drum inspection tool to discover contamination, if any, before removing the drum from the drum processing enclosure. In addition, a solid state digital grab elevation readout is located on the control console. The readout tells the operator the height of the grab above a fixed reference point and indicates grab motion. The drum grab jaws are designed to clamp on the upper flange at equally spaced variations in drum diameter. The grab is equipped with a slack cable limit switch which prevents opening the jaws unless the load is firmly supported on the floor.

A standard crane hook adapter is provided which may be attached to the drum grab for handling other loads.

Electrical cable handling gear for the bridge and trolley is provided with separate cars which run parallel to the bridge or trolley. These light-weight cars are equipped with large diameter sheaves at each end providing long radius turns for the cables. Cable take-up is provided with independent weighted sheaves for each cable to compensate for stretch. The cables themselves are radiation-resistant and have been provided with quick disconnect plugs for ease of connection/removal.

284 325

The crane target grid system provided for accurate remote control positioning consists of fields of anodized aluminum targets, one for each normal drum set down location in the decay pits, drum pickup location for cement filled drums, and at the drumming station. Alphabetical and numerical designations on the targets provide positive identification for points of bridge and trolley travel. Lines on the targets are used in conjunction with a cross hair on the camera for precise location of the load. The targets are mounted upon stainless steel wire supports between steel frames. Suitable ceiling anchors are to be provided by the Purchaser. The aluminum targets are viewed on a control console TV monitor. The TV camera and incandescent lights are located on the trolley pointed directly at the targets.

Two electrical circuits are provided for the trolley, bridge, hoist and grab jaw motion, one for high-speed and one for low-speed motors. Thus, the crane will be operable in the event of electrical failure in any one circuit. This permits the lifting or travel to be completed, the load released and the crane returned to a safe area for repair of the faulty circuit.

The crane drive speeds are:

	High Speed	Low Speed
Bridge	125 fpm	2.5 fpm
Trolley	125 fpm	2.5 fpm
Drum Grab Hoist	30 fpm	7-1/2 fpm

The two-speed drives provide fast transport but with accurate locating capability, reducing the chance of damage to the drums. Higher crane speeds are not necessary because the operator will have more than ample time to transfer drums while drum filling and mixing are being accomplished automatically.

For safety and to assist positioning accuracy, the drum must be raised to the full up position before high speed operation is possible with the bridge or trolley. In this position, the drum is between the bridge beams. It will clear all obstacles cleared by the crane and is supported to eliminate swinging. It is virtually impossible to spill or damage drums due to operator error in low speed operation (2.5 fpm). The bridge or trolley may be moved at low speed with the grab at any elevation. This speed will not induce significant load swing or permit damage to containers or equipment that may come in contact with the load.

284 326

Controls for the crane include spring-return, toggle-type (joy-stick) switches mounted in the control console. With one switch the operator can select the speed and the direction of motion of the bridge and, with a second switch, he can select the speed and direction of the trolley. These controls can be used independently or simultaneously to reach a desired position as seen on the TV monitors. A third, similar, switch is provided to control the speed and up or down travel direction of the grab while the operator refers to the digital grab elevation readout and TV monitors.

b. Fixed Bridge Crane

This equipment is a standard crane trolley and grab assembly as described above. The trolley rails are mounted on fixed beams rather than on a bridge as with a bridge crane. Cable handling equipment, TV systems, etc. are supplied as with the bridge crane described in (a) above. This equipment is supplied to reduce cost and space requirements when single horizontal axis motion is required. Crane capacity is one ton.

c. Drum Handling Lift Truck

The drum handling lift truck is provided for handling empty and low radiation level drums such as those filled with compacted waste. It is used in the radwaste building for stacking and transporting drums in storage, for transferring drums from the cement filling station to staging areas beneath the bridge crane, and for moving drums filled with compacted waste.

The lift truck is battery powered and has a drum lift capacity of 1,000 lbs. It has been designed for severe duty and complies with all applicable requirements of ANSI B-56.1 - 1969 "Safety Standards for Power Industrial Trucks," as required by the U.S. Department of Labor, and the Occupational Safety and Health Administration Act of 1970 (OSHA) Section 1910.178.

The truck is operator ridden and is counter-balanced. It has been equipped with a specially designed drum grab by S-E-Co. The drum grab provides drum clamping and unclamping through a d.c. linear actuator, and 180° horizontal rotation with a d.c. motor driven gear box. The grab has an extension of approximately 5 feet which, with the truck's lift, allows drums to be stacked three high.

All controls for operating the truck and drum grab are located for ease of operation. The truck is powered by a UL approved industrial-rated d.c. motor, heavy duty, full ball bearing, with a high starting torque and maximum overload capacity. The SCR motor control provided ensures infinite speed control, smooth starts and more operating time per battery charge.

d. Rail Mounted Transfer Cars

Rail mounted transfer cars are provided for transportation interfacing and movement of drums in areas of limited head room. They are designed to complement Drumming Station operation, Fixed Bridge Cranes in the drumming room, and Bridge Cranes in the Radwaste building.

Each transfer car is supplied with separate tracks and are capable of transporting two drums each. The cars are equipped with cradle assemblies to guide drums to a secure position.

The transfer cars are capable of being moved onto the same track and are provided with automatic couplers to allow retrival and movement of disabled cars to maintenance areas and the completion of operations.

The cars are driven by electric motors taking their power from conductors. Controls are remotely located and include push button switches. Semi-automatic operation and control logic is provided through a limit switch system which allows car movements to predetermined positions. A graphic display package is also provided with the controls. This display is a schematic representation of the transfer car system and allows the operator to monitor operations with light indications.

7. Drum Inspection and Labeling Station

Smear testing and labeling per 49 CFR 173 may not be required provided drums are shipped in a cask or other approved container. Therefore, low level drums to be shipped unshielded on a standard truck will require labeling and smear testing to prove that the external contamination of the drums does not exceed legal limits.

When required labeling and smear testing are normally accomplished in conjunction with radiation measurement and truck loading.

A small steel shield wall is supplied to permit performance of these functions in relative safety. The steel shield wall is attached to concrete shielding forming a box around a radioactive drum. The top of the enclosure is open so that the bridge crane may place drums into and remove drums from the enclosure.

When a drum is placed on the hot side of the shield wall, it is resting on a motor driven turntable which provides the operator the ability to rotate the drum. The drum may be rotated to provide smear testing and radiation measuring capability by means of vertical access openings in a fixed location down each side of the shield wall.

A hand tool is provided to permit the operator to smear test the drum, working through the slot alongside the steel shield wall.

Labels are applied through the vertical access openings from either side of the shield wall utilizing a hand-held tool. After measuring drum radiation level, the operator records the required information on the label and inserts the label in a holder on one end of the hand tool. Holding the handle on the other end of the tool, the operator inserts the label through the vertical slot, guiding it visually with the mirrors, and presses the label on the drum.

All openings are located in such a position that no direct-line radiation can pass through them to the operator's body.

Stainless steel vertical mirrors are provided inside the station on both sides for viewing the drum.

The station may be equipped with a means of attaching an open top drum head to a DOT 17H drum if this function is desirable such as in PWR stations requiring cartridge filter disposal.

8. Compactor

The S-E-Co. dry waste compactor is designed specifically to compact paper, cloth, glass, floor sweepings and other low-level dry waste in standard 55-gallon drums. It has several unique features which make it particularly suitable for this service. (See attached print No. LD11796-A.)

The hydraulic system operates at the relatively low pressure of 780 psi for long life. However, the compacting piston is seven inches in diameter, giving a total force of 30,000 pounds. The five inch diameter piston rod plus a thirteen inch stop tube prevent damage to any cylinder or ram components due to eccentric loading. Likewise, the frame is designed for stall-out loads either eccentric or on center.

The drum rests on a contoured plate which supports the bottom of the drum during compaction. This plate is pushed out of the main frame by a small hydraulic cylinder in the base, so that the loaded drum can easily be picked up by an overhead hoist or lift truck.

With the ram in the up position, the vertical clearance to the bottom of the drum is sixty inches, or twenty-six inches above the top of the drum. Ordinarily, this space could not be filled with waste at the start of compaction, but the S-E-Co. compactor is equipped with a drum extension which is open for loading and closed for compacting. This permits compacting a full sixty inch stack of waste.

The drum extension space is evacuated by a built-in fan to prevent the dust's escaping into the room. The air to the fan is drawn through a roughing filter and then a 0.3 micron HEPA filter, effectively trapping the dust. The differential pressure gauges tell the operator when the filters need changing. The used filters can be dropped into a drum in the compactor without being touched by hand.

To prepare for loading and compacting, an empty, open-top drum is placed on its support plate which is then drawn into position underneath the ram. A hinged work table is swung into place and locked. This table clamps against the top false wire of the drum, holding the drum securely in place, and also provides a seal for the drum extension space. The table adds to the convenience of filling the drum. After the drum is filled with loose waste, the drum extension door is closed and locked shut and then the waste is compacted.

All of the preceding motions are interlocked with limit switches so that the ram cannot be operated unless the drum is all the way into the compacting position and unless the drum extension door is closed. Further safety is provided by spring-return-type controls for each of the two hydraulic cylinders. The hydraulic fluid is phosphate ester to minimize fire hazard and to help ensure long life of the hydraulic components.

Details of components and construction are as follows:

Hydraulic System

Compressive force is obtained through the hydraulic cylinder assembly rated at 1950 psi and operated at 780 psi. The 7" diameter cylinder is equipped with a 5" diameter chrome plated piston rod and 1-1/4" thick reinforced steel plate platen.

Attached to the platen are four spikes with stripper plate for puncturing plastic bags at the start of compacting. This will relieve pressure buildup in bags during compaction.

284 330

The 57" stroke cylinder includes a 13" stop tube to limit the stroke to 44". This provides added support to the rod when experiencing eccentric loads. It also serves to improve life of seals, packing and other components. The rod gland is externally removable without disassembling the cylinder. A self-compensating and self-relieving lip seal is used that can conform with pressure variations and mechanical deflections. A wiper seal is also supplied that protects the lip seal from external dirt. The cylinder is sealed to the heads by static "O" rings.

The piston rod is chrome plated for corrosion and scratch resistance. The surface is polished to 10 micro inch finish or better for maximum seal life.

The hydraulic pump and control valves are mounted on a 55-gallon capacity hydraulic fluid reservoir built into the compactor frame. The reservoir is complete with fill and drain fittings, fluid level sight glass and thermometer. A hydraulic pressure gauge, reading in pounds of thrust, is mounted at the operator's station.

The hydraulic pump is a variable volume, pressure compensated, vane-type unit rated at 1500 psi. With this type of pump, the output pressure during the working stroke is equal to the resistance met by the cylinder, rather than operating at full pressure through a relief valve. When the cylinder stalls, and the pressure builds up to the pre-set maximum, then the flow is zero except flow through the bearings. Thus, horsepower, heat generation and wear are always at a minimum. The net result is a smaller motor requirement and maximum pump life.

The maximum output pressure of the pump (780 psi = 30,000 pounds compacting force) is set on the pump at final assembly in our shop. In addition, there is a safety relief valve set to a slightly higher pressure.

The pump and other operating parts of the hydraulic system are protected by a screen filter on the suction line, by a high pressure fine filter on the supply line, and by an automatic air bleed valve.

Directional control of the compacting cylinder is obtained through a 3/4" four-way hydraulic valve rated at 3000 psi. It is solenoid and pilot-operated. Response time is 0.12 seconds maximum at 500 psi. Maximum continuous rating is

80 cycles per minute. A regenerative circuit is used to give rapid advance until substantial compacting resistance is met, and then half speed advance to full compacting pressure.

Control of the drum extension cylinder is through a 1/4" four-way hydraulic valve rated at 5000 psi. It is solenoid operated. Because this cylinder is much smaller than the compacting cylinder, a speed control is incorporated.

All hydraulic tubing is stainless steel with stainless steel ferrule-type fittings.

Air Filtration Assembly

This assembly consists of a roughing filter, two HEPA filters operating in parallel, a suitable fan, gaskets, air plenum, pressure gauges reading ΔP across the roughing filter and the HEPA filters and connection for attaching the system outlet to the plant radioactive vent system. The filters are located behind the circular drum extension plate and air is pulled from the compaction chamber over the top of this plate.

The roughing filter is 1" thick modacrylic fiber with a nominal capacity of 840 cfm, .09" water gauge initial resistance and a recommended discard resistance of 0.5 water gauge. The primary purpose of the roughing filter is to extend the working life span of the HEPA filters. Each of the two cell-type 12" x 12" x 5-7/8" HEPA filters is waterproof, fire retardant, glass fiber filter media with standard plywood sides and neoprene gaskets. Nominal capacity of each filter at 2" water gauge ΔP is 300 cfm. Recommended discard resistance is 4" water gauge ΔP. The HEPA filters are 99.9% efficient, with DOP test method on 0.3 micron particles.

The direct drive centrifugal exhaust fan housing is cast iron with epoxy coating. The dynamically balanced radial fan wheel is mounted directly on the motor shaft to assure permanent alignment. It is a cast aluminum wheel to lessen weight and provide maximum resistance to potential corrosive fumes and dust. The fan wheel is directly mounted upon the shaft on a 1 hp 3400 rpm motor. Capacity of the fan is 600 cfm at 3" static water pressure. The fan is mounted to a plenum at the rear of the compactor frame. The fan discharge nozzle may be connected to the plant radioactive vent system.

284 332

Pressure gauges mounted at the operator's station measure pressure drop across the roughing filter and the HEPA filters. The operator may readily determine when filters are dirty and require changing.

Controls

Ram motion and direction are controlled by large heavy-duty operating levers located at the operator's station, as is the drum extension cylinder. Control push buttons and indicating lights are also mounted in this location. A NEMA 12 electrical box complete with disconnect switch, wired to all compactor electrical components is built into the right side of the machine.

The controls are located conveniently, are simple to operate, and are of rugged construction.

Compactor Frame

The fram is of heavy-duty welded carbon steel "box" type construction. The frame is designed to withstand eccentric loading under maximum operating force of the machine. Construction details minimize radiation traps. Controls and instrumentation are flush-mounted on the hollow frame with no exposed wiring on the front or sides of the machine.

The drum rests on a contoured plate which supports the bottom of the drum during compaction. This plate is pushed out of the main frame by a small hydraulic cylinder in the base so that the loaded drum can be picked up by an overhead hoist.

Loading Table

A one piece table hinged on one side swings away from the top of the drum permitting easier drum loading and helps to prevent spillage and minimizes the possibility of drum rim distortion during compaction. An over-the-center type lock secures the table to the frame during compaction. The lock is opened and the table is moved out and to the side when moving a drum into or out of the machine. An interlocking limit switch requires the table to be closed for operating of the compactor and to be open for operation of the drum slide.

Drum Extension

A 26" high circular steel extension is located above the drum to permit compacting material to be stacked up to 60" high. A one piece hinged door segment of the extension swings out 180° to permit loading waste into the drum. When compacting, the door is locked in a closed position

284 333

with a hand-operated, over-the-center clamp. Limit sw ch interlocks, in compliance with O.S.H.A. regulations, prevent operation of the compactor with the doors open.

A second hinged segment of the circular extension is then swung out of the machine for access to the roughing and HEPA filters. To change filters, the operator removes six bolts attaching the drum extension to the left-hand machine column. The extension is next swung out of the way. The operator may then, by using a hook, drop the roughing filter directly into a drum positioned in the machine. This exposes the HEPA filters which are removed by using an extension socket wrench to loosen four clamp screws.

9. Controls

Control Console

The control console is a free-standing, desk-type, dust-tight enclosure. All control and indicating devices required for remote operation of the bridge crane and drumming station are located on this console. The controls are located for ease of operation, and writing space is provided for the operator. The control console consists of modules, each approximately 24" wide, for each bridge crane, drumming, and decanting station supplied. Additional modules are provided when required for other functions.

In one module for each bridge crane are the TV monitors with their control units, conveniently grouped for operator surveillance while operating the crane. Large, toggle-type control handles are provided to operate the crane. Removable plates located both on the front of the desk and under the desk, plus doors on the rear, are provided for each access to the interior equipment for maintenance and replacement.

The drum processing control module contains a graphic panel of the system and all the manual switches and visual indicators for operating the drumming and decanting stations.

A separate matching module may be provided on the control console for the indicators and controls to transfer concentratres, resins and other wastes to the drumming and decanting stations. This allows the same operator to control these operations and the drumming and decanting stations in a safe manner.

284 334

Electrical Cabinet

A free-standing electrical cabinet is provided containing control logic, starters and relays for the decanting station, the drumming station and the bridge crane. All equipment and terminal boards are easily accessible for maintenance and replacement. Either top or bottom entry for control and power cables can be accommodated. This cabinet is connected to the control console at the floor level with a steel wireway which also serves as a walkway between the two cabinets. Spacing is adequate to permit opening doors in the cabinets and to provide space for maintenance.

Electrical Cable

All interconnecting cables between the console, control cabinet, crane, drumming and decanting stations are provided with preper-length cable fitted with terminals for easy field connection. Cables are radiation resistant and are designed to operate with the crane cable handling equipment. Cables are factory connected to the control room and are not disconnected for shipment. Plugs are assembled on each cable to plug into receptacles on the processing equipment and crane. All electrical connections for the drumming and decanting stations are on the safe side of the shield walls.

Record Board

A record board, to be mounted on the Purchaser's radwaste control room wall, is supplied to record the location of all drums in the crane bay. This board consists of an etched plan view drawing mounted on a suitable backboard. Drum set-down positions are represented by hooks identified by alpha-numeric designations to agree with the grid targets. The operator can place circular discs on these hooks. On the disc can be inscribed the number of the drum, its weight, the date it was drummed and the drum radiation level as of that date. Glancing at this board, the operator will know where all drums under his control are located for later rearrangement within the decay pits or for truck loading.

10. Shield Wall Support Frames

The shield wall support frames consist of heavy angle iron frames machined after welding on the surfaces which contact the shield wall. To the forward face and angle of the frames are welded 1/4" plates which project forward to form the inside of the Purchaser's concrete walls. These structures

284 335

are inserted into the station concrete shield walls prior to pouring. After installation of the shield walls, they form a radiation seal between the safe and hot sides.

C. Equipment Arrangement

Since each nuclear plant has site-sensitive conditions that should influence the arrangement of the solid radwaste area and equipment, it is S-E-Co.'s policy to work with the customer and his architect-engineers to arrive at the best overall arrangement for the customer's individual conditions. S-E-Co. makes drawings and alternate arrangements considering such things as operator safety, maintenance safety, ease of overall operation, adequate decay pit storage, sufficient empty drum storage, convenient location of the control room, free and clear access for dry waste from the remainder of the station, access to radioactive areas, etc.

The equipment requires a relatively small amount of floor space which permits good utilization of building volume and an infinite number of feasible arrangements optimized for the various site conditions.

The equipment is designed to handle two to three drums through the processing equipment per hour and utilize a single operator working in the shielded control room. With 16 to 24 drum-per-shift capacity, it is anticipated that the operator will fill drums with cement at the start of each shift prior to processing. This will require 15 to 30 minutes under normal conditions.

There are two versions of the cement handling equipment. One is designed to be placed inside the building, either in a side bay or under the crane. The other is designed to place the cement storage silo outside the building with the day tank and nozzle for placing the cement in the drum inside the building.

There is no reason to place the decanting station under the crane unless that is the best location for some other reason such as short piping runs to the drumming station.

The control room may be placed at any location within the radwaste area or it may be outside the radwaste area, whichever is most feasible from an operating standpoint. It is necessary to have access to the electrical cables from the crane, drumming and decanting station, otherwise, the control room may be placed in any location.

The crane bay may be from 25' to more than 60' wide, depending upon available space and optimum arrangement. We prefer to have approximately 23 feet of the head room in the crane bay because this provides optimum flexibility in equipment arrangement, the ability to stack drums five

284 336

high in decay pits if necessary for emergency storage, the ability to bring any standard truck in under the bridge crane for toploading the truck or casks, and ample storage under the crane for dry waste or empty drums if desired. With 23 feet of head room, the inside cement tank and cement filling station can be placed under the crane where there was as little as 18 feet and as much as 38 feet of head room available. Penalties are paid in economics for variations from the 23 foot ideal height.

A number of drawings, as discussed below, are included to outline various features and arrangement flexibility.

1. Figure 6 shows a 46' x 92' area (6,440 square feet) laid out typically for a single nuclear unit. It includes one drumming station, one decanting station, a bridge crane, a cement filling station, compactor, two decay pits, a drum inspection and labeling station, control room, a special drum-handling lift truck, and storage room for empty drums and dry waste drums. Various features of this arrangement are as follows:

    a. Shield walls

    The crane bay in the area of empty drum storage, control room, and cement filling station is separated from the working area by a floor-to-ceiling shield wall. Shield walls around the decay pits and processing equipment are as high as feasible while permitting crane access to the areas. The drumming and decanting stations are separated by a concrete shield wall to avoid the necessity of decontaminating both units if it is necessary to work on the hot side of the shield wall on either unit. Note also that the passageways to the decay pits and processing equipment are covered as is the working position for the operator at the drum inspection and labeling station. The decay pits are placed at the end of the building as far from the truck bay as possible to minimize any potential radiation shine.

    Preventive maintenance and most other maintenance for the drumming and decanting stations is done from the safe side of the shield wall adjacent to the truck bay.

    b. Decay Pits

    The low and high level decay pits are divided equally and will hold a total of 740 drums when the drums are stacked five high. Under normal operating conditions the decay pits would hold drums stacked no more than two or three

284 337

high. The remainder is for insurance in the event of interruptions in transportation or other types of emergencies.

There is room for 475 empty and/or dry-waste-filled drums. The empty drum storage area holding 218 drums is convenient to the inlet conveyor of the cement filling station.

c. Cement Filling Station

The cement filling station is located convenient to the control room. This would normally be operated by the single operator 15 to 30 minutes per shift prior to processing to fill the drums with cement. Empty drums are placed on the ingoing cement conveyor where the drums are filled with cement and capped. They are then pushed on to a gravity conveyor where they are stored. The outgoing section of the conveyor goes to the crane bay by means of a penetration in the shield wall. This provides a means of supplying cement-filled drums to the crane for pickup. Note that this position is completely shielded from all other equipment in the crane bay.

The line for filling the cement tank from a bulk cement truck runs to the outside of the station to avoid the necessity of dirty cement trucks entering a potentially radioactive area.

d. Truck Bay

The truck bay is suppressed approximately four feet to handle two separate transportation modes. Handling of radioactive containers can be done remotely with the bridge crane with top loading casks and trucks. Receipt of nonradioactive materials such as empty drums may be more conveniently handled by means of the lift truck end-loading from the trailer.

e. Control Room

The control room is shielded from radioactive zones and includes a record board providing the operator the location of every drum within the crane bay.

f. Compactor

The compactor is shown in a separate room, having adequate access from the remainder of the station and access for the

284 338

lift truck to handle filled drums. Storage for uncompacted dry waste is shown.

g. Drum Inspection and Labeling Station

The drum inspection and labeling station is located conveniently for crane handling between the decay pits and the truck bay. The operator is in a covered position while this equipment is in operation and is safe from overhead loads and radioactive containers on the truck or elsewhere under the crane.

2. Figure No. 7 shows a very conservative arrangement for a two-unit station.

a. The 10,988 square feet has six decay pits capable of storing a total of 2,196 drums in these high, intermediate, and low level decay pits. The high level decay pits are in 25 inch square storage silos with concrete plugs on the top. Each of the 52 cells stores four drums stacked one on top of the other at each end of the crane runway. The S-E-Co. bridge crane can remotely remove the plugs for access to these high level storage cells.

b. This arrangement is equipped with two S-E-Co. remotely operated bridge cranes. When not in use, the cranes may be parked over the high level storage cells which is a safe area due to the concrete plugs on top of each silo. This area is also used for crane maintenance.

c. There are two truck bays so that two operations may be proceeding at the same time if this should be desirable.

d. The control room is a combination control room, used for both the liquid and solid radwaste systems. We prefer this arrangement in many cases because it makes coordination of transfer of radwaste much simpler. If the control rooms are not combined, we recommend that transfer functions be placed on the solid radwaste system control console.

3. This drawing does not show a shield wall separating the drumming station from the decanting station. Since this drawing was made, the arrangement has been changed to include this feature.

3. Drawings LD13857 and LD13858 illustrate an arrangement currently being built for a power plant in the U.S.A. in which the drumming equipment is separated from the storage and shipping area by a substantial distance. They are in separate buildings a few hundred feet apart. This particular installation is

currently a two-unit station and is planned to be four-unit station at some later date. The radwaste storage building as shown on LD13857 is arranged to handle waste from all four units eventually.

Drawings LD13858 shows the two drumming and two decanting stations for this two-unit plant located in the basement of the Auxiliary Building, near the radwaste storage tanks, to minimize piping runs. Drums are transported to and from the drum processing enclosures from remotely operated transfer cars by means of fixed bridge cranes. The fixed bridge cranes move on only one axis. The remotely operated cars transfer cement filled drums to the processing equipment from the Storage Building.

Note in the lower right-hand corner of the drawing that there is shown an overhead hatch, "Filter Drop Area". This is a hatch in the floor above to permit lowering prelined concrete drums containing cartridge filters to the transfer cars for transport to the Storage Building.

Drawing LD13857 shows the Storage Building arranged with ample decay pits, two truck bays, and access to the transfer car tunnel so that drums may be removed from or loaded on the transfer car by means of the remotely operated bridge cranes. The drum inspection and labeling station is located between the two truck bays in a position convenient to the trucks. The operator of this equipment is fully protected from radiation exposure. A side bay contains the control room for operation of the drumming stations, decanting stations, fixed bridge cranes, tunnel transfer cars, and the bridge cranes. It also includes ample space for storing empty drums and the cement filling station.

In operation, empty drums are delivered to the Storage Building where they are filled with cement at the filling station. A gravity conveyor delivers the cement-filled drums to a pick-up point in the crane bay. The cranes carry the cement filled drums and load them on the transfer cars. The transfer cars deliver the drums to a position under a fixed bridge crane. The fixed bridge crane places the drums into one of the two drum processing enclosures in the basement of the Auxiliary Building. Once the drums have been filled, mixed, and weighed, and their radiation level has been measured, the fixed bridge cranes return the drums to the cars for delivery to the Storage Building for storage in one of the decay pits.

A typical arrangement for the rail transfer car tunnel is shown on LC8626. These cars may be either electric or battery-powered.

294 343

4. Drawing LD14157 shows an arrangement of a Storage Building prepared for a European utility requiring on-site storage. As with the preceding arrangement, the processing equipment is in the Auxiliary Building and drums are transported to the Storage Building by means of the remotely operated transfer car.

   In this case, the building is arranged with 35 feet of head room and one large decay pit which will hold a total of 7,054 drums. As shown on the key plan, the building is arranged so that it may be expanded at some future date if permanent storage does not go according to schedule or if on-site storage becomes satisfactory for the long term. A truck bay and drum inspection and labeling station are included to ensure that future transportation from this site can be done conveniently utilizing the remotely operated bridge crane. In this case, as in many others, a relatively safe area over the truck bay is utilized for crane maintenance.

   The concept of separating the storage, shipping, and solidificiation agent area from the processing equipment area by placing them in two separate buildings seems particularly useful for retrofits where the space near the liquid radwaste system may be limited, for nuclear parks where one waste handling storage area may be desirable for multiunit installations, or for on-site storage should this concept become feasible in the U.S.A.

5. Drawing LD14255 shows an arrangement for a single nuclear unit installation. It is included primarily to show the arrangement for an outside cement storage silo feeding an inside cement day tank and filling station.

   The arrangement may be of interest because of the separate dry waste compaction and storage area.

D. Customer Supplied Services

   1. Utilities, Vents and Drains.

Purchaser-supplied utilities and vent and drain connections required at the S-E-Co. shipping unit boundary are listed below. Flow and power requirements shown are for each component supplied:

284 341

CONNECTION	INTERFACE	DESCRIPTION
*Water	Drumming-Decanting Station	Primary or demineralized water, 50 gpm, 52/45 psig, 35 to 100°F
**Station Air	Drumming-Decanting Station	90-115 psig, 75 scfm, dry and clean
	Cement Filling Station	90-115 psig, 50 scfm, dry and clean
Electrical Power	Control Panel	460 V, 3 phase, 60 Hz.
	Bridge Crane	20 kw
	Drumming-Decanting Station	24 kw
	Service Outlets	120 V, 1 phase, 60 Hz. 5 kw
Electrical Power	Drum Inspection & Labeling Station	460 V, 3 phase, 60 Hz., 5 kw
Electrical Power	Compactor	460 V, 3 phase, 60 Hz., 10 kw
Electrical Power	Cement Filling Station	460 V, 3 phase, 60 Hz., 15 kw
Vent (Contaminated Air)	Drumming Station	170 scfm, -1" H_2O
	Decanting Station	10 scfm, atmospheric
Vent (Station Air Exhaust)	Drumming-Decanting Station	100 scfm, atmospheric pressure
Vent (Contaminated Air)	Compactor	660 scfm, -2" H_2O (from S-E-Co. supplied fan and filter)
Vent (Bag Filter Exhaust)	Cement Filling Station	10" x 12" duct to outside of building (16) scfm @ 6" H_2O)
Equipment Drain	Drumming Station	A 2-1/2" closed drain system is recommended.
	Decanting Station	A 2-1/2" closed drain system is recommended.

284 342

CONNECTION	INTERFACE	DESCRIPTION
Floor Drain	Radwaste Area	Conventional floor drains in radwaste area should be provided to handle water from periodic external wash down.

*If water regulator is supplied, 50 gpm @ 50 to 150 psig.

**S-E-Co. will supply pressure regulation and lubrication equipment for the air line. Oil separation equipment will also be provided for the air exhaust line.

D. Customer Supplied Services (Continued)

2. Containers

The drumming station is designed to utilize 55-gallon drums of the closed head Type 17C per 49 CFR 178. Each drum is fitted with a 4" opening centered in the top head. This fitting provides positive assurance that the torque incurred during remote capping operations will not loosen or twist the fitting. The cap should be ordered without internal lugs to ensure proper clearance for the collet on the capper mechanism. Drums having the above fitting and cap can be obtained from most major drum manufacturers having plants located throughout the United States.

Tolerances on normal drum manufacture drawings are plus or minus 1/16" on the horizontal location of the cap fitting and plus or minus 1/8" on the overall height of the drum. While the drum processing unit has built-in flexibility, substantially exceeding the above tolerances, drums not manufactured to reasonable tolerances may cause difficulty in the remote handling system.

The S-E-Co. crane and drumming station will also handle a 17H-type, open head drum. If filling is to be accomplished in the drum processing unit, a cap and fitting should be supplied with the open type head. Open head type drums are not recommended for normal use due to the increased possibility of leaking, increased cost and lower strength.

Refer to the Appendix for diagrams of closed head and open top drums for detailed specifications.

3. Mixing Weights

The mixing weight is an 18-inch length of #10 reinforcing bar readily available from steel supply houses. The bar is bent at its midpoint to a 120° included angle.

284 343

VI.
SYSTEM DEVELOPMENT

A. General

Stock Equipment Company is a designer and builder of specialized equipment for electric power stations. The company has 50 years of experience in this endeavor, and because of this experience realizes that to meet the requirements as outlined in Section II, Design Objectives and Major Features, it is normally impossible to purchase equipment meeting these criteria which was designed for general use or other specific applications. This apparently is particularly true when considering small equipment such as that applicable to radwaste systems.

Therefore, the S-E-Co. development program, whether it be equipment, research and development or testing, is aimed at designing equipment specifically for this application. In addition to having total in house design capability, Stock Equipment Company follows through on this by manufacturing components, including metering pumps, decanting pumps, gear transmissions and other drives, valve actuators, solid state electronic controls, nuclear guages, and other components.

The overall equipment development program includes the following components.

B. Establish Required Design Criteria

On any major system or component the following steps are usually taken.

1. Visit operating stations, utilities, and engineering firms to better define functional requirements.

2. Review literature concerning what equipment is available that may serve the purpose and review operating reports and other information that may bear on the problem.

3. Review regulations that may impact the particular design and possible regulation changes. This is primarily accomplished through discussions with regulatory bodies.

4. Through preliminary engineering, establish major criteria for those items that may serve the purpose. In some cases, this may involve building prototypes and testing of components.

5. Depending upon components, this may or may not involve solidification testing along with the above steps.

C. Equipment Design

Specific pieces of equipment are then designed. Based upon experience in the Engineering Department, those components that deviate significantly from other items previously designed will usually be mocked up in prototype-form and tested prior to producing this equipment. Design modoficiations, as required, are made based upon prototype testing results.

D. Contract Equipment

Equipment is fully assembled, piped, and wired after which it receives in plant testing prior to shipment. Continuity tests and the high pot tests are run on all electrical wiring and components. The equipment is operated mechanically. All limit switches are set. Fluid is pumped through the various process and spray piping. Handling equipment is load-tested and crashtested to ensure that the handling equipment is safe and operates as designed. Drums are cycled through the drum processing enclosure, and the decanting tank is calibrated to ensure accuracy of the instrumentation.

E. Solidification Testing

S-E-Co. has run solidification tests for approximately eight years. Test criteria have been primarily to establish that solidification formulas produce a product that is free-standing without free water. Tests are also conducted to improve the quantity of waste materials that can be successfully solidified in the shipping container. A relatively small amount of work has been done regarding leachability. This work has been suspended because of a lack of standardized leachability test procedures. The basic solidification tests have involved most available types of cement, a significant number of additives, all waste streams known to be released by nuclear power plants, as well as tests on polymers and other solidification agents. More recently tests have been conducted utilizing effluents produced by volume reduction equipment such as calciners and thin-film evaporators.

It is S-E-Co.'s policy to work with the utility to define the effluents and control ranges possible in the liquid radwaste system. From this data, laboratory-scale tests and, where unusual or new circumstances develop, full-scale tests are run to establish pretested formulas for use in the process control plan at individual stations. This is done for each contract since the waste streams and measure of control normaly vary somewhat from station to station. The pretested formulas have a built in safety factor to ensure that variations in effluents at individual stations will not result in unsolidified waste in the shipping containers.

284 345

F. Miscellaneous Testing

Various and sundry other tests are performed, as required, to ensure that the S-E-Co. equipment is, in fact, a bonafide radwaste system and that all components are satisfactory.

For example, a series of tests were conducted some time ago on 55-gallon drums, both open-top and closed-top design. The drums were hydrotested to destruction, compression tested to destruction, overloaded from a weight standpoint and stacked on top of one another at maximum crane speeds, and were submitted to vacuum conditions to destruction.

With the advent of the four-inch screwed closure in a nominal DOT 17C 16-gauge container, tests were also run to qualify this container to meet DOT 7A Specifications.

Miscellaneous other tests also include tests to determine reasons for gas evolution in solidified masses, physical restrains on operating the handling equipment, alternate filling methods (such as double-filling, vibration, moving nozzle, compacting, jet spraying, mixing radwaste streams, etc.).

Both the equipment development and solidification test programs are on-going programs to ensure that the S-E-Co. equipment is improved where possible and at the same time meets required technical criteria. This program is expected to produce incremental changes to the equipment with time as improved approaches are developed.

G. Operating Experience

The first S-E-Co. Solid Radwaste System was installed at Public Service Electric & Gas Company's Salem Station. This unit has started up and initially generated electricity in December of 1976. While some operating experience has been obtained, overall operation has been limited due to problems with equipment extraneous to that of the S-E-Co. Solid Radwaste System. However, that experience which has been gained, coupled with that of continued research, development and testing have been utilized in the design of the system described in this Topical Report.

The first units of the re-designed system have been installed and are currently in the final stages of pre-operational testing. This equipment has been retrofitted to an operating station; hence, operational experience is expected to become available shortly.

The installations mentioned above require handling of conventional radwaste streams from 2 P.W.R. units and 2 B.W.R. units. To date, equipment has been sold to handle solid radwaste from 4 B.W.R.'S and 18 P.W.R.'S. Contracts require handling of conventional radwaste plus the product from crystallizers, fluid-bed dryers, calciners and incinerators. Interfacing equipment to handling crystalizer products is presently in the final stages of development and full-scale

284 346

solidification tests using S-E-Co. test equipment coupled to a crystalizer pilot plant are in progress at this time. Interface equipment development to handle fluid-bed dryer, calciner, and incinerator product has been started and preliminary solidification testing has been completed. Additional full-scale testing is expected to be progress in early 1979.

284 347

VII

RADIATION EXPOSURE CONTROL

A. General

The S-E-Co. Solid Radwaste System has been designed to minimize possible radiation exposure to operating and maintenance personnel. Initial design and development of the system approached this subject on the basis of eliminating possible sources for exposure, regardless of the radioactivity level of the radwaste being processed. This concept is fundamental to equipment design and system operation. Various features provided with the S-E-Co. Solid Radwaste System for radiation exposure control and prevention have been detailed in depth under Sections II and V of this Topical Report.

B. Radiation Zones

Typical system arrangements for a single and a double unit installation are shown on Figure No. 6 and No. 7 in the Appendix. Radiation zones for the components comprising these arrangements will primarily depend on their location. However, the specific radiation levels within the zones will depend upon various site specific factors.

Summarized below are the zone classifications and estimated radiation levels for major components and areas comprising a typical installation.

ITEM	ZONE	RADIATION LEVEL (mrem/hr)
Control Station	I	<1.0 (typically $\leq .2$)
Drumming Station - Safe Side	I-IV	typically $\leq .5$ (during truck loading <100)
Hot Side	III-V	5 to >100 (after flush <100)
Decanting Station - Safe Side	I-IV	typically $\leq .5$ (during truck loading <100)
Hot Side	III-V	5 to >100 (after flush <100)

284 348

Cement Station	I	<1 (typically $\leq .2$)
Drum Inspection And Labeling Station	II	< 2.5
Dry Waste [illegible]	I	< 1 (typically $\leq .2$)
Truck Bay	I-IV	typically $\leq .5$ (during truck loading < 100)
Low Level Storage Area	V	≥ 100
High Level Storage Area	V	≥ 100

C. Operation

The use of an integrated, automatic control system, utilizing a closed-circuit television system permits total remote operation and monitoring of radwaste processing. Operation of the traveling bridge crane and the drumming and decanting stations are controlled from the control station (Zone 1). The radiation exposure incident upon operating personnel in this area should be only that of plant background. The time required for operators to be in the control station will necessarily depend upon various factors. These would include such items as waste generation quantity and type, operation of any liquid system auxiliary equipment such as volume reduction equipment, operations of the traveling bridge crane other than drum transport for solidification processing, and the particular Process Control Program utilized at the specific station.

The S-E-Co. Solid Radwaste System has been designed to allow operation of the drumming station, decanting station, and the traveling bridge crane by a single operator at the control station. A single drumming-decanting station unit as indicated on Figure No. 6 (Appendix) provides a processing capability of 2-3 drums/hour. This includes operation of the traveling bridge crane for transport of drums from the cement station to the drumming station and then to either the high or low level storage areas. For typically encountered radwastes, a single operator can process approximately 67-100 gallons of radwaste an hour with an average drum loading of 33.5 gallons. With a radiation field $\leq .2$ mrem/hr at the control station, exposure would then be < 0.003 man-mrem per gallon of radwaste. Annual exposure would be a function of the total quantity of radwaste processed during the year.

284 349

In order to solidify radwastes, the cement station is required to fill drums with pre-determined amounts of cement. The cement station is controlled by a single operator and requires an average of 3 minutes per drum of operation. With the cement station located in a Zone I area, having a radiation field of $\leq$.2 mrem/hr. the exposure incident to personnel would then be $<$.01 man-mrem per drum. For typically encountered radwastes, average drum loading is approximately 33.5 gallons per drum. This translates into an exposure of $<$0.0003 man-mrems per gallon of radwaste processed as a result of operating the cement station.

The S-E-Co. drum inspection and labeling station has been provided to allow smear testing, labeling and radiation measurements to be performed without an operator receiving direct-line radiation exposure. Handling and transport of the drums from the high and low storage areas to this station and then for subsequent truck loading is accomplished with the traveling bridge crane. Operator time required at the drum inspection and labeling station and control station for crane operation should be approximately ten minutes per drum (each). With a radiation field of $<$ 2.5 mrem/hr at the drum inspection and labeling station and $\leq$.2 mrem/hr at the control station, the exposure per drum would be $<$.417 mrem and $<$.033 mrem, respectfully. With an average drum loading of 33.5 gallons of typically encountered radwastes, this would result in an exposure of $<$ .012 man-mrem/gallon at the drum inspection and labeling station, and $<$ .001 man-mrem/gallon at the control station.

The time required for crane operation to load trucks will depend upon the particular method and procedure employed for this operation.

D. Maintenance

A major aspect of radiation exposure control and prevention is that of personnel exposure as a result of maintenance. This concept has been approached with the S-E-Co. Solid Radwaste System on a basis of minimizing sources for exposure and the requirements for maintenance. Features of the system provide for minimizing not only the individual exposure but also the collective dose from maintenance, are detailed throughout this Topical Report.

A Generic Environmental Impact Statement (GEIS) on the Treatment of Radioactive Wastes from L.W.R. Fuel Cycle Operations, drafted in 1977, by Westinghouse Hanford Company to Battelle-Northwest, evaluated the usage of the S-E-Co. Solid Radwaste System for this application. Total radiation exposure as a result of routine maintenance was estimated in this G.E.I.S. report to be less than 1 man-rem per year.

284 350

Listed below is a summary of annual inspection and maintenance requirements for a typical single drumming-decanting unit installation by major component. Manhours for completion of the various activities have been estimated and the radiation exposure incident to personnel performing these activities have been derived.

a. Traveling Bridge Crane

The traveling bridge crane is used for the transport and handling of 55-gallon drums to/from the drumming station, the high and low level storage areas, the drum inspection and labeling station, and for truck loading operations. The crane is remotely operated from the control console, utilizing a closed-circuit television system. Two independent electrical circuits, one for high speed and the other for low speed operation, have been provided so that an electrical failure in any one circuit will not prevent remote completion of an operation or movement of the crane to a safe maintenance area. Crane design and component selection have been directed at avoiding dust traps and are water tight, should decontamination by hosing be required. Materials of construction resist cummulative radiation buildup to 10^7 rads.

Periodic inspection, lubrication, and adjustment of crane components are required for assuring operability. Specific routine maintenance requirements and recommended schedules are provided for in the Operating and Maintenance Manual. These tasks can be accomplished by moving the crane to a safe maintenance area. Listed below is a summary of the annual maintenance requirements and estimated radiation exposure for a typical installation as indicated on Figure No. 6 (Appendix).

Requirement	Annual Man-Hours	Radiation Level (mrem/hr)	Annual Exposure (man-mrem/yr)
Inspection	12	≤ .5	≤ 6
Lubrication	12	≤ .5	≤ 6
Adjustment	10	≤ .5	≤ 5

b. Drumming and Decanting Stations

The drumming and decanting stations are compact assemblies of components used to drum radioactive slurries and solutions, and to remotely decant slurries, respectively. These components are mounted on 12-inch thick steel shield walls having stepped machined penetrations which allows for

284 351

the precise location and alignment of components. This also allows for the assembly of driver components normally requiring routine maintenance on the safe side of the shield wall. Penetrations in the walls, plugs, operating shafts, etc., are stepped to prevent radiation streaming to the safe side. Shielding provided is equivalent to 39 inches of concrete.

The majority of inspection, lubrication, and adjustments required for these stations is performed on the safe side of the shield walls. The only items requiring scheduled maintenance is that of the position lift mechanism, capper mechanism, and clamp-tumble mechanism. These items are located at the drum process enclosure with maintenance scheduled every 5-years. These items are easily removed and may be taken to a safe area for maintenance. The exposure resulting from this is indicated in the annual maintenance exposure summary listed below.

Requirement	Annual Man-Hours	Radiation Level (mrem/hr)	Annual Exposure (man-mrem/yr)
Inspection	8	≤ .5	≤ 4
Lubrication	10		
(5-yr. items)	.6	≤ .5	≤ 5
Adjustments	12	≤ .5	≤ 6

c. Control Station

The control station consists of the electrical cabinets, and a free-standing desk console which is used for operation of the traveling bridge crane, drumming station, and decanting station. This station is located in a Zone I area which has a radiation level equivalent to that of the plant's background. Routine maintenance requirements for the station would involve verification and calibration of controls and instruments. Recommended schedules for performing these operations is on an annual basis, and would require approximately 10 manhours for completion. Based upon this, annual exposure would then be ≤ 2 man-mrem per year.

d. Cement Station

The cement station consists of all the equipment necessary for storing and filling 55-gallon drums with predetermined quantities (by weight) of cement. Component location and access for performing routine maintenance such as lubrication, inspection, and adjustments are readily accessible to personnel. Maintenance platforms have been provided for

284 352

components which are not accessible from the floor level. Listed below is a summary of the routine maintenance requirements and the resulting maintenance exposure for these operations.

Requirement	Annual Man-Hours	Radiation Level (mrem/hr)	Annual Exposure (man-mrem/yr)
Inspection	6	$\leq .2$	≤ 1.2
Lubrication	12	$\leq .2$	≤ 2.4
Adjustment	8	$\leq .2$	≤ 1.6

e. Drum Inspection & Labeling Station

The drum inspection and labeling station as indicated in Figure No. 6, is located in a Zone II area. Located inside of the enclosure is the turntable assembly which consists of a gear box and motor. This assembly is removable as a unit from the enclosure and moved to a safe maintenance area with the crane. Schedule lubrication for this assembly is on a six-month basis, and would require 1 man-hour a year to accomplish. With this being performed in an area with a radiation level of $\leq .2$ mrem/hr., the annual exposure would then be $\leq .2$ man-mrem per year.

284 353

APPLICABLE FEDERAL REGULATIONS, REGULATORY GUIDES, AND N.R.C. BRANCH TECHNICAL POSITIONS

The S-E-Co. Solid Radwaste System is designed, fabricated and provides system operation consistent with Federal Regulations, Regulatory Guides, and N.R.C. Branch Technical Positions applicable to radwaste solidification systems. The following section delineates this subject in further detail.

A. Federal Regulations

1. Title 10, Chapter 1, Code of Federal Regulations - Energy, Part 20.

   The S-E-Co. Solid Radwaste System has been designed to minimize possible radiation exposure to operating and maintenance personnel (ALARA) not only on an individual but also on a collective dose basis. Features of system which have been provided for radiation exposure protection are detailed in depth in Sections II, V, and VII in this Topical Report.

   Equipment design has also been directed at preventing the release of radionuclides and harmfull contaminates to the station's environment. System operation solidifies radwastes with cement in specific ratios (pre-tested formulas) in 55-gallon drums. Ceme . is accurately weighed into drums prior to its combination with cement. Equipment provided for this purpose allows for dust-free operation to prevent dust from being released to the environment. Drum handling and processing equipment are remotely operated with components in contact with radioactive wastes located on 12-inch thick steel shield walls. Filling, mixing, and capping operations for radwastes are accomplished within an enclosed drum process enclosure. This enclosure isolates these operations from the station's environment. Connections are provided to connect the enclosure to the station's radioactive vent and drain systems.

2. Title 49, Code of Federal Regulations, Part 173

   The S-E-Co. Solid Radwaste System provides equipment and controls to accurately combine specific quantities of radwaste with cement in accordance with pretested formulas to assure complete solidification. Solidification results in a free-standing monolith with the radwaste uniformly distributed in compliance with DOT and NRC regulations and guidelines. This subject is discussed in further detail in Sections II, III, IV and V of this Topical Report.

284 354

The drum inspection and labeling station allows for drum smear testing and labeling in conjunction with radiation monitoring without an operator being exposed to direct-line radiation. This station allows for the gathering of necessary information required for the shipment of solidified radwastes.

3. Title 49, Code of Federal Regulations, Part 178.

The S-E-Co. Solid Radwaste System has been designed to utilize 55-gallon drums. Specified drums are 16-gauge, DOT approved, Type 17C closed-top drums, which have been provided with a four-inch opening centered in the top head. Drums are obtained by the plant's operator/owner from major drum manufacturers in the United States of America. Reference Drawing C9198 and the DOT 7A Test Report located in the Appendix of this Topical Report.

B. Regulatory Guides

1. Regulatory Guide 1.143

The S-E-Co. Solid Radwaste System is designed and fabricated consistent with the applicable requirements of this regulatory guide. Component design and fabrication as indicated in Section IX of this Topical Report is in compliance with the requirements listed under Equipment Codes (Table 1) of this regulatory guide. S-E-Co.'s Quality Assurance Program is discussed in Section X of this Topical Report.

2. Regulatory Guide 1.26

See Regulatory Guide 1.143

3. Regulatory Guide 8.8

The S-E-Co. Solid Radwaste System has been designed to minimize possible radiation exposure to operating and maintenance personnel. Design and development of the system approach this subject on a basis of eliminating possible sources of exposure, regardless of the radioactivity level of the radwaste being processed. This concept is fundamental to equipment design and operation and allows the establishment of effective radwaste management programs for assuring equipment operability, reliability and safety. The various features provided with the S-E-Co. Solid Radwaste System to provide radiation exposure protection as outlined in this regulatory guide, are detailed throughout this Topical Report. Stock Equipment Company also provides training and instruction

284 355

sessions for operating personnel as well as instruction manuals for operating and maintaining equipment.

C. N.R.C. Branch Technical Positions

1. ESTB No. 11-3

The S-E-Co. Solid Radwaste System provides for the establishment of an effective Process Control Program to assure compliance with solidification criteria and the requirements of this N.R.C. Branch Technical Position. This subject is discussed in further detail under Section IV of this Topical Report.

D. ANSI Draft Standard N 198 (Draft 1, Rev. 6, Nov. 1978)

The proposed American National Standard, ANSI N198, "Solid Radioactive Waste Processing System for Light Water Cooled Reactor Plants", establishes guidelines for the design, construction and operating features for solid radioactive waste processing systems. The S-E-Co. Solid Radwaste System is designed, constructed, and provides system operation consistent with most of the applicable requirements and recommendations of this draft standard. Areas for discussion are indicated below in reference to specific pages and paragraphs of this standard.

Page 11, 4.2.6 Sampling

Equipment supplied by S-E-Co. does not include sample lines. Should sampling of the liquid and slurry radioactive waste sources be required, this would be best accomplished at the liquid system equipment or interfacing lines prior to the S-E-Co. Equipment.

Page 14, 5.1.5 Chemical Addition

Chemical addition, if required, is accomplished in the liquid radwaste system. This would normally apply to pH control. Should additives to the cement be necessary to improve processing efficiency, this could be accomplished prior to or at the cement station.

Page 17, 5.4.5 Slurry Piping

In some cases, due to space limitations, bends in slurry piping are not 5 pipe diameter radii or long radius bends. This piping is used when pumping slurry with the S-E-Co. metering pump. Tests with this type of pump (reference report in Appendix) have indicated that pipe radius criteria is not necessary for preventing pluggages.

284 356

Page 23, 5.8.2.2

Operator monitoring of filling and capping operations is accomplished with an illuminated graphics display. The television system provided with the crane is utilized for drum inspection and monitoring of drum handling operations and transport.

Page 26, 6.1.2 Remote Viewing See 5.8.2.2

6.2 Table 6-1, Controls and Instrumentation

The S-E-Co. Solid Radwaste System complies where applicable except the following:

4.1 Cement - The cement station is provided with low level alarms. This system utilizes a main storage tank and a day tank where low level alarms are not required.

5.5 Radiation Level - The S-E-Co. System utilizes 55-gallon drums only. Filling is on a batched basis and radiation monitors provide information utilized for adjustment of the Process Control Program should control of drum radiation levels be required.

284 357

IX

CODES AND STANDARDS

The S-E-Co. Solid Radwaste System is designed and constructed in accordance with the requirements of N.R.C. Regulatory Guide 1.143.

All pressure vessels are designed and built in accordance with the A.S.M.E. Boiler Code, Section VIII, Div. 1.

Material for pressure vessels is selected from and in accordance with the A.S.M.E. Code, Section II (SA - Ferrous, SB - Non-Ferrous). All pressure retaining parts, including heads and shell plates, require a Certified Material Test Report.

Process piping for the system is designed in accordance with A.N.S.I. B31.1. Pipe is selected from A.S.M.E. Code, Section II and is seamless austenitic stainless steel, A.S.T.M. A-312, Grade TP 304L or Grade TP 316L. Process piping is Schedule 40S. Vent and drain pipe, 2-1/2-inch or larger is Schedule 10S. (Pipe requires a Certified Material Test Report.)

Permanently connected piping employees butt welds using consumable inserts unless prohibited by design consideration. The G.T.A.W. welding process is used.

Bridge cranes are fabricated with the latest available CMAA specification at the time of manufacture. All other components are fabricated per S-E-Co. Commercial Quality Assurance Standards and commonly accepted practice for intended service.

Welders working on pressure vessels, cranes, pumps, piping, and dry waste compactors are certified in accordance with the A.S.M.E. Code, Section IX. Individual Weld Procedure Qualification Tests and Welder Qualification Records are available for review at Stock Equipment Company.

Upon completion of a project, data books for A.S.M.E. Coded items are forwarded to the Buyer, with one copy being permanently retained by S-E-Co. These data books incorporate all required documentation such as Mill Test Reports, Certificates of Compliance and data reports required by the A.S.M.E. Code.

Packaging, shipping and handling of equipment is in accordance with A.N.S.I. N45.2.2. Written procedures are made available for review with approval.

X

QUALITY `SSURANCE PROGRAM

A. Introduction

Stock Equipment Company maintains a quality assurance program for all nuclear products manufactured. This program is documented with quality assurance manuals, procedures, and policies. The following discussion summarizes various aspects of this program, and has been generalized for this report.

B. Certifications

Stock Equipment Company has been issued the following ASME Certificates of Authorization:

ASME Section VIII

"U" Pressure Vessels

ASME Section III, Class 2 & 3

"N" Vessels, Tanks, and Fluid conditions devices

"NPT" Vessel and tank parts, piping subassemblies and component supports.

"NA" Shop assembly of completed and stamped class 2 & 3 Appertenances, piping subassemblies and component supports.

284 359

ASME

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Certificate of Authorization

Number 12,614

THIS IS TO CERTIFY that STOCK EQUIPMENT COMPANY

16490 Chillicothe Road, Chagrin Falls, Ohio - Location Only

is hereby authorized to use the U PRESSURE VESSEL *symbol of The American Society of Mechanical Engineers for*

ASME CODE PRESSURE VESSELS AND EXTENDED FOR FIELD FABRICATION IF PERMITTED BY THE ACCEPTED QUALITY CONTROL SYSTEM

in accordance with the applicable rules of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers. The use of the Code symbol and the authority granted by this certificate of authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers.

THIS AUTHORIZATION *expires on* April 30, 1981

Authorized on December 15, 1977 *for*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
by the BOILER AND PRESSURE VESSEL COMMITTEE

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Chairman Paul M. Brister

Secretary W B Hoyt

284 360

ASME

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Certificate of Authorization

Number **N -** 1709

THIS IS TO CERTIFY that STOCK EQUIPMENT COMPANY;
16490 CHILLICOTHE ROAD; CHAGRIN FALLS, OHIO 44422

is hereby authorized to use the N *symbol of The American Society of Mechanical Engineers for*

CLASS 2 & 3 VESSELS, TANKS & FLUID CONDITIONING DEVICES

in accordance with the applicable rules of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers. The use of the Code symbol and the authority granted by this certificate of authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers.

THIS AUTHORIZATION *expires on* APRIL 15, 1980

Authorized on APRIL 15, 1977 *for*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
by the BOILER AND PRESSURE VESSEL COMMITTEE

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Chairman L. P. Zick, Jr.

Secretary W. B. Hoyt

284 361

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Certificate of Authorization

Number **N** - 1711

THIS IS TO CERTIFY that STOCK EQUIPMENT COMPANY;

16490 CHILLICOTHE ROAD; CHAGRIN FALLS, OHIO 44422

is hereby authorized to use the NPT
symbol of The American Society of Mechanical Engineers for

CLASS 2 & 3 VESSEL & TANK PARTS, PIPING SUBASSEMBLIES &
COMPONENT SUPPORTS

in accordance with the applicable rules of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers. The use of the Code symbol and the authority granted by this certificate of authorization are subject to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers.

THIS AUTHORIZATION *expires on* APRIL 15, 1980

Authorized on APRIL 15, 1977 *for*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
by the BOILER AND PRESSURE VESSEL COMMITTEE

Chairman

Secretary

284 362

ASME

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Certificate of Authorization

Number **N -** 1710

THIS IS TO CERTIFY that STOCK EQUIPMENT COMPANY;

16490 CHILLICOTHE ROAD; CHAGRIN FALLS, OHIO 44422

is hereby authorized to use the NA *symbol of The American Society of Mechanical Engineers for*

SHOP ASSEMBLY OF COMPLETED & STAMPED CLASS 2 & 3 COMPONENTS, APPURTENANCES, PIPING SUBASSEMBLIES & COMPONENT SUPPORTS

in accordance with the applicable rules of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers. The use of the Code symbol and the authority granted by this certificate of authorization are subiect to the provisions of the agreement set forth in the application. Any construction stamped with this symbol shall have been built strictly in accordance with the provisions of the Boiler and Pressure Vessel Code of The American Society of Mechanical Engineers.

THIS AUTHORIZATION *expires on* APRIL 15, 1980

Authorized on APRIL 15, 1977 *for*

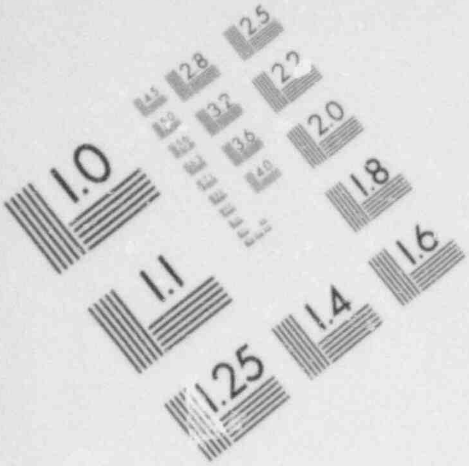
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
by the BOILER AND PRESSURE VESSEL COMMITTEE

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Chairman L. P. Zick, Jr.

Secretary W B Hoyt

284 363



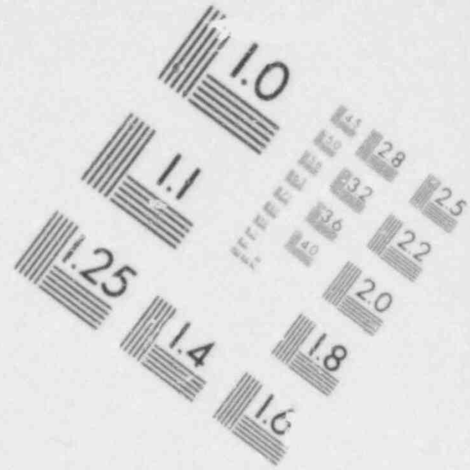
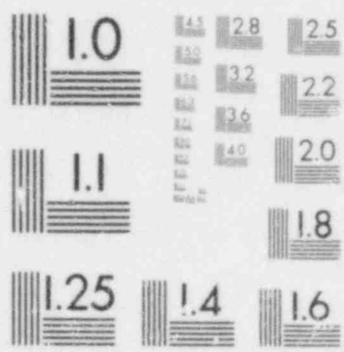
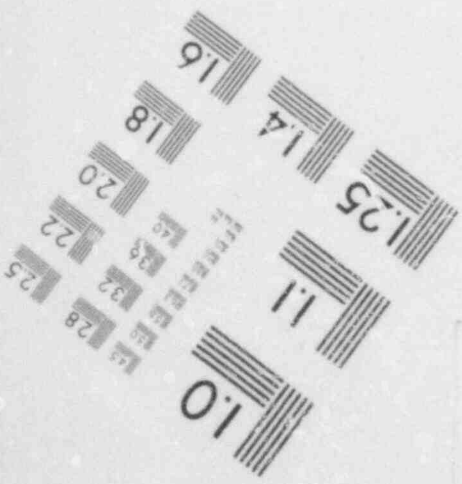
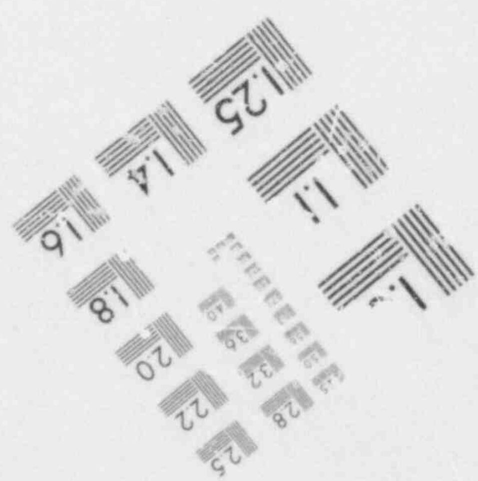


IMAGE EVALUATION TEST TARGET (MT-3)



6″





C. Organization and Responsibilities

The President has the ultimate responsibility for the maintenance of the Quality Assurance Program. It is his responsibility to review on a minimum yearly basis, the status and adequacy of the Quality Assurance Program. The President will have the final authority for resolution of differences which may involve the Quality Assurance Department and any other operating department.

The Quality Assurance Manager, reporting directly to the President, has the organizational responsibility and authority for the implementation and administration of the Quality Assurance Program. He assures that the quality assurance requirements are established, disseminated and implemented by the affected function in accordance with the CODE and design specifications.

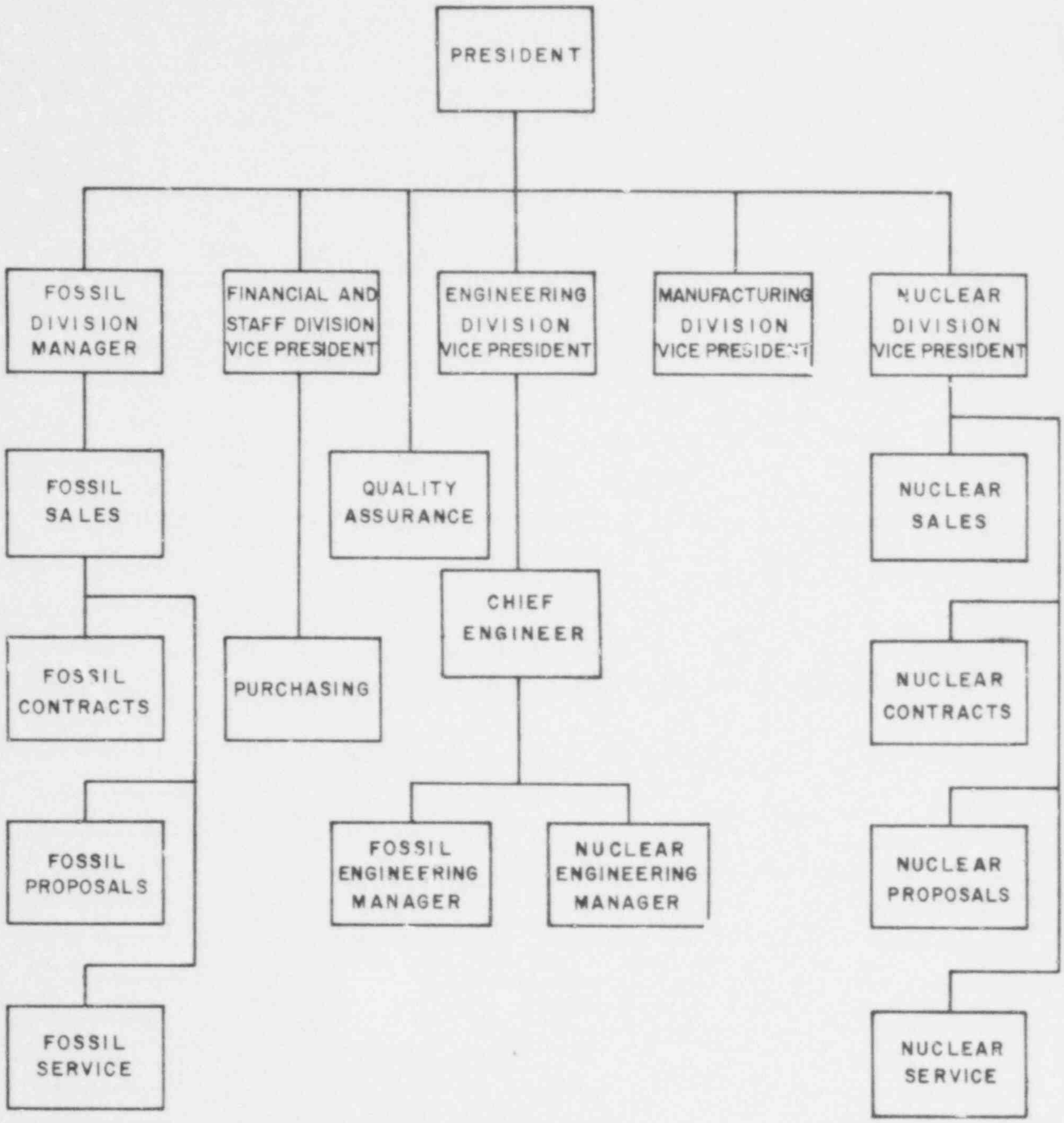
The Quality Assurance Manager is ultimately responsible for all S-E-Co. inspectors and the selection of services from any sublet nondestructive companies that may be required. Selection of subcontracted engineering services will be the responsibility of the Vice President of Engineering and the Quality Assurance Manager.

The Quality Assurance Manager has the authority to stop a project at any time if quality assurance requirements have been violated.

The Quality Assurance Department, under the direction of the Quality Assurance Manager, functions independently from any other operating department. The primary function of the Quality Assurance Department is to evaluate the quality assurance and quality control of items in order to assure strict compliance with the CODE, S-E-Co. drawings, specifications and procedures.

Organizational charts illustrating the structure of Stock Equipment Company are presented in the following pages.

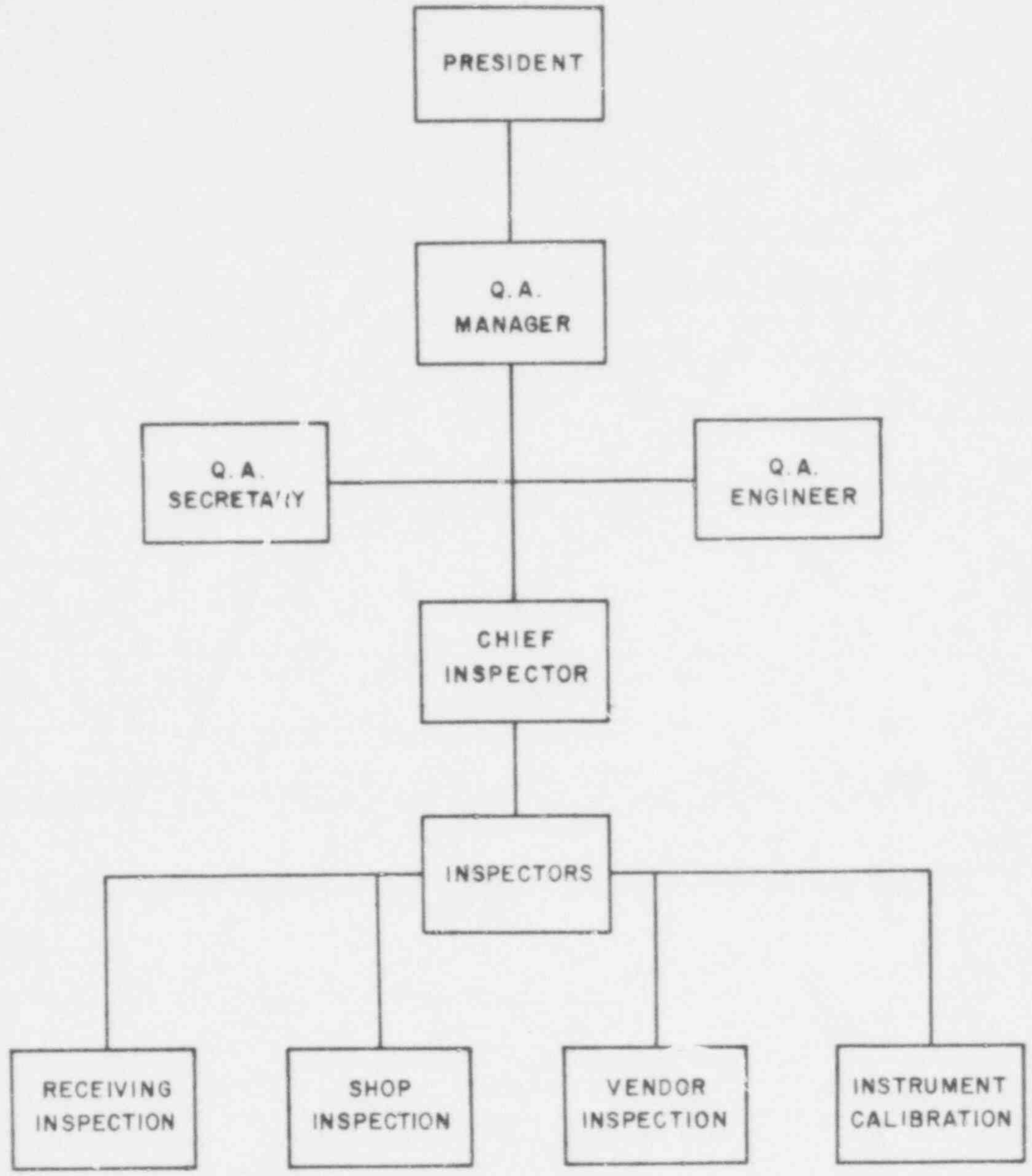
285 001



285 002 ~~285 001~~

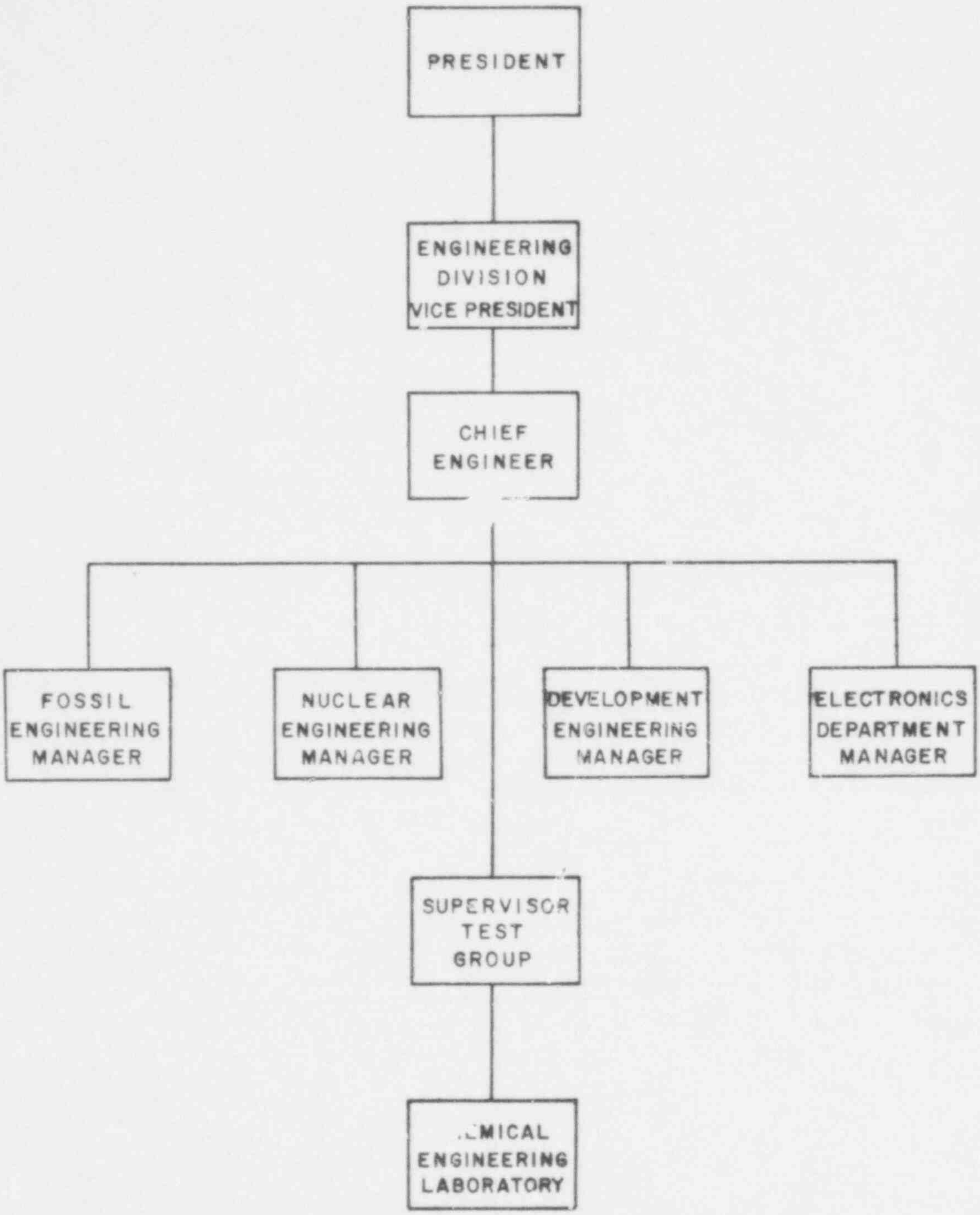
SECTION: I QUALITY CONTROL MANUAL	Revision Letter - A
SUBJECT: STOCK EQUIPMENT COMPANY ORGANIZATION	Date Issued - 2-1-79
	Page 4 of 9
Stock Equipment Company Standards	Number - 4

361



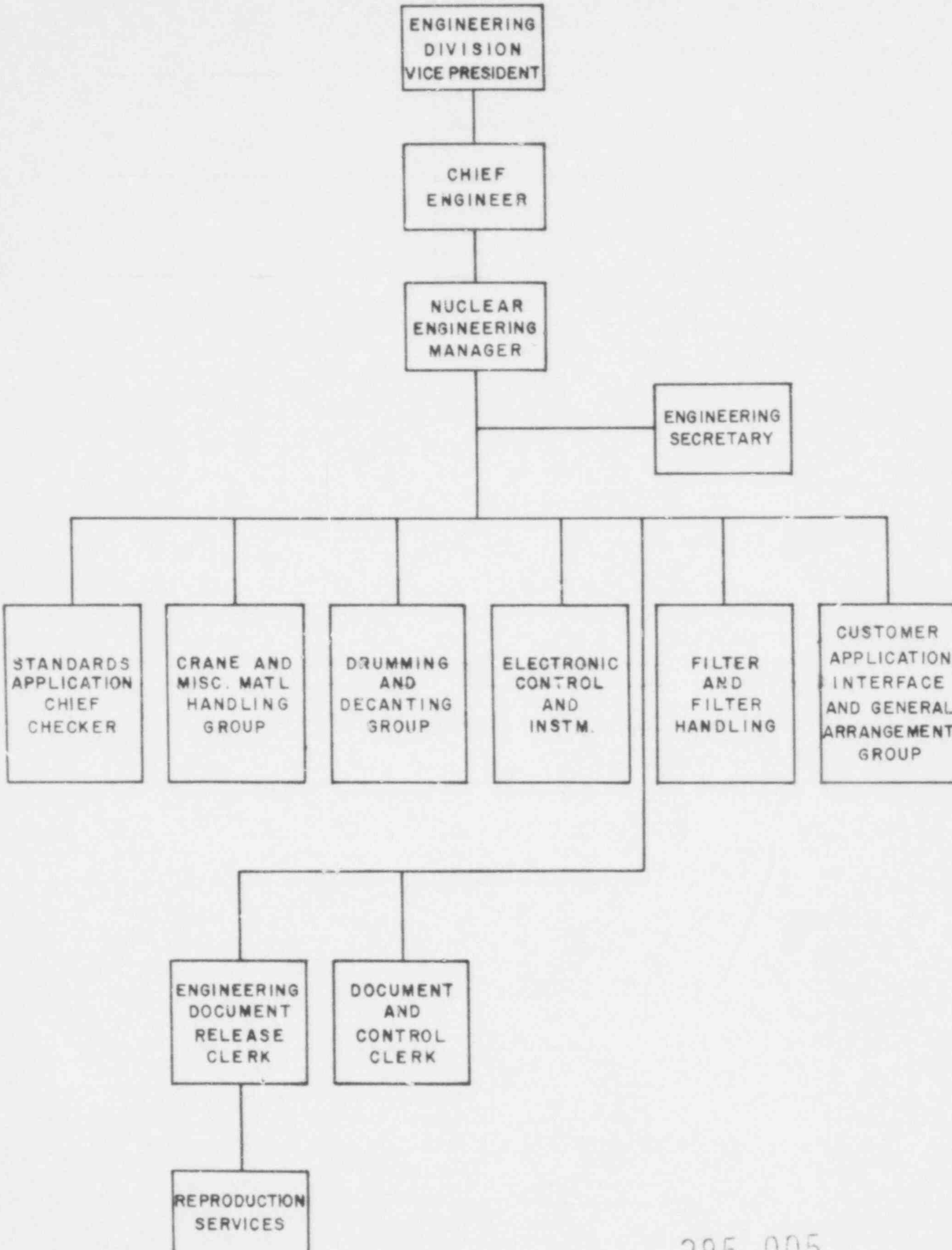
285 003

SECTION: I QUALITY CONTROL MANUAL	Revision Letter - O
	Date Issued - NOV 1, 1978
SUBJECT: QUALITY ASSURANCE DEPARTMENT	Page 5 of 9
Stock Equipment Company Standards	Number - 5



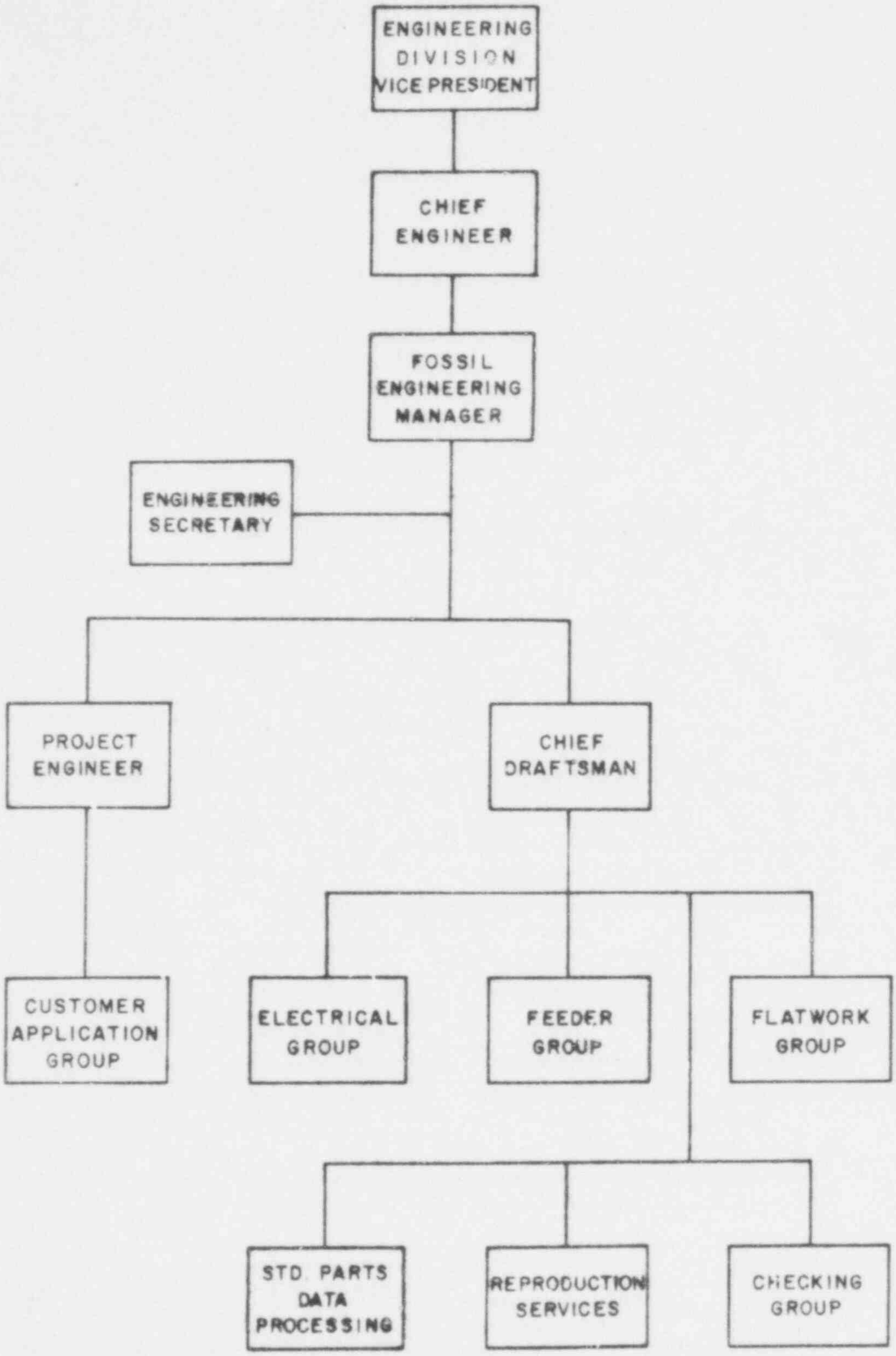
285 004

SECTION: I QUALITY CONTROL MANUAL	Revision Letter - A
SUBJECT: ENGINEERING DEPARTMENT ORGANIZATION	Date Issued - 2-1-79
	Page 6 of 9
Stock Equipment Company Standards	Number - 6



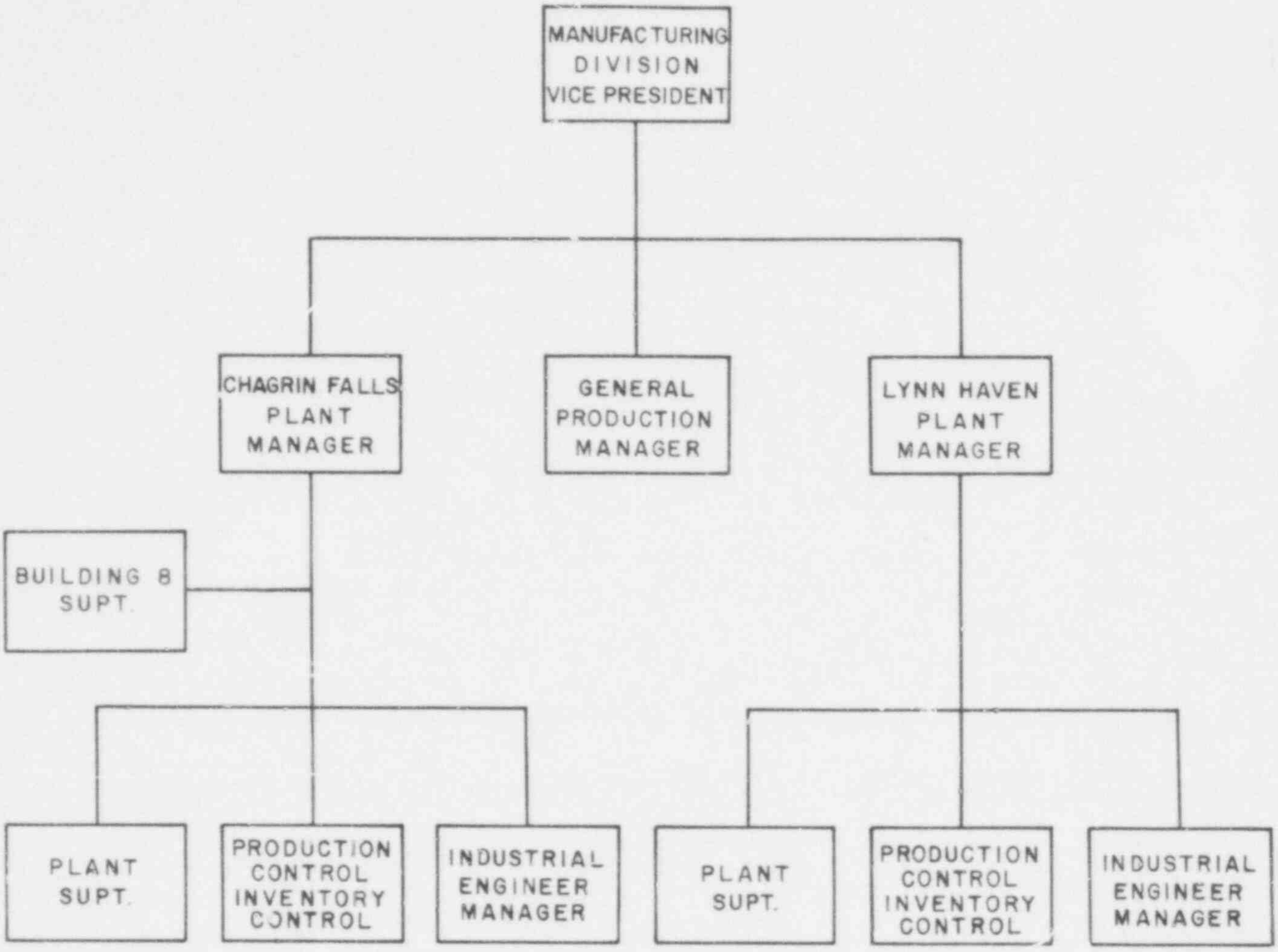
285 005

SECTION: I QUALITY CONTROL MANUAL	Revision Letter - O
SUBJECT: NUCLEAR DIVISION ORGANIZATION	Date Issued - NOV. 1, 1978
	Page 7 of 9
Stock Equipment Company Standards	Number - 7



285 006

SECTION: I QUALITY CONTROL MANUAL	Revision Letter - A
	Date Issued - 2-1-75
SUBJECT: FOSSIL DIVISION ORGANIZATION	Page 8 of 9
Stock Equipment Company Standards	Number - 8



285 007

SECTION: I QUALITY CONTROL MANUAL	Revision Letter - O
	Date Issued - NOV. 1, 1978
SUBJECT: PRODUCTION ORGANIZATION CHART	Page 9 of 9
Stock Equipment Company Standards	Number - 9

D. Design Control

Upon acceptance of an order, contract engineering will relay complete order information including design specifications and special requirements to the Chief Engineer. These documents will be reviewed and recorded in Engineering. The design specifications will also be reviewed with Management, Engineering Supervision, Contract Engineering and Quality Assurance.

A Project Engineer(s) will review the order design specifications to compare and ensure that specifications are in accordance with all governing regulations and codes. All discrepancies will be reported to the Contract's Manager for discussion with the owner and necessary order revisions will be processed as above.

All design changes will be documented and referred to the Contract Manager for discussion and clearance with the owner.

The Project Engineer is responsible for assemblying all the necessary drawings, documentation, calculations and bills of material. All details subassemblies, systems drawings, and bills of materials are checked by an assigned checker for accuracy, clarity, procedures, certifications and inspection procedures. All changes are referred to the Project Engineer for review, approval and change.

Design reports, when required, are checked by individuals other than those who performed the original design.

Final design and production drawings are submitted to the Quality Assurance Manager or designee for review and approval. All required inspection, examination or testing operations that must be performed are tabulated on a "Quality Bill of Material", for detail parts. This list, along with the production drawings, will then be used by the Production Department for developing Manufacturing Orders upon release of the project for manufacture.

E. Document Control

Drawings, procedures and other records required for full documentation carry revision notations. Any and all such revised documents are issued complete with revision notices to all recorded receipients of previous documents. Revision notices are signed and returned to the originator to record receipt of the reissued document and that those obsoleted have been destroyed.

F. Procurement

Purchase orders include all technical information and instructions. They specifically reference and include prints of all drawings and procedures involved, including correct revision letters.

285 003

Source inspections, certifications, and other vendor responsibilities are specifically stated on the face of the purchase order or the appropriate procedure and part print attached to the purchase order.

When required, purchase orders will be reviewed and approved by the Quality Assurance Manager to ensure that all code and contract requirements are noted.

The Quality Assurance Department will advise Purcahsing of the ability of vendors to meet quality standards. The Quality Assurance Department maintains performance histories of all vendors. In addition, the department reviews and/or audits annually those vendors whose quality assurance programs are commensurate with that required for an Approved Vendor's status.

G. Manufacturing Control

The Engineering Department is responsible for preparing the necessary engineering releases prior to sending a job to the Production Department. Once released, it is then routed through Processing, and Production and Inventory Control where an expanded sequence of operations (Manufacturing Order) is made using engineering drawings and Quality Bills of Material. Where required by Code or governing regulations, the Quality Assurance Manager will review and approve the Manufacturing Order, prior to its release for manufacture.

The Manufacturing Order will accompany the parts throughout their processing. Individuals responsible for each operation performed on the items, will initial or insert their employee number, verifying and identifying completion of the operation. The parts will be inspected by qualified inspector at designated check or inspection points. Acceptable items are moved to the next operation for processing or to final production inspection and stockroom. Unacceptable items are tagged with a "Defective Material Tag" and segregated from production flow.

All items are identified as directed by the engineering drawing or quality assurance procedure in the specified manner to positively identify the part and not be detrimental to it. Where required, parts in addition to the S-E-Co. part number, parts will also be identified with their heat number or a material identification number for full traceability. Material including weld material which require full traceability, is under the jurisdiction of the Quality Assurance Department. The department maintains certifications and records and authorizes issuance of the material.

H. Non-conformance

Non-conformances may be discovered at any time, not limited to, but including the following:

1) Receiving inspections.
2) Manufacturing - In-process inspection
3) Outside vendor manufacturing inspections

285 009

4) Assembly
5) Test

After non-conformances are discovered, the process of documentation, segregation, disposition and preventive - corrective action follow in that order. Documentation of the non-conformance is provided with a Non-conforming Material Report. The final disposition based on design data provided by Engineering is rendered by the Quality Assurance Manager. Conditions adverse to quality or non-confirming material which fails to meet ASME code or governing regulation specifications are immediately identified, documented, segregated and not further processed until a procedure for remedying the deficiency or proper disposition has taken place. Significant conditions adverse to quality are reported to the President of the Company.

I. Inspection

Receiving, shop, and vendor inspections, and personnel performing instrument calibration are performed by qualified inspectors from the Quality Control Department. The Chief Inspector in charge of the department reports directly to the Quality Assurance Manager. Only measuring equipment belonging to and used by the Quality Control Department are used for final product verification. All S-E-Co. owned and employee owned measuring equipment are under a calibration program. Periodic calibration of measuring equipment is performed by qualified individuals of the Quality Control Department to known standards whose accuracies are traceable to the National Standards. Records and calibration status are maintained by the Quality Control Department and labeled on each individual instrument.

J. Audits

The Quality Assurance Manager is responsible for scheduling system audits for determining the effectiveness of the Quality Assurance Program. Audits are performed by trained individuals who are independent of the areas or functions audits. Monthly audits are conducted for various functions and results are documented and reported to the Quality Assurance Manager and Company Management. The Quality Assurance Manager is responsible for assuring that required corrective actions or improvements have been accomplished by the responsible department supervisors.

K. Records

Permanent records including all required tests, specifications, procedures and Codes shall be maintained in the Q.A.D.

No document shall be removed from the Q.A.D. without a suitable entry made regarding the date of removal, person to whom assigned, and identification of specification, procedure, or CODE that has been removed.

285 010

In addition to the above-mentioned permanent file, there shall be one or more duplicates of operating procedures which are to be used as working copies by the various engineering, manufacturing, and inspection groups. Written records shall be maintained as to the identity of the specifications, date of issuance and the department responsible for the use and preservation of these working copies.

285 011

XI
POSTULATED ACCIDENT ANALYSES

The S-E-Co. Solid Radwaste System has incorporated designs and safeguards to prevent accidents from occurring, whether from equipment malfunctions or from operator error. Where the possibility of such occurrences would be feasible, equipment design has been provided (where possible) to prevent such accidents from having an adverse affect upon the station's environment.

The following section discusses various features provided with the S-E-Co. Solid Radwaste System for preventing accidents and indicates possible corrective actions for hypothetical cases.

A. Solidification

A major aspect when evaluating the environmental impact as a result of a postulated accident is the assurance that the solidified waste form contains no free liquid which would require technical difficulties for cleanup and decontamination. This would have particular importance in the transport of the solidified waste to burial sites. The S-E-Co. Solid Radwaste System has incorporated many safeguards against the possibility of free-standing water from occuring. The implementation of Process Control Programs and the qualification of pre-tested solidification formulas with the particular waste stream to be solidified will help assure that free-standing water will not result. The equipment supplied by Stock Equipment Company provides the accuracy, control, and reliability that the process can be run within the parameters controlled by the S-E-Co. equipment. The incorporation of numerous interlocks and automatic operations help preclude the possibility of operator error. In addition, should an error occur and the process be run outside of the limits specified by the pre-tested solidification formulas, the S-E-Co. equipment provides a means of remote re-opening of the drum and movement to an area such as the drum inspection and labeling station for examination of the drum and evaluation as to whether solidification criteria has been met.

B. Travelling Bridge Crane

The travelling bridge crane provides for precise transport and handling of 55-gallon drums in the radwaste processing area, the high and low level storage areas, and the truck loading area. The crane is remotely operated from the control station utilizing a closed-circuit television system, a grab elevation display and status indicating lights. Crane controls for operation of the grab, hoist, trolley, and bridge are located for ease of operation and spring-return to the "off" position upon release. Numerous design features have been provided with the crane to assure safe-reliable operation.

285 012

Two separate power and control circuits with separate high and low speed motors have been provided to assure that an electrical failure in any one circuit will not prevent remote completion of an operation or movement of the crane to a safe maintenance area. The power, control, and television cables are multiple conductor in compliance with IEEE Standards for Qualify Class IE Equipment. They have been provided with specially designed cable handling equipment to assure long life. The cables are cut to length and have quick disconnect receptacles to minimize replacement time should a failure occur. In the eventuality of a total power failure, a portable power generator could be connected to the control station to complete crane operation until power has been restored. This type of corrective action would not require maintenance personnel to be exposed to radiation levels above plant background.

The cameras utilized for the closed-circuit television system are located on the crane. An upward viewing camera with cross-hairs is mounted on the trolley to view the overhead target grid system. This camera along with the drum location board allows the operator to know where the crane is located and allows positioning to within 1/4". A downward viewing camera mounted on the drum grab assists the operator when operating the hoist and provides visual verification of drum clamping with the grab. This camera is also utilized to inspect the top heads of drums for contamination prior to their removal from the drum process enclosure. Two cameras with remote horizontal tilt are mounted on the crane's bridge. These cameras allow the operator to monitor operations, survey the radwaste area, and maintain his perspective as to the location and for dynamic usage. They have been shock tested and vibration tested to withstand 10 Gs horizontal and 20 Gs vertical force loading. They can be remote focused to within 3 inches and can be used in areas where lighting is as low as 5 lumens. This feature allows all necessary lighting for the radwaste area to be mounted on the crane. Thus, any lighting problems can be corrected in a safe maintenance area.

The cameras on the crane also allow the operator to inspect the radwaste processing area and high and low level storage areas. In the eventuality that a drum has fallen over in any of these areas, the operator can accurately determine its location and orientation. A drum uprighting fixture has been provided with the crane to attach to the grab. This allows remote correction without maintenance exposure.

Redundant interlocks have been provided to prevent high speed operation of the bridge and trolley unless loads have been raised to the "full-up" position. In this position, the grab and its load (drum) will clear all permanent objects under the crane and is supported to eliminate swinging. The grab elevation readout and drum location board also provides the operator with the location of the grab in relation to permanent obstacles in the radwaste areas. In addition, the surveillance cameras can be utilized to monitor

285 013

transport for preventing collisions with obstructions.

Redundant interlocks are also provided to limit hoist travel to within design parameters and preventing the accidental release of suspended drums. Load sensing devices have been provided with a redundant motor-operated clamp actuator to provide positive load release. Possible failures of this system would not result in unintentional load release.

The crane has been designed to accept collisions into end stops without damage. Redundant limit switch systems have been provided to first cut power of the high-speed motor and then the low speed motor as the bridge or trolley approaches its operating limits. The crane is also equipped with compression-type shock absorbers to minimize possible impact.

C. Decanting Station

The decanting station is a compact assembly of components which are mounted on both sides of a 12-inch thick steel shield wall. Mounted on the safe side of the wall are all motors, four-way air valves, air cylinders, controls, and as many of the gear reducers as is possible. On the hot side of the wall are the decanting tank, the pumping ends of the metering and decanting pumps, and pipe manifolding. All these components have been designed for ease of removal to minimize any possible maintenance time.

The decanting station is remotely operated from the control console. Controls provided incorporate positive operator initiated actions and interlocks to assure safe reliable operation. Indicating devices, gauges and an illuminated graphics display informs the operator as to equipment status, feed flows, valve positions (closed-open) and the process operation being performed. Alarm annunciations are also provided to alert the operator of malfunctions.

Indicating gauges have been provided for monitoring flush water pressure and machinery air pressure. Connections for these are provided on the safe side of the shield walls. In the eventuality of loss of either of these systems, portable air compressors and/or water supplies could be brought in. Should loss of the air supply occur, all valves and the metering pump fail-safe to the "closed" position.

Failure of any components on the "hot" side of the shield wall would result in exposure of maintenance personnel. However, the exposure incident to personnel should be less than 100 m.rem/hr. providing flushing operations are performed. Components on the hot side of the wall are compact assemblies and designed to facilitate removal and installation. Piping is provided with flanged connections to minimize assembly time. Should a problem occur, such as a line break, maintenance time for repair should be less than one (1) man-hour. The overhead crane can be utilized for removal of damaged lines by attaching an auxiliary hook to the crane's grab. This will minimize exposure to maintenance personnel from handling the contaminated line.

285 014

A break in a process line used for radioactive wastes would result in the release of contaminates. This would primarily be confined to the decanting station "cell" and would require portable equipment for decontamination and cleanup. (See Fig. No. 6 in Appendix)

Process lines provided with a typical S-E-Co. System as indicated in Figure No. 6 (Appendix) contain a maximum of 1-1/4 gallon in any one pipe section. Exposure incident to personnel would be dependent upon the specific waste stream and the concentration of radionuclides and activity associated with it.

The use of portable shields and sound health physics judgments for cleanup operations will minimize exposure to personnel. All equipment is capable of decontamination by hosing to minimize any residual contamination to their exteriors.

D. Drumming Station

The drumming station is also a compact assembly of components located on the "hot" and "safe" side of a 12-inch thick steel shield wall. Located on the safe side are all motors, 4-way air valves, valve operators, and as many of the gear reducers as is practical. On the hot side of the wall are the pumping end of the concentrated waste metering pump, and associated components of the drum process enclosure.

Operation of the station is controlled remotely at the control console. Controls and indicating devices provided allow for manual or automatic processing operations and inform the operator of equipment status and operation.

The drum process enclosure allows for the uncapping, filling, recapping and tumbling sequence of operations to be performed in a totally isolated area. The enclosure is connected to the station's radioactive vent and drain systems. This prevents the release of any contaminates to the station's environment as a result of drumming operations.

Multiple interlocks and safety devices have been provided to assure proper operation. Should a malfunction occur resulting in the spilling of waste within the drum process enclosure, spray systems can be remotely operated to flush the enclosure and/or drum. Residual contamination of the enclosure can be minimized by utilizing decon solutions, if necessary. The connection of the enclosure to the drain system has been provided with a drain trap. This trap is easily removed and may be placed into a 55-gallon drum for subsequent disposal should trapped solids such as cement plug the trap.

Since concentrated waste feed lines (not supplied by S-E-Co.) require heat tracing for maintaing waste temperature, a thermocouple has been provided to monitor waste temperature. This thermocouple is interlocked with control and alarm circuitry to prevent filling operations of waste in excess of 180°F. A gauge has also been provided on the

285 015

control console to allow the operator to monitor concentrated waste temperatures. In the eventuality of interlock failure and filling operations of waste in excess of 180°F, the operator can stop the processing operation - remove the drum's cap and thereby prevent possible pressurization of the drum. Aerosoles released are vented to the station's radioactive vent system.

In the eventuality of a malfunction resulting in a drum falling inside the enclosure, it would be necessary for the access doors on the enclosure to be opened. Prior to doing this, the enclosure's spray systems could be utilized to remove sources of radiation. This would isolate the major source for exposure to the drum should filling already be completed. The radiation monitor at the enclosure would also provide relevant information for health physics judgments. Portable shielding and mechanical extensions could be utilized for uprighting or attaching lines to the drum, as required, minimizing exposure to personnel.

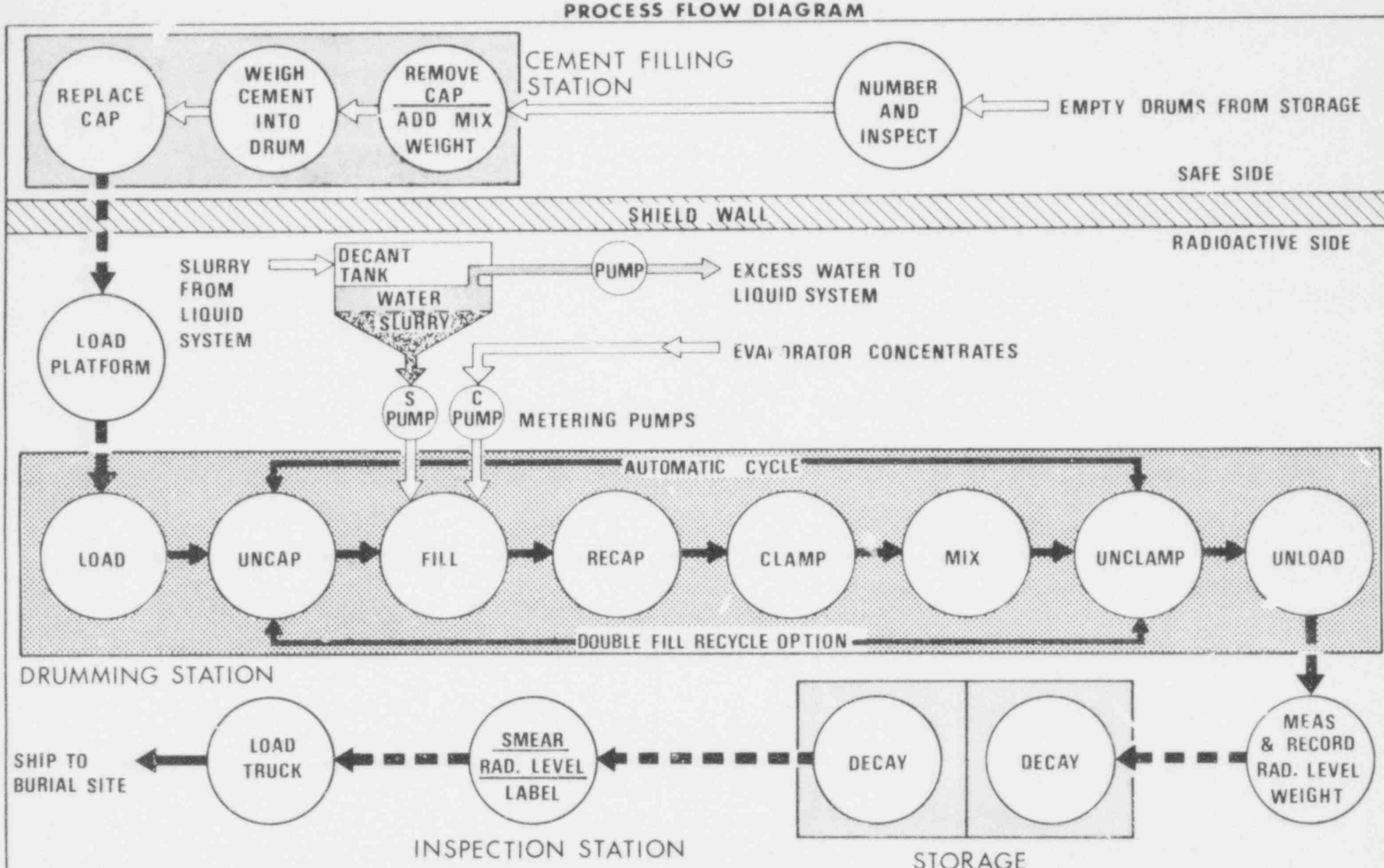
Should it be necessary to remove the drum from the exposure, it could be pulled out through a door opening. Once removed, it would not be necessary to manually upright the drum. This would be accomplished with the crane using the drum uprighting fixture. The drum could then be remotely transported to the drum inspection and labeling station or elsewhere for inspection of damage.

E. High and Low Level Drum Storage Areas

The high and low level storage area should never require entry by maintenance personnel. In the eventuality that an accident has occurred in these areas, the most feasible type of occurrence would be that of a drum falling over. Under these circumstances, an operator at the control console would utilize the crane's camera system to note the exact location and orientation of the drum. The crane would then be moved to a safe maintenance area where the drum uprighting fixture could be installed. With this fixture, the operator is then able to remotely upright and relocate the fallen drum.

285 016

S-E-Co. SOLID RADWASTE SYSTEM
PROCESS FLOW DIAGRAM



DOCUMENT/ PAGE PULLED

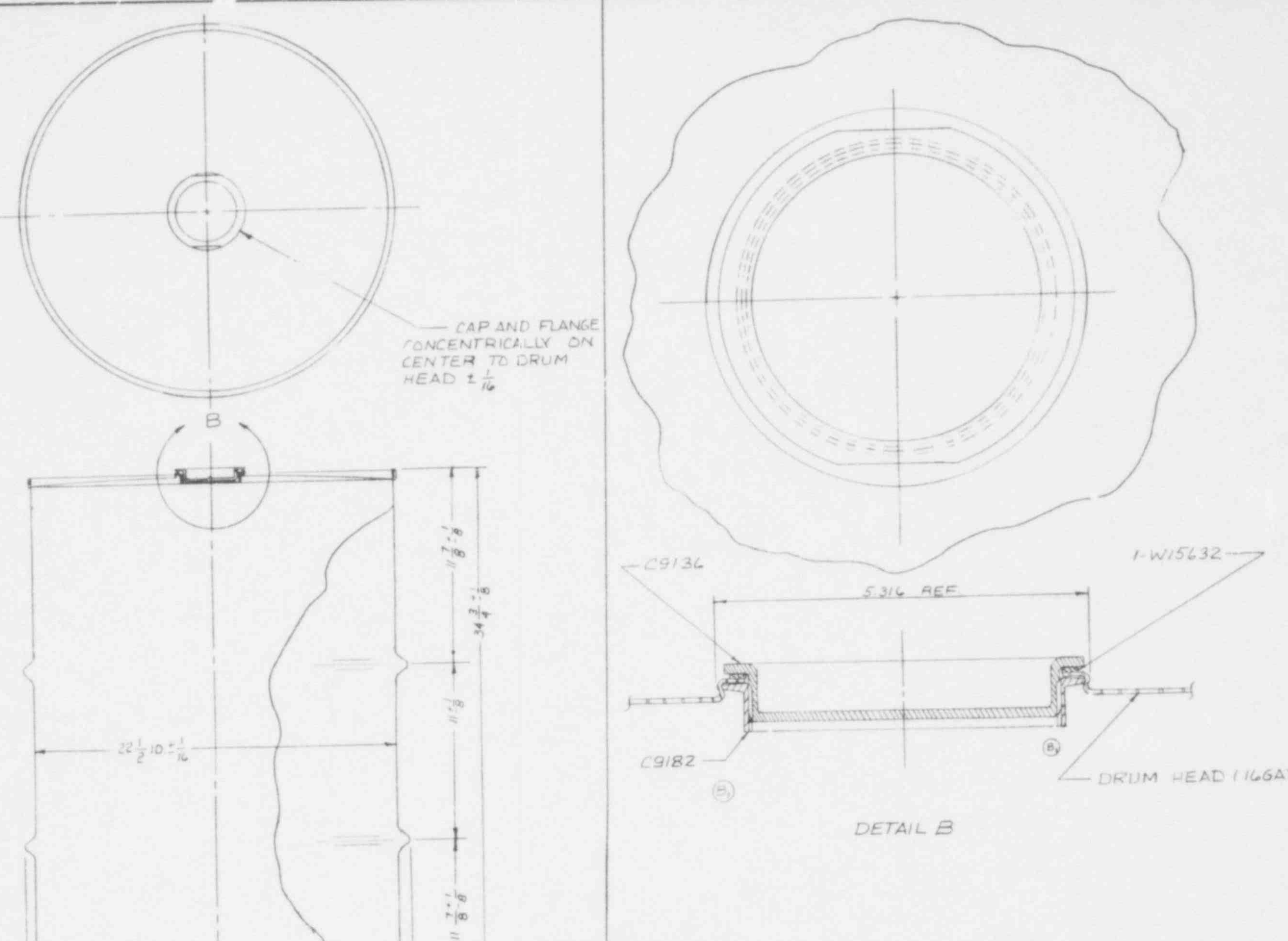
ANO. 7907030482

NO. OF PAGES 16

REASON:

- [x] PAGE ILLEGIBLE:
  - [ ] HARD COPY FILED AT: PDR CF OTHER ______
  - [ ] BETTER COPY REQUESTED ON ___/___/___
- [x] PAGE TOO LARGE TO FILM:
  - [ ] HARD COPY FILED AT: PDR CF OTHER ______
  - [ ] FILMED ON APERTURE CARD NO. ______

285 018



NOTES:
1. DRUM TO BE MANUFACTURED AND TESTED IN COMPLIANCE WITH DOT SPECIFICATION 17C. PER CFR TITLE 49 SECTION 178.
2. EMBOSSING TO COMPLY WITH DOT SPECIFICATION FOR TYPE 17C DRUM.

THIS DRAWING IS PROPRIETARY AND INFORMATION CONTAINED THEREIN SHALL NOT BE REPRODUCED OR USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF STOCK EQUIPMENT CO.

LTR	DATE	LOC	BY
B	6-14-78	~	HOLLO
A	10-9-77	B4	HOLLO

REVISED PART IS INTERCHANGEABLE WITH ORIGINAL

TOLERANCES: UNLESS OTHERWISE SPECIFIED
MACHINED FRACTIONAL DIMENSIONS ± .015
MACHINED DECIMAL DIMENSIONS ± .01

REF DWG

S.E.CO. NO

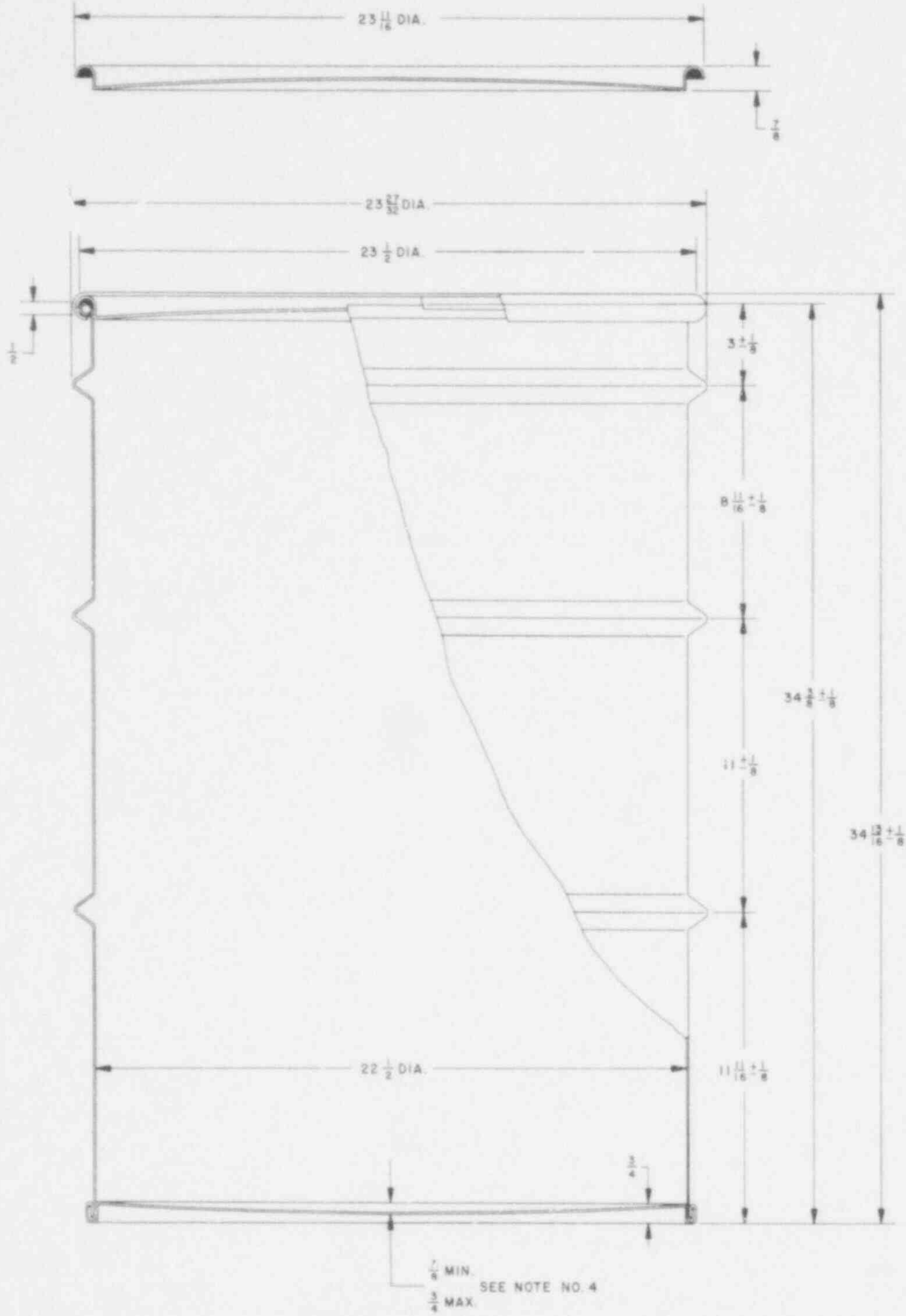
DRUM ASSEMBLY - 55 GALLON 4 INCH BUNG
TIGHT HEAD DOT 17-C
PER ANSI MH 2.4 - 1974

SCALE: SEE DWG
DR. 1-24-77 BY T. HOLLO
CHK. 7-27-77 BY T.H.

STOCK EQUIPMENT CO.
CLEVELAND OHIO

C9198 -B

NOTE: PURCHASER TO CHECK HIS SUPPORT STEEL FOR LOADS IMPOSED BY THIS EQUIPMENT



NOTES:

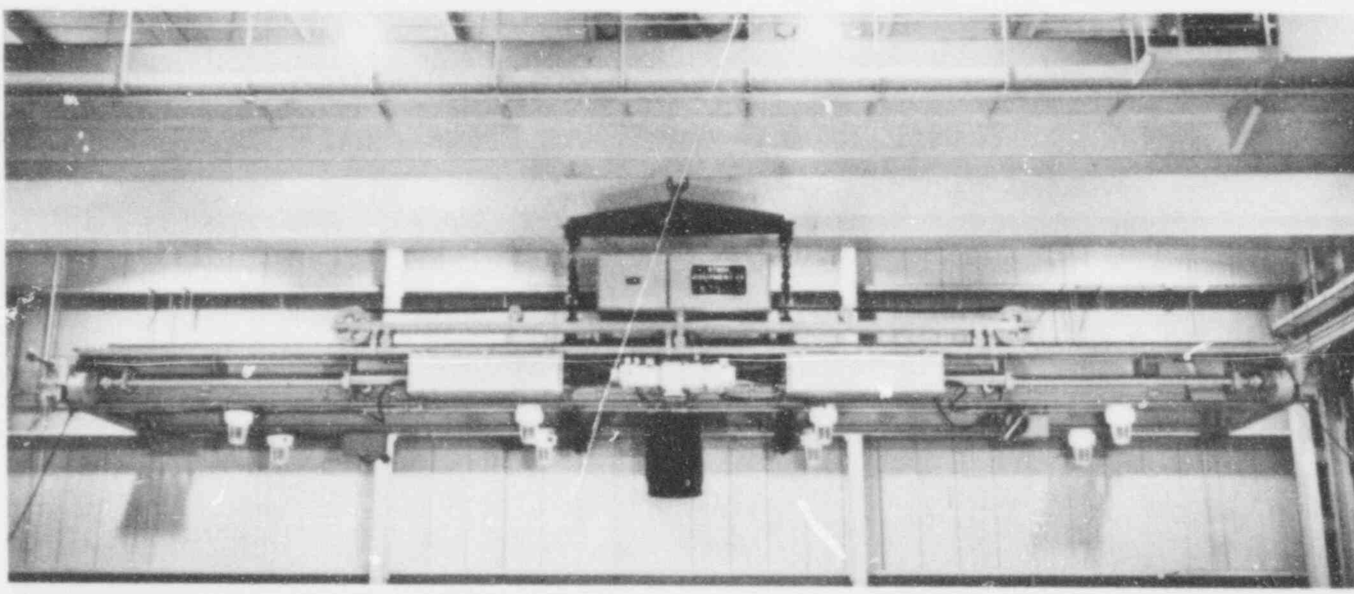
1. TOLERANCE ON ALL DIMENSIONS ± 1/16 EXCEPT AS NOTED.
2. TOP HEAD TO BE SUPPLIED WITH GASKET.
3. EMBOSSING TO COMPLY WITH DOT SPECIFICATION FOR TYPE 17H DRUM.
4. CONVEXITY APPLIES TO BOTH TOP AND BOTTOM HEADS.

MATERIAL:

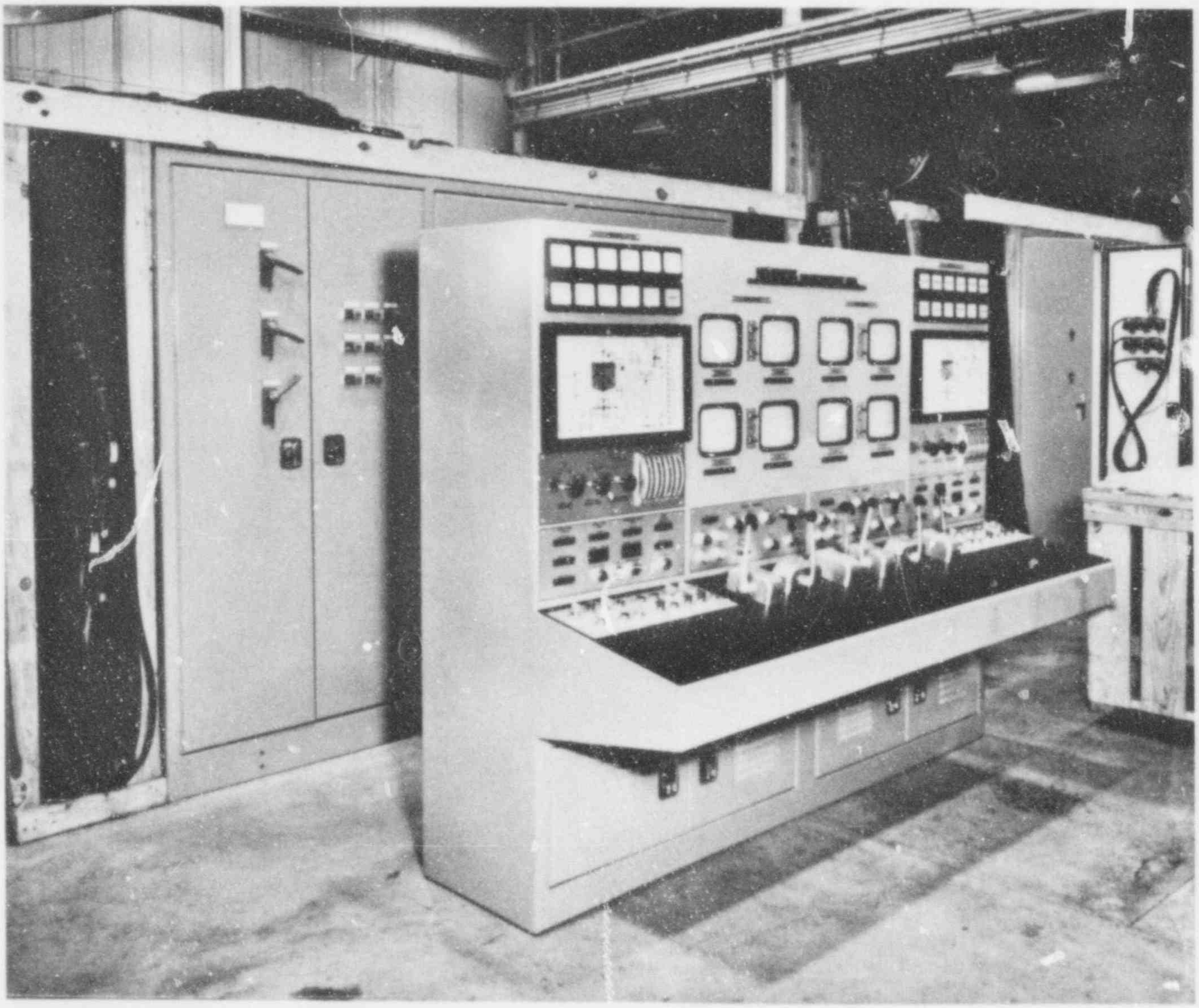
LOW CARBON COMMERCIAL QUALITY STEEL PER CFR TITLE 49, PARA 173.24

18 GA. (.0478) BODY AND BOTTOM HEAD
16 GA. (.0598) TOP HEAD
12 GA. (.1046) CLOSING RING

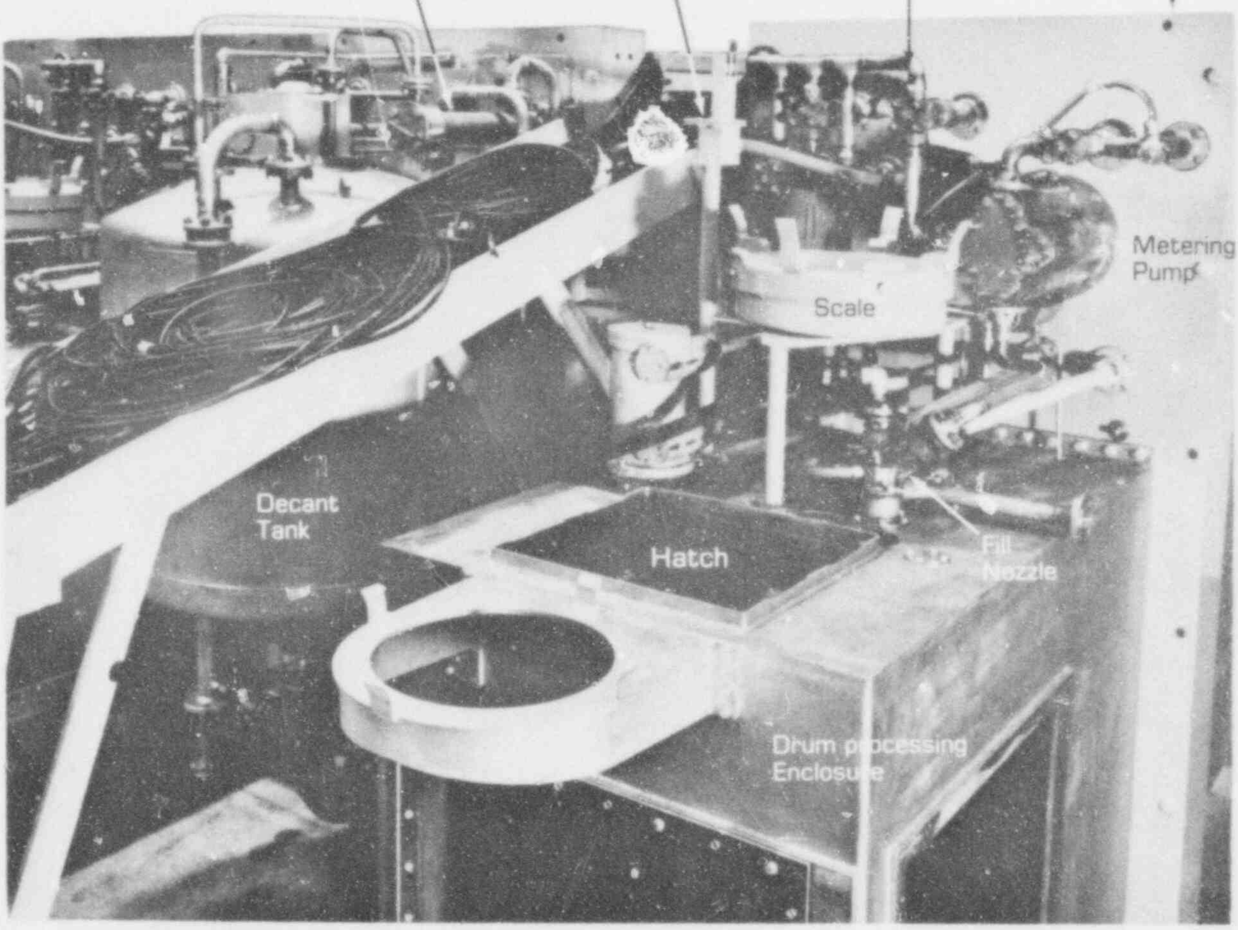
DRUM, 55 GALLON - FULL REMOVABLE HEAD DOT 17H PER ANSI MH 2.5 1974	
DR BY B. ROSE; CK'D BY P. NICHOLSON; APP BY C. MCGUIRE; DATE 11-2-78	STOCK EQUIPMENT CO. CLEVELAND, OHIO 44115
	L-D13174-0



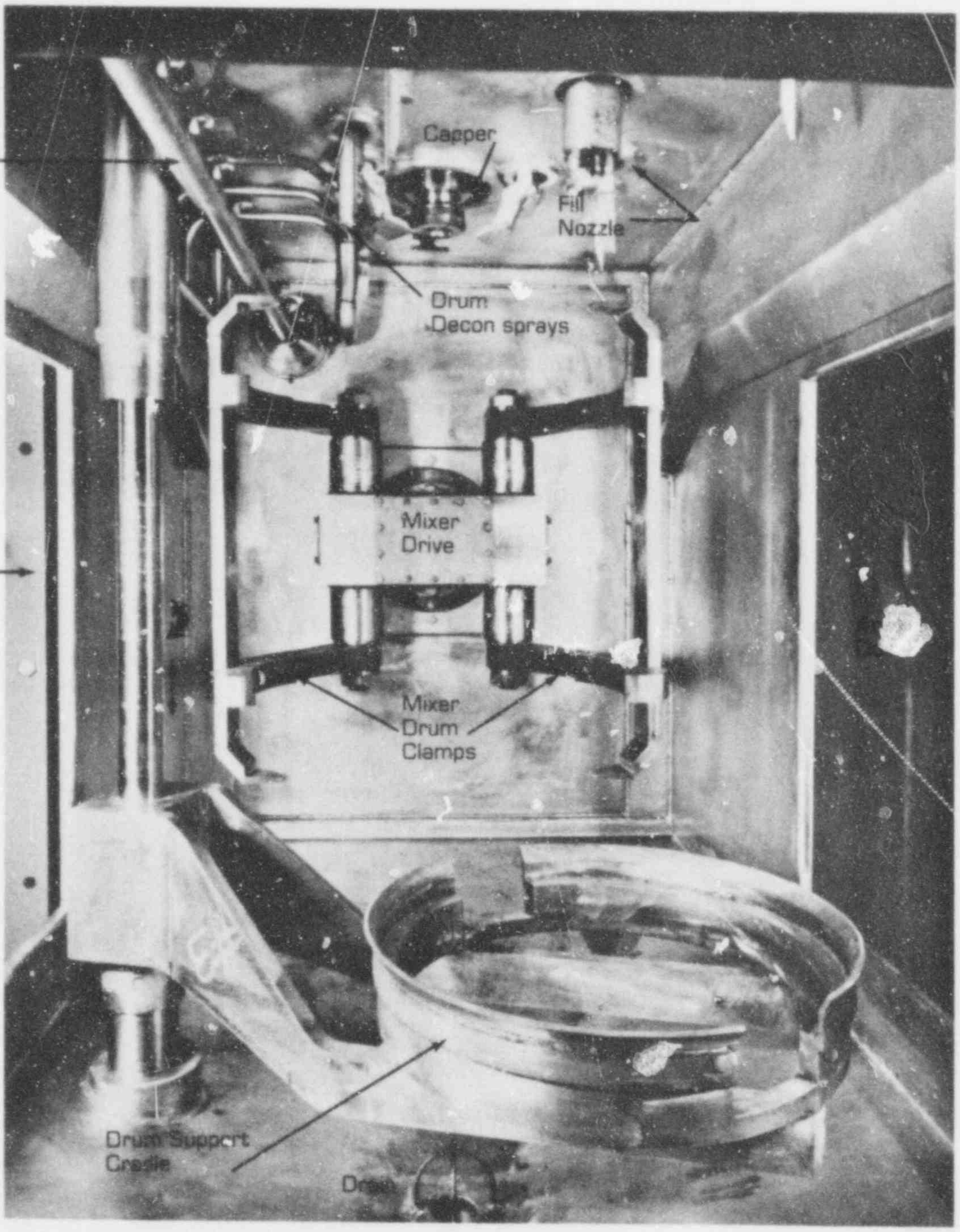
S-E-Co. SOLID RADWASTE SYSTEM
REMOTELY OPERATED BRIDGE CRANE



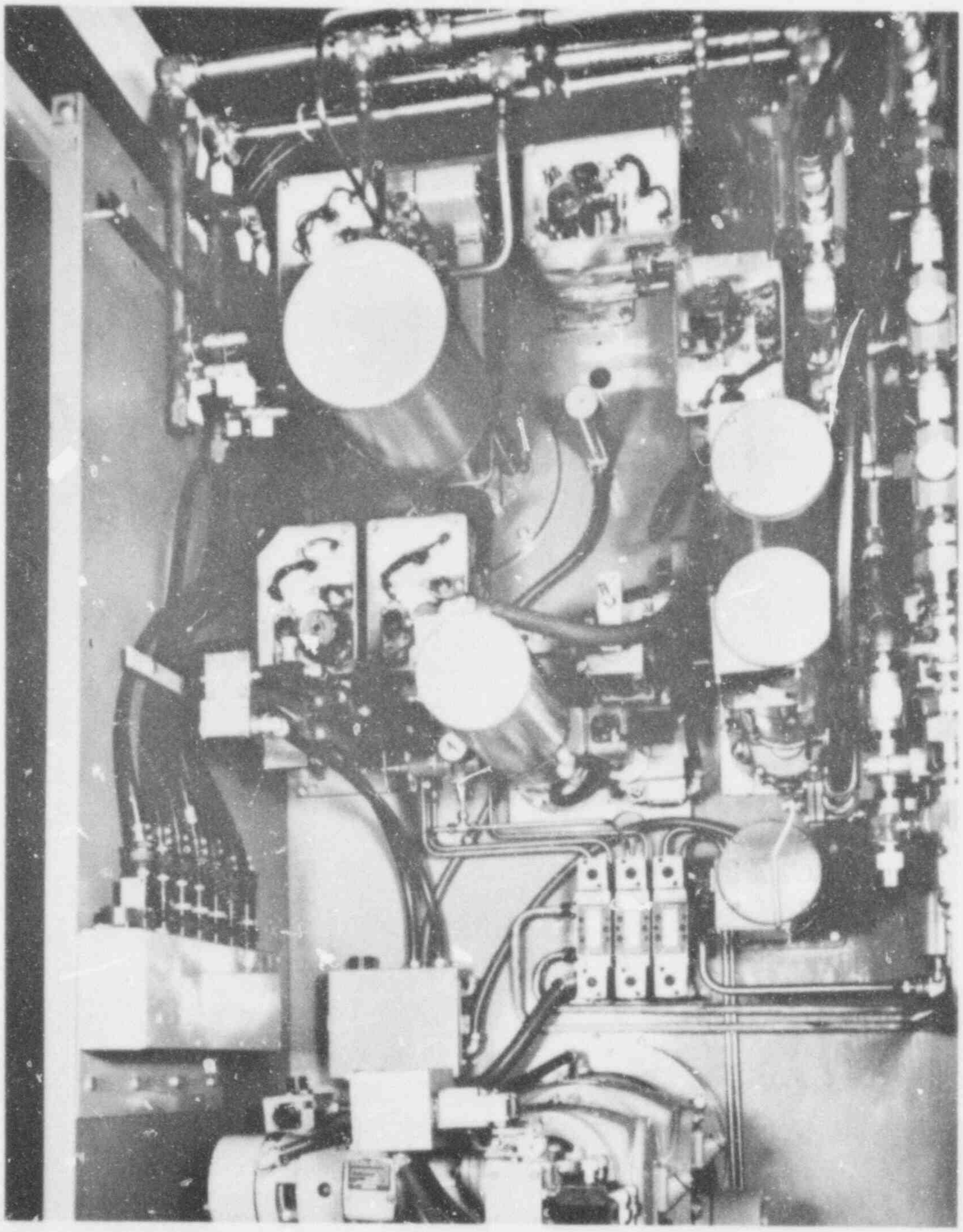
S-E-Co. SOLID RADWASTE SYSTEM
CONTROL CONSOLE AND ELECTRICAL CABINET
(TWO UNIT INSTALLATION)



S-E-Co. SOLID RADWASTE SYSTEM
DECANTING AND DRUMMING STATION
ASSEMBLY AND TEST STAND

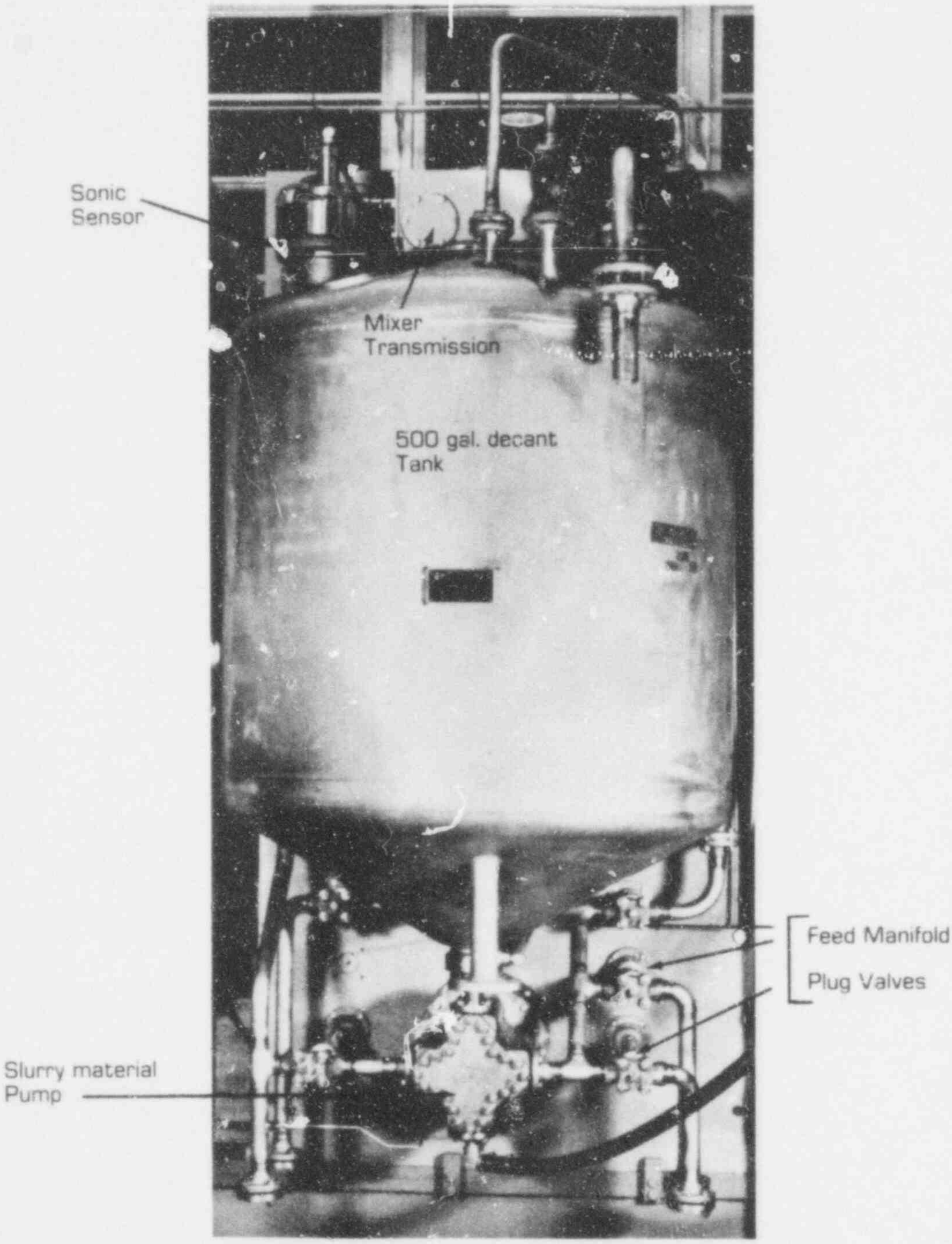


S-E-Co. SOLID RADWASTE SYSTEM
INTERIOR DRUM PROCESSING
ENCLOSURE



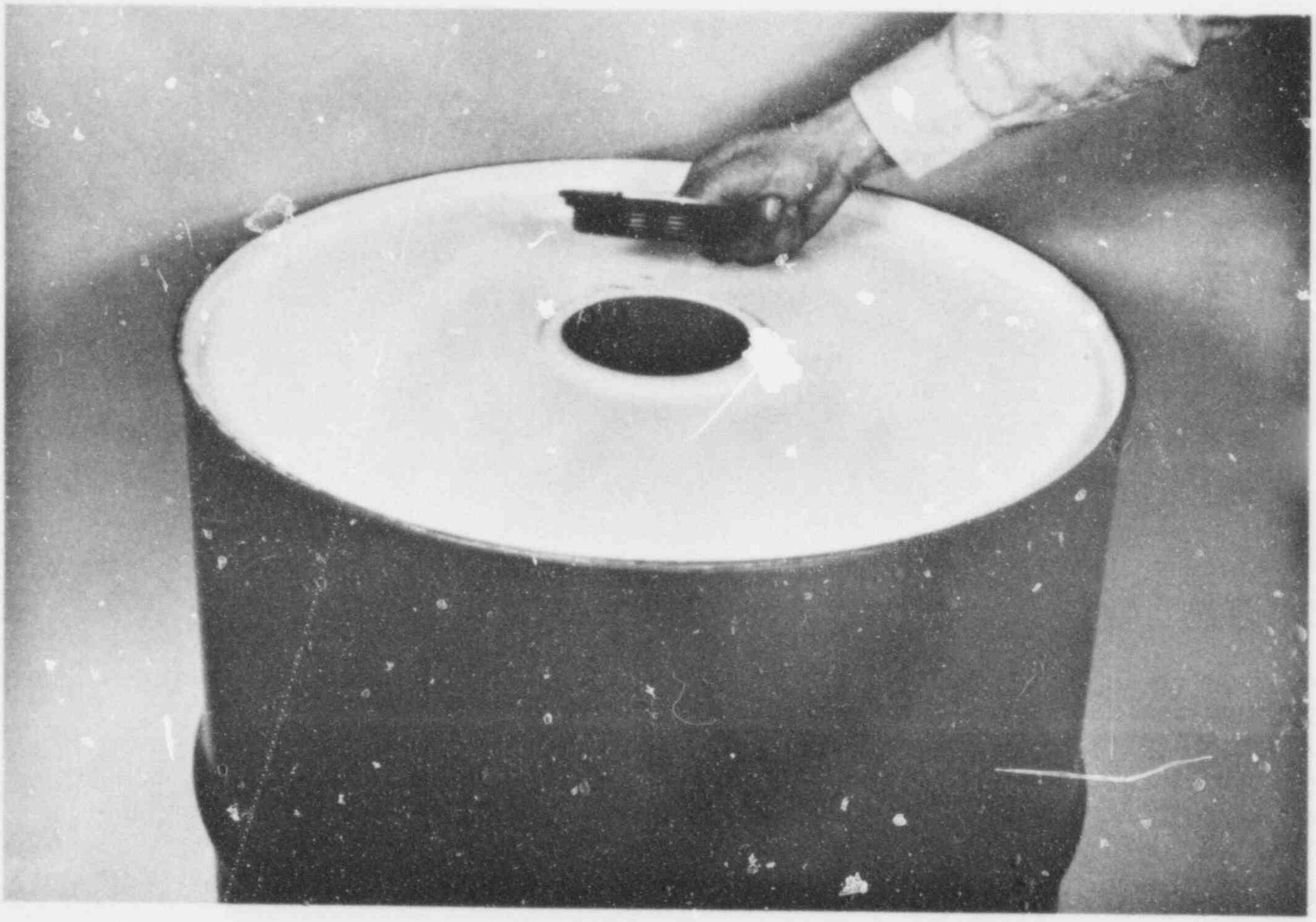
S-E-Co. SOLID RADWASTE SYSTEM
SAFE SIDE OF DRUMMING
STATION SHIELD WALL

285 025



S-E-Co. SOLID RADWASTE SYSTEM
DECANTING STATION
WITH METERING PUMP AND FEED MANIFOLD

285 026



S-E-Co. SOLID RADWASTE SYSTEM
16 GAGE, DOT 17C, 55 GAL. DRUM
WITH 4" SCREWED CAP

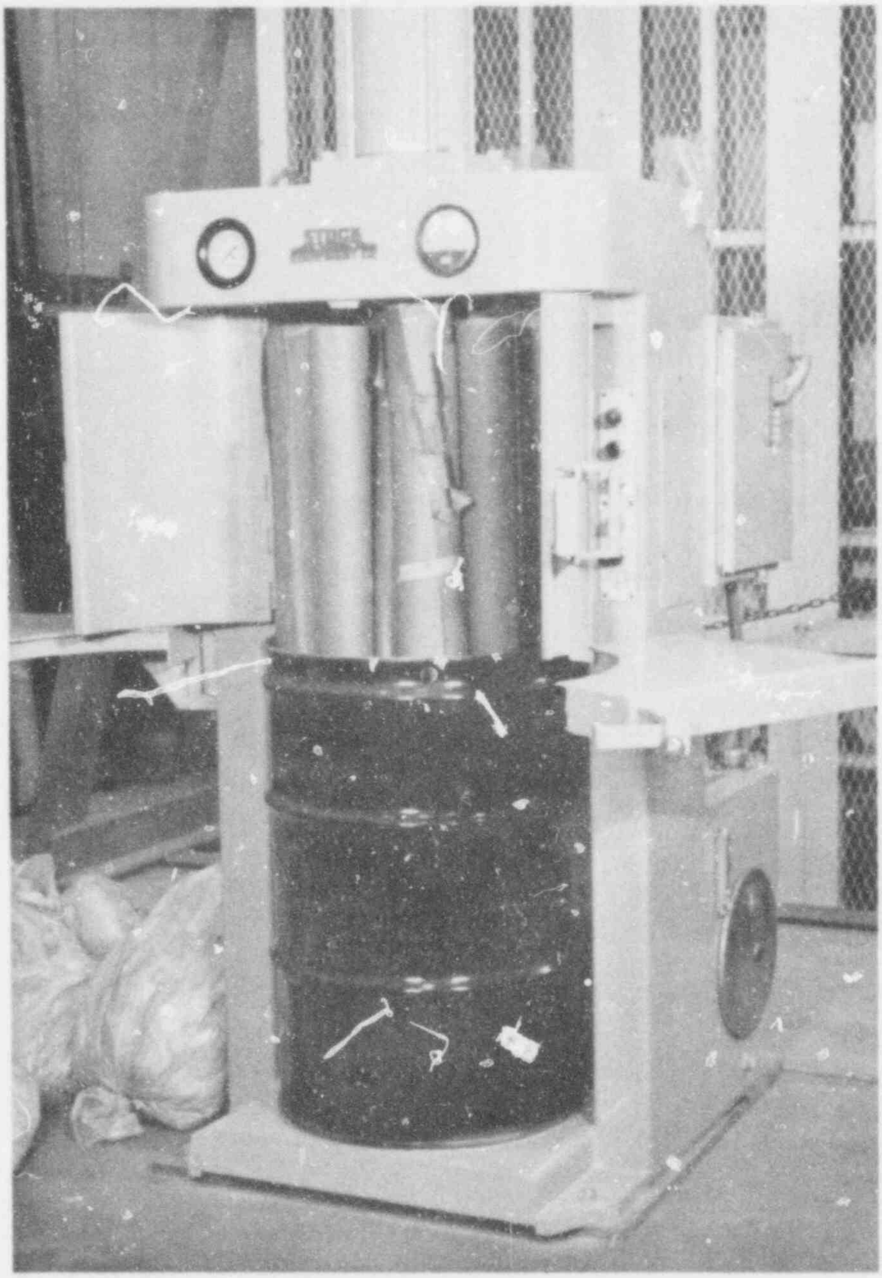


Figure 7 - S-E-Co. hydraulic compactor, drum loaded with rolled paper. Drum extension and split loading table open.

285 028

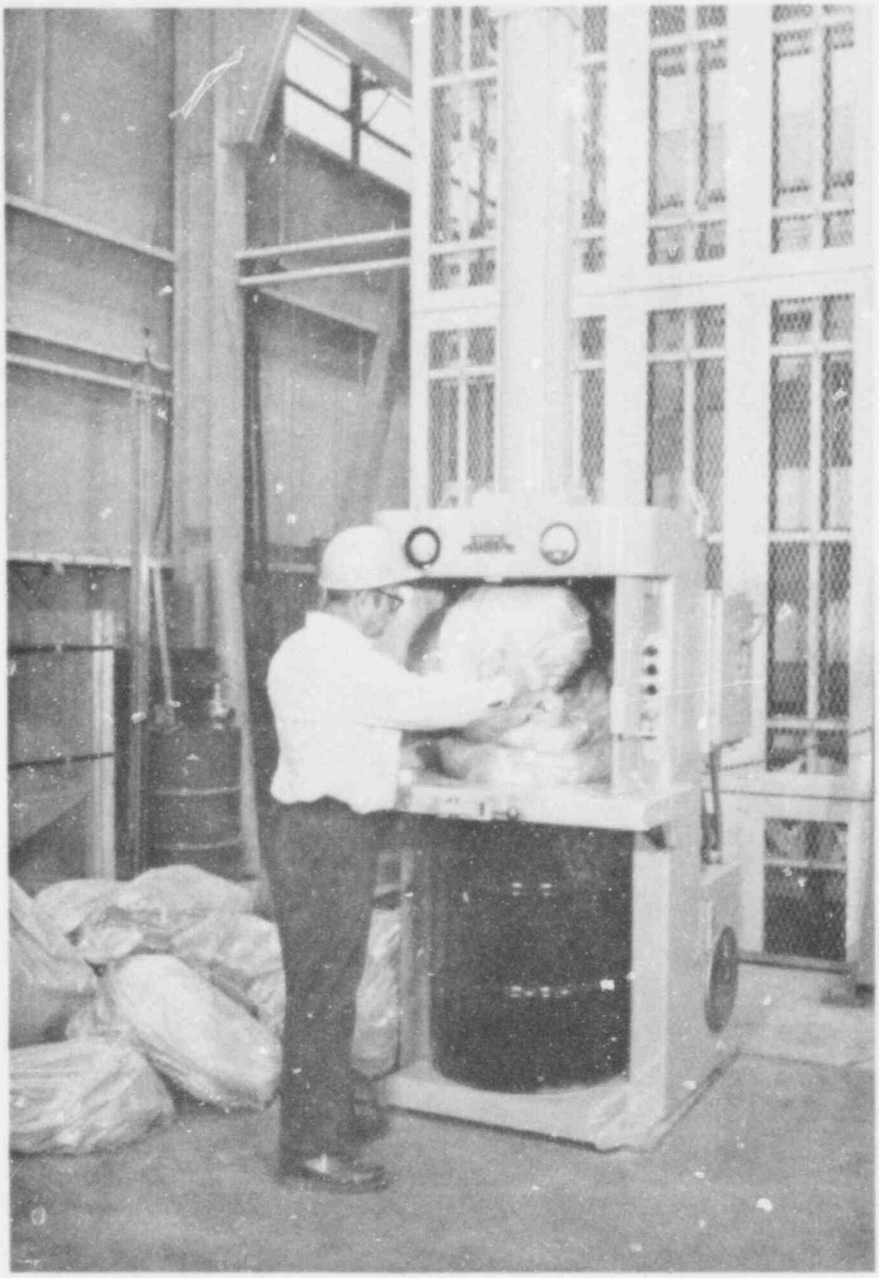


Figure 10 - S-E-Co. hydraulic compactor stacking waste up to 60" high prior to compacting.

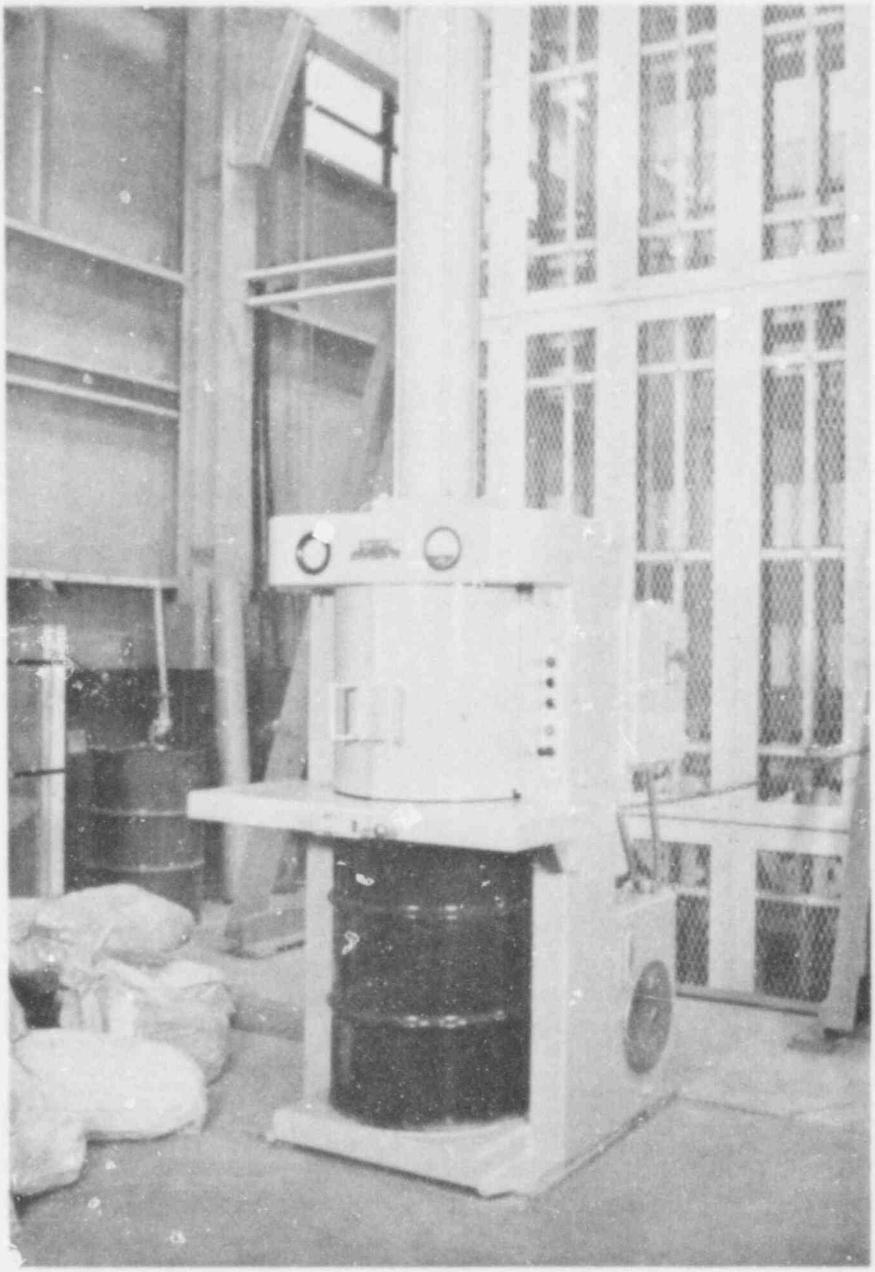


Figure 5 - S-E-Co. hydraulic compactor ready for operation with drum in place and drum extension doors closed.

STOCK EQUIPMENT CO.
CLEVELAND, OHIO

BY D. C. Marsh D. C. Marsh **TEST REPORT No.** 51

APPROVED P.C. Williams DATE July 23, 1973 PAGE 1 OF 6

P.C. Williams

REFERENCE Request by P.C. Williams of July 9, 1973

TITLE Axial Compression, Stacking and Burst Pressure Tests on 55 gallon Drums.

1.0 OBJECT

1.1 Prove that the strength of 55 gallon drums is ample for stacking in decay vaults and storage silos.

1.2 Determine the burst pressure of fixed and removable head drums.

2.0 RESULTS

2.1 A 16 gage 17C drum supported a net axial load of 16,460 pounds before yielding. The drum height was collapsed 10-1/2 inches yet it did not leak.

2.2 A water filled 16 gage fixed head drum supported three drums which weighed 2881 lbs. when stacked in a 25 inch square storage silo.

2.3 A 16 gage fixed head drum began leaking at an internal pressure of 90 psig.

2.4 A 16 gage drum with a 16 gage removable head began leaking when the gasket blew out at 45 psig.

2.5 A 16 gage drum with an 18 gage removable head began leaking at 12 psig. About 1/3 of the head periphery popped out of the retaining ring at 24 psig.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Based on the above results, typical 16 gage drums filled with cemented radwaste can be stacked four high with a large margin of safety. There will be no deformation of the drum head seams.

3.2 Internal pressure in tight head drums should be minimized to prevent distortion of the head. Based on the difficulti[illegible] [illegible]rved in obtaining a tight head seal and on the weakness of the joint, removable head drums should not be used under pressure.

POOR ORIGINAL

285 031

Axial Compression, Stacking and Burst Pressure Tests on 55 gallon Drums

4.0 DISCUSSION

4.1 Axial Compression Test

A new 16 gage 55 gallon fixed head steel drum manufactured to D.O.T. Specification 17C by Jones & Laughlin Steel Company was tested. After a 3/4 inch pipe elbow had been brazed to the center of the bottom head, the drum was placed between the platens of a 600 ton compression testing machine. The bottom head flange periphery was placed on a ring of flat steel blocks and the drum was completely filled with water. A hose connected to the pipe elbow was filled with water to a high point 18 feet above the drum bottom. From this high point, which was vented to atmosphere, water could overflow to the drain.

A spider fabricated from 1/4 inch diameter hot rolled steel rod was placed on the top head flange. The spider arrangement, which is shown in Fig. 2, simulated the eight points of contact with four drums in a stacked array on 26 inch centers. A steel plate approximately 30 x 30 x 1-3/8 inches weighing 359 pounds was placed on top of the spider. The upper platen of the test machine applied the primary load to this plate. Deflection of the drum was measured with a spring-loaded steel tape attached to the machine cross head.

Primary load was observed at 1000 pound intervals to 10,000 pounds, 2000 pound intervals to the yield point at 19,560 pounds. At yield, the upper cylindrical portion of the shell flattened in five evenly spaced triangular shaped planes. The base of these triangular planes lay at the intersection of the upper chine ring with the upper cylindrical portion. After the shell yielded the load dropped sharply. Load was then increased in increments of deformation until the drum height had been reduced by 10-1/2 inches. After yielding the upper chine ring folded flat and bulged outward. The center cylindrical shell portion then developed five flattened triangular areas and the lower chine ring folded similarly to the upper ring. The load deflection plot shown in Fig. 1 has two curves which illustrate both the elastic deflection characteristic and the plastic collapse which followed. Variations in the collapse curve correlate with various stages in the folding process. The static head of water, 7.8 psig, acting over a 22.5 inch drum diameter exerted an upward force of approximately 3100 lbs. This resulted in a net axial load of 16,460 on the drum walls at yield.

Although the drum was severely distorted by this test there were no leaks from the internal water pressure. The longitudinal shell seam was severely folded yet showed no signs of separation. Neither top nor bottom shell to head seams were deformed. The eight load contact points with the top head seam were indented .020/.050 deep. Final appearance of the drum after testing is shown in Fig. 2.

4.2 Drum Stacking Test

Four 12 inch channels were attached to a base plate forming a 25 inch square section silo. A new 16 gage steel fixed head D.O.T. 17C 55 gallon drum was filled 90% with water, capped and positioned in the bottom of the silo. The S-E-Co. radwaste crane and drum grab were used to stack three drums, which had been filled with sand and water, on top of the test drum. These sand filled removable head drums weighed 973, 974 and 934 lbs. respectively. Each was lowered into the silo at maximum drum grab speed. The drums were removed and carefully examined after the test. None of the drums showed any damage. The test drum did not leak. A photo of the test silo, drums and S-E-Co. drum grab is shown in Fig. 3.

4.3 Burst Test - Fixed Head Drum

A new drum, as described in 4.1, was completely filled with water through a fitting in the drum cap. The drum heads bowed then extended the first fold of the head-side seam as water pressure gradually increased. There was no change in appearance of the drum sides as the heads deformed into ellipsoidal shapes. At 90 psig a leak developed at the top head seam due to unrolling of the seam. The leak occurred where the longitudinal seams were rolled into the top seam. Appearance of the drum after the test shows in Fig. 4.

4.4 Burst Test - Removable Head Drums

4.4.1 A new 16 gage removable head drum per D.O.T. Specification 17H, 55 gallon capacity, was used. The removable head was 16 gage steel .062 inch thickness. Since the object of the test was to determine the burst strength, several gaskets and sealants were tried to obtain a good head seal. A 3/8 inch square sponge rubber ring bonded to the head with General Electric R.T.V. Silicone was finally used. The drum was completely filled with water through a connection brazed to the center of the cylindrical shell 180 degrees from the longitudinal seam. As pressure gradually increased, both top and bottom heads bowed and unrolled similarly to the fixed head drum. Since the top head connection of a removable head drum is much weaker than the connection of a fixed head, leakage developed at only 45 psig. The leak was located at the joint in the clamp ring and was due to the gasket blowing out. A photograph of the leaking drum after test is shown in Fig. 5.

4.4.2 The test was then repeated, except that an 18 gage steel head .051 with thickness was used. The head bowed readily and began leaking at 12 psig. It burst open at 24 psig. The failure initiated at the joint in the clamping ring as before. In contrast to the 16 gage head failure which was quite localized, the joint opened up about 120 degrees

DCM:gbw

cc - Standard Distribution: Manufacturing
Engineering
Sales
Service
R&D Test Report File
NPI File
Arthur J. Stock
J. R. Stock
Paul Williams
Dave Marsh
Bob Chaapel

STOCK EQUIPMENT CO.

CLEVELAND, OHIO

BY D.C. MARSH — TEST REPORT No. 51

APPROVED ____ DATE 7-12-73 PAGE 5 OF 6

REFERENCE REQUEST OF A.J. STOCK ON 7-9-73

TITLE LOAD VS. DEFLECTION OF 55 GALLON 16 GAGE 17C DRUM FILLED WITH WATER AT A CONSTANT PRESSURE OF 7.8PSIG

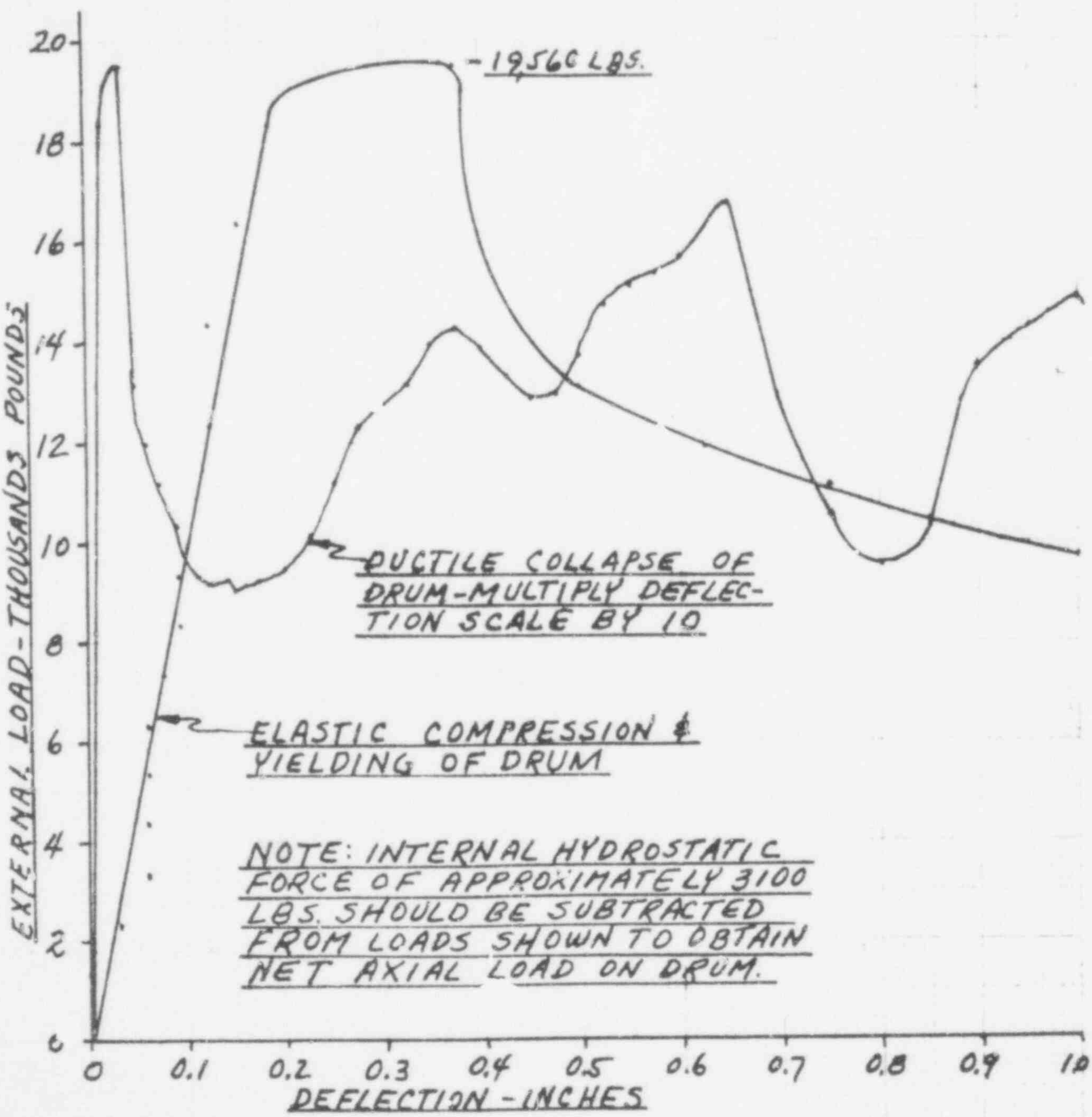


FIGURE 1

285 035

FORM 311 MR 6026-70

Compression, Stacking & Burst Pressure Tests On 55 Gallon Drums

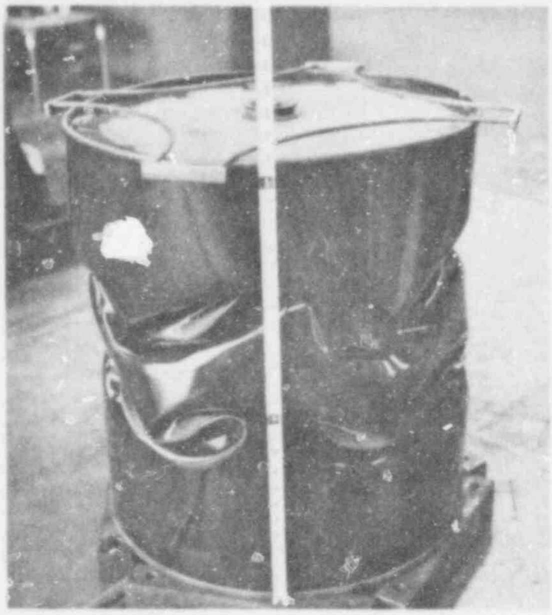


Figure 2 - 17C 16 Gage Fixed Head Drum After Maximum Load of 19,560 lbs.

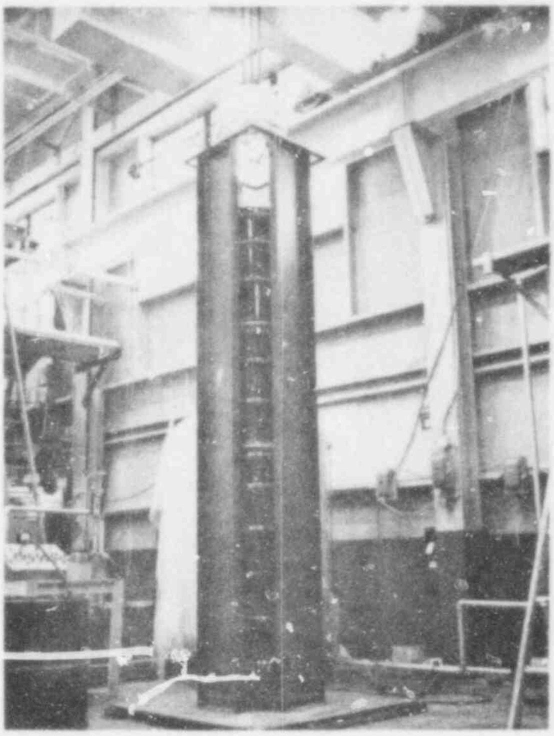


Figure 3 - Stacking Drums In 25 Inch Square Silo.

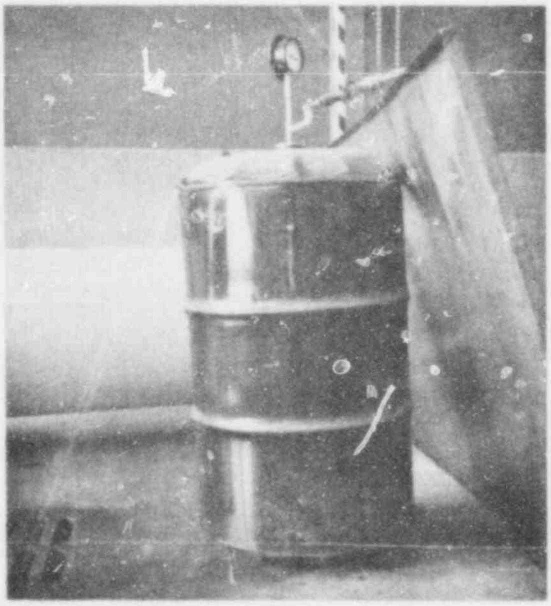


Figure 4 - 17C 16 Gage Fixed Head Drum Leaking At 90 PSIG.

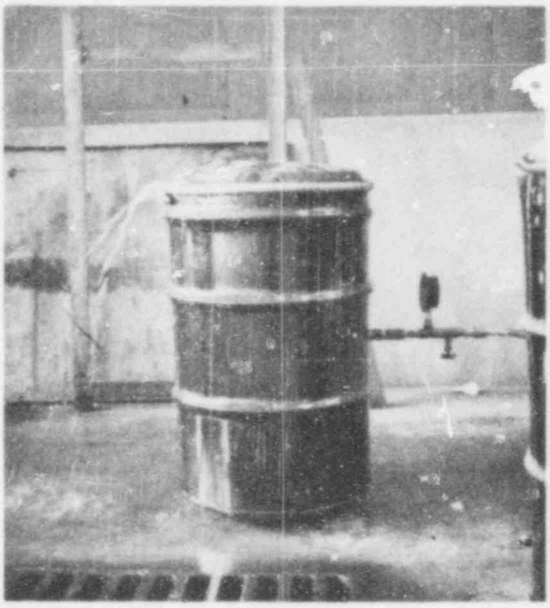


Figure 5 - 17C 16 Gage Removable Head Drum After 45 PSIG Maximum Burst Pressure.

STOCK EQUIPMENT CO.
CLEVELAND, OHIO

BY D. C. Marsh D. C. Marsh — TEST REPORT No. 48

APPROVED P. C. Williams — DATE 7/13/73 — PAGE 1 OF 6

REFERENCE Request of P. C. Williams on 6/25/73

TITLE Resin Handling Ability of S-E-Co. 1-Z3960 Radwaste Pump

1.0 INTRODUCTION

S-E-Co. Model 1-Z3960 is designed to pump accurately metered volumes of liquid radioactive wastes. It is a unique piston-type design mounted on a 12" thick steel radiation shield wall. Stepped operating rods connect the pump to a multiple air cylinder actuator located on the safe side of the shield. Servicing of pump wearing parts and packing is accomplished through plugs in the shield thereby protecting maintenance personnel from radiation and avoiding necessity for decontaminating the decanting tank and other equipment. Flush water connections at the pump cylinder permit flushing of the pump cavity and piping.

2.0 OBJECT

The object of this test was to determine the ability of the design to deliver demineralizer resin slurries under adverse nditions. The test piping and pump were intentionally plugged with resins to determine whether flow could be re-established after incorrect operation procedures were followed.

3.0 RESULTS

3.1 After intentionally plugging the pump and test loop (164.1 equivalent feet of 1 1/2" pipe) plus up to 6 days of settling time, normal circulation was easily re-established.

Restarting the pump and in some cases injecting 1 to 2 gallons of 40 PSIG flush water into the inlet piping was all that was necessary to clear the loop.

3.2 The pump, when restarted after being intentionally plugged, always began to cycle even though the inlet piping was plugged. The pump and valve configuration, therefore, eliminated packing of resins that could prevent pump operation.

3.3 After failure to re-establish flow and before injection of flush water, a centrifugal pump was used to boost inlet pressure. It was of no assistance because the slurries tested were too thick to be handled by the centrifugal pump.

285 037

3.4 When the resin tank mixer was shut down allowing the beads to settle, Radwaste pump delivery decreased. Delivery would continue until substantial' ll of the beads had settled.

4.0 CONCLUSIONS

Model 1-Z3960 Radwaste Pump will operate very successfully on bead resins when installed in the full S-E-Co. Radwaste Disposal System. If the resin feed system and pump plug with resins due to operator error or equipment malfunction, introduction of a small quantity of flush water into the inlet line will clear the system.

5.0 DISCUSSION

5.1 Test Set-up

Photographs showing the 1-Z3960 pump and test arrangement are shown in Figures 1 - 4 inclusive. Piping dimensions and elevations are shown in Figure 5.

Inlet piping leading from the conical bottom of the 400 gallon resin tank to the test pump included:

one (1) 2" X 1 1/2" reducer
three (3) 1 1/2" ball valves
one (1) 1 1/2" tee (run to branch)
two (2) 1 1/2" tee (run)
four (4) 1 1/2" union
seven (7) 1 1/2" 90° std. ell
one (1) 1 1/2" gate valve
28.6 feet 1 1/2" sch. 40 galvanized pipe

The discharge piping returning from the test pump to the top of the 400 gallon resin tank included:

4.0 feet 1" sch. 40 galvanized pipe
one (1) 1" union
one (1) 1" X 1 1/2" increaser
one (1) 1 1/2" gate valve
five (5) 1 1/2" 90° std. ell
30.7 feet 1 1/2" sch. 40 galvanized pipe

Converting these fittings to equivalent lengths of 1 1/2" schedule 40 pipe using the methods of Crane Co. Technical Paper No. 410:

Inlet piping = 79.7 feet
Discharge piping = 84.4 feet

5.2 Procedure

The 400 gallon tank was filled with 157 gallons of used bead-type demineralizer resins plus additional water. The resins were allowed to settle under the water so that the pumping of various free water to resin ratios could be evaluated. After a desired free water ratio had been established, the tank mixer was operated to establish a uniform slurry. Slurries containing 5.8 to 26 percent free water were tested. The pump was then started and the resin circulated through the test piping loop using atmospheric inlet pressure. The pump and mixer were shut down for periods ranging from 1 minute to 6 days. For some runs, the piping and pump were flushed with water before shutting down. This was accomplished by closing Valve V-1 as shown on Figure 5 and admitting water while the pump continued operating.

For several runs, the system was shut down without flushing. Resin then settled in the piping, particularly the vertical run to the top of the 400 gallon tank. Under all conditions tested the pump was able to clear this solid slug in the discharge piping. Photographs illustrating the initial break up of this resin slug are shown in Figures 6 and 7. Normal slurry delivery is shown in Figures 8 and 9.

During some runs, the mixer was shut down while the pump continued to operate. As the resin settled, pump delivery gradually decreased and stopped as the inlet piping blocked up. The pump continued cycling as delivery ceased. In one case the pump continued del'vering resins at a reduced rate after substantially all the free water in the system had collected above the settled beads.

When the system had been plugged either by stopping the mixer or by not flushing before shutting down the pump, the blocked inlet pipe was cleared by admitting water at 40 PSIG as described above. One to two gallons of flush water was sufficient to re-establish normal slurry flow. In no case did the pump piston fill with resin and become jammed so that it could not cycle. Pump air supply pressure was regulated to 60 PSIG for all tests.

Resin Handling Ability of S-E-Co. 1-Z3960 Radwaste Pump

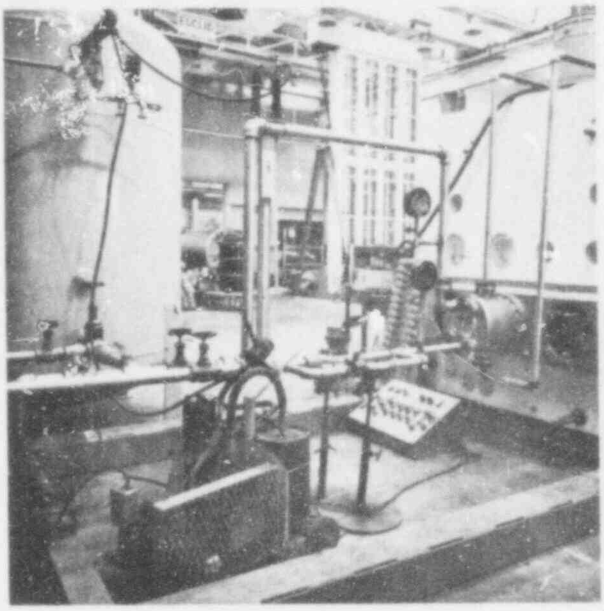


Figure 1 - Radwaste Pump Mounted On Hot Side of Shield Wall.

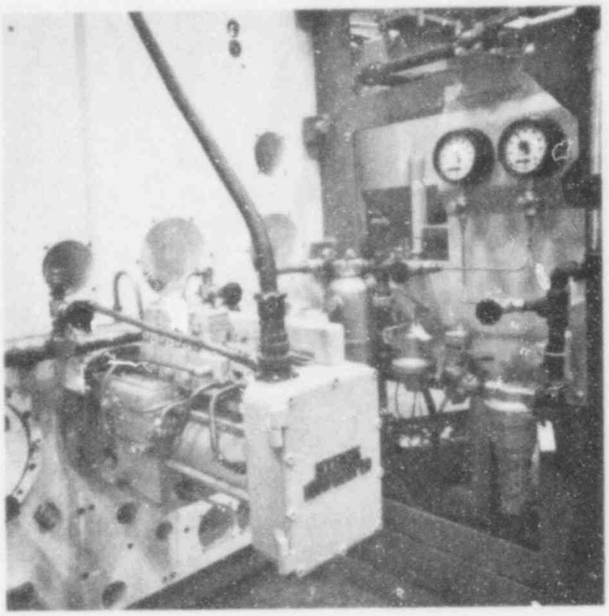


Figure 2 - Radwaste Pump Actuator On Safe Side of Shield Wall

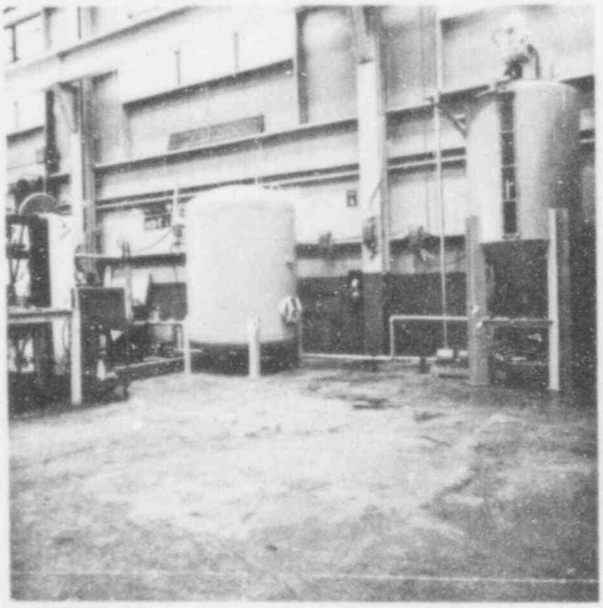


Figure 3 - General View Showing Pump and Shield Wall @ L.H., 1000 Gallon Reservoir in Center, 400 Gallon Resin Tank @ R.H.

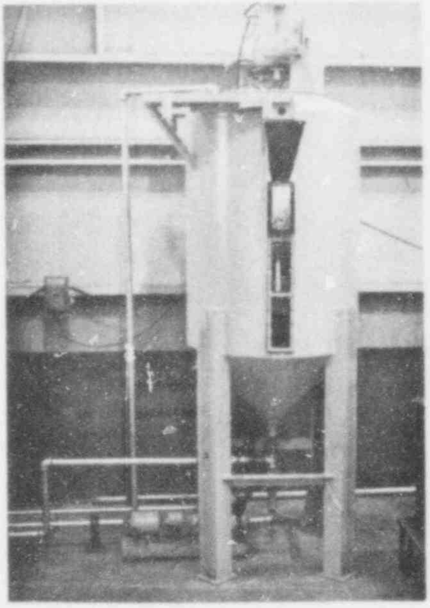


Figure 4 - 400 Gallon Resin Tank With Mixer, Resin Return Pipe To Top of Tank.

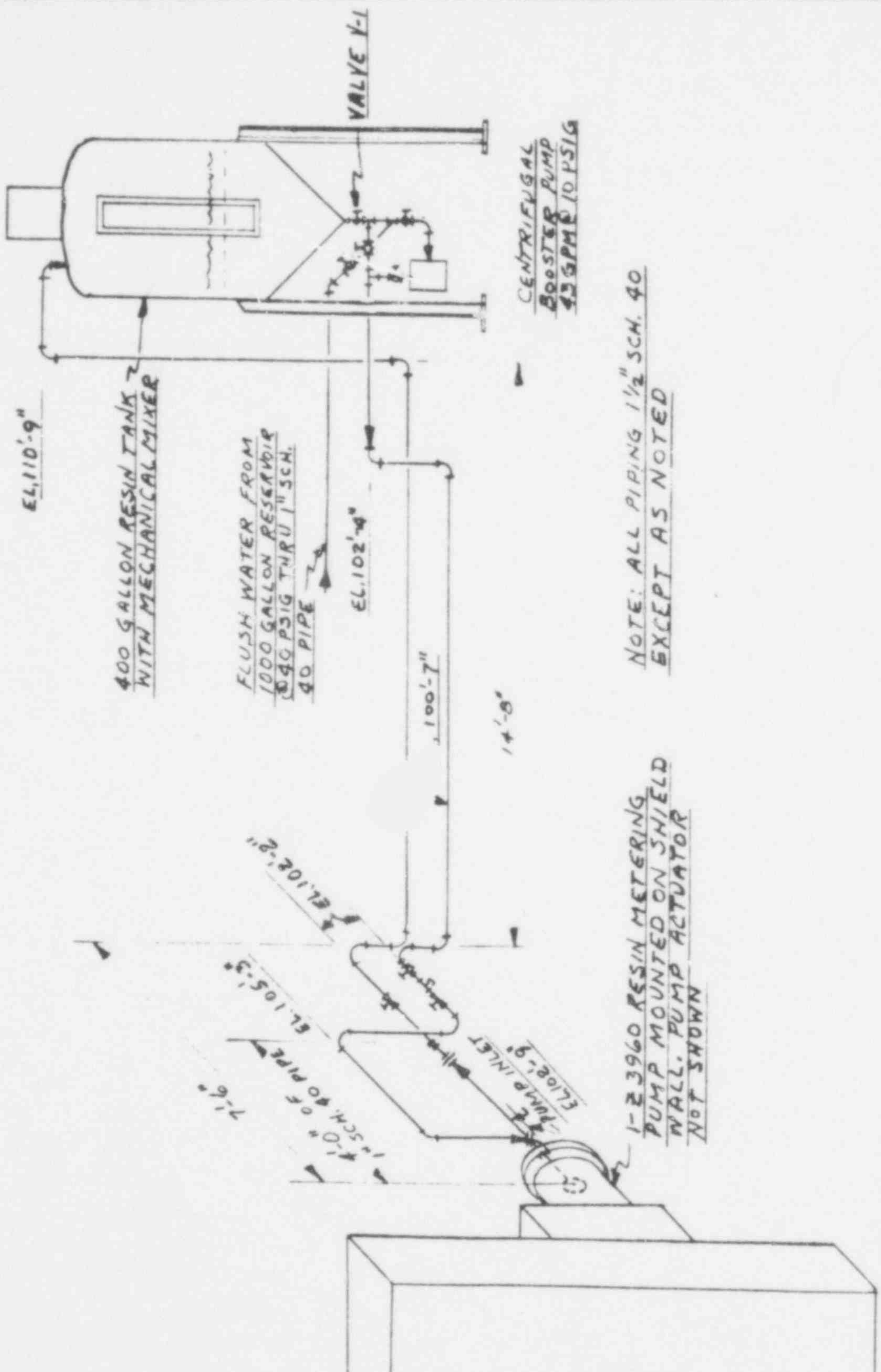


FIGURE 5 - RESIN HANDLING TEST PIPING DIMENSIONS

285 041

Resin Handling Ability of S-E-Co. 1-Z3960 Radwaste Pump

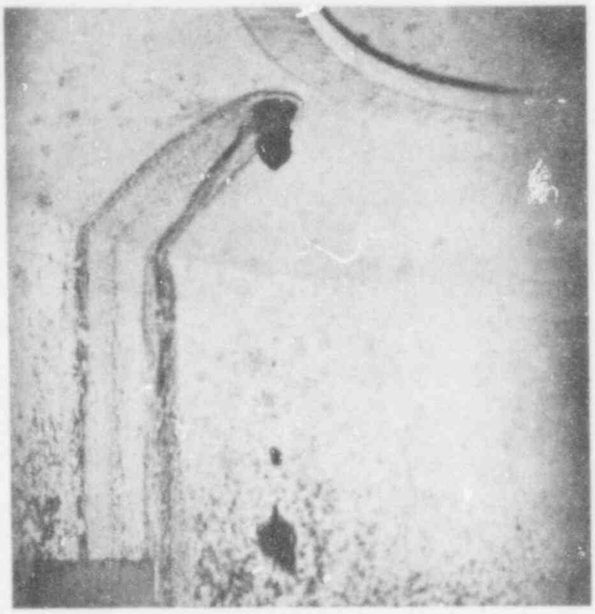


Figure 6 - Initial Stroke With Solid Slurry In Pipe

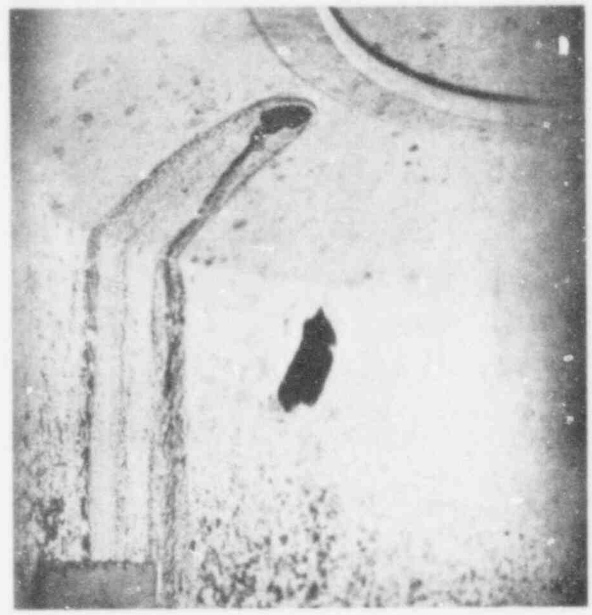


Figure 7 - Initial Stroke Continued

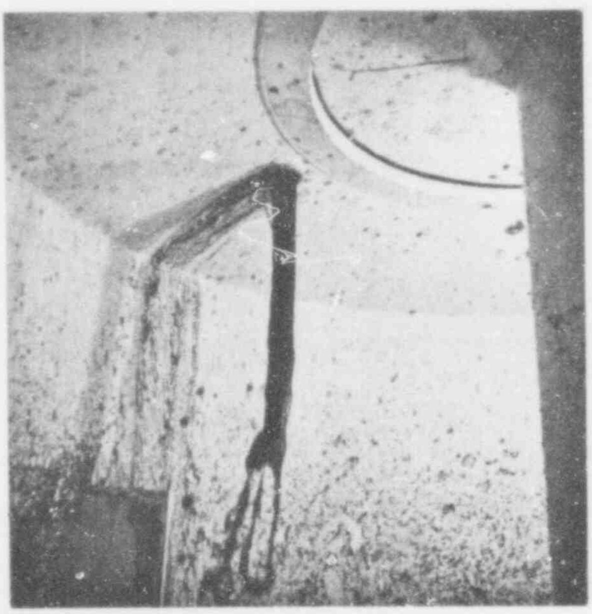


Figure 8 - Start Of Stroke With Normal Slurry Mixture

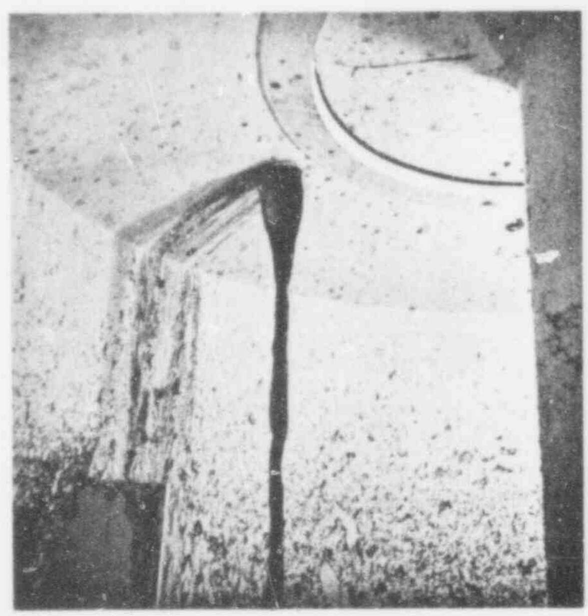


Figure 9 - Normal Slurry Delivery

TEST PROCEDURE FOR

16 Ga. 17 Tight Head Drums with 4" Screw Fitting

A test was conducted today on August 11, 1977 at the United States Steel Products Division, 14700 Harvard Avenue, Dolton, Illinois, using the following drums for tests:

	Test No.	Dot Test Pressure	Failed	Passed	Tested To
16 Ga. 17C Tight Head With 4" Fitting in Center of Head					
Hydrostatically tested to: 40# psi (Used same drum on both tests)	#1	(With 60 durometer neoprene gasket)	(Failed)		43#
	#2	(With 70 durometer neoprene gasket which was used on subsequent tests)		x	41#
Drop tested at four different quadrants from 4 ft., striking the concrete at 45° angle - filled with 90% water:	#1			x	
	#2			x	
	#3			x	
	#4		x (chime failure)		
Drop tested at four different quadrants from 4 ft., striking the concrete at 45° angle - filled with 90% concrete.	#1			x	
	#2			x	
	#3		x (crease in middle-couple drops of water showed)		
	#4		x (Additional water showed)		
Dropped flat on its side from 4 ft. onto concrete - filled with 90% water: Used same drum	On side			x	
	On top			x	
18 Ga. 17E Tight Head with 4" Fitting Near the Edge					
Hydrostatically tested to: (No test made)					
Drop tested at fitting from 4 ft., striking the concrete at 45° angle - filled with 90% water:				x	
Drop tested at two quadrants from 4 ft., striking the concrete at 45° angle - filled with 90% cement:	At 180°			x	
	A 0°			x	
20/18 Ga. 17E Tight Head With 4" Fitting Near the Edge					
Hydrostatically tested to: Used same drum on both tests:	#1	15#		x	15#
	#2	20#		x	* 21#
Dropped flat on its side from 4 ft. onto concrete - filled with 90% water: (Used same drum on 3 tests)	#1			x	
	#2			x	
	#3		x (Bottom metal at knuckle radius tore)		
Dropped from 4 ft. onto concrete at 45° angle on the fitting at top chime - filled with 90% water:				** x	

* 4" view shows 20# because 1# had been released before decision made to show this view

** Dripping seen is from water on lifting sling.