ATCOR ENGINEERED SYSTEMS, INC.

TOPICAL REPORT

ATC-132-A-NP-A

RADWASTE SOLIDIFICATION SYSTEM

Submitted to:

Division of Regulatory Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

JANUARY 1982

BY

ATCOR ENGINEERED SYSTEMS, INC.

FARMINGTON, CONNECTICUT 06032

THIS REPORT, ATC-132-A-NP-A, SUPERCEDES AND REPLACES ALL EARLIER VERSIONS OF THE SAME REPORT

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 3, 1981

Mr. Martin Brownstein
Director of Engineering
ATCOR
270 Farmington Avenue
Farmington, Conn. 06032

Dear Mr. Brownstein:

Subject: Acceptance for Referencing of Topical Report ATC-132A

The Nuclear Regulatory Commission has completed its review of ATCOR Licensing Topical Report ATC-132A entitled "ATCOR Radioactive Waste Solidification System" dated April 15, 1978 as augmented by responses, dated November 28, 1978 and April 24, 1979, to NRC staff requests for additional information. In addition, members of the staff witnessed operation of the ATCOR radioactive waste solidification system at the Point Beach Nuclear Power Station. The report describes the design and operation of the ATCOR Washington Corporation, Radioactive Waste Solidification System (RWSS), which combines wet radwaste (e.g., spent resin, evaporator bottoms and filter sludge) with cement to obtain complete solidification for eventual offsite shipment to a licensed burial facility. In addition, the report describes process parameters and the system design features for developing and implementing a process control program to reasonably assure complete solidification of process radwaste and the absence of free water in the solidified products. The summary of our evaluation is attached.

Based on the review, our principal findings are: 1) the Radwaste Solidification System is capable of safely processing and solidifying wet radioactive wastes generated by light water reactors, 2) the acceptable process parameters and the system design features are provided for implementing a process control program to reasonably assure that the solid waste product is a homogeneous mixture of process waste in a cement binder and contains no free water, 3) there are no direct releases of radioactive material in liquid and gaseous effluents from the RWSS to the environment, and 4) the system design includes radiation protection measures to ensure that occupational exposure to personnel involved with the operation, maintenance and inspection of the RWSS is maintained as low as is reasonably achievable.

As a result of our review, we conclude that ATCOR-ATC-132A, when augmented by the information in the responses to NRC requests for information is acceptable for referencing in license applications to the extent specified and under the limitations in the report and the topical report evaluation. When this report is referenced, the reference must include both the proprietary and non-proprietary versions.

We do not intend to repeat our review of this topical report when it appears as a reference in a particular license application except to assure that the material presented is applicable to the specified plant involved. Our acceptance applies only to the features described in the topical report, and the responses to our requests for information.

Any future license applications which reference the ATCOR radwaste solidification system should include, in the Safety Analysis Reports, the information on 1) the types of process wet radwaste to be solidified, 2) the system process capacity and plant interfaces with the ATCOR system, 3) the applicant's own process control program based on the recommended ATCOR process parameters, 4) the waste container to be utilized, 5) the system and equipment layouts, and 6) any exceptions and/or deviations from the accepted version of ATCOR Topical Report, ATC-132A.

In accordance with Title 10 of the Code of Federal Regulations, Part 2.790, ATCOR must submit an application for withholding the proprietary version of ATC-132 from public disclosure on the grounds that it contains trade secrets or privileged or confidential information. This application shall be accompanied by an affidavit which: (i) identifies the document or part sought to be withheld and the position of the person making the affidavit, and (ii) contains a full statement of the reasons on the basis of which it is claimed that the information should be withheld from public disclosure and shall address with specificity the consideration listed in paragraph (b)(4) of 10 CFR 2.790.

In accordance with established procedures (NUREG-0390), it is requested that ATCOR Company Inc. publish approved proprietary and non-proprietary versions of ATC-132A within three months of receipt of this letter. The approved version should include this letter and the enclosed evaluation following the title page and must appropriately incorporate the information submitted in the two responses to NRC's request for information.

Should Nuclear Regulatory Commission criteria or regulations change such that our conclusions as to the acceptability of the report are invalidated, ATCOR and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation or submit justification for the continued effective applicability of the topical report without revision of their respective documentation.

Sincerely,

Robert L. Tedesco, Assistant Director
for Licensing
Division of Licensing

Enclosure:
Topical Report Evaluation

TOPICAL REPORT EVALUATION

REPORT NUMBER: ATC-132A

REPORT TITLE: RADIOACTIVE WASTE SOLIDIFICATION SYSTEM

ORIGINATING ORGANIZATION: ATCOR ENGINEERED SYSTEMS, INC.

REVIEWED BY: EFFLUENT TREATMENT SYSTEMS BRANCH, DSI, NRR

RADIOLOGICAL ASSESSMENT BRANCH, DSI, NRR

SUMMARY OF REPORT

The report describes the design and operation of the ATCOR Engineered Systems, Inc. Radioactive Waste Solidification System (RWSS), which combines wet radwaste (spent resin, evaporator bottoms, filter sludge, etc.) with cement to obtain complete solidification for eventual offsite shipment to a licensed burial facility. In addition, the report describes process parameters and the system design features for developing and implementing a process control program to reasonably assure complete solidification of process radwaste and the absence of free water in the solidified products.

The principal findings in the report are: 1) the Radwaste Solidification System is capable of safely processing and solidifying wet radioactive wastes generated by light water reactors, 2) the acceptable process parameters and the system design features are provided for implementing a process control program to reasonably assure that the solid waste product is a homogeneous mixture of process waste in a cement binder and contains no free water, 3) there are no direct releases of radioactive material in liquid and gaseous effluents from the RWSS to the environment, and 4) the system design includes

radiation protection measures to ensure that occupational exposure to personnel involved with the operation, maintenance and inspection of the RWSS is maintained as low as is reasonably achievable.

Any future license applications which reference the ATCOR radwaste solidification system should include, in the Safety Analysis Reports, the information on 1) the types of process wet radwaste to be solidified, 2) the system process capacity and plant interfaces with the ATCOR system, 3) the applicant's own process control program based on the recommended ATCOR process parameters, 4) the waste container to be utilized, 5) the system and equipment layouts, and 6) any exceptions and/or deviations from the ATCOR Topical Report, ATC-132A, dated April 15, 1978.

SUMMARY OF REGULATORY EVALUATION

In our evaluation of ATC-132A, we have reviewed 1) the RWSS design description including piping and instrumentation diagrams, 2) the RWSS method of operation, 3) the RWSS quality group classification, 4) the quality assurance program for the design, construction, and testing of the RWSS, 5) the process parameters and the system design features to implement a process control program for the RWSS to reasonably assure that the proposed method of solidification is capable of solidifying the range of constituents expected to be present in the process wastes, 6) the RWSS design capacity in comparison with design basis input waste volumes, 7) the interfaces with other plant systems, and 8) the RWSS radiation protection design features to ensure occupational exposure is maintained as low as is reasonably achievable.

In addition, we have observed an ATCOR Radwaste Solidification System installed as referenced in this Topical Report at an operating nuclear power plant and discussed operating history with plant personnel and ATCOR representatives.

The RWSS mixes and combines metered quantities of process wet radwastes and dry cement in the screw type mixing unit (mixer/feeder) before discharge to a disposable waste container (to be provided by users). The process wet radwastes are sampled, chemically preconditioned and/or dewatered within the waste tank (capacity to be specified by users). The waste flow from the waste tank is controlled by the waste metering positive displacement pump and monitored by a tachometer mounted on the control panel. The motor speed control (two presetable speed controls) is accomplished remotely from the control panel and the pump stroke adjustment is accomplishable locally at the pump. Dry cement (Masonary or Portland type, provided by users) is fed into the mixing unit by a cement feeder. The feeder is driven by a motor with a variable speed drive control which is preset and adjusted locally at the feeder drive.

The system is capable of solidifying spent resins, filter precoat backwash, cellulose fibers, spent powdered resin, spent resin regeneration chemical wastes (sodium sulfate), and evaporator concentrates. The report establishes the various processing steps, controls, and process parameters with boundary conditions within which the RWSS should be operated to reasonably assure complete solidification of process radwastes. The system design also provides appropriate instrumentation and wet waste sampling capability necessary for users to successfully develop and implement a plant specific process control program. Operating nuclear power stations utilizing the system process information and design features provided by ATCOR have successfully developed and implemented their process control program and they have demonstrated reasonable assurance that they have achieved complete solidification of wet radwastes. We consider, therefore, that ATCOR has provided in the Topical Report, adequate information and system design features for users to develop and implement a process control program to reasonably assure complete solidification of the variety of constituents expected to be present in the process wastes and the absence of free water in the solidified products.

The report defines the equipment normally furnished by ATCOR as a part of the RWSS, the systems that will interface with the RWSS, and the equipment features (interlocks, alarms, monitors, controls, etc.) which are required to be functional before processing of wet radwaste can commence. The RWSS scope of supply includes 1) skid mounted waste tank assembly complete with an agitator, an ultrasonic level probe, strip heaters, and an emergency waste return pump; 2) cement bin assembly complete with a cement storage bin, vent filter, cement truck loading panel; 3) cement feeder; 4) cement conveyor; 5) mixer feeder; 6) waste metering pump; 7) container transfer equipment complete with a drum transfer cart, and drum conveyor handling system; 8) splatter shield assembly;

9) bridge crane; 10) TV camera and monitoring system; and 11) main control panel. The scope does not include disposal containers or shielded transfer casks.

The design, construction, quality group classification, and qulity assurance provisions for the RWSS equipment are in accordance with Regulatory Guide 1.143, "Design Guidance for Radioactdive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," Rev. 1, October 1979, and are therefore acceptable. The conformance of the seismic design criteria for the building that will house the RWSS will be reviewed for each individual application.

The RWSS will interface with 1) the plant service water system, 2) plant service air system, 3) plant ventilation system, 4) waste tank overflow connection, 5) dewatering filter outlet, 6) the liquid radwaste system, and 7) chemical addition lines to the waste tank. The capability to sample and the provision for chemical preconditioning prior to transferring to the waste tank should be provided by users.

The ATCOR RWSS has a minimum processing capacity of approximately 56,000 ft^3/year of processed waste using 55 gallon drums with a RWSS availability factor of 2/3 and 5 days/week operation. We estimate that a 3400 MWt with deep bed condensate demineralizers will generate approximately 23,000 ft^3/year of processed waste and that a 3400 MWt BWR with deep bed condensate demineralizers with regenerant solutions concentrated will generate approximately 41,000 ft^3/year of processed waste. Therefore, we consider the processing capacity of ATCOR RWSS to be capable of meeting the demand of a 3400 MWt BWR or PWR.

The radiation protection design features for the ATCOR radwaste solidification system are consistent with the guidelines of Regulatory Guide 8.8, Rev. 2, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Sations will be As Low As Is Reasonably Achievable." Many of the design features incorporated in the ATCOR system are based on several years of operational experience in the nuclear industry. Waste container filling, capping, and decontamination operations are all performed remotely from a shielded control area. The operator can view these operations using either a TV monitoring system or a lead glass shield window. Overfilling the waste container is precluded by filling the container in two stages. A splatter shield over the container during filling prevents spilling of waste material outside the container.

The ATCOR system also has provisions to remotely cap and monitor the filled waste container for contamination. All components critical to system operation are provided with remote manual handcranking of equipment for operation in the event of power failure or equipment breakdown. To minimize maintenance exposure, ATCOR equipment is modularized and skid-mounted to the greatest possible extent. These design features are intended to minimize radiation exposures to users of the ATCOR system.

The ATCOR system is designed to minimize the accumulation and deposition of crud in system components. Pipe runs are designed to be as short as possible to minimize crud traps and blockage. Sharp turns in piping are eliminated by making all piping bends five times the pipe diameter. Low points and pockets in pipes where crud can accumulate are avoided. Where practicable, all waste lines and valves have butt weld end connections to minimize crud buildup. All pipes and pump housings which have contact with radioactive wastes include valving and piping to permit complete flushing. These components are drained and flushed prior to maintenance work to minimize personnel exposure. These features are in accordance with those contained in Regulatory Guide 8.8 with respect to crud reduction to minimize personnel exposure.

The layout of the ATCOR system is arranged such that all operations are controlled from the radwaste control area which is located in a low radiation zone. The operator can observe filling and capping operations through shielded windows and/or a closed circuit television system. Access to lower radiation areas where maintenance must be performed does not require passage through higher radiation zones. Equipment is arranged to allow ease of component inspection and maintenance access. Valves not containing waste are located on a common valve rack and located in a low radiation area. All monitors associated with waste and drum handling are located external to the equipment, thus allowing for maintenance in low radiation zones. The waste tank assembly is located in a separate shielded cubicle. The shielding for these areas will be compatible with the guidelines contained in Regulatory Guide 8.8.

ATCOR has divided the area in which the radwaste solidification system is located into five radiation zones. The dose rate criterion for each of these zones is derived from expected occupancy and access restrictions. Using these radiation zones, ATCOR has performed an assessment of the doses that will be received by personnel maintaining the radwaste solidification system. This assessment is based on the number of man-hours required to perform various functions, the frequency, and the radiation zone involved. ATCOR estimates that the annual exposure resulting from normal operation and system maintenance will be aprroximately 3.12 man-rems. We find the bases for ATCOR's exposure estimate acceptable and consistent with the acceptance criteria contained in Standard Review Plan 12.4.

Based on the information presented in the Topical Report and on the ATCOR responses to our review questions, we find ATCOR's submittal acceptable. The Applicant's design features are consistent with the guidelines of Regulatory Guide 8.8 and are intended to maintain radiation exposures as low as is reasonably achievable.

REGULATORY POSITION

The ATCOR Topical Report, ATC-132A, provides an acceptable basis for the following:

(1) The Radwaste Solidification System can safely process solid wastes at anticipated waste feed rates for 3400 MWt light water reactors.

(2) The design, construction, quality assurance provisions and quality group classification of the Radwqaste Solidification System are in accordance with Regulatory Guide 1.143, Rev. 1, October 1979.

(3) ATCOR has provided in the Topical Report adequate information and system design features for users to develop and implement a process control program to reasonably assure complete solidification of process wet radwastes.

(4) The Radwaste Solidification System design features are consistent with the guidelines of Regulatory Guide 8.8 and intended to maintain radiation exposures as low as is reasonably achievable.

(5) There are no direct releases of radioactdive material in liquid and gaseous effluents from the operation of the ATCOR radwaste solidification system.

The capability of the plant radioactive waste treatment systems to meet the requirements of Appendix I to 10 CFR Part 0 is site dependent and will be evaluated for individual license applications. In addition, the packaging and shipping of all processed wastes in accordance with the applicable requirements of 10 CFR Part 71 and 49 CFR Part 170-178 will be determined for individual license applications.

We conclude that ATCOR Topical Report, ATC-132A, is acceptable for reference in future license applications for light water reactors. Any application incorporating this report by reference should include all deviations from this report.

ABSTRACT

This Topical Report describes the design and operation of the ATCOR System for solidification of low level radioactive waste from nuclear power plants. The ATCOR radwaste solidification system, as designed, utilizes cement as a waste solidification media. Cement was chosen over other solidification agents primarily because cement exhibits the following desirable characteristics and properties:

1) Produces a strong monolithic structure of adequate strength with no free water.

2) Produces a material with an acceptable leach-rate for shallow land burial purposes.

3) Adaptable to a reliable and easily operated processing system.

4) Produces a homogeneous reproducible product from batch to batch without extensive system operational modifications.

5) Can be designed into an operating system such that the operating environment is dust-free, non-explosive and non-flamable and free from other chemical hazards.

6) Has the ability to resist high levels of radiation without degradation.

7) Is commercially available.

The system, as described, has the capability to solidify waste in containers ranging from a 55 gallon drum size up to 100 cubic foot liners. The most common waste types that are solidified include the typical waste forms generated by both Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR).

Included in the report are sections which address the following major topics: system process, process parameter requirements, the major equipment and typical equipment arrangement illustrating the system and how the concept of ALARA is applied. The other remaining sections describe the applicable system design codes and standards, the quality assurance program, the research and development program, experience list and the postulated accident analysis.

PROPRIETARY INFORMATION

The following pages and/or sections in the ATCOR TOPICAL REPORT NO. ATC-132 RADIOACTIVE WASTE SOLIDIFICATION SYSTEM are considered to be proprietary by ATCOR and are not to be used or duplicated for public information and distribution without direct written permission of ATCOR.

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1.0 INTRODUCTION

Immobilization of liquid radioactive wastes generated by nuclear power plants and facilities is required prior to the acceptance of these wastes at a burial site. The system described in this topical report provides a means for the waste generator to initially mix the waste with cement, feed the mixture into shipping containers and to remotely handle the solidified waste package to a storage location. The equipment described has been supplied to over twenty nuclear power plants, both in the United States and Overseas.

The ATCOR Radwaste Solidification System uses a continuous mixing technique where the liquid wastes and the dry cement are accurately metered and blended in a twin screw mixer and discharged into a shipping container. Features are incorporated, based on the experience gained in the operating systems, which assist the operator in reducing radiation exposure. The system, such as the remote location of non-waste bearing valves from the contaminated components plus the incorporation of quick removal features in equipment design allows for quick access to the equipment for maintenance. Provisions for flushing of the equipment exposed to the waste are included as well as flushing of the mixing unit in order to prevent inadvertent solidification of cemented waste within the mixer.

The choice of cement as the binder in the ATCOR Radwaste Solidification System is the result of research conducted by ATCOR to develop an economical and acceptable binder for the evaporator bottoms and resin slurries which are the typical liquid waste streams produced by a nuclear power plant. Provisions are discussed which allow the pretreatment of the wastes, if required, to place the waste in a form which will be capable of solidification. Typical pretreatment operations include the adjustment of the waste pH in the case of evaporator bottoms and the removal of excess transport water in the case of resin slurries. The use of a masonry-type cement, containing a high lime content, minimizes the pretreatment required to successfully solidify the wastes. Remote handling of and transportation of filled containers containing solidified waste is accomplished from the remote control panel using a completely instrumented control system. Equipment such as electro-mechanical drum conveyors, liner transfer carts or overhead cranes are remotely operated. A closed circuit television system typically allows the operator to visually monitor the operations in process.

The ATCOR Radwaste Solidification System is the result of over ten years of development in both the chemistry of the solidifying agent and engineering of a reliable system. ATCOR systems are the culmination of the design and experience of many systems along with several years of operation in nuclear power plants. ATCOR's broad experience in the nuclear industry has served to provide a unique insight into practical design considerations. The system is designed with ALARA considerations in mind and designed to meet the applicable industry standards and regulations such as USNRC Regulatory Guide 1.143 and USNRC Regulatory Guide 8.8. The equipment and design are all controlled by ATCOR's Quality Assurance Program.

The purpose of this report is to present the necessary data on the A[illegible]R Radwaste Soldification System to enable the Nuclear Regulatory Commiss[illegible]n to evaluate the system for installation in nuclear facilities in the United States.

2.0 PROCESS DESCRIPTION

2.1 General System Description

Basically, the radioactive waste solidification system mixes separate feeds of moist radioactive waste and dry cement in a small-volume continuous mixer. Resin slurries and other solid waste materials are preconditioned and dewatered within the waste tank to provide sufficient moisture when mixed with dry cement. Normal operation of the system includes direct filling of dry cement into the cement storage silo or bin from a bulk cement unloading truck. Waste flow from the waste tank is controlled by the waste metering pump. Flow is monitored by a tachometer installed on the main control panel. Cement and waste are introduced into the mixer/feeder unit for intimate mixing and discharge into a container. The small-volume continuous mixer limits the surface in contact with wet cement and also minimizes the quantity of wet cement in the system at any time. A manual handcrank is provided to permit emptying of the mixer/feeder by the operator in case of a power loss or equipment malfunction.

Flush water spray nozzles are provided inside the mixer/feeder to remove any cement residue. The cement-bearing flush water is collected in an empty container; thus, there is no release of any cement into plant piping. Flushing of the waste feeder, tanks, and associated piping is also performed.

The system is designed with safeguards to ensure trouble-free operation. The control panel has been designed to be easily understood and simple to operate. Automatic functional controls sequence the entire operation and interlocks are provided to preclude unsafe operation or operator error.

2.2 CONTROLS SYSTEMS DESCRIPTION

2.2.1 Solidification System Main Control Panel

The control panel provides a complete graphic display of the system with running lights, pilot lights, and indicators clearly showing the operating condition of the entire system including valve positions and flow rates. The running lights, readout devices and pushbutton starters for manual operation are located adjacent to the pertinent component illustrated on the graphic display.

The following is a brief description of the various automatic controls.

2.2.2 Functional Mode Selector

A control marked Manual-Off-Automatic is provided to select either automatic or manual operation. Normally, the system will be operated from the automatic mode; however, manual remote operation is provided for special or emergency operations. With the mode selector switch in "manual", individual components are operated using the component control provided on the graphic display section of the control panel. In the "Automatic" mode, the system is controlled according to various primary phases of operation. These phases are:

a) Waste Conditioning Phase

b) Mix/Feed Phase

c) Mixer/Feeder Flush Phase

d) Waste Tank Flush Phase

Manual override during AUTOMATIC processing is not possible with the ATCOR system. to enable manual override during any phase of automatic operation, the operator has to press the Emergency Stop pushbutton. Pressing this button, at any time, terminates power to the entire system. All valves and motors will consequently be returned to their respective normal closed and/or off position. To permit manual operation, the operator must place the functional mode selector switch to the MANUAL position mode in order to carry out any manual operation.

2.2.3 Waste Conditioning Phase

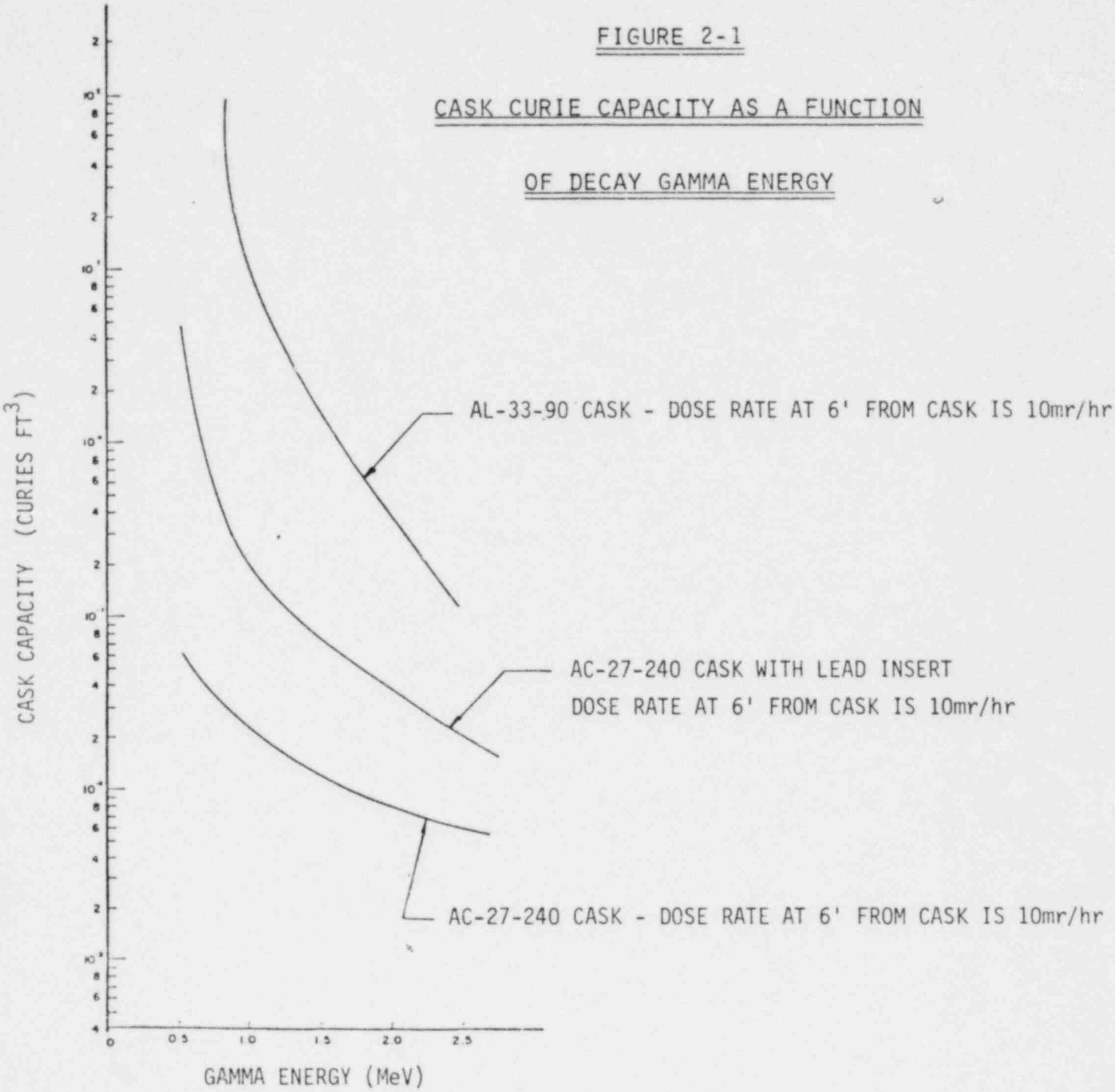
Automatic sequencing in this phase begins with the proper placement of a container in the fill position. The remainder of the waste conditioning phase is concerned with preliminary operations prior to filling the container. A process selector switch is used to set conditions relative to the type of waste to be processed. Further, positioning of this switch sets up the proper waste feeder speed consistent with the waste to be processed. Solid radioactive wastes are conditioned in this phase to contain sufficient moisture so that when mixed with dry cement, a cement mixture with acceptable consistency will be produced. Prior to waste solidification and radiation acknowledge, the operator visually observes the rad reading on the panel mounted indicator. An automatic alarm annunciates on the ATCOR panel and main control room panel upon exceeding the predetermined rad level. Part of the alarm function and circuitry is to signal an interlock which automatically prevents any waste processing by the operator.

ATCOR supplies a family of curves to allow the customer to determine the acceptable radiation limit for each shipping cask or shield prior to waste solidification. A typical curve is shown on Figure 2-1.

FIGURE 2-1

CASK CURIE CAPACITY AS A FUNCTION

OF DECAY GAMMA ENERGY



The waste conditioning phase is concluded by acknowledging the radiation level control after the moisture content of solid waste has been adjusted. This pushbutton is provided as one means toward preventing the possibility of overloading the shielding capabilities of the transportation container. The operator is reminded to read the dose rate located on the Main Solidification System Control Panel. No other phase of operation can be initiated until the radiation level control is acknowledged.

A reset is provided to enable return to any step in the waste conditioning phase, to repeat an operation, or return to a given step after a power failure.

2.2.4 Mix/Feed Phase (Product Mixing and Package Filling)

These controls are used for filling the container with cemented product. Initiating the mix/feed phase automatically activates all the necessary components to begin container filling. For example, the proper valves automatically open, the mixer/feeder starts, the cement feeder starts followed by the waste feeder. The waste feeder and cement feeder tachometer are utilized in this phase to visually verify that the flow of waste and cement are proper.

The conditioned waste product and dry cement are introduced into the mixer/feeder simultaneously. While the materials are being conveyed to the mixer/feeder, the screw flight arrangement within the mixer/feeder insures thorough mixing action. To preclude overfilling, the container is filled in two stages. The product mixing and package filling operations are continued until the waste tank is emptied.

2.2.5 Mixer/Feeder Flush Phase

This phase is designed to flush all parts of the solidification system that have been in contact with wet cement; namely, the mixer/feeder and the fill pipe. As in the waste conditioning phase, this cycle requires the proper placement of a container in position, followed by depressing the mixer/feeder flush phase start pushbutton. Level controls preclude container overfilling.

2.2.6 Waste Tank Flush Phase

The waste tank flush phase completes the solidification process. Since no cemented product remains in the system, all flush water during this phase can be directed back to the liquid radwaste system. Flushing progresses in preset timed cycles.

As with all the other phases, a "Reset" control is provided to enable the operator to repeat the entire waste tank flush phase. The solidification system will be in a shutdown condition with the completion of the flush operation.

2.3 Sub Systems

An explanation of the following sub systems and operations that occur within the primary phases are discussed in detail. The sub systems to be discussed are:

a) Cement Storage Silo Loading

b) Cement Metering

c) Waste Conditioning

d) Waste Metering

e) Product Mixing and Package Filling

f) System Flushing

g) Container Positioning

h) Capping

i) Decontamination

j) Radiation Monitoring and Smear Testing

k) Flush Water Siphon System

The above operations are all controlled from the Main Control Panel and Auxiliary Panels.

2.3.1 Dry cement is pneumatically conveyed to a cement storage silo or bin from a standard self unloading bulk cement truck. The silo is typically sized to receive a complete or full truck load quantity of cement, which is normally about 600 cu. ft.

To commence, the cement truck is positioned adjacent to the cement fill inlet panel. The driver removes the dust cover and connects the truck cement fill line to the fill nozzle inside the panel. When properly connected, the cement line actuates a limit switch that is mounted on the fill connection. A signal from the limit switch performs the following functions:

a) Actuates the alarm circuit which sounds on the cement fill inlet panel when the cement bin high level is reached.

b) Starts the bin vent filter flexing cycles.

c) Illuminates the Truck Connected light on the main panel.

When the high level alarm sounds on the cement fill inlet panel, the driver disconnects the cement truck fill line.

Disconnecting the line silences the alarm, stops the bin vent filter flexing cycles, and extinguishes the Truck Connected light on the main panel.

Rotating paddle type level detectors are used to provide the low level and high level signals to the main control panel. A dust free environment is maintained by the use of a standard automatic, self-cleaning, bag type vent filter or bin vent. The bin vent mounts directly on top of the silo.

2.3.2 Cement Metering

The cement storage silo is equipped with a standard vibrating bin bottom. The function of the vibrating bin bottom is to promote the flow of cement from the upper regions of the silo and to relieve headload and compaction of cement at the final outlet. Basically, the cement is kept constantly mobile thereby preventing possible bridging, rat-holing, or congestion prior to entering the cement feeder. The cement feeder selected by ATCOR to meter cement is a standard design. The cement feeder, coupled with the vibrating bin bottom, ensures a cement metering accuracy of at least 2%. This type of feed control is necessary to assure the final cemented waste product consistency is acceptable. The feeder is initially calibrated during pre-operational system testing, to deliver a predetermined flow of cement to the mixing unit (mixer/feeder). A local, manually adjustable, variable speed drive control is used to select the feeder speed and consequently provide the required output flow of cement. Remote meter readout of cement flow "CFM" is provided on the main control panel.

In cases where the building layout cannot physically permit the desired short run distance between the cement silo discharge and mixer inlet, an intermediate cement conveyor unit is required. Cement conveyors are also necessary when trying to fit a system into an existing building or plant. The cement conveyor is used to receive metered cement from the cement feeder and convey the cement at a constant discharge rate into the mixer/feeder.

The cement conveyor design selected by ATCOR is one that is widely used in various dry material and cement conveying applications.

2.3.3 Waste Conditioning and Metering

The waste tank receives radioactive wastes such as a slurry of resin, filter sludges, evaporator bottoms, or other types of miscellaneous waste. The moisture content of the slurry waste material within the tank is preconditioned by the addition or removal of water to ensure a proper cement mixture. Properly "conditioned" radioactive waste is then accurately fed and metered into the mixer/feeder unit for subsequent mixing with cement using a positive displacement waste metering pump.

Conditioning of solid radioactive waste is performed within the waste tank as a batch process. For normal operation, the waste slurry inlet valve is remotely opened from the Main Control Panel. The waste source transfer system is initiated from the Purchaser's Solid Waste Control Panel and the transfer of material is initiated into the waste tank. The filling process is automatically terminated upon reaching the tank high level waste condition. When the high level is reached, the waste transfer pump stops. At this point, the slurry has an excess of free water which must be removed.

ATCOR PROPRIETARY INFORMATION

2.3.3.1 Bead Type Resin Slurry

ATCOR PROPRIETARY INFORMATION

2.3.3.2 Filter Sludges (Solka Floc-Powdex Resin)

ATCOR PROPRIETARY INFORMATION

2.3.3.3 Evaporator Concentrates

ATCOR PROPRIETARY INFORMATION

2.3.3.4 Chemical Drains & Miscellaneous Waste

ATCOR PROPRIETARY INFORMATION

2.3.3.5 Waste Metering

ATCOR PROPRIETARY INFORMATION

2.3.4 Product Mixing And Package Filling (Mix Feed Phase)

ATCOR PROPRIETARY INFORMATION

2.3.5 System Flushing

ATCOR PROPRIETARY INFORMATION

2.3.6 Container Positioning, Capping, Decontamination, Radiation Monitoring, Smear Testing and Flush Water Siphon System

2.3.6.1 Container Positioning

ATCOR uses two types of transfer modes for container positioning. One method is using a powered roller drum conveyor system, the second method is using a motorized transfer cart. As the name implies, the drum conveyor is limited to transfer and positioning of standard 55 gallon drums. Using a transfer cart provides the flexibility of transporting drums, large volume liners or a combination of both. The motorized cart rides on two floor mounted rails.

The roller conveyor drum handling system is provided for simple and positive drum transfer operations. The operator manually places empty drums on the input conveyor. Next, drums are remotely transferred to the various stations for filling, capping, decontamination, radiological smear inspection and accumulation for storage pick-up. Positioning at each station is automatic and controlled by the operator from the control area. Filled drums are finally accumulated on the remaining conveyor sections for eventual pick up to the storage area.

As previously discussed, transfer carts are primarily used for transporting liners to the fill station, capping, decontamination and radiological smear station. The cart normally contains a single liner ranging in volume from 50 cubic feet to 100 cubic feet. In some instances, the customer prefers to have the flexibility in filling either drums or liners. To satisfy this requirement, the cart is designed with a drum spacer section. When drums are to be filled, the operator installs the spacer thereby making the drum height equal to the filling height of a liner.

Accurate container positioning is achieved by using standard limit switches or photo electric switches to remotely position the container and stop the drum conveying system or transfer cart.

2.3.6.2 <u>Capping</u>

Using the controls provided on the main panel, the operator moves the container to the capping station. At the capping station, the operator can attach any labels or information (radiation level, data, identification number, etc.) on the drum cover prior to placing it on the remote capper.

ATCOR uses a remote operated capper, manufactured by Kenway Engineering, to secure drum lids on either 55 gallon drums or liners designed with a 55 gallon drum opening. A detailed description of the capper is provided in Section 4.0.

For liners that do not have a standard drum opening, a remote, mechanically operated liner closure tool is provided. The liner opening is equipped with a two step, self latching Tiona Betts, Inc. or equal cover. The closure tool operates on the principle of a reach rod and mechanically closes the cover.

Container placement at the capping station is accomplished as previously discussed in the CONTAINER POSITIONING section. Operator viewing during the entire capping operation is provided by either a TV monitoring system or a lead glass shield window. Capped containers are then remotely moved to the subsequent decontamination station.

2.3.6.3 Decontamination

Drum decontamination consists of a spray booth which is remotely lowered over the drum. When in place, the mating surfaces of the booth and drum conveyor are contacted to completely enclose the drum and prevent the spread of contamination. Water is used to spray wash all of the drum surfaces. An air blast cycle is used to remove most of the remaining water accumulated atop the drum cover. Another approach used by ATCOR is to place a drum on a turntable. A stationary, vertical pipe header, with appropriately placed spray nozzles wash the rotating drum. A second stationary header is used to air dry the drum. Spread of contamination is prevented by performing decontamination in a contained area and separated from the process aisle.

Liners are similarly decontaminated using the turntable and stationary spray header approach described for drums. Spray booths are not practical due to the physical size; also a large number of spray nozzles would be required for complete water spray coverage.

Design of the decontamination spray booth is strictly a function of the physical container size e.g.: 55 gallon drums or large volume containers. The decontamination spray station is usually a custom designed unit to suit the customer's specific design requirements and building layout. Equal decontamination capability is afforded by either of ATCOR's design approaches. In all cases, decontamination cleaning and air drying is performed in a completely enclosed barrier to restrict further spread of contamination and separated from the process aisle and storage area.

2.3.6.4 Radiation Monitoring

Radiation level detectors are located 1) adjacent to the waste tank, 2) at the container filling station. Remote readout from each detector is displayed on the main control panel. The waste tank monitoring system provides the option of pre-selecting the ultimate shipping container to be used. Pre-selection is achieved, when necessary, by either diluting or concentrating the specific activity of waste within the tank prior to solidification. The "Radiation Acknowledge" pushbutton must be activated prior to starting the Mix Feed Phase of operation. At the filling station, the monitoring system measures the specific activity of the final cemented waste product. The scale range of 1 mr/hr to 100R/hr would be selected and used by ATCOR if unspecified.

2.3.6.5 Smear Testing

ATCOR provides an optional remote operated radiological smear device for testing the external surfaces of the container filled with radioactive cemented waste. The entire smear operation is performed remotely from a control console behind a shield wall. Once the sample has been taken, the swab is extended through a wall opening for removal. Depending upon the results of the smear, will determine if the container can be picked up for storage or returned to the decontamination station for further cleaning.

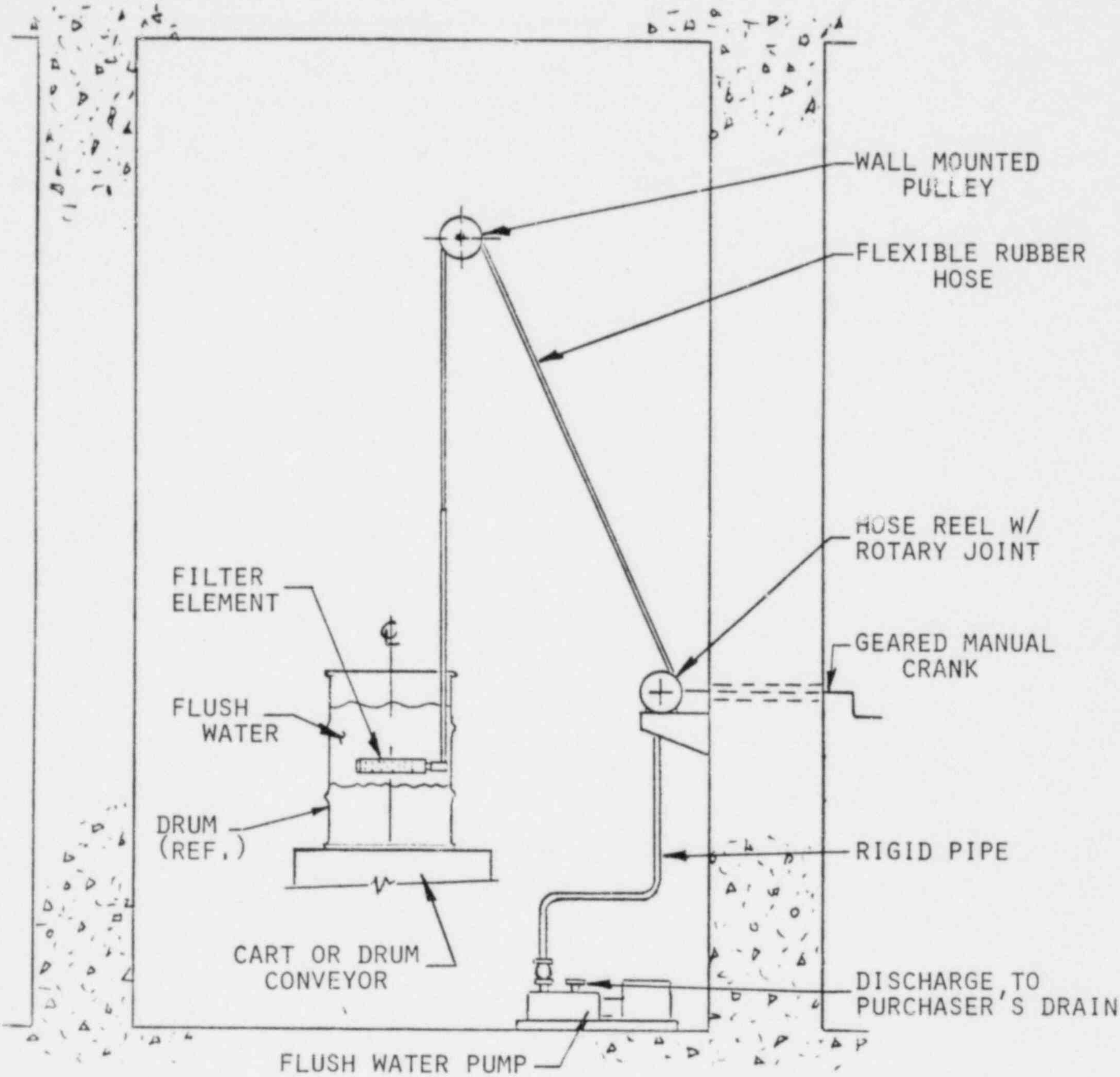
2.3.6.6 Flush Water Siphon System

A simple flush procedure for the removal of cemented residue inside the mixer has been developed to eliminate the need to handle, ship or bury drums containing flush water. Therefore, each drum or larger volume container contains only cemented waste product and not worthless flush water.

Basically, flushing the mixer/feeder is performed directly into an empty 55 gallon drum or larger volume container. This drum is then set aside to allow the cement contents to settle and harden. A siphon, which can be remotely inserted into the drum, is provided to decant the excess water for return to the waste tank or for processing. This drum is then filled with cemented waste at the start of the next solidification batch. The flush water siphon system consists of a packaged assembly. Included is one pump and motor, valves, and pressure switch, all mounted on a common baseplate. Additional items include a flexible hose, filter, winch and pulley system plus all necessary controls. A typical layout is illustrated in Figure 2-3.

Removal and replacement of the filter is a manual operation. The operation consists of merely threading the filter into a mating fitting which takes only minutes. The filter itself is capable of being backwashed; however, we recommend replacing the filter entirely. The decant system procedure is

FIGURE 2-3



TYPICAL FLUSH WATER SIPHON SYSTEM

ATCOR

to remove excess water several days after flushing into a drum. This duration is more than ample, since it takes only a few hours for the cement to actually settle and take an initial set in the drum. Once the cement forms a hard layer in the drum the filter will only see plain water. It is not anticipated that the filter will become contaminated as expected with precoat filters, for example. Degree of filtration for the filter used is 75 mesh particle size.

2.4 Interface Service Requirements

The following in-plant services are required to operate the Radwaste Solidification System.

Electric - 460 volts, 3 phase, 60 cycle
- 115 volts, 1 phase, 60 cycle

Flush Water and Decontamination Water -

30-35 GPM @ 100 PSI min. to 125 PSI max.

Air - 90-100 PSI for valve operators
- 6 SCFM at 90 PSI for Bin Vent
- 10 SCFM at 90-100 PSI for Drum Capper
- 10 SCFM at 90-100 PSI for Smear Station & Decontamination Station

2.5 System Interlocks and Alarms

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2.5.1 Waste Process System Interlocks

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2.5.2 Drum Handling Conveyor System or Transfer Cart Interlocks

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2.5.3 Decon System Interlocks

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2.5.4 Crane System Interlocks

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2.6 Alarm Conditions

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2.7 Fail Safe Features Incorporated in Control System

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2.8 Piping and Instrument Diagram

ATCOR Drawing number 8121-D-01 sheets 1 through 3 illustrate a typical ATCOR radwaste solidification system. Also included is a P&ID Instrument and Equipment Symbol chart.

3.0 PROCESS PARAMETERS

The importance of solidification system process control requires the use of instrumentation, automation and detection devices to:

- Provide visual indication of system running status and assure fail safe operation.
- Alert the operator to any abnormal or unusual occurrence during system operation.
- Automatically terminate a single phase of operation should the operator fail to detect or foresee a problem.

3.1 Process Parameter Controls

The controlling instrumentation and process control technique, used by ATCOR, is a direct result of actual plant operating experience. The following is a detailed description of the instrumentation used and their controlling functions.

3.1.1 Waste Tank Instrumentation

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3.1.2 Cement Bin Instrumentation

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3.1.3 Cement Feeder or Cement Feeder Conveyor Instrumentation

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3.1.4 Container Filling Instrumentation

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3.1.5 Waste Flow Instrumentation

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3.1.6 Cement Flow Instrumentation

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3.1.7 Process Selector Switch

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3.2 Frequency of Calibration

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3.3 Sampling Requirements of Wastes

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3.4 Description of Solidification Agent

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3.5 Waste Feed Characteristics

Typical PWR and BWR waste types solidified with the ATCOR system are described as follows:

3.5.1 Deep Bed Resins

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3.5.2 Waste Filter and Floor Drain Filter Sludge

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3.5.3 Cellulose Fibers (Solka Floc)

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3.5.4 Clean-Up Filter/Demineralizer Sludge (including Fuel Pool Filter/Demineralizer Sludge)

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3.5.6 Evaporator Concentrates Bottoms consisting of:

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3.5.7 Floor Drains and Miscellaneous Waste

3.5.8 Other-Spent Filter Cartridges-(encapsulated with cemented waste)

3.5.9 Tables 3-3 and 3-4 show the flowrates of waste and cement along with an operating tolerance needed to form a free standing, homogeneous product.

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3.5.10 Tables 3-5 and 3-6 list the Waste/Cement Mixtures for wastes solidified with Masonry Cement and Portland Type I Cement respectively.

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3.5.11 The basis for defining the mixing tolerances and ratios presented in Tables 3-3 through 3-6 is a function of actual system operating experience, shop testing, and laboratory sample experimentation.

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3.6 Waste Product Leachability

Currently, confirmed data regarding Masonry cement leachability is not available. It is our understanding that Brookhaven National Laboratory is in the process of performing laboratory leachability tests on Masonry cement and will report their results in the near future.

We have in our investigation found that Masonry cement will produce better leachability results than found with Portland cement. We have included a copy of the Brookhaven results on Portland cement as the expected results from the Masonry cement will be presented in a similar format in the near future (See Attachment 3-2).

ATCOR concurs with referenced Brookhaven National Laboratory (BNL) study results on leachability of waste solidified with Portland cement. Report Number BNL-NUREG-50591. ATCOR's investigation on leachability of waste solidified with Masonry cement reveals that the product exhibits better properties, with respect to free standing water, when tested using a variety of waste products. The fact that breakdown of waste product did not occur after 24 days ascertains that the product is superior to plain ordinary Type I Portland Cement (less additive).

3.7 Acceptance Criteria of Solidified Product

Tables 3-3 through 3-6 indicate operating flowrates of waste and cement along with operating tolerances needed to form acceptable waste products. Although there is no published and approved acceptance criteria for radioactive waste, we use the following criteria to describe acceptable solidified liquid wastes:

3.7.1 There should be no free-standing liquids after 24 hours of mixing the waste with the cement.

3.7.2 The product should be free-standing, non-friable after 24 hours of mixing the waste with the cement.

3.7.3 The product without support of sample container should be able to survive a four (4) foot drop test onto an unyielding flat structure with only localized failure noted.

3.7.4 The product should be able (without support of its container) to support a compressive load of not less than three (3) times its own containerized weight.

3.7.5 The product when exposed in free-standing water for 168 hours should show no visable signs of failure.

The variances in our operating tolerances indicate with conservatism compliance with the above, self-imposed criteria.

3.8 System Process Capacity

Process capacity of the ATCOR system is provided using typical waste type projections for a BWR.

3 8.1 ATCOR Radwaste Solidification System Process Capacity Drums Per Year Using Specific BWR Solid Waste Type Projections

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3.8.2 Drums Per Year Using Specific PWR Solid Waste Type Projections

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3.8.3 References

ATCOR PROPRIETARY INFORMATION

3.9 System Process Capability

3.9.1 Calculation of Annual Anticipated System Availability

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3.10 Estimated Exposure to Personnel

Based on design features of the ATCOR Radioactive Waste Solidification System and in plant shielding in the form of concrete walls is such that personnel exposure to radiation during normal operation is minimal and is estimated to be less than 2 rem per year. This exposure has been calculated as follows:

Drums/year x number of operators x radiation level ÷ drum/year

a) From answer #2, BWR Waste Projections equal a total of 5773 drums/year.

b) Number of operators equal 1 1/2 men

c) Radiation level is 0.002R/Hr.

d) ATCOR Radwaste System can process 9 drums/hour

5773 drums/year x 1.5M x 0.002R/Hr ÷ 9 drums/Hr = 1.92 Man-rem/year.

The system has been designed to provide emergency process functions in cases of a loss of electric power or other similar emergencies. The design features remote mechanical operation from behind the shielding. The exposure in the event of such an emergency would be the same for the time spent in normal operation.

Exposure during system maintenance has been kept to as low as practical by separation of process equipment which does not contain radioactive residues from those which have processed waste and cement paste. Those portions of the system which are required to contain and process radioactive waste have been designed to minimize radioactive material build up and each component has been designed to remove residues by high pressure low volume spray devices. The radiation exposure during maintenance periods is estimated to be less than 1.2 rem per year. This exposure has been calculated below:

D.R. (1) x time (2) = total maintenance exposure

(10) mrem/hr x (120) hours = 1.2 rem where:

a) Maximum dose rate expected after flush. Experience has shown that the radiation levels have been less by a factor of 3.

b) The time allotted for these maintenance functions should not exceed this value and it is also necessary to point out that most of the maintenance time will not be in the area of highest dose rate.

Attachment 3-1

PROCESS CONTROL PROGRAM FOR MASONRY CEMENT - IN-LINE MIXER RADWASTE SOLIDIFICATION SYSTEM

A-SP-001

Controlled Copy Number__________

Prepared By: ______________________________ Date: ______________

Approved By:

Department Manager ______________________ Date: ______________

Quality Assurance ______________________ Date: ______________

APPROVED FOR IMPLEMENTATION______________ Date: ______________

PROCEDURE NUMBER: A-SP-001

Rev.	Description	Approval: Department Manager	Date	Quality Assurance	Date
-	ORIGINAL ISSUE				

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ATTACHMENT 3-2

BNL-NUREG-50591

CRITICAL REVIEW OF THE PROPERTIES OF SOLIDIFIED RADIOACTIVE WASTE PACKAGES GENERATED AT NUCLEAR POWER REACTORS

P. COLOMBO AND R. M. NEILSON, JR.

MANUSCRIPT COMPLETED - OCTOBER - 1976
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PREPARED FOR THE UNITED STATES NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH
UNDER CONTRACT NO. EY-76-C-02-0016

WASTE FORM PROPERTIES AND INTERACTIONS WITH THEIR CONTAINER

Cement

The chemical and physical properties of cement are well known and much experience with it as a construction material has evolved over the years. It is also readily available and inexpensive. However, knowledge of the effect of mixing cement with radioactive wastes is somewhat limited.

No information on the properties of cement waste forms as are currently being generated at nuclear power reactors is available. Some property information is known for simulated cement waste forms as is appreciable information for the pure cement system itself. However, property evaluations made on such cement waste forms can only serve as indications of waste form properties since in general they do not adequately simulate power reactor wastes. Also many differing power reactor wastes are often mixed and solidified together with the result that the properties of the waste, which relates to the ultimate properties of the solidified form, are not known. As mentioned previously, the chemical and physical properties of even a given waste type within a reactor varies over wide ranges of specific activity, radionuclide content, pH, salt content, chemical composition, viscosity, etc., making simulations difficult.

Leach rate testing of cements has used a wide variety of testing methods with little attempt at standardization. Among other factors, values determined depend upon the radionuclide measured, leachant composition, frequency of leachant changing, pH, temperature, and duration of testing. These tests generally do not attempt to predict the rate of radionuclide release, but rather to serve as a comparison for different solidification methods. Because different test procedures are used, leachability data found in the literature cannot normally be correlated. Leach rates are reported in many different units. The most common appears to be as a fraction release of the species of interest, or as a bulk leach rate, g/(cm^2-day), which relates the mass of the sample, its external surface area, and the duration of leach testing to the cumulative fraction release of the species of interest.

Bulk leach rates for cement monoliths of 10^{-1}-10^{-9} g/(cm^2-day) have been reported in the literature. Values for the leaching of soluble salts, such as sodium nitrate in cement, are generally 10^{-1}-10^{-2} g/(cm^2-day), with the higher values associated with high salt content. Cesium and strontium exhibit lower bulk leach rates when adsorbed on sludges, clays, ion exchange resins and zeolites. Leach rates of strontium from hydroxide sludges of 10^{-4}-10^{-6} g/(cm^2-day) are generally reported. Cesium and strontium leach rates from clays and zeolites of 10^{-2}-10^{-5} g/(cm^2-day) are found in the literature. Mixed ion exchange resins in cement leached in sea water released 3.15% of contained Cs^{137} in 2540 hours. Leachability of organic ion exchange resins increases with total radiation dose. Ziolites in cement exhibit cesium and strontium release rates of generally 10^{-4}-10^{-5} g/(cm^2-day), but the rate of cesium release is increased by the addition of ferric hydroxide sludge to the concrete. Plutonium and americium bulk leach rates in cement of 10^{-7}-10^{-9} g/(cm^2-day) have been reported. The leach rates of cesium and strontium are also a function of the type of cement used, portland, high alumina, or pozzolanic. The relatively high leach rates for many concrete waste forms is ascribed to the inherent porosity of the material, with an actual surface area exposed to the leachant of up to 8000 times that of the external surface.

The thermal stability of concrete waste forms under normal conditions for the incorporation of Savannah River Plant high level waste has been classified as adequate. That concrete itself is thermally stable under normal conditions is evidenced by the extent to which concrete is used as a construction material. Concrete is incombustible and has good fire resistant properties. In fire environments it tends to lose hydration water above 250°F (121°C) but with only relatively small decreases in the compressive strength under 1000°F (538°C). If held at this or higher temperatures for appreciable periods of time, considerable strength losses and failure by cracking or spallation may occur. The effect of high temperatures on concrete is highly dependent on the aggregate, which is radioactive waste in this case. No information on the thermal stability of power reactor concrete waste forms has been found. Concrete waste forms may fail due to gas generation as a result of waste decomposition or because of differences in thermal expansion of the concrete and the waste. This behavior is aggrevated in power reactor waste forms since the waste content of the concrete is high, resulting in low mechanical strengths. In a fire, waste form damage is dependent upon the rate at which heat is absorbed by the concrete. The thermal conductivity of concrete is highly dependent upon the aggregate, density, and water content, with values of 3.4-8.6×10^{-3} cal/sec/cm/°C reported for commercial construction concretes.

The mechanical strengths of concrete waste forms currently generated at power reactors are not known. However, low strengths are probable due to the high waste loadings used. Some concretes may have essentially no mechanical strength either as a result of the cement not curing or the waste loading being so high that sufficient cement is not present to bind it together. The compressive, tensile, and impact strengths of the waste are directly related to failure under load and resultant dispersion of the waste. The effect of hydroxide sludge content on compressive strength has been measured and is found to decrease rapidly with sludge loading, however, these waste forms are not directly indicative of power reactor waste forms.

Evaluation of the likelihood of cracking, fracturing, and resultant dispersion of the waste form requires a knowledge of its mecahnical properties which is currently not available. Concrete waste forms are also susceptible to degradation as a result of free-thaw cycling. This may be of particular importance since some wastes contain substantial quantities of absorbed water.

Considering the activity contents of solidified power reactor waste forms, it is unlikely that radiation stability is of major importance. Concrete itself has good radiation stability as shown by its use and long term exposure in reactor applications. However, the presence of water, nitrates, and other components susceptible to radiolysis could result in gas generation and pressurization problems which are potentially hazardous. The radiation stability of reactor wastes has not been evaluated in the context of incorporation into concrete forms.

Concrete is susceptible to corrosion in burial environments, particularly by acid and sulfate waters. Sulfate and boric acid containing wastes may contribute significantly to such corrosion. Chemical reactions of a waste constituent may result in degradation of the waste form. Corrosion of the concrete waste form would be expected to increase leachability, decrease mechanical strength, and promote dispersibility. The integrity at long times and in burial environments of power reactor waste forms as currently generated is not known. Concrete placed in a moist environment is alkaline due to dissolution of hydroxides and hydration of free lime. This should have little affect on the container since at ordinary temperatures steel is rather stable in an alkali environment.

Concrete itself is not biodegradable although it may be affected by the action of chemicals generated by organisms in the soil. However, if the constituents of the waste incorporated in the waste form are biodegradable, radionuclide dispersibility may result.

4.0 EQUIPMENT DESCRIPTIONS

As a minimum, the following particular general requirements are applicable to all ATCOR supplied equipment and assemblies.

4.1 General

4.1.1 Materials of construction for all surfaces wetted by waste or solidification process fluids are 304, 316 stainless steel, or special alloy material.

4.1.2 Due to the possibility of stress corrosion cracking in stainless steel, every effort is made to prevent contamination of stainless steel equipment, including fasteners, with foreign materials, particularly halogens, during the period of manufacture, fabrication, assembly, transportation, and storage.

4.1.3 The skids, shell supports, cradles, and base plates are carbon steel. The skid mounting is equipped with a drip-lip type base for collecting the leakage f m all pumps and other sources. The skid drain lip is designed to contain or collect small amounts of leakage, such as pump seal leakage or abnormal spillage. At the end of the lip is a piped connection, which extends to a local floor drain. A collection tank with varying capacities, receive the floor drains which are temporarily stored prior to waste solidification. The intent of the skid drain lip is to confine any leakage to a small area and to permit drainage to a collection tank.

4.1.4 Gaskets for all integrally mounted equipment is supplied.

4.1.5 For design purposes, the integrated radiation dose rates over 40 years for various sections of this equipment are:

a. Waste feed tank and internal components and associated valves, piping, and instruments 1.0×10^6 rads.

b. Waste metering and feed system: 3×10^5 rads.

c. Other components in contact with radioactive fluids 1×10^5 rads.

NOTE: Radiation dose rate is defined by the utility or architectural engineering firm. The above stated values are typical.

4.1.6 Manholes of adequate size are provided for inspection or maintainance of components.

4.1.7 Insofar as practicable, interfaces with Purchaser-supplied piping and components are minimized.

4.1.8 Modularized skid-mounted sections are used to the greatest possible extent.

4.0 EQUIPMENT DESCRIPTIONS (Cont'd)

4.1.9 Arrangement and design of equipment skid components consider maintenance requirements (e.g. clearance, frequency, and duration) and access limitations due to radioactivity within or near a component.

4.2 Testing

4.2.1 ATCOR is responsible for all test procedures and tests conducted at points of manufacture called for in our Specification and in applicable codes and standards. Testing of equipment, piping, pumps and valves is conducted according to the following:

4.2.1.1 Piping systems, valves and pumps are hydrostatically tested in their entirety. Testing is performed in accordance with applicable ASME or ANSI codes, but in no case at less than 75 psig. The test pressure is held for a minimum of 30 minutes with no leakage indicated. Atmospheric tanks are water filled leak tested with no leakage permitted.

4.2.1.2 Nondestructive examination (NDE) procedures and acceptance standards are in accordance with ASME B & PV Code, Section VIII and API 650, 620.

4.2.1.3 The control panel is tested to demonstrate proper operation of all safety features and alarms, the inherent safety designed into the system, and the effectiveness of the remote procedures using simulated signals.

4.3 Shop Assembly

4.3.1 Each unit is preassembled insofar as practicable for shipping.

4.3.2 The skids and each piece of the equipment is provided with lifting lugs or brackets.

4.3.3 Bolt hole orientation of vertical flanges straddle the vertical component centerline.

4.4 Surface Preparation and Cleaning

4.4.1 All external surfaces are smoothly contoured and free from dents, gouges, sharp corners, or rough edges.

4.4.2 All equipment is neatly finished and all metal parts shall be smooth and free from surface blowholes and other surface imperfections. Patching, peening, or caulking is not to be permitted.

4.4.3 Cleaning procedures are in accordance with the requirements of ANSI N45.2.2.

4.0 EQUIPMENT DESCRIPTIONS (Cont'd)

4.5 Painting

4.5.1 The carbon steel surfaces of the waste solidification system receive the following coating treatment:

The exterior surfaces are prepared in accordance with the Structural Steel Painting Specification SSPC-SP10, Near White Blast Cleaning with a profile range of 1.5 to 3.0 mils.

Prepared surfaces are painted with Carboline, Carbozinc 11 (or approved equal) in accordance with the paint manufacturers coating system requirements. Stainless steel parts are not painted.

4.6 Preparation for Shipment

4.6.1 Packing, shipping, receiving, storage and handling is in accordance with ANSI N45.2.2

4.6.2 Shipment of equipment and components to the jobsite without specific release by ATCOR and the Purchaser's inspector (when required) is not permitted.

NOTE: All descriptions represent typical equipment supplied by ATCOR. Dimensions and capacities will vary according to the size of the system and the type of container to be filled.

4.7 WASTE TANK ASSEMBLY

The tank is a custom designed radwaste processing and waste conditioning tank. All wetted parts are 316 stainless steel, ASTM-A312, A240. The supports and leg construction are carbon steel ASTM-A36, A285, A283, A306 with a No. 11 Carbo Zinc paint system or equal applied. A support structure for mounting the waste feeder is integral with the waste tank support structure. A removable 20 inch diameter manhole cover assembly is provided for tank access.

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4.7.1 Filter Data for Dewatering Bead Resin

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4.7.2 Filter Data for Dewatering Powdex Resin and Solka Floc

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4.7.3 Heaters and Controls

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4.0 EQUIPMENT DESCRIPTIONS (Cont'd)

4.7.4 Testing

ATCOR PROPRIETARY INFORMATION

4.8 CEMENT BIN ASSEMBLY

4.8.1 Cement Storage Bin

The cement bin is fabricated from 3/16 inch thick ASTM-A-36 or A-285 carbon steel. Connection to mate with the vibrating bin bottom and level detectors are provided. The bin cover includes a cement fill inlet loading adapter, in addition to a flanged vent connection for the automatic bag dust filter, and 20 inch diameter pressure-vacuum manhole. For personnel safety, the bin is furnished with a caged safety ladder and guard rail. The bin is provided with four (4) structural steel legs which in turn will be anchored to a skid. Refer to Figure 4-2.

4.8.2 Cement Silo Vent Filter Assembly

A silo vent filter assembly is furnished to provide for dust-free operation. This unit is a standard automatic self-cleaning, bag-type filter with a pre-wired electrical blow-back timer control and pressure gauge. Purchaser is required to supply 6 cfm of clean, dry compressed air for automatic filter bag cleaning. The bag filter is provided with an additional air maze panel-type filter directly mounted to the bag filter exhaust. The additional exhaust filter has a cement dust retaining efficiency equal to the primary bag filters.

Overall Dimensions: 85: High x 40" Wide x 40" Long

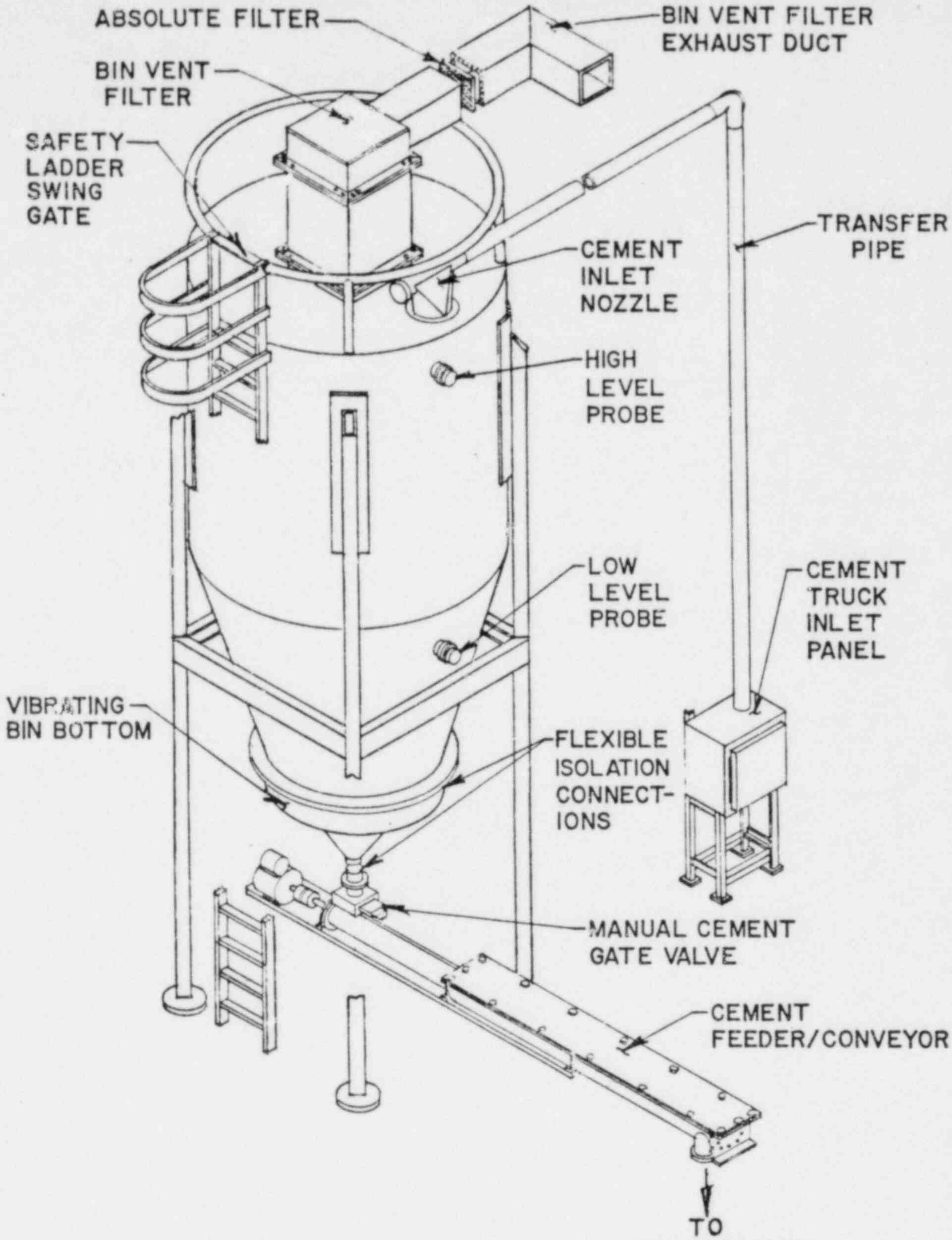
Filter area: 183 Sq. Ft. Filter Area

Air Flow: 900-950 ACFM (Nominal from Bulk Truck)

Air to Filter Ratio: 6.0 to 1.0

Number of Bags: 36, 50" Long

Manufacturer: Flex Kleen 58BVBS25 or equal



CEMENT STORAGE BIN & FEED ASSEMBLY

FIGURE 4-2

4.0 EQUIPMENT DESCRIPTIONS (Cont'd)

4.8.3 Cement Fill Station/ Inlet Panel

The cement fill station is designed to accommodate truckload delivery of dry cement and direct the cement to the cement bin. A limit switch is mounted on the fill connection of the panel. When the driver connects the truck hose and energizes the switch with the truck cement fill line, the line actuates the limit switch. The limit switch sends a signal to start the dust collector flexing cycles, allows the alarm to sound on the inlet panel when the cement bin high level is reached and illuminates the TRUCK CONNECTED light on the main system panel. With high cement level, the alarm sounds. Removal of the fill line automatically silences the alarm, and terminates the filling operation by stopping the dust collector and extinguishing the light.

The panel includes a lockable cover of 10-gauge steel construction; the interior is fitted with a Kamlock with limit switch and dust cover.

4.9 CEMENT FEEDER

4.9.1 Cement Feeder/Conveyor

The dry cement feeder is used for the precision metering of cement. The cement to the feeder is preconditioned to a constant bulk density by the vibrating cement bin bottom to assure steady uninterrupted flow of material. When used with the vibrating bin bottom, the cement feeder will meter the cement with an accuracy of approximately 2%. The feeder is driven by a one and one-half H.P. motor with a variable speed drive control to give an output cement rate of 0-2 cfm. Speed control is accomplished locally at the feeder drive.

The unit is made of carbon steel with all required surfaces protected with a corrosion resistant paint. A typical Cement Feeder/Conveyor Specification is included on page 29.

4.9.2 Cement Feeder (Vibrating Type)

The dry cement feeder is a heavy-duty unit which is used for the precision metering of cement. Vibration of the feed material preconditions it to a constant density to assure steady uninterrupted flow of material. It consists of a vibrating trough and screw and a variable speed transmission which is locally controlled at the drive. The variable speed transmission is driven by a standard TEFC (460/60/3) motor. A tachometer, with readout on the control panel calibrated from 0 to 2 cfm is used to monitor cement flow rate. The unit is made of carbon steel with all required surfaces protected with a corrosion resistant paint.

ATCOR ENGINEERED SYSTEMS, INC.
A Chem-Nuclear Company
270 Farmington Avenue
Farmington, CT 06032

SPECIFICATION NO.__________
DATE__________

CUSTOMER'S NAME __________ TYPICAL
SPECIFICATION __________
LOCATION __________

ITEM NO. __________

MATERIAL

CEMENT FEEDER/CONVEYOR

ATCOR PROPRIETARY INFORMATION

4.0 EQUIPMENT DESCRIPTIONS (Cont'd)

4.9.3 Cement Conveyor

The cement conveyor receives dry cement from the cement feeder (located beneath the cement bin) and discharges the cement into the mixer/feeder for eventual mixing.

The cement conveyor is specifically designed for conveying bulk materials such as cement, at a steady flowrate. The unit consists of a 6 inch carbon steel screw which rotates inside a 12 guage carbon steel stationary trough. To prevent cement dusting, the trough is gasketed and covered with a 14 guage carbon steel cover. The trough ends are also gasketed and covered. Sealed ball bearings are mounted for supporting the screw at each trough end. An intermediate bronze bearing supports the center of the screw.

Driving the conveyor is a 2 HP, TEFC, 1800 RPM motor which is belted to obtain a final output screw speed of 75 RPM. An OSHA approved guard encloses the belt drive to protect personnel.

4.10 CEMENT MIXER/FEEDER

The mixer/feeder intimately mixes and positively conveys the desired radioactive waste materials and cement to the system fill pipe assembly. A twin counter-rotating blade assembly is designed to blend the waste material and cement into a complete and homogeneous product. The unit is designed to process material at a constant discharge rate of 1.0 CFM. To ensure thorough cleanout, flushing of the unit is accomplished by the use of a dual rotating spray manifold design which includes a series of spray nozzles. A 22 inch x 8 inch inspection window is furnished on the removable cover to facilitate inspection and viewing of the mixer internals without the necessity to remove the entire cover. Water tightness and cover fit is achieved by the use of a heavy gauge and gasketed cover material. Quick release, adjustable type clamps secure and hold the cover in place. The cover can be lifted or replaced in less than one minute. The unit is driven by a remotely mounted 2 HP, TEFC, 100 RPM direct drive gear motor. Should there be either a power failure or drive failure, the mixer can be manually rotated through a remotely located handwheel. A painted arrow over the handwheel showing the proper direction of rotation is required and is provided by the utility. The handwheel bypasses the motor completely and directly turns the mixer shaft through a gear arrangement. All major components in contact with radioactive waste materials are constructed from 304 stainless steel. Refer to Figure 4-3.

4.10.1 Mixer/Feeder Vent Filter

ATCOR PROPRIETARY INFORMATION

4.11 PUMPS

4.11.1 Combination Waste Metering and Dewatering Pump

ATCOR PROPRIETARY INFORMATION

4.11.2 Emergency Waste Return Pump or Transfer Pump

ATCOR PROPRIETARY INFORMATION

4.12 CONTAINER TRANSFER EQUIPMENT

4.12.1 Drum Transfer Cart

The cart is designed to safely accommodate eight (8) 55 gallon drums. Dimensionally, the cart is approximately 10 feet long, 5 feet wide and 1 foot high. Materials of construction are ASTM-A-37 or equivalent carbon steel with all steel surfaces properly prepared and painted. The cart is designed to permit ease of decontamination, maintenance and be resistant to water washdown. The cart will ride on two floor mounted A.S.C.E., 20# rails. The rails are recessed into the floor to minimize vehicle interference or obstruction in the truck access area. To facilitate remote loading and positioning of the drums, using the overhead crane, drum centering guides are provided on the cart.

The cart is propelled using a combination 3/4 HP, 460 volt, TEFC gear motor drive and travels at a speed of approximately 15 feet per minute.

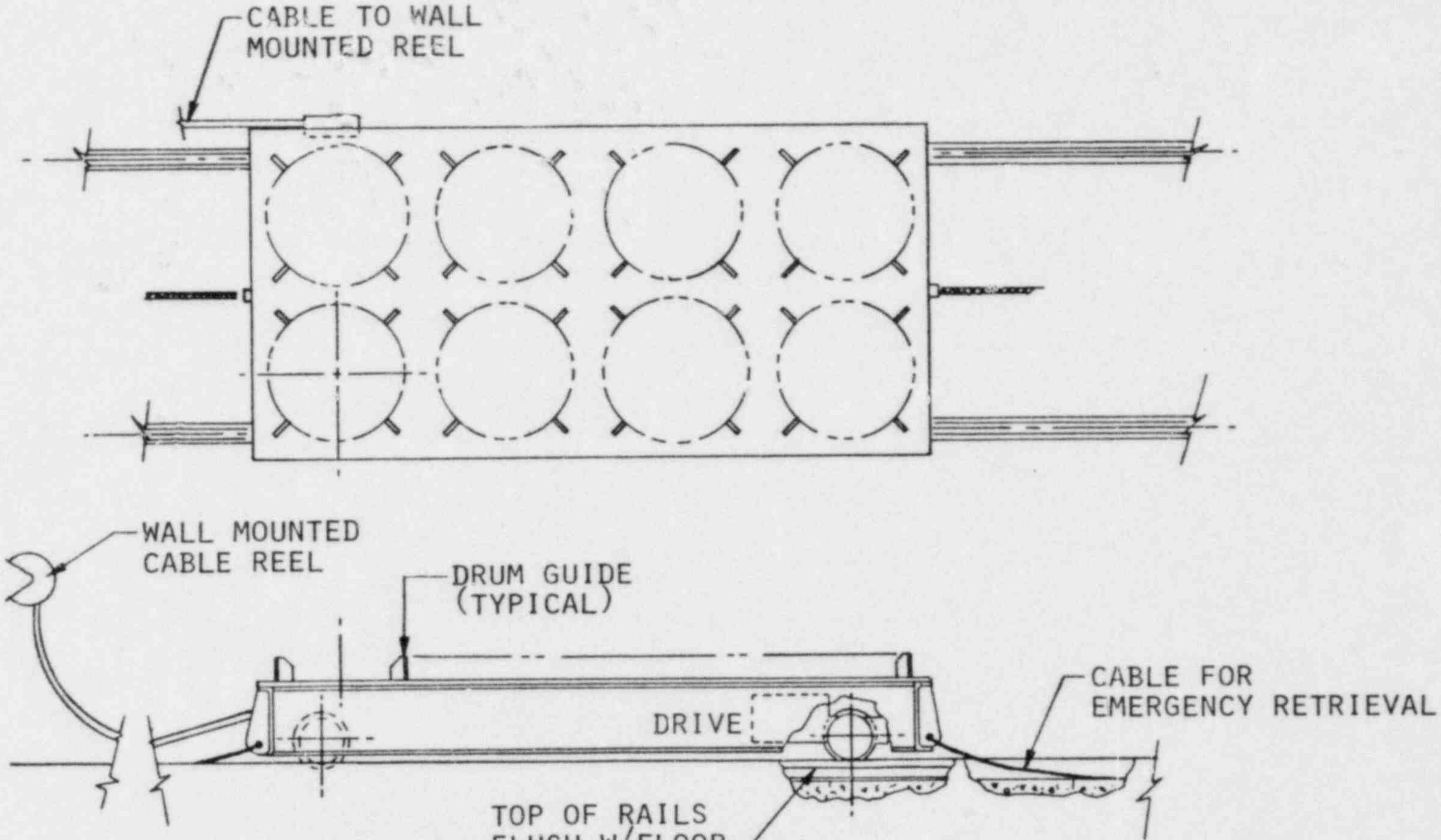
The cart drive is powered through a wall mounted cable reel. In the event of a drive failure, a cable arrangement to permit remote retrieval using either the ATCOR or purchaser's crane is provided. Refer to Figure 4-4 for typical cart configuration.

4.12.2 15 Ton Cart and Turntable Assembly

This cart is constructed of structural channels and carbon steel plate mounted atop two (2) crane end truck assemblies. All surfaces are painted to facilitate decontamination and to withstand operation conditions within the cubicle. The cart rides on standard ASCE 40# rails, which should be recessed into the floor. A spacer is provided to facilitate 55 gallon drum handling. Adjustable liner guides are mounted atop the turntable to accommodate the varied container sizes.

A turntable is built into the cart to provide the necessary container rotation during decontamination and smear operations. The turntable is designed to carry the maximum liner load (30,000 lbs.) uniformly distributed on the surface of the turntable. All drives are suitably enclosed against the operating conditions. A cable reel is used to power the turntable.

FIGURE 4-4



EIGHT DRUM TRANSFER CART

ATCOR

The cart is propelled by a continuous chain and sprocket drive, driven by a 3/4 HP gear motor. The cart motor is located in a low radiation area to reduce maintenance exposure. A manual handcrank is provided for emergency manual cart movement at the motor location. The cart moves at approximately 15 feet per minute. A control console provided for the decon operation will operate the cart motions. Photo switches are used to provide cart position indication. Interlocks are provided to preclude unsafe cart operation during capping, decontamination and smear operations.

4.12.3 Drum Conveyor Handling System

The drum handling system consists of the following major components:

4.12.3.1 Input Drum Conveyor - This is a chain driven live roller unit. It is used to accumulate eight (8) drums and provide the mechanism to sequentially load the process aisle conveyor.

4.12.3.2 Input to Process Aisle Drum Transfer Unit - This is a chain driven live roller unit. A pneumatic cylinder is used to lift the center roller section of the transfer unit, which permits a drum to be loaded on one side and transferred to the process aisle conveyor (a ninety degree turn).

4.12.3.3 Process Aisle Drum Conveyor Unit - This is a chain driven live roller conveyor which is used to process drums between the input and the decontamination station. It provides separate fill, drum accumulation, capping and decon conveyor sections which can be individually operated.

4.12.3.4 Smear Station Conveyor Unit - This conveyor section is equipped with a rotating capability which permits full drum rotation during smear sampling operation.

4.12.3.5 Accumulation to Storage Conveyor Unit - This live roller conveyor section is used to accumulate drums prior to lifting into storage by the overhead crane.

The previous described equipment is furnished with handcranks, on inidividual conveyor sections, to permit drum handling in case of a motor failure. ATCOR provides all required position devices and controls to safely operate this system. All drum conveyors have reversing capability.

A description of operation for the drum handling system is presented in Section 2.

4.13 CONTROL PANEL

4.13.1 Solidification System Main Control Panel

The solidification process system is fully instrumented to monitor at the control panel the operating condition of system components, flow rates, and material levels. Interlocks are provided to prevent operation in an unsafe manner.

Functional automatic controls are provided in which the operator actuates controls sequentially. A Pushbutton control can only be actuated if the previous pushbutton control operation has been completed and the system condition is satisfactory. The control system has been designed to simplify the operator's job and also preclude the possibility of making an error.
A manual control mode is also provided to individually operate any item of equipment for test purposes or special operation.

The control panel provides a complete graphic display of the system with running lights, pilot lights, and indicators to clearly show the operating condition (including valve positions) of the entire system. The running lights, readout devices and pushbutton starters for manual operation are located adjacent to the pertinent component illustrated in the graphic display. A NEMA 12 dust-tight control cabinet is provided to contain all relays, timers, etc., mounted and prewired internally to terminals. Refer to Figure 4-5.

4.13.2 Materials Handling Control System

The major portion of the materials handling system is involved with the control of the single girder transfer crane system. The crane control panel contains a mimic of the system operating functions. This allows the operator to perform remote pushbutton control of all drum grab, hoist and crane system functions. Cart control is also provided on this panel. A graphic representation of the area is also provided which detail crane/trolley positions as well as position indicator lights for critical drum position points such as drum conveyor pick up, storage area grid and the trailer loading position, etc. Located in the same area as the main control panel will be the television monitor and camera control unit. This permits remote operation of the system by a single operator.

4.13.3 Fail Safe Features and Analysis of Malfunctions

All equipment provided within the ATCOR system is designed to fail in the safe position. Should a loss of air or electrical power occur, the system is designed to fail automatically in a safe position. All hoist and crane system motions would be inoperable and all equipment will be in a fixed position until power is restored; therefore, a drum would not be inadvertently released, etc. In the case of power failure to the carts, the operator could elect to wait until power is returned or hand crank the cart to a safe position.

4.13.4 Transfer Mechanism Controls

The controls to fully operate the transfer are provided within a NEMA 12 control cabinet. Graphic indication of the various drum positions is provided along with individual pushbutton controls for the following: Drum input conveyor loading, fill station transfer, fill station drum clamp and vibrator operation, capper station, transfer and accumulation conveyor transfer.

4.13.5 Crane Control System

A pendant is provided to facilitate low level drum handling. The main control system, however, is provided within a single control panel to facilitate all remote drum handling operations. The crane control panel contains a mimic of the pendant and provides pushbuttons to perform all required crane system functions. A graphic of the area is also provided to indicate detailed crane/trolley positions as well as position indicator lights for critical drum handling position points such as input and discharge of fill stations, decon station, and smear station. Interlocks are provided to insure safe system operation.

A description of the equipment previously discussed, is presented in paragraph 4.20 of this section.

4.14 PIPING AND VALVES

General: Piping and valves are constructed to ANSI B31.1 Power Piping Code.

Line Sizes: Flush water lines range from a minimum of 1/2 inch and up to 2 inch schedule 40.

Resin Piping: 2 inch, schedule 40, line sizes are normally used; however, for short straight runs (up to 10 feet) 1 inch size is used. All pipe bends are five times the pipe diameter; that is, no elbows and sharp turns are permitted.

Liquid Waste Piping: 1 inch through 2 inch, schedule 40, line sizes are used.

Cemented waste discharge piping and flanges used are 8 inch minimum.

Connections: Butt weld end, 150 lb. flanges, socket weld end.

Materials of Construction: ASTM-A312TP 304 or TP316.

All surfaces and component parts in direct contact with radioactive waste will be constructed from one of the following: 304L or 316SS. Other special alloy materials can be substituted for stainless steel if desired by the customer. The particular type of stainless steel is usually specified by the customer. If unspecified, ATCOR selects 316 stainless steel as a standard material. All nonwaste-bearing equipment in contact with flush water will be fabricated from 304 stainless steel.

4.14.1 Ram Type Valve

A ram type valve is provided as an alternate means of resin or waste removal from the waste tank. Valve construction consists of 316 stainless steel wetted parts and body, also a TFE gland packing is furnished. The valve comes equipped with an air to open, air to close cylinder, 4-way solenoid valve and position indicator switches. A 2 1/2 inch, 150# flange connection is provided to mate with the tank connection.

4.14.2 Valve, Knifegate

The mixer/feeder discharge contains a remote air operated knifegate valve for on-off control of cement/waste slurry materials. Open-close valve control is remotely operated through a

self-supported double-acting pneumatic cylinder mounted to the valve. The valve is constructed with a drip tight resilient seat. A solenoid valve and valve position indicating limit switches are mounted and provided with each valve. Should emergency opening or closing of the valve be required, a manual override is provided with the valve. Manual operation is achieved by use of a locally mounted lever arm which is inserted directly into the valve mechanism.

4.14.3 Valves, Plug

Plug valves are used throughout the solidification system for flow control and shut off of radioactive waste material and flush water through the system piping. Valve materials of construction are ASTM-A351CF-8M, 316 stainless steel body, 316 stainless steel wetted parts, ultra high molecular weight (UHMW) polyethylene sleeve. Plug Valves are remotely opened or closed by an air operator mounted on the valve. Valve position indicating limit switches and solenoid valve are furnished and mounted to each valve.

4.14.4 Valves, Butterfly

The butterfly valve is installed at the waste tank discharge for shutting off or permitting flow of waste material into the waste metering pump. The valve is remotely operated through a pneumatic rotary air to open and air to close actuator directly mounted to the valve.

Valve construction consists of an ASTM-A-351CF8M 316 SS body and disc, ethylene propylene seat. All other wetted parts are constructed from stainless steel. A solenoid valve and position indicating switches are provided and mounted to each valve. This valve is provided with a local manual override to permit manual valve operation in the event of a power failure or loss of air.

4.15 INSTRUMENTATION

4.15.1 Waste Tank & Waste Container Ultrasonic Level Sensing Equipment

ATCOR PROPRIETARY INFORMATION

4.15.2 Waste Flow Switch

ATCOR PROPRIETARY INFORMATION

4.16 FILL PIPE AND SPLATTER SHIELD ASSEMBLY

ATCOR PROPRIETARY INFORMATION

4.17 CAPPER

4.17.1 Drum Capper/Liner Capper

The function of the drum capper is to remotely cap a standard 55-gallon drum with ATCOR approved cover/ring clamp assembly. The capping operation is performed from the control console located behind the shield wall which permits remote operation from a low radiation area. This device has been supplied previously by ATCOR and has demonstrated satisfactory and quick performance.

The capping mechanism consists of a vertical telescoping arm which is raised or lowered by two (2) air cylinders.
Connected to the lower end of the arm is a plate containing three (3) air actuated holding fingers for the drum clamp and cover, and an air wrench for loosening or tightening the clamp bolt. In addition, another air cylinder is provided to position the vertical arm, once retracted, to a stored position. In the stored position, the capping mechanism is capable of moving horizontally using guided rollers on a fixed beam. The beam also acts as a support for the capper. The horizontal motion of the capper is controlled from the control console in both the fore and aft directions. Capper movement is accomplished using an air motor driving a chain through a pulley arrangement.

The capping controls consist of electrically actuated air control valves directing air to the air cylinders or operators. The air required for capping is 6 cfm @ 80 psi.

The capping operation commences by placing the lid and ring assembly up between the clamping fingers and then engaging the ring clamp bolt assembly. At this point, the operator, using the capper controls, raises the capping head to the up position and transfers the assembly over the shield wall cutout to the capping area. When the assembly contacts the bumper, it stops and the operator remotely lowers the capping head to the drum. The operator then spreads the ring clamp assembly open and actuates the socket air wrench to loosen the bolt. Next, the bolt is tightened, the capper support arm is raised and the trolley assembly is driven back to the operator location.

4.17.2 Liner Capping

To perform remote liner capping, the identical capper as previously described will be used. In order to facilitate the use of a single capper design, the liner must be fabricated with an opening identical to a standard 55 gallon drum opening. A standard 55 gallon drum cover with ring clamp will be used to enclose the liner opening using the capper.

4.18 DECONTAMINATION STATION

4.18.1 Liner Decontamination Station

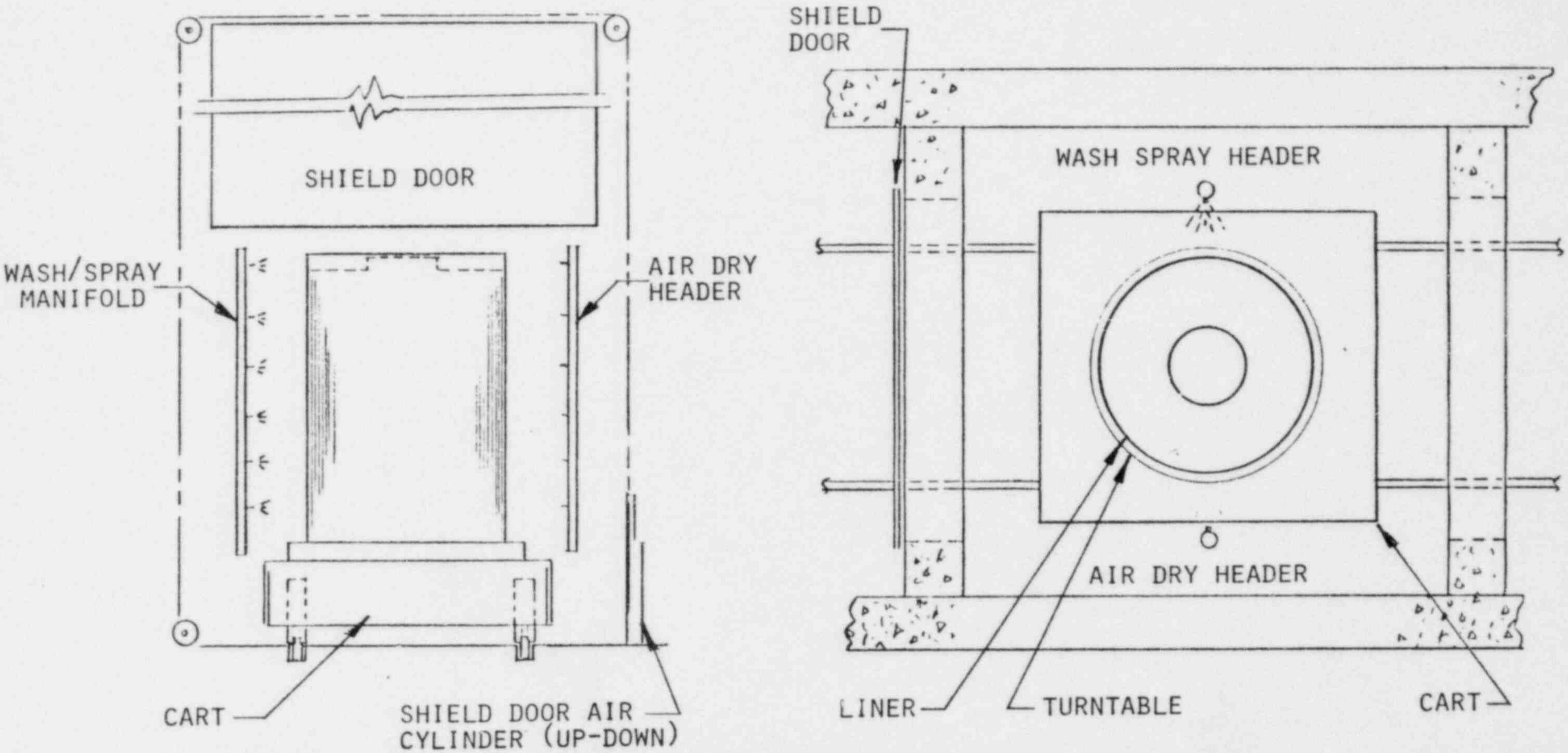
The liner decontamination station is shown on Figure 4-7. Basically, a stationary header, with appropriately placed spray nozzles for maximum cleaning coverage, is used to spray the container on the rotating turntable. A second stationary header, is furnished to air dry the container. Piping supplied is 300 series stainless steel. All structural steel ASTM-A-36 is specially painted to suit the area operating conditions. The cubicle is sealed off from the process aisle by doors to contain the spray within the cubicle. Air cylinders, located on the coldside, are used to power the doors. Remote control of the doors and all decontamination operation is performed from the decontamination station control panel. Added safety using interlocks is provided to insure trouble-free operation. Interlock switches are installed at the cubicle entrance to prevent the cart from accidentally moving into the doors, etc. Area venting and a drain for resulting flush water must be provided by the Purchaser.

4.18.2 Drum Decontamination Station

The drum decontamination station is shown on Figure 4-7A. The decontamination station includes a spray booth which is lowered over the drum. In place, the mating surfaces of the booth and drum conveyor contact to completely enclose and seal the drum. Water is used to spray wash all drum surfaces. An air blast cycle is used to remove most of the remaining water accumulated atop the drum cover.

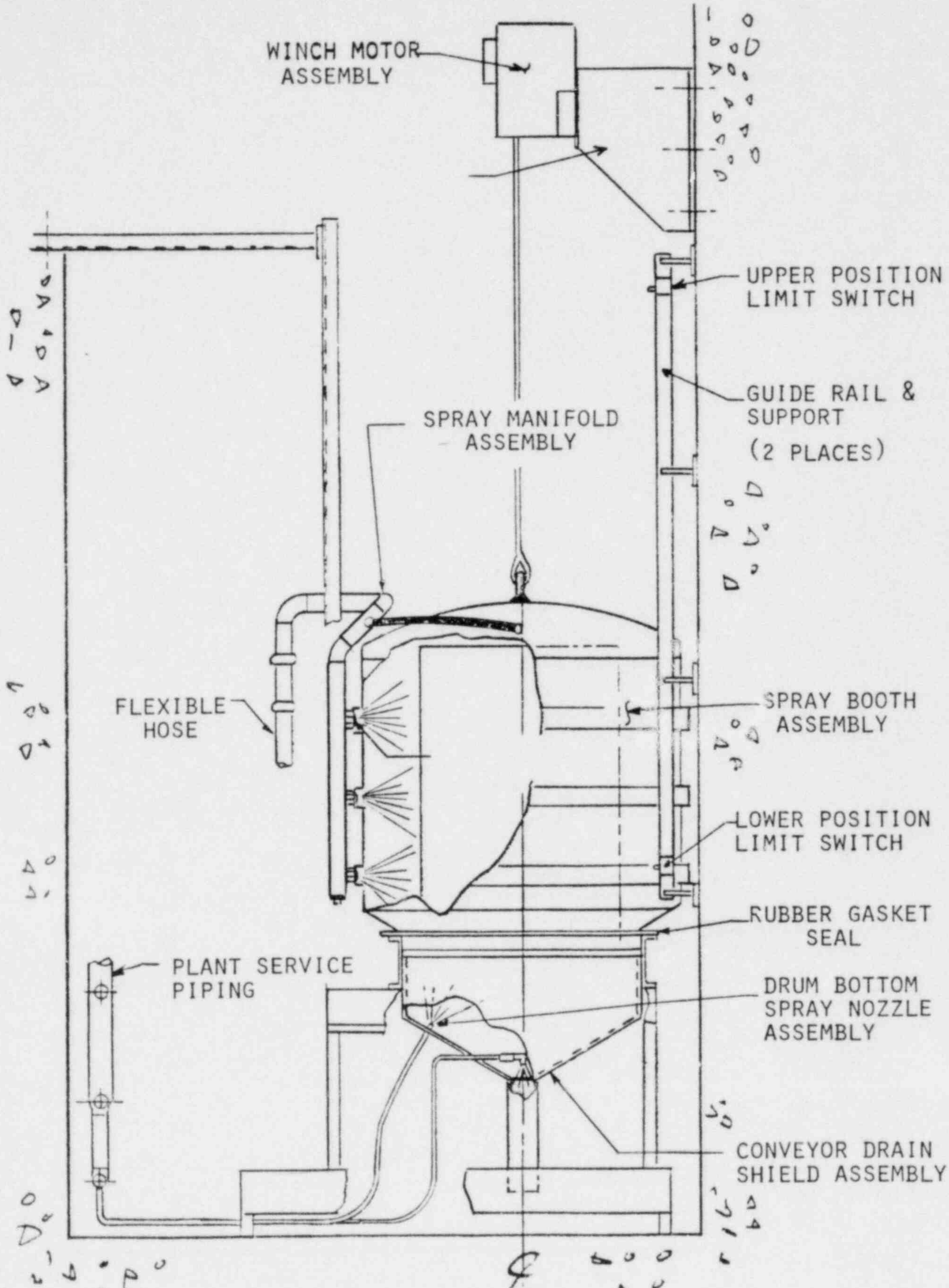
The decontamination booth is fabricated of 300 Series stainless steel. This unit is designed to be lowered onto the drum conveyor and provide a closed system for spray washing of Specification 17H standard 55-gallon drums. The decontamination station is provided with a fixed manifold of stainless steel pipes and nozzles for the water spray. The booth is supported by a winch and cable arrangement. The winch is driven by a fractional horsepower TENV motor to provide a speed of approximately 10 feet per minute. Guide rails are used to assure proper alignment between the booth and drum conveyor. Both the booth and drum conveyor contacting surfaces are sealed and gasketed to confine spray operations within the control area. Limit switches are used to indicate up (stored) and down (sealed) booth positions. The unit is remotely operated from the decontamination station control panel located in the control area.

FIGURE 4-7



LINER DECON STATION

ATCOR



DRUM DECONTAMINATION STATION

FIGURE 4-7A

ATCOR

4.19 SMEAR STATION

The function of the smear station is to remotely smear test the external surfaces of a container filled with radioactive cemented waste. The entire smear operation is performed remotely from a control console located behind a shield wall and in a low radiation area.

The smear arm assembly consists of a pneumatic rotary actuator plus a standard linear air cylinder. Mounted to the end of the air cylinder is the swab and roller guide. The arm assembly is connected to a trolley assembly which travels on a wall mounted I-beam located inside the process aisle. An air motor drive and cable arrangement provides the necessary fore and aft motion of travel along the I-beam.

Operationally, the arm assembly is rotated such that it lies horizontal or parallel to the I-beam and the swab assembly is extended through the shield wall opening. The operator manually places the smear onto the swab assembly where it is firmly held in place. Once the container is remotely advanced to the smear station, the turntable is started. Next the operator presses the appropriate pushbuttons on the control panel to sequentially: a) move the trolley over the container; b) rotate the arm assembly to the vertical position; c) extend the arm. The arm is slowly extended along the side of the rotating container. A roller is provided to guide the swab evenly over the container contour. Once the sample has been taken, the sequence of operation is complete when the swab is extended through the wall opening for removal. The container can then be picked up for storage or returned to the decontamination station for further cleaning depending on the results of the smear test.

Pneumatic supply required for operation is 80-100 PSI air. Refer to Figure 4-8.

4.20 CRANE SYSTEM

ATCOR has incorporated many subtle features which provide for safe operation as well as equipment safeguards beyond that of the usually furnished bridge crane. The following is a brief description of the features offered presently within ATCOR's design:

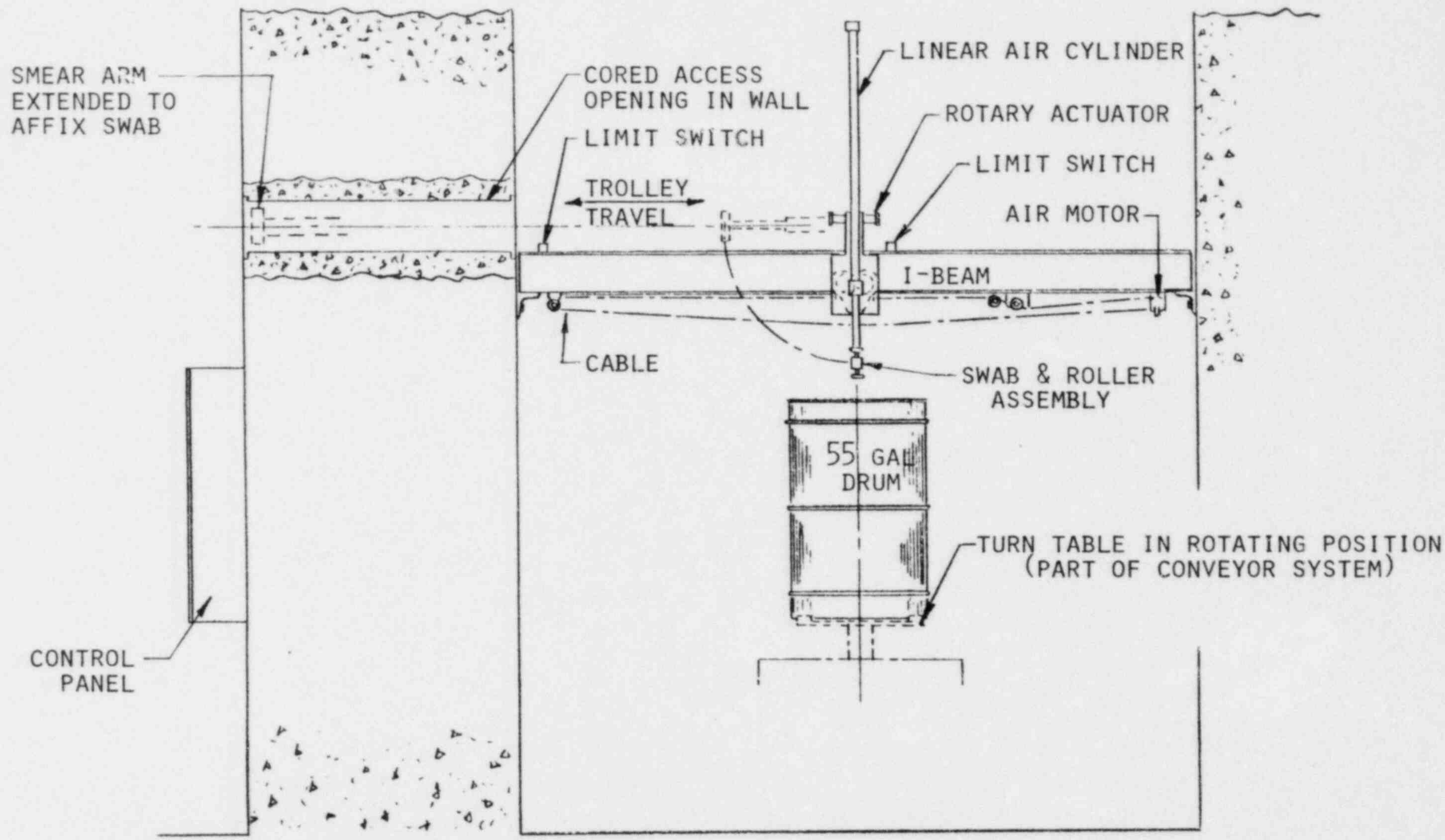
4.20.1 Slack Line Cable Limit Switch - A normally open switch opens, should the hoist cable go slack. This interlock prevents further downward travel of the hoist hook block which thereby precludes inadvertent placement of drums onto obstructions.

4.20.2 Geared Up and Down Hoist Switch - This device is used to limit downward travel as well as interlock to allow trolley travel with the hoist hook in the Up position only.

4.20.3 Separate individually wired hoist motors. This will provide a redundant capability of lowering a container to the floor remotely at all times in case of a motor failure.

FIGURE 4-8

SMEAR STATION ASSEMBLY



4.20.4 All crane system motor starters are located remote of the equipment to facilitate repair in a low radiation environment.

4.20.5 Redundant single girder trolley drive motors are provided.

4.20.6 Redundant crane drive motors are provided.

4.20.7 All motor brakes are controlled to release from the system control panel.

4.20.8 All position indicating limit switches are mounted on crane bridge or trolley to reduce limit switches in the radiation areas.

4.20.9 Redundant hoist motion limit switches are provided to insure safe operation. Speed control is provided within the crane control system. The following is a list of the speeds typically used within the various crane system components.

Hoist Speeds: 5/15 feet per minute
Trolley Speed: 5/15 feet per minute
Bridge Speed: 15/30 feet per minute

The above stated speeds in no case exceed 20 feet per minute for Hoist and Trolley motions or 50 feet per minute for the bridge due to the product being handled.

4.20.10 Drum Lifting Device - Mechanical Type

The drum lifting device illustrated in Figure 4-9 is of all steel construction, weighs approximately 125 pounds, and has a lifting capacity of 1,000 pounds. Operation of the drum lifting device is completely mechanical and requires no connections for electricity or air. Two lifting pads are provided to grip a drum. The radius of the lifting pads is 12-15/16 inches and their arc length is 8 inches. The height of the lifting pad is 2 1/2 inches.

4.20.11 Drum Lifting/Righting Device (Drum Grab Unit) - Motorized

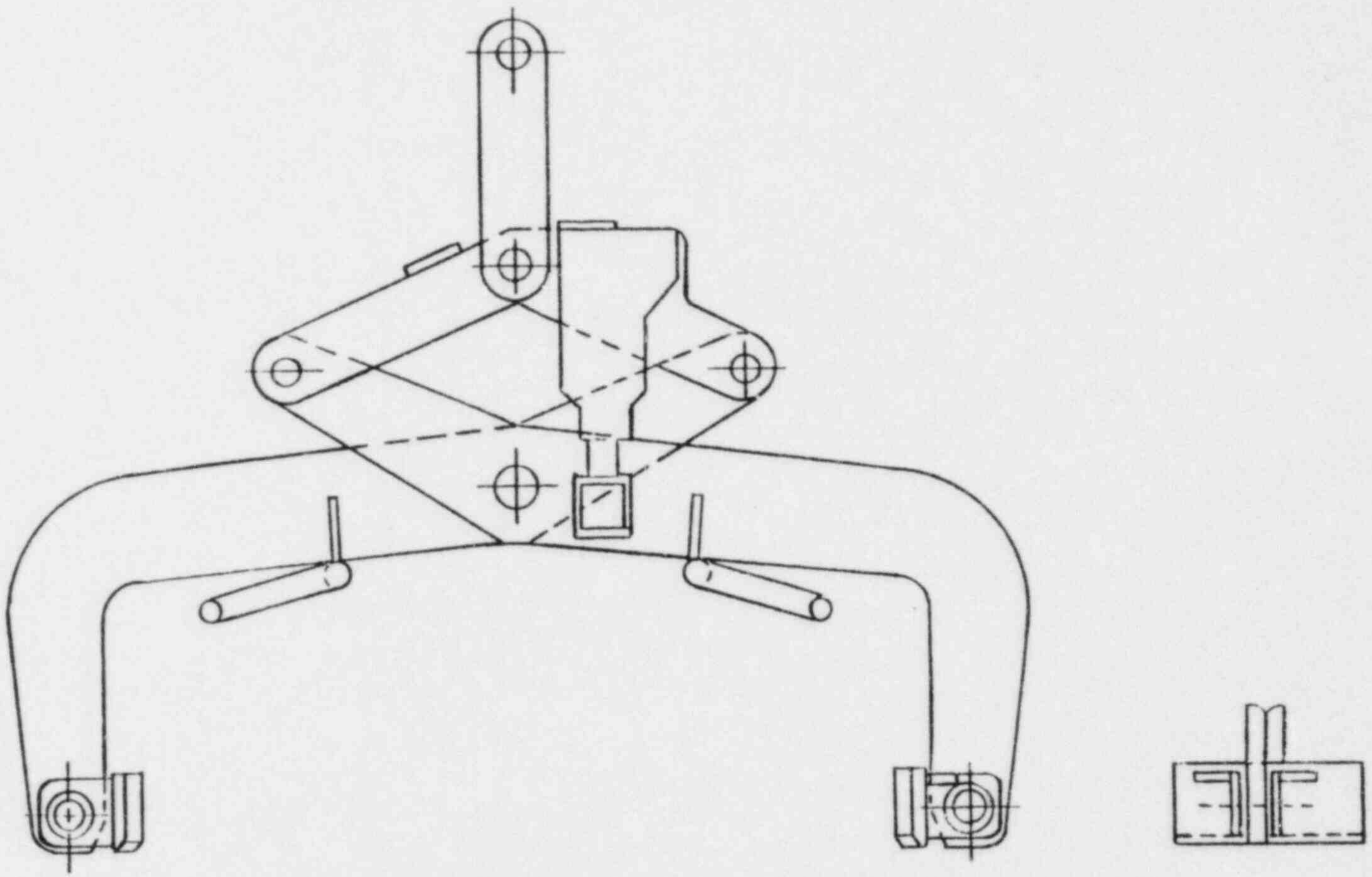
Material to be Handled
55 gallon drums - 1,000# maximum weight

Equipment Specifications

Capacity:	1,000#
Range:	22 1/2" to 24" with maximum opening of 25".
Legs:	25" (legs approach each other at approximately 13 F.P.M.)
Gripping Pads:	7" diameter with 360° continuous rotation
Motors:	TENV Hoist Duty Type
Power:	460 VAC, 3 Phase, 60 Hertz
Est. Weight:	730#

The Drum Righting Device is an electro-mechanical unit utilizing two legs (180° displacement) with full tilt and rotation capabilities. Gripping pads are utilized at the end of the grab legs to insure "positive" grip at all angles and full load capacity.

FIGURE 4-9



GRAPPLE LIFTING DEVICE

CAPACITY 1000 LBS.

ATCOR

-39A-

Operation of the drum righting device is done remotely from the operator's control console. The unit is positioned over the object drum. With the grab legs open, the unit is rotated and lowered until the gripping pads are centered on the drum circumference and between the drums upper structural ribs. The gripping legs are closed. Initial pressure is applied by motor drive; from then on, the gripping pressure is automatic and proportionate to the weight of the load. Rollover from horizontal top vertical position or vice versa will be controlled by gravity. One (1) HP motor is required for leg movement.

4.20.12 Television Camera and Monitoring System

The crane system has coverage over almost the entire Solid Radwaste Area and traverse over all walls within this area. Thus, mounting the television cameras onto the hoist trolley and bridge enables full visibility during all operations, such as drum filling, drum closure, decon/smear station operations, emplacement for storage and retrieval of stored containers. Since the camera system is suspended from the crane for all the aforementioned operations, it will always be in position to observe the operation in progress. Monitors for the TV system are located by the main control panel.

5.0 EQUIPMENT ARRANGEMENT

All equipment is located and installed to comply with ALARA operator dose requirements. Allowances for maintenance access is a critical consideration when arranging equipment. Components are located such that access to lower radiation areas where maintenance must be performed does not require passage through zones of higher radiation. The main control panel and auxiliary control panels, for example, are located outside the tank and waste process areas. All operations are remotely performed from their respective control panels.

Skids, pumps, etc. are arranged to allow ease of component inspection and maintenance access. Adequate shielding of high frequency access areas and during processing of high activity waste require about 3 foot concrete shield walls or equivalent. Areas of less frequent access would require less shielding.

5.1 Interface and Scope of Supply

ATCOR's responsibility is to provide the design, material procurement, fabrication, assembly, certification, delivery to job site, testing, and placing in commercial operation one (1) remotely operated radwaste solidification system (RSS). The system shall meet the specified requirements and shall operate either using 55 gallon drums or liners as the disposable containers for the solidified radwaste. The system includes but is not limited to the following:

5.1.1 Solidification agent storage tank complete with remote loading system.

5.1.2 Solidification agent metering and feed system.

5.1.3 Waste feed tank complete with agitator and dewatering system.

5.1.4 Waste metering and feed system.

5.1.5 Mixing device to produce a homogeneous mixture of solidification agent and wastes.

5.1.6 Drum or liner filling station.

5.1.7 Flush system.

5.1.8 Remote capping system.

5.1.9 Decontamination and monitoring station.

5.1.10 One (1) drum or liner transfer system.

5.1.11 Optical surveillance facilities (including shield windows, television equipment, etc.)

5.1.12 Bridge crane and container grappling system.

5.1.13 One (1) radiation monitoring system for measuring container radiation levels.

5.1.14 All wiring, piping, controls, valves, and other accessories which are internal to the ATCOR system, components, panels, and skids. All control and manual valves in drain lines, process lines, flush lines, lines interfacing with the Purchaser's systems and in lines required to maintain and operate the system. All equipment supports.

5.1.15 Control and distribution panels, completely assembled, for remote monitoring, operation, and control of the radwaste solidification system and crane.

5.1.16 A recommended spare parts list including prices.

5.2 Work Not Included - Performed by Purchaser

The following related work is not included in ATCOR's scope of supply:

5.2.1 Receiving, unloading, and storage at the jobsite and erection labor.

5.2.2 Equipment foundations and anchor bolts.

5.2.3 Concrete shield walls.

5.2.4 Crane rails and supports.

5.2.5 Lighting of area.

5.2.6 Heat tracing and thermal insulation. (See Note 1 Below)

5.2.7 Electrical power for instrumentation, control and operating equipment.

5.2.8 All wiring, piping, and ducts which are external to and which do not form an integral part of the equipment, components, panels, and skids.

5.2.9 Electrical power connections for motors and heaters.

5.2.10 The utility services.

5.2.11 Ventilation for the solidification area. (See Note 2, next page)

Note:1 ATCOR's scope of supply is to provide electric strip heaters for the waste tank only. It is ATCOR's responsibility to advise the customer and recommend the heat tracing requirements needed for waste piping, pumps, in-line instrumentation, etc. Upon ATCOR's recommendation, all heat tracing is provided by others. Waste concentrates are immediately and intimately mixed with dry cement insomuch as crystallized particles become a part of the cement matrix. Based on actual operating experience, crystallization within the mixer/feeder is not a problem; therefore, we do not recommend heat tracing for this unit.

Note 2 Filtration of dry cement is accomplished using a standard vent filter directly mounted to the cement silo. The automatic and self cleaning vent filter has a dust retaining efficiency of 99.9% of particles 2 micron or larger. Further protection is assured by using an additional secondary panel type filter directly attached to the vent discharge. This filter has the identical dust retaining efficiency of the primary vent filter that is 99.9% of particles 2 microns and over.

Equal filtration is provided for venting the displaced air during radwaste container filling. The vent filter is part of the mixer/feeder cover design. It is manually replaced after every 50 hours of system operation. The filter is secured by a standard hose clamp and is clearly accessible for removal and replacement. Only normal or standard ventillation requirements typical for ventillating the plant radwaste area is needed.

5.3 Recommended Layout

Figure 5-1 illustrates a typical arrangement of the Radwaste Solidification System. The entire system is located to provide maximum utilization of available space.

The skid mounted cement bin assembly is located in a shielded cubicle. The capacity of the bulk bin is normally 600 cu. ft. while this is a sufficient volume to receive a complete truck load of cement, a volume of about 150 cu.ft. remains in reserve. Filling of the cement bin from the bulk cement truck is through a hose connection into the cement fill panel. Venting and filtration during filling is achieved through the cement bin vent.

As shown in the elevation view, Fig. 5-1, the skid mounted waste tank assembly is located in a separate shielded cubicle above the Filling Area. This arrangement isolates components which store and meter radioactive waste in separate shielded areas. Provisions are made to empty key components of all radioactive materials in case of malfunction, so that service or maintenance can be made without undue radiation exposure. In addition, both the waste feeder and agitator drives are remotely located to facilitate routine maintenance.

Empty liners are picked up from a storage area (truck bay) and positioned beneath the overhead crane using a fork lift truck. The next operation consists of lifting the empty liner, using the overhead crane, and lowering the liner onto the process aisle transfer cart. With the liner placed on the cart, the motorized vehicle remotely positions the liner at the designated fill, closure and pickup stations. When full, once more the overhead crane is used to remotely place the filled liner into the storage area.

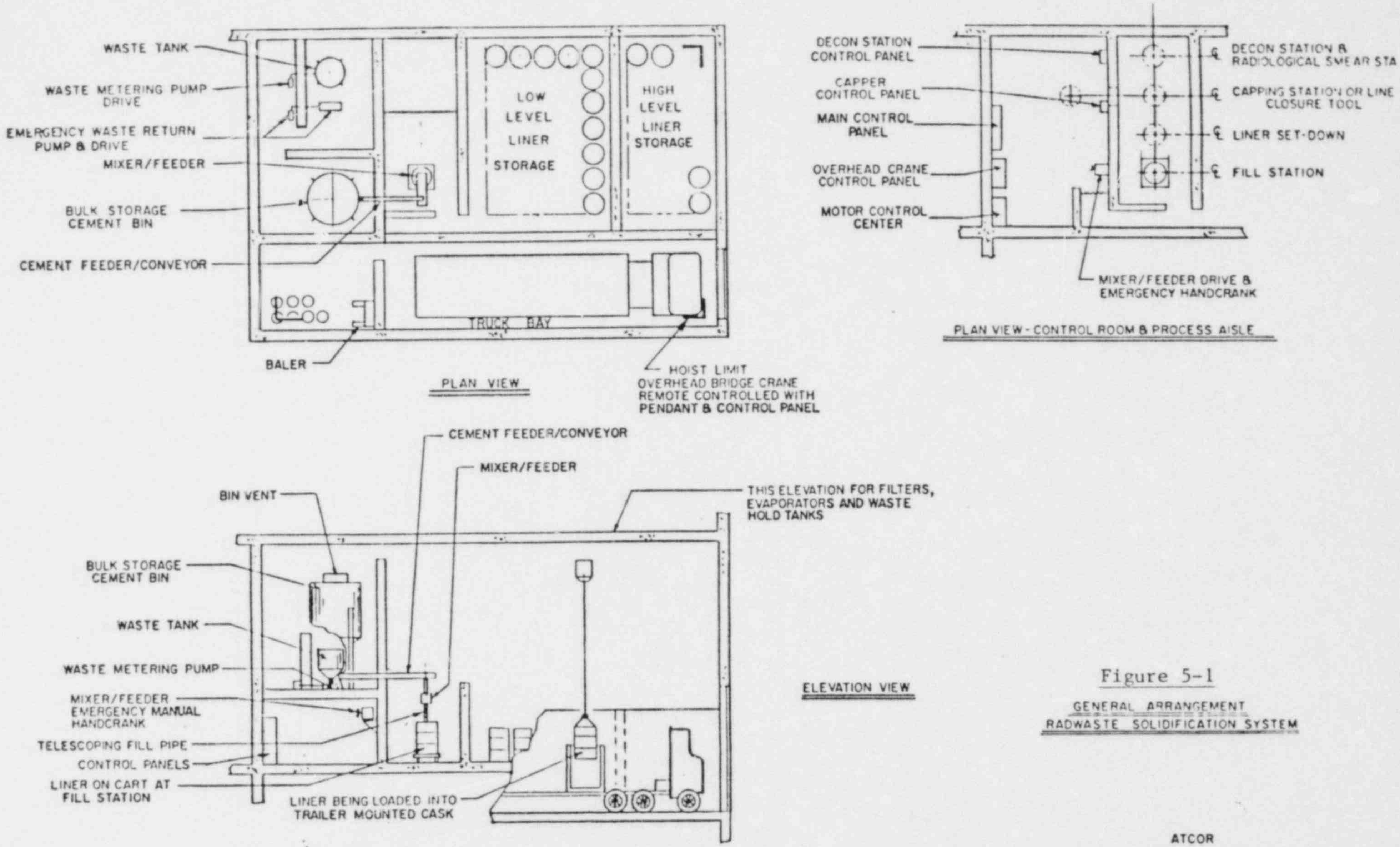


Figure 5-1

GENERAL ARRANGEMENT
RADWASTE SOLIDIFICATION SYSTEM

ATCOR

Although not illustrated on Figure 5-1, handling and filling of drums would be carried out in a similar operation using a motorized Drum Conveyor System. For example, the operator manually carries the empty drum through the control area and places it on the drum input conveyor. From the input conveyor, a motorized drum conveying system remotely moves the drum to each station shown on Figure 5-1. At the drum pick up point, the crane lifts the drum and places it into the drum storage area.

Figure 5-1 shows the low-level and high-level storage areas located in the building lay-out. A shield-wall separates the tuck-bay access area from the process aisle where containers are filled with cemented radioactive waste. The control room is located on the opposite side of the process aisle and is also separated by a shield wall. All operations are remotely performed from this shielded area to minimize personnel exposure in accordance with ALARA criteria.

5.4 Compliance with "ALARA"

The system design and arrangement is in compliance with "ALARA" as specified in the USNRC Regulatory Guides 8.8 and 8.10. As shown on the ATCOR layout drawing (Figure 5-1), the system arrangement affords complete remote operation. All container process, handling and storage equipment is operated from a remote shielded location using television cameras for full visibility of operation. Through experience, ATCOR has designed and located all components to minimize service time. All valves, which do not contain waste, are supplied on a common valve rack and located in a low radiation area outside the waste tank cubicle. All motors associated with waste and container handling are located external to the equipment, thus allowing for maintenance without personnel exposure. For example, the discharge valve from the waste tank is critical for waste return; therefore, it is supplied with a remote manual override. Should this valve fail to open, manual opening of this valve combined with starting the pump will empty the waste tank of its contents. Additional emergency waste removal is accomplished utilizing a back up emergency waste return pump. If a problem occurs with the normal waste metering pump, the emergency return pump is provided for this service. Further, wherever critical to system operation, remote manual handcranking of equipment such as the mixer/feeder and conveyor motors is provided. The crane system also is provided with redundant capabilities. Based on operational experience, valves and components are selected to insure minimum leakage and spillage. All penetrations of shielding are designed to minimize exposure.

A decontamination station for drums or larger volume containers and a smear station are provided to insure that contamination of the containers is not spread. Further a sealed retractible fill pipe is used to insure that the area does not become contaminated. The system is dust free and vented through filters to insure the air borne contamination is minimized. All waste bearing components and piping are provided with a complete remote automatic flushing capability to insure that the equipment is cleaned prior to servicing.

The length of pipe runs are minimized to the shortest possible and practical distance between two points. All waste piping bends, no exceptions, are 5 times the pipe diameter with all waste inlet and return lines properly sized. For example, liquid waste lines are 1 1/2 inch diameter minimum, resin slurry lines are 2 inch diameter minimum.

On all applicable construction drawings, general notes are included to alert the field what specific piping requirements must be adhered to eg. no low points, pockets where material can accummulate, etc. ATCOR's piping drawings take all of these key points into consideration during skid design and fabrication.

ATCOR's normal scope of supply is to include valving and piping to permit flushing of all waste lines. Further, ATCOR provides standard pump designs that are specially modified to include additional flush connections such that the entire pump housing can be completely flushed along with any return line. Flush provisions for waste piping beyond ATCOR's interface is provided by the customer upon ATCOR's recommendation. All waste lines and valves have butt weld end connections. The only exception in using butt weld connections is where it becomes necessary to remove and replace component parts. To permit ease of maintenance, flanged connections will be used.

Radiation zone designations relating to Figure 5-1 is presented in Table 5-1 below.

TABLE 5-1

RADIATION ZONE DESIGNATIONS FOR FIGURE 5-1

Area	Clean Shutdown	During Operation	During Maintenance
High Level Storage	1	5	3
Low Level Storage	1	5	3
Process Aisle	3	5	2
Waste Tank Cubicle	3	5	2
Cement Bin Area	1	2	1
Operator Control Area	1	2	1
Baler Area	2	5	1
Truck Bay Area	1	5	1

Legend:

Radiation Zone 1 $\leq$ 1 mrem/hour

2 $\leq$ 2.5 mrem/hour

3 $\leq$ 15 mrem/hour

4 $\leq$ 100 mrem/hour

5 $>$ 100 mrem/hour

6.0 REGULATIONS, CODES AND STANDARDS

Design, fabrication, operation, and maintenance of the ATCOR Radwaste Solidification System is consistant with the applicable regulations, codes, and standards of the nuclear industry.

6.1 U.S. NRC REGULATORY GUIDES

6.1.1 REG GUIDE 1.143 DESIGN GUIDANCE FOR RADIOACTIVE WASTE MANAGEMENT SYSTEMS, STRUCTURE, AND COMPONENTS INSTALLED IN LIGHT-WATER-COOLED NUCLEAR POWER PLANTS.

6.1.2 REG GUIDE 1.26 QUALITY GROUP CLASSIFICATIONS AND STANDARDS FOR WATER, STEAM, AND RADIOACTIVE WASTE CONTAINING COMPONENTS OF NUCLEAR POWER PLANTS (Quality Group D)

6.1.3 REG GUIDE 8.8 INFORMATION RELEVANT TO MAINTAINING OCCUPATIONAL RADIATION EXPOSURE AS LOW AS REASONABLY ACHIEVABLE (NUCLEAR POWER REACTORS)

6.1.4 REG GUIDE 8.10 OPERATING PHILOSOPHY FOR MAINTAINING OCCUPATIONAL RADIATION EXPOSURES AS LOW AS REASONABLY ACHIEVABLE

6.1.5 U.S. NRC Branch Technical Position - ETSB No. 11-3 DESIGN GUIDANCE FOR SOLID RADIOACTIVE WASTE MANAGEMENT SYSTEMS INSTALLED IN LIGHT-WATER-COOLED NUCLEAR POWER REACTOR PLANTS

6.1.6 U.S. NRC - TITLE 10, CODE OF FEDERAL REGULATIONS, PART 50, APPENDIX B, LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

6.1.7 U.S. NRC - TITLE 10, CODE OF FEDERAL REGULATIONS, PART 20, STANDARDS FOR PROTECTION AGAINST RADIATION

6.1.8 U.S. NRC - TITLE 10, CODE OF FEDERAL REGULATIONS, PART 71, APPENDIX E, PACKAGING OF RADIOACTIVE MATERIAL FOR TRANSPORT AND TRANSPORTATION OF RADIOACTIVE MATERIAL UNDER CERTAIN CONDITIONS

6.2 CODES AND STANDARDS

6.2.1 ASME Boiler and Presure Vessel Code Sections II, VIII, and IX

6.2.2 ANSI B16.5, B31.1, N45.2, N45.2.2, and ANSI/ANS-55.1

6.2.3 API - 620 and 650

6.2.4 MSS, SP-81

6.2.5 IEEE, NEMA, and NFPA70

6.2.6 AWS D1.1

Applicable equipment codes for ATCOR supplied equipment is shown on Table 6-1 and conform with Regulatory Guide 1.143.

TABLE NO. 6-1
MATERIALS, PARTS AND COMPONENTS CODES AND STANDARDS

EQUIPMENT	DESIGN & FAB	MATERIALS	QUAL/PROCEDURE	INSPECT TESTING
Pumps	Mfrs. Stds.	Mfrs. Stds.	Not Req'd.	Hydraulic Institute
Piping	ANSI B31.1	ASTM	ASTM IX	ANSI B31.1
Valves	ANSI B31.1	ASTM	ASME IX	ANSI B31.1
Conditioning Tank - (Atmospheric tank)	API 650	ASME II	ASME VIII, IX	API 650
Cement Stor. Bin	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.
Cement Truck Fill	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.
Cement Conveyor	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.
Bag Filter	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.
Waste Mixer	ATCOR Custom Fab.	ASTM	ASME IX	ATCOR Stds.
Fill Pipe & Shield	ATCOR Custom Fab.	ASTM	ASME IX	ATCOR Stds.
Drum Capper	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.

7.0 QUALITY ASSURANCE PROGRAM

ATCOR's Quality Assurance Manual has been reviewed and approved by the U.S. Nuclear Regulatory Commission.

The ATCOR Quality Assurance Program is applied throughout equipment and system design, fabrication, construction and test phases. The Quality Assurance Program, as applied, affords the planned and systematic action necessary to provide adequate confidence of a component, or system's ability to perform satisfactorily in service. ATCOR Subvendor Quality Assurance Programs are surveyed prior to contract issuance to assure conformance with the customer's specifications.

The Quality Assurance Manager, reporting directly to the President, is assigned complete control for the project. He is responsible for checking, auditing, inspecting, or otherwise verifying that an activity has been correctly performed as an independent, divorced from all activities concerned with design, planning, procurement, fabrication or testing of the components or systems.

Attachment 7-1 provides a general outline of the ATCOR Quality Assurance Program A-QA-001. Attachment 7-2 provides a comparison of Reg. Guide 1.143 Section 6 with the ATCOR Quality Assurance Program.

A system of checks and balances is used to assure design control. Each design is subjected to the following within the ATCOR system: review, approval, release and distribution prior to design acceptance. Once a design is completed and accepted, it is maintained current in engineering control files. Support drawings and specifications are similarly kept up to date. If, for any reason, a design change is required during construction, an approval by the Project Engineer is mandatory prior to implementation; thereby, design continuity is maintained.

Frequent inspections and quality audits are performed to assure quality compliance and program effectiveness.

As part of each system, ATCOR furnishes the following items:

1) Complete set of "As Built" equipment drawings.

2) Complete set of "As Built" electrical schematics.

3) Complete set of "As Built" installation drawings.

4) Quality assurance, fabrication and test records for non-standard equipment.

5) Preoperational system start-up test results.

Typical Q.A. data required by ATCOR for the major equipment within the Radwaste Solidification Systems are shown within TABLE 7-1.

TABLE 7-1

TYPICAL Q.A. DATA REQUIRED BY ATCOR ON ALL ATCOR SOLIDIFICATION SYSTEMS Equipment Description	WELDER QUALS.	WELD PROCEDURES	MATERIAL TRACE-ABILITY (INCL. HEAT NOS.)	MATL. CERTIFICATION C of C	Q.A. PROCEDURES	TEST PROCEDURES	CERTIFIED TEST REPORTS	DIMENENSIONAL CHECK	CERTIFICATE OF COM-PLIANCE (to ATCOR spec. on dwg.) & P.O.
Waste Tank	1*	1*	X	X	X		X	X	X
Ultrasonic Level Indicator				X				X	X
Agitator				X				X	X
Tank Discharge Valve				X				X	X
Radiation Detector				X			X	X	X
Emergency Return Pump				X		2*	X		X
Waste Feeder				X	X	2*	X		X
Waste Process and Flush Valves			X	X	X	2*	X	X	X
Cement Bin	1*	1*	X	X	X			X	X
Cement Feeder				X	X			X	X
Mixer Feeder	1*	1*		X	X			X	X
Mixer Feeder Discharge Valve				X				X	X
Fill Pipe & Splatter Shield	1*	1*		X	X			X	X
Main Control Panel						X		X	X
Drum Handling System	3*	3*		X				X	X
Drum Transfer Cart	3*	3*		X				X	X
Drum Lift Device				X					X
Drum Capper				X		X		X	X
Drum Decon Station	1*	1*		X				X	X

NOTE: ALL OF THE ABOVE LISTED EQUIPMENT IS TYPICAL BUT MAY NOT BE INCLUDED IN EACH SPECIFIC SYSTEM.

*NOTE 1: Welding & procedure per Section IX, ASME code.

*NOTE 2: Pumps will be hydrostatically tested at a pressure of 1.5 times design pressure. Valves will by hydrostatically tested per manufacturer's standard test procedure.

*NOTE 3: Welding per AWS-D1.1

ATTACHMENT 7-1
OUTLINE OF ATCOR QUALITY ASSURANCE PROGRAM A-QA-001

ATCOR PROPRIETARY INFORMATION

ATTACHMENT 7-2

COMPARISON OF REG. GUIDE 1.143 (SECTION 6)
WITH THE ATCOR QUALITY ASSURANCE PROGRAM A-QA-001
REFERENCE: ATTACHMENT 7-1 OUTLINE OF ATCOR QUALITY ASSURANCE PROGRAM A-QA-001

ATCOR PROPRIETARY INFORMATION

8.0 RESEARCH AND DEVELOPMENT PROGRAM

ATCOR's solidification systems research and development program is an ongoing program which began in 1969. Our basic research and development program covers two distinct areas. The first was development of a suitable product for disposal. The second was the development of equipment process and controls to produce the desired waste/cement product with optimum remote operation and maximum repeatability.

8.1 Solidification Agent

Because of cement's universal acceptance as a solidification agent, ATCOR's starting point was to test all commercially available cement formulations to meet current acceptance standards when combined with typical BWR and PWR generated wastes. All laboratory experimentation used test samples which were 2-1/2 inches in diameter and 4-1/2 inches in length. Numerous waste to cement ratio's were evaluated for each type of waste tested. However, it was determined that neutralization of boric acid wastes was necessary in order to accomplish an acceptable product. At this point ATCOR investigated various neutralizing agents in the form of additives, using a test program similar to that done for cement. A brief list of the additives tested are as follows:

- Caustic Soda ($NaOH$)
- Calcium Oxide (CaO)
- Washing Soda (Na_2CO_3)
- Sodium Silicate ($Na_2S_1O_3$)
- Slaked Lime ($Ca[OH]_2$)

Of the above listed additives, slaked lime was chosen based on product acceptability, commercial availability, improved stability and ability to overcome the inhibiting or set acceleration problems of various types of wastes, lower transportation costs due to 35% less bulk density as compared to Portland Cement, and last but not least, Masonry Cements higher waste incorporation factor.

Portland cement and waste mixtures for a final product based on the following:

$$V_p = 1/2\ V_c + V_w$$

Vp - Final Product Volume
Vc - Cement Volume
Vw - Waste Volume

whereas with Masonry Cement there is a large increase in the waste incorporated based on the following:

$$V_p = 1/3\ V_c + V_w$$

At this point we concluded our basic research; Table 8-1 lists the various waste to cement ratios found through experimental testing.

TABLE 8-1

Recommended Waste to Cement Ratios Using Masonry Cement

Type of Waste (by weight percentage)	Waste to Cement Ratios (by volume)
12-25% H_3BO_3	0.8
25% Na_2SO_4	1.0
50% Na_2SO_4	1.5
Resin Slurries, Powdex, Filter Aid	1.25
Laundry Sludges	1.0

The above stated laboratory investigation results were then re-tested using 55 gallon test drums prior to demonstrating acceptability at operating nuclear power plants using the actual mixer unit. All tests confirmed our experimental small sample results. At this point, we preoperationally tested systems during start-ups at various power plants which enable us to gather data based on feeding and mixing using the actual equipment and process controls. Experience at various sites since 1972 (date of Prairie Island start-up) has consistently verified our laboratory experimental results.

Currently ATCOR is involved in an R & D program to insure solidification of incinerated waste forms as well as powdered waste generated by a waste volume reduction system.

8.2 Process and Equipment

Once the solidification media was determined, ATCOR designed a system using proven techniques in the area of dry materials handling, slurry processing and mixing to insure optimum system performance. ATCOR routinely performs, during system start-up, full demonstration of equipment and product acceptability. Further, ATCOR is continually upgrading equipment to insure that any developmental changes are upgraded into older systems. Our mixing unit has been upgraded to its present configuration by four (4) distinct design changes which improve product mixing and flushing. A typical pre-op procedure is enclosed (Section 11, page 63) and involves demonstration of all process and materials handling system components. Our concern along with feedback from operating systems has allowed ATCOR to perfect our system to its present state.

8.2.1 Test Procedure

Complete system preoperational testing is accomplished at the plant upon completion of installation. The scope of preoperational testing is defined in Section 1 of the procedure. Initial testing is performed using non-radioactive water as a waste substitute. Once the system is initially tested using water and cement, final system testing is accomplished using radioactive waste and cement. System acceptance by the plant is dependent upon satisfactory operation of the system in addition to satisfying the requirements defined by the specification.

9.0 EXPERIENCE

ATCOR has provided Radwaste Solidification and Processing Systems to nuclear power plants both in the United States and overseas. ATCOR's systems have been designed to process and solidify wastes for both BWR and PWR plants. ATCOR systems are designed to the specifications and requirements of many utilities and architectural-engineering firms. Under these contracts, ATCOR provides the system design, selection and supply of quality equipment, system integration, quality assurance, start-up supervision, system performance testing, and complete system documentation, including installation, operation and maintenance manuals. A summary of ATCOR's experience in radioactive waste solidification systems is shown on Table 9-1.

ATCOR has been assigned patent #3883441 by the United States Patent Office for the ATCOR Solidification System. This patent, covering continuous in-line mixing of radioactive waste metered from a waste tank and cement metered from a cement bin, describes the basic inventions made by ATCOR engineers several years ago.

Operating experience (since 1972) of the ATCOR Solidification System in nuclear power plants has provided a solid demonstration of the validity of the ATCOR approach. Although others may have copied the continuous processing, in-line mixer approach, they have lacked the actual nuclear power plant experience which is essential to assure trouble-free operation. ATCOR has actual experience and covering a wide range of operating conditions. This data and pl rating experience has resulted in the constant improvement in equipment reliability and ease of operation that comes only with vast amounts of in-plant operating experience. Some of the significant improvement currently offered, as compared to previous radwaste systems supplied, are noted as follows:

9.1 Remote Operation

Operations which can be performed from low radiation control areas are so located. This includes manual overrides for key valves as well as remotely mounted motors and drives for process equipment. This reduces personnel exposure during operation and facilities system maintenance.

9.2 Mixer/Feeder

ATCOR's mixer/feeder has been completely re-designed to eliminate maintenance problems. The newer design provides for closer tolerances, improved and more positive mixing, minimum mixer contents during processing, an improved flush system with emergency flush capability, remote manual override, increased drive capacity and quick access type removable covers for improved unit maintainability.

9.3 Automatic Operation

ATCOR is continually improving the system automatic operation to provide less chance for operator error. Although the key to successful operation remains with the "qualified operator", ATCOR has designed the system with numerous interlocks and programmed the operation to back-up the operator during normal and non-routine operations. ATCOR has developed an understanding of nuclear plant radwaste operations and includes this understanding in the design of our systems.

9.4 Skid Mounted Equipment

Considerable savings in both manpower and installation costs is afforded with the supply of pre-fabricated, premounted and prewired equipment packages. On this basis, ATCOR can provide its customer with skid mounted sub-assemblies.

3883441

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE

Commissioner of Patents

A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL INVENTION THE TITLE AND DESCRIPTION OF WHICH ARE CONTAINED IN THE SPECIFICATION OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PATENT OFFICE IN THE CLAIMANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID CLAIMANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A PATENT UNDER THE LAW.

NOW, THEREFORE, THESE Letters Patent ARE TO GRANT UNTO THE SAID CLAIMANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID CLAIMANT(S) FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF ISSUE FEES AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM MAKING, USING OR SELLING THE SAID INVENTION THROUGHOUT THE UNITED STATES.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this thirteenth day of May, in the year of our Lord one thousand nine hundred and seventy-five, and of the Independence of the United States of America the one hundred and ninety-ninth.

Attest:

Ruth C. Mason
Attesting Officer

C. Marshall Dann
Commissioner of Patents

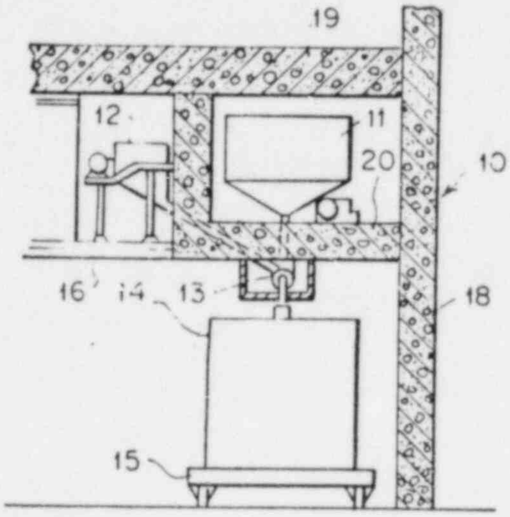


Fig. 1.

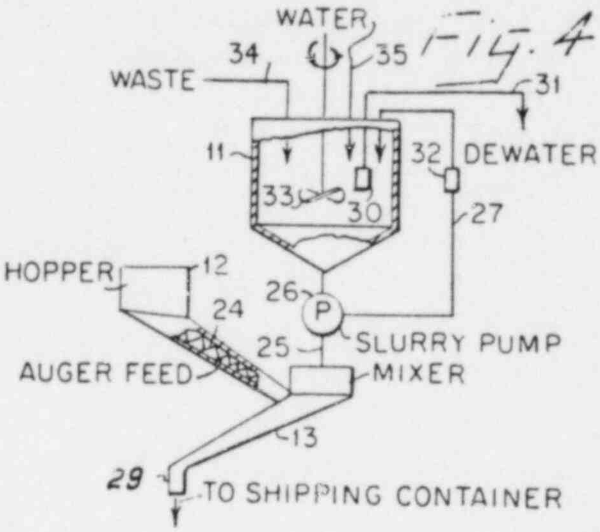


Fig. 4

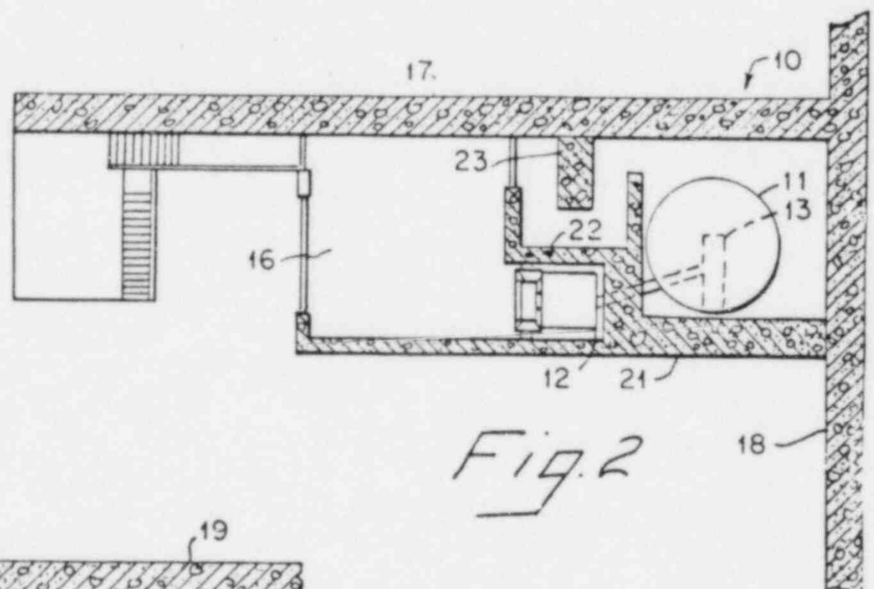
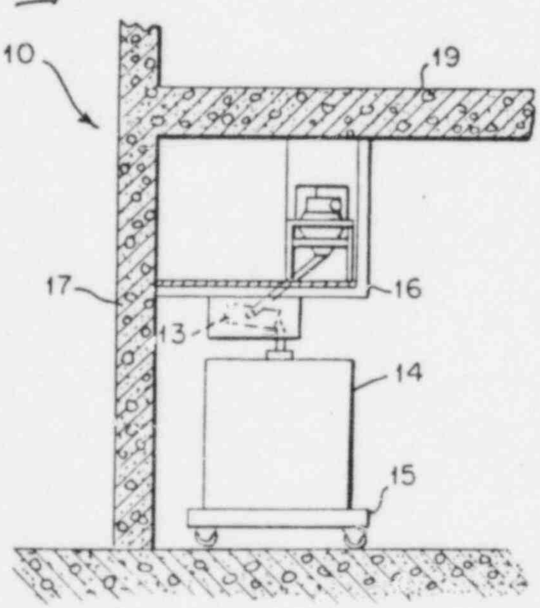


Fig. 2

Fig. 3



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United States Patent [19]

Murphy et al.

[11] 3,883,441

[45] May 13, 1975

[54] APPARATUS FOR FIXING RADIOACTIVE WASTE

[75] Inventors: John D. Murphy, Bedford Hills; John Pirro, Jr., Rutland; Monsey Lawrence; Stanley F. Wisla, both of Yorktown Heights, all of N.Y.

[73] Assignee: Atcor Inc., Park Mall, Peekskill, N.Y.

[22] Filed: July 20, 1970

[21] Appl. No.: 56,625

[52] U.S. Cl. .... 252/301.1 W

[51] Int. Cl. C09k 3/00

[58] Field of Search .... 252/301.1 R, 301.1 W

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Primary Examiner—Benjamin R. Padgett
Assistant Examiner—R. L. Tate

[57] ABSTRACT

Fixing radioactive waste is disclosed in which the waste is collected as a slurry in aqueous media in a metering tank located within the nuclear facilities. Collection of waste is continued from time to time until a sufficient quantity of material to make up a full shipment to a burial ground has been collected. The slurry is then cast in shipping containers for shipment to a burial ground or the like by metering through a mixer into which fixing materials are simultaneously metered at a rate to yield the desired proportions of materials.

3 Claims, 4 Drawing Figures

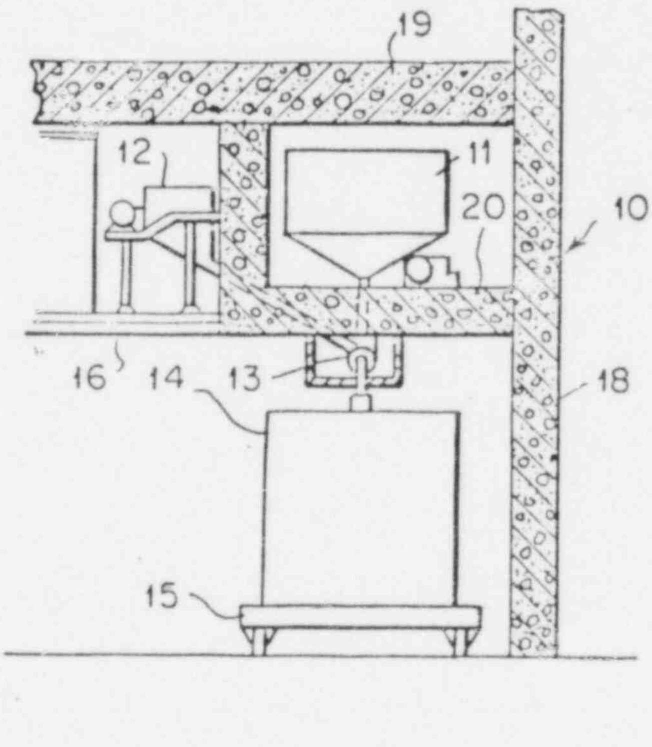

TABLE 9-1

RADWASTE SOLIDIFICATION EXPERIENCE

PURCHASER	NUCLEAR PLANT	SYSTEM DELIVERY	CONTAINER	DESCRIPTION
Northern States Power Company	Monticello (548MWe-BWR)	1972	Drum	Solidification System
Northern States Power Company	Prairie Island (1060MWe-PWR)	1974	Drum	Solidification System
Wisconsin Public Service Company	Kewaunee (540MWe-PWR)	1974	Drum	Solidification System
Boston Edison Company	Pilgrim (670MWe-BWR)	1974	Shielded Liner	Solidification System
Duquesne Light Company	Beaver Valley (852MWe-PWR)	1975	Liner	Solidification System
Taiwan Power Company	Kuo Sheng (1102MWe-BWR)	1977	Drum	Solidification System
Sumitomo & Tokyo Electric Power Company	Test Facility	1975	Drum	Solidification System
Cincinnati Gas & Electric Co.	Zimmer (810-MWe-BWR)	1976	Drum/Liner	Solidification System

TABLE 9-1 (Cont'd)

RADWASTE SOLIDIFICATION EXPERIENCE

PURCHASER	NUCLEAR PLANT	SYSTEM DELIVERY	CONTAINER	DESCRIPTION
Tennessee Valley Authority	Bellefonte (1213MWe-PWR)	1976	Liner	Solidification System
Long Island Light Company	Shoreham (820MWe-BWR)	1976	Liner	Solidification System
Wisconsin Electric Power Company (SEE NOTE BELOW)	Point Beach (497MWe-PWR)	1977	Drum/Liner	Solidification System
Omaha Public Power District	Ft. Calhoun (457MWe-PWR)	1977	Drum/Liner	Solidification System
Texas Utilities	Commanche Peak (1150MWe-PWR)	1979	Liner	Solidification System
Taiwan Power Company	Maanshan (1000MWe-PWR)	1979	Drum	Solidification System
Korea Electric Company Units 5 & 6	Korea Nuclear (1000MWe-PWR)	1980	Drum	Solidification System
N.I.R.A. ENEL, Italy	Cirene 40 MWe	1981	Liner	Solidification System

NOTE: SYSTEM OPERATION DEMONSTRATED AND WITNESSED BY U.S.N.R.C.

TABLE 9-1 (Cont'd)

RADWASTE SOLIDIFICATION EXPERIENCE

PURCHASER	NUCLEAR PLANT	SYSTEM DELIVERY	CONTAINER	DESCRIPTION
Fuerzas Electricas de Cataluna Spain	ASCO, Unit 2 (880 MWe-PWR)	1980	Drum	Solidification System
Chem-Nuclear Systems, Inc.	Mobile Solidification Systems	1980	In-Container Mixing for Liners	Fillhead & Control Panel for Dow and Cement Solidification Agents
Iberduero SA	Central Nuclear de Lemoniz (900 MWe-PWR)	1981	Drum	Solidification System
Northeast Utilities	Millstone (652-828 MWe) (BWR-PWR)	1981	In-Container Mixing Liners	Solidification System, Dow Unit 2, Unit 2, Unit 2 CPF
Fuerzas Electricas de Cataluna Spain	ASCO, Unit I (880 MWe-PWR)	1981	Drums	Solidification System
Commonwealth Edison	Quad Cities (800 MWe-BWR)	1982	In-Container Mixing Liners	Fillhead & Control Panel for Dow Solidification Agent
Korea Electric Co.	Korea Nuclear Units 7 & 8 (1000MWe-PWR)	1983	Drums	Solidification System

10.0 POSTULATED ACCIDENT ANALYSIS

10.1 Equipment

The following is an analysis of postulated process equipment failures and malfunctions and the associated corrective action. Items not listed or mentioned are not considered vital enough to cause a significant problem or incident; therefore, these components will not be discussed.

10.1.1 Remote Operating Valves

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10.1.2 Waste Tank Heaters

ATCOR PROPRIETARY INFORMATION

10.1.3 Waste Tank Level Instrumentation

ATCOR PROPRIETARY INFORMATION

10.1.4 Waste Metering Pump

ATCOR PROPRIETARY INFORMATION

10.1.5 Mixer/Feeder

ATCOR PROPRIETARY INFORMATION

10.1.6 Cement Feeder - Conveyor

ATCOR PROPRIETARY INFORMATION

10.1.7 Material Handling Equipment

ATCOR PROPRIETARY INFORMATION

10.1.8 Crane System

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10.1.9 Hoist Motor Failure

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10.1.10 Single Girder Trolley Drive Motor Failure

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10.1.11 Crane Bridge Drive Motor Failure

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10.1.12 Festoon Cable System Failure

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10.1.13 Hoist Motion Limit Switch Failure

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10.1.14 Position Indicating Limit Switch Failure

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10.1.15 Motor Starter Failure

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10.2 POSTULATED RELEASE OF AIRBORNE RADIOACTIVITY

Potential for release to the atmosphere of significant quantities of radioactivity resulting from a failure of the radioactive waste solidification system is quite small for the following reasons:

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The following are two (2) scenarios which describe situations where radioactivity could be released from the system:

10.2.1. Transfer of the Radioactive Waste to the Waste Conditioning Tank

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10.2.2. Filling of Waste Container From Mixer/Feeder Without Having a Waste Receptical in Place

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11.0 TYPICAL ATCOR PREOPERATIONAL TEST PROCEDURE

11.1 The following attachment is an excerpt from a typical ATCOR Pre-Op Test Procedure which outlines the essence of procedural steps taken and documentation produced by ATCOR personnel in a pre-op test:

Preoperational Test No. ####
Start-up System No. Su-####

TYPICAL PRE-OP TEST PROCEDURE

OUTLINE FOR THE ATCOR RADWASTE SOLIDIFICATION SYSTEMS

ATCOR ENGINEERED SYSTEMS, INC.

Revisions:

REV.	DATE	DESCRIPTION	PREPARED BY	APPROVED BY

PREPARED BY (Project Engineer) DATE________________
ATCOR ENGINEERED SYSTEMS, INC.

REVIEWED BY (Engineering Manager) DATE________________
ATCOR ENGINEERED SYSTEMS, INC.

THIS PROCEDURE HAS BEEN COMPLETELY EXECUTED.

RESPONSIBLE ENGINEER ______________________ DATE________________
ATCOR ENGINEERED SYSTEMS, INC.

WITNESSED BY______________________ DATE________________
(COMPANY)

TEST RESULTS HAVE BEEN REVIEWED AND ARE SATISFACTORY.

ACCEPTED BY______________________ DATE________________
(COMPANY)

TABLE OF CONTENTS

Section

1.0 PREFACE

Documentation

After satisfactory completion and acceptance of this Test Procedure, it shall be filed (with all supporting documents) in the Plant Historical Record in accordance with the Plant Administrative Procedures.

Addendum

Additions, deletions, and/or changes to this Test Procedure may be accomplished by means of a Test Change Notice. A Test Change Notice may be required because of a design change or an inadequacy in the original procedure. Each test Change Notice shall be reviewed and approved at the jobsite in accordance with the Plant Administrative Procedures. One or more Test Change Notices may be incorporated into this procedure (at some l^ter date) by a revision.

2.0 OBJECTIVES

To demonstrate the capability of the Radwaste Solidification System (RSS) to render in a safe manner, all radioactive wastes (spent ion exchange resins, evaporator concentrates, cartridge filters, laundry wastes and chemical drain wastes) into a homogeneous solid product suitable for transportation and subsequent disposal. Also to demonstrate the satisfactory ability of the RSS to interface with balance of plant systems (e.g. waste input systems, resin sluicing, direct feed to waste feeder). In general, the tests shall demonstrate the RSS ability to meet the requirements of the contract specification.

3.0 PREREQUISITES

3.1 Completion of Construction: Construction has been completed. A fully executed Release to Start-up has been reviewed, found satisfactory, and is on file.

Verified by:____________________ Date:__________

3.2 Completion of Construction Testing: Construction tests have been completed on the system and its components. Data sheets and test records have been reviewed, found satisfactory and are on file.

Verified by:____________________ Date:__________

3.3 System Completion: A physical inspection of the system and its components (piping, valves, instruments, electrical wiring, etc.) has confirmed the (a) completeness, (b) proper installation, and (c) conformance with the latest revision and drawing change notices of the applicable piping, wiring and instrument diagrams.

Verified by:____________________ Date:__________

3.4 Calibration:

(1) All instruments, valves, meters, relays, etc., are operational and properly calibrated. Data sheets and calibration records have been reviewed, found satisfactory and are on file.

Verified by:____________________ Date:__________

(2) Test apparatus being used in conjunction with the test are operational and properly calibrated. Calibration records have been reviewed, found satisfactory, and are on file.
Verified by:____________________ Date:___________

3.5 System Components: It has been demonstrated that each individual component and/or subsystem has met its functional requirements. Data sheets, test records, and standard test procedures have been reviewed, found satisfactory and are on file.
Verified by:____________________ Date:___________

3.6 System Operational - Mechanical: The following support and/or related mechanical systems (or subsystems) are operational:

(1) Instrument Air System - - - - -psig (80 - 125 psig max.)
(2) Service Water - - - - - - - - - -psig (100 - 140 psig max.)
Verified by:____________________ Date:___________

3.7 System Operational - Electrical: The following support and/or related electrical systems (or subsystems) are operational:

(1) 480 volt, a-c power available at ____________________
(2) 120 volt, a-c power available at ____________________
Verified by:____________________ Date:___________

3.8 System Operational - Instrument: The following support and/or related instrument systems (or subsystems) are operational:

Verified by:____________________ Date:___________

3.9 Deficiencies: Outstanding work items that could affect the implementation of this test have been completed.
Verified by:____________________ Date:___________

4.0 Special Tests: (when required)

5.0 PRECAUTIONS:

(1) A test container such as a 55 gallon drum should be available for waste filling.

(2) Never operate Waste Metering Pump and Resin Sluice Pumps dry or when the Waste Tank is empty. This can be prevented by visual monitoring of the Waste Tank level indicator, Waste Flow Switch NO-FLOW signal and low pressure switch signal.

(3) During all pre-operational testing, non-radioactive waste is to be substituted to simulate actual waste materials.

6.0 SYSTEM TESTS

6.1 INITIAL STATUS

(1) Waste Feed Tank is empty and can be filled with sufficient quantity of service water, spent resin or waste solution to conduct the calibration tests.
Verified by:____________________ Date:___________

(2) Cement truck is available to load cement silo. Cement Silo is empty.

NOTE: A small quantity of cement will be required during calibration tests. Before starting of system tests, cement level should be above the low level alarm set point.
Verified by:____________________ Date:___________

(3) 55 gallon drums for filling the cemented waste and flush water is located on the conveyor at the fill station.
Verified by:____________________ Date:___________

(4) Initial status of electrical breakers shall be verified in closed position.

(5) Lime Batch Bin is filled with Lime (if applicable).
Verified by:____________________ Date:___________

6.2 Special Test Equipment

Modified 55 gallon drum with a valve and hose connection as shown in Figure 11-1.

Water supply hose w/valve	Lightweight rod approx. 20'
25' tape measure and 6' rule	Drum transfer device
55 gal. drum supply (10-15)	Walkie-talkie
Stop Watch and scale	Flexible Hose

6.3 Test Instructions - Calibration

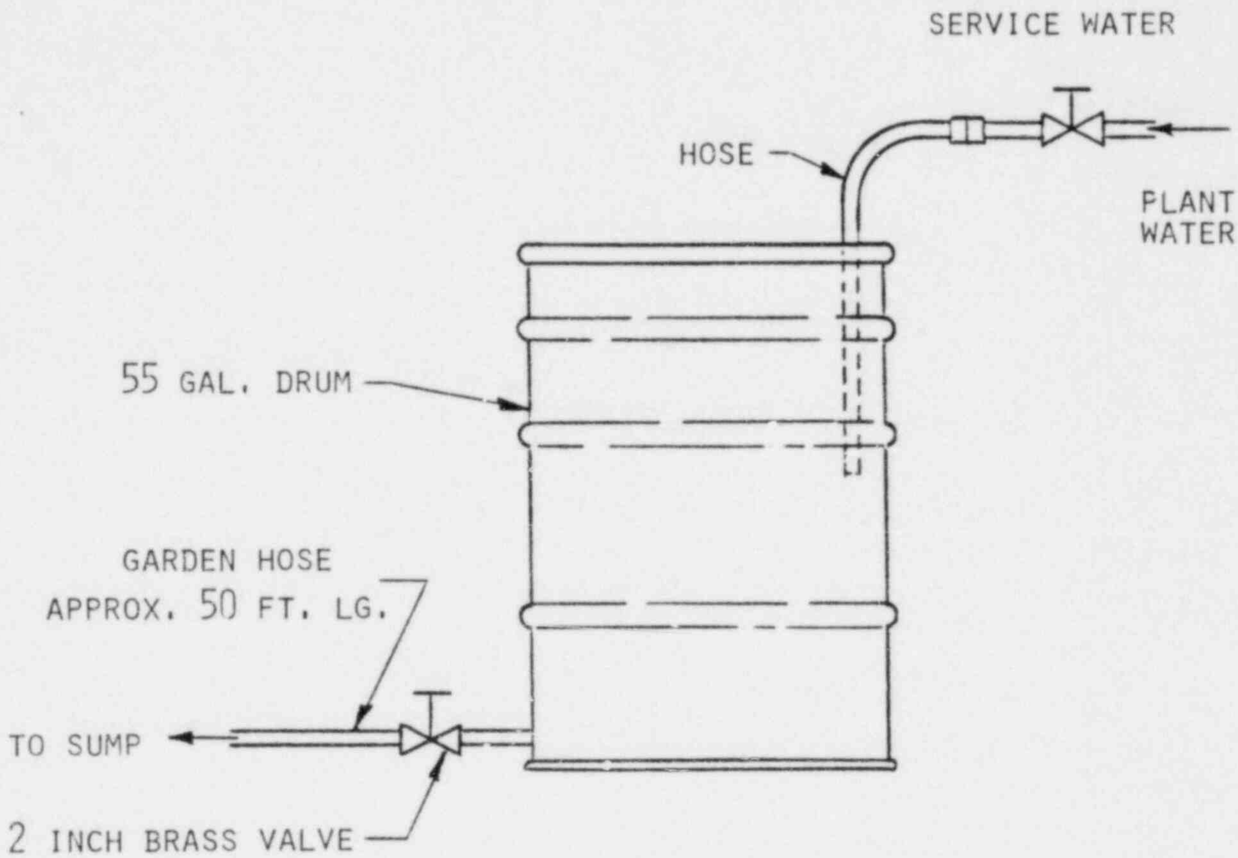
6.3.1 Equipment These checks are used to assure that the Radwaste Solidification System and Supportive Systems are ready for pre-op testing. They consist of the following:

(1) Equipment - Mechanical: Verify that all mechanical equipment, has been checked out with respect to proper installation and operation.
Verified by:____________________ Date:___________

(2) Equipment - Valves: Verify OPEN AND CLOSE operation of all valves listed, including indication on Control Panel.
Verified by:____________________ Date:___________

(3) Control System: Verify proper controls operation of the main control panel in both the manual and automatic operating modes prior to using cement and water (or waste).
Verified by:____________________ Date:___________

FIGURE 11-1



PRE-OP TEST COLLECTION CONTAINER

(MODIFIED 55 GAL. DRUM AND ACCESSORIES)

To simulate operation wihtout using material perform the following:

a) Remove heaters from all motor starters.
b) Place jumpers within the panel to simulate flow of waste and cement, and to bypass Waste Feeder High and Low pressure switch settings.
c) Assure that 120V control power & air supply services are available.

d) Assure that all timers are properly set per electrical drawing and operating instructions.

Verify proper electrical sequencing operations by simulation. Actual test runs will be verified after all equipment alignment and calibrations have been made.

MANUAL OPERATION VERIFIED BY/DATE____________________

AUTOMATIC OPERATION VERIFIED BY/DATE____________________

e) After completion of the above reconnect heaters from all motor starters and remove all jumpers.

6.4 Instrument Calibration Verification

Verify that all instrumentation has been checked out by reviewing the calibration and test data sheets for completeness and accuracy.
Verified by:____________________ Date:____________

7.0 OPERATING INSTRUCTIONS

The Operational Procedure shall be followed to perform pre-operational testing. The responsible engineer shall sign off at the end of each operating phase. Any comments or remarks shall be noted in writing and will become a part of the Operation Test Procedure.
Verified by:____________________ Date:____________

Atcor[SM]
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