CHEM-NUCLEAR SYSTEMS, INC.

TOPICAL REPORT

CNSI-2

4313-01354-01NP

MOBILE CEMENT SOLIDIFICATION SYSTEM

Submitted to:

STANDARDIZATION AND SPECIAL PROJECTS BRANCH
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

MARCH 1982

Revision 1

BY

CHEM-NUCLEAR SYSTEMS, INC.

COLUMBIA, SOUTH CAROLINA

THIS REPORT, CNSI-2, (4313-01354-01NP), REVISION 1 SUPERCEDES AND REPLACES ALL EARLIER VERSIONS OF THE SAME REPORT

CHEM—NUCLEAR SYSTEMS INC.

P.O. Box 1866 • Bellevue, Washington 98009 • (206) 827-0711

March 22, 1932

Mr. James R. Miller, Chief
Standardization and Special Projects Branch
U. S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20555

Attention: Jack Berggren, Project Manager

Reference: Chem-Nuclear Systems, Inc. Mobile Cement Solidification System Topical Report CNSI-2

Dear Mr. Miller:

Chem-Nuclear Systems, Inc. herewith submits twenty-five proprietary and fifteen non-proprietary copies of Revision 1 to the document entitled "Mobile Cement Solidification System Topical Report CNSI-2" previously submitted on November 9, 1981. This revision supercedes and replaces the previous version in it's entirety. Please note the word "mobile" has been added to the title to more clearly define the system described therein.

The referenced report was submitted in conjunction with South Carolina Electric and Gas Company's operating license application for the Virgil C. Summer Nuclear Plant. Their application was submitted October 30, 1981 under Docket No. 50-395.

Enclosed is our affidavit in support of the request to withhold the proprietary version of Revision 1 from public disclosure pursuant to the provisions of Section 2.790 of Title 10, Code of Federal Regulations.

If you need further information regarding the submittal of Revision 1, please do not hesitate to contact me.

Sincerely,

CHEM-NUCLEAR SYSTEMS, INC.

Chryl A. Marsh

Chryl A. Marsh
Licensing Coordinator

CAM:slj

Enclosure: Affidavit
40 copies of Rev. 1 to CNSI-2

cc: R. L. Bangart, Effluent Treatment Systems Branch/NRC
Karl Price, South Carolina Electric & Gas
David Ebenhack, Regulatory Affairs Director/CNSI
Gary Moffatt, South Carolina Electric & Gas

AFFIDAVIT SUBMITTED TO NUCLEAR REGULATORY COMMISSION CONCERNING CONFIDENTIAL INFORMATION AND TRADE SECRETS CONTAINED IN CHEM-NUCLEAR SYSTEMS INC., MOBILE CEMENT SOLIDIFICATION SYSTEM TOPICAL REPORT

STATE OF WASHINGTON)
) ss:
COUNTY OF KING)

David G. Ebenhack states as follows on behalf of Chem-Nuclear Systems, Inc.:

1. I am the Director of Regulatory Affairs for Chem-Nuclear Systems, Inc.

2. I have reviewed and am familiar with the contents of Revision 1 of the report prepared by Chem-Nuclear Systems, Inc., dated March, 1982 and entitled "CNSI Mobile Cement Solidification System Topical Report CNSI-2" (hereinafter "the Report".

3. Chem-Nuclear Systems, Inc. (hereinafter "CNSI") has submitted forty copies of the Report to the Nuclear Regulatory Commission. Twenty-five copies of such report contain proprietary information which should be withheld from public disclosure. The other fifteen copies of the Report furnished to the Commission do not contain proprietary information, as trade secret information and privileged commercial data have been removed from these copies so as to make them available for such public disclosure as may be requested.

4. CNSI, as part of its radioactive waste disposal services, provides a cement solidification unit which in many respects is a system unique to CNSI. Detailed information concerning the design and operation of the cement solidification system has always been held in confidence by CNSI. The engineering design for the unit, and the process used in mixing and solidifying liquid radioactive waste is considered confidential information that includes Company trade secrets incorporated into such design and processes, which confidential information is deleted from the forty copies of the abbreviated CNSI Report furnished to the Commission and available for public disclosure.

Employees of CNSI sign an agreement regarding protection of trade secret information at the time of entering Company employment, and the data contained in the proprietary version of the Report submitted to the Commission contains the type of information CNSI regards as protected and of the type not to be disclosed to unauthorized persons, including especially competitors, by present or former employees.

5. CNSI has obtained a competitive edge in the field of liquid radioactive waste solidification because of its extensive experience in the field and financial commitment to research, development and design concerning system components and improvements. CNSI mobile units, chemical process operating procedures, and process control procedures are presently superior to the equipment used by competitors for similar processes and this superiority is the basis on which system details are being withheld.

The information contained in the proprietary version of the Report is not available from public sources.

6. Public disclosure of the proprietary version of the Report would cause substantial harm to the competitive position of CNSI. The Company has invested in the neighborhood of $1 million over the last two years in engineering salaries and capital equipment investment, and has committed to capital construction $1.5 million so as to refine and improve CNSI's radioactive waste solidification system. Competitors of CNSI would have great difficulty in duplicating the system developed by CNSI, due not only to the financial investment of the company, but also to the unique skills, talents and expertise of CNSI employees who developed the system which is described in detail in the proprietary version of the Report.

7. The right of the public to disclosure of information held by the government is protected by the submission by CNSI of fifteen copies of the Report with confidential trade secret information ommitted, and therefore, the CNSI competitive position clearly deserves protection, in regard to the twenty-five copies of the Report containing confidential information.

David G. Ebenhack

David G.Ebenhack, Director
Regulatory Affairs

STATE OF WASHINGTON)
) ss:
COUNTY OF KING)

On this 12th day of March, 1982, before me, a Notary Public in and for the State of Washington, duly commissioned and sworn, personally appeared David G. Ebenhack, to me known to be the Director of Regulatory Affairs for Chem-Nuclear Systems, Inc., and on oath stated that he was authorized to make this affidavit on behalf of the corporation.

IN WITNESS WEREOF, I have set my hand and affixed my official seal the day and year first above written.

Barbara Fischer

NOTARY PUBLIC in and for the State of Washington, residing in Bellevue

ABSTRACT

This Topical Report describes the design and operation of the Chem-Nuclear Mobile Cement Solidification System. The system was developed to provide a mobile, simple, economical, and reliable method of solidifying radioactive liquid wastes, resin slurries and sludges for transportation and disposal.

The system features, verified by extensive pilot plant testing and in-plant experience are as follows:

1.) The system is fully transportable by trailer. Assembly of the components prior to operation typically takes three days or less.

2.) The binder chosen for the system is Portland I Cement with additives selected to optimize the product properties. The selection was made for the following reasons:

   a. Proper formulation assures long term structural integrity and strength that is a well documented part of cement technology.

   b. Commercial availability of cement and lime is worldwide in bulk or bags at competitive cost.

   c. Cement admixtures are generally non-flammable, non-explosive, and not considered harmful to the environment.

   d. The exothermic nature of cement hydration in bulk quantity is chemically controllable, and can be moderated to ensure safe, practical set of aqueous wastes, even those containing significant levels of boron or sulfate.

   e. Solidification waste volume efficiencies are as high as 75% for aqueous streams, and may be higher for particulate slurries.

3.) Laboratory PCP procedures have been developed that permit verification of solidification formulas, and simulate the effects of exothermic reactions in large containers. Hydration chemistry assures the formation of a solid, dry matrix over a reasonably broad, controllable range of cement/water ratios. A number of radionuclides are chemically fixed in cement structure and are not significantly leached. The process has been successfully tested using a variety of waste streams and combinations of waste streams to simulate power plant wastes in addition to full-scale operation on actual waste streams at power plants.

4.) Cement treatment of waste facilitates uncomplicated processing arrangements such that the same disposable liner can be used to receive the waste, accomplish de-watering or pH conditioning, and contain the solidification reaction.

PROPRIETARY INFORMATION

The following pages and/or sections in the CNSI TOPICAL REPORT NO. CNSI-2, 4313-01354-01P, Rev.1, Mobile Cement Solidification System (MCSS) are considered to be proprietary by Chem-Nuclear Systems, Inc. (CNSI) and are not to be used or duplicated for public information and distribution without direct written permission of CNSI.

SECTION	TITLE	PAGE(s)
APPENDIX 1	SOLIDIFICATION CHEMISTRY OF PROCESSING NUCLEAR WASTES WITH CEMENT	1.1 TO 1.12
APPENDIX 2	TYPICAL PROCESS CONTROL PROGRAM FOR THE MCSS	2.1 TO 2.21
APPENDIX 3	TYPICAL OPERATING PROCEDURE FOR THE MCSS	3.1 TO 3.14
APPENDIX 4	TYPICAL ASSEMBLY AND DISASSEMBLY PROCEDURE FOR THE MCSS	4.1 TO 4.19
APPENDIX 5	DRAWING	5.1 TO 5.2

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1.0 INTRODUCTION

Immobilization of liquid radioactive wastes generated by nuclear power plants and utilities 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 mix the waste with cement in the shipping containers.

The CNSI Mobile Cement Solidification System uses a batch mixing technique where the concentrated liquid wastes or resin slurries are preconditioned with additives and mixed with dry cement in a shipping container (liner). Features are incorporated in the solidification system, based on the experience gained in the operating systems, which assist the operator in reducing radiation exposure, such as the incorporation of quick removal features into the equipment design which allows for quick access to the equipment for maintenance. Provisions for flushing of the equipment exposed to the waste are included. Two types of systems are available -- the Trailer Mounted Mobile Solidification Units (MSU) and the Skid Mounted Portable Solidification Units (PSU).

The choice of cement as the binder in the CNSI Mobile Cement Solidification System is the result of research conducted by CNSI to develop an economical, readily available and acceptable binder for the evaporator bottoms and resin slurries which are the typical liquid waste streams produced by a nuclear power utility. 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 addition of other additives is used to limit the maximum temperature reached during solidification and produce a more efficient packaging of the waste. The final concrete product is non-flammable and has sufficient compressive strength to far exceed any proposed requirements for burial.

The CNSI Mobile Cement 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. CNSI mobile systems are the culmination of the design and experience of many systems along with several years of operation in nuclear utilities. CNSI'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 purpose of this report is to present the necessary data on the CNSI Radwaste Soldification System to enable the Nuclear Regulatory Commission to evaluate the system for use in nuclear utilities in the United States.

2.0 PROCESS DESCRIPTION

2.1 General System Description

Basically, the mobile cement solidification system (MCSS) mixes separate feeds of radioactive wastes and dry Portland cement in the shipping container. Resin slurries and other solid waste materials are preconditioned and dewatered within the shipping container to provide sufficient moisture when mixed with dry cement. Normal operation of the system includes transfer of dry cement from a cement storage bin or from a bulk cement truck into the waste container. The waste from the plant's waste tank is pumped to the shipping container by the utility's permanently installed pumps. After the correct metered amount has been transferred, the waste flow is stopped and the correct amount of additives is added to precondition the waste. Dry Portland cement is transferred to the shipping container with a pneumatic transfer system. Mixing of the waste with the additives and the cement is accomplished by a disposable agitator pre-mounted in the shipping container which is driven by a hydraulic motor. Instrumentation is available to monitor the level of waste and cement level in the shipping container and the temperature of the cement billet during solidification.

Prior to transferring the waste to the shipping container the CNSI Process Control Procedure (PCP) is used to verify solidification and to determine the quantities of additives and cement required. A sample of the waste is obtained and processed to ensure that a solidified product can be obtained. A typical PCP is provided as Appendix 2 to this Topical report.

The Fillhead and Extension Skirt Assembly provides the means to control the spread of contamination and cement dust during the solidification operation. The Fillhead seals onto the opening of the shipping container and is attached to the container by one of two methods during the solidification operation. The hydraulic motor located on the Fillhead is engaged with the disposable mixer blade assembly to provide the agitation required. Flush water spray nozzles are provided inside the fillhead to remove any cement residue and contamination. Flushing of the associated piping is also performed.

The system is designed with interlocks and safeguards to ensure trouble-free operation. The control panel has been designed to be easily understood and simple to operate. Interlocks and alarms are provided to preclude unsafe operation or operator error.

Either of the two systems described in this Topical Report, the Mobile Solidification Unit (MSU) or the Portable Solidification Unit (PSU), is designed to be transported to the power utility, set up by the CNSI operator and operated as a mobile solidification service in conjunction with the CNSI Waste Transportation Services. The MSU system uses trailer mounted components to solidify the wastes as shown on figure 5-1. The PSU system is designed to be located in the utility's Radwaste Processing building. The PSU is shown in Figure 5-2. Either system uses essentially the same equipment to perform the solidification of the wastes.

2.2 MCSS Sub-System Descriptions

2.2.1 Solidification System Main Control Panel

The control panel provides a complete display of the system with running lights, pilot lights, and indicators clearly showing the operating condition of the entire system. The running lights, readout devices and pushbutton starters for manual operation are located adjacent to the pertinent component illustrated on the display. A tv monitor located on the control panel shows the operator the actual waste process in the container.

2.2.2 Radwaste Transfer

Radwaste is transferred to the MCSS by pump discharge through a stainless steel hose to the waste container. The Plant Connection Stand contains an automatic shutoff valve and connections for sampling and flushing.

2.2.3 Dewatering System

A pneumatic diaphragm pump assembly with sample and flush connections removes excess resin sluice water from the waste container before solidification. Mechanical filtration through a disposable filter in the waste container removes waste solids from the sluice water and allows excess water to be returned to the plant. This system can be used to recirculate waste to sample proper chemical mix, if necessary.

2.2.4 Cement Transfer System

Portland I cement is delivered to the site and pneumatically transferred to the CNSI bulk container which may be a bulk cement trailer or an upright silo. A pneumatic transfer system transfers the required weight of cement to the disposable liner. The transfer system is designed to eliminate any cement dusting or "hands-on" contact with the cement. The bulk container may be located up to 100 feet from the disposable liner. The pneumatic transfer air is separated from the cement using a venturi scrubber or a bag house system.

2.2.5 Fillhead Assembly

The fillhead assembly contains a hydraulic mixing motor which mates to the disposable mixer assembly located in the disposable liner. Separate piping for dewatering, waste addition, cement addition, chemical treatment and venting are contained in the fillhead which clamps directly to the disposable liner. It also includes instrumentation for monitoring liner level, temperature and pressure and general radiation as well as a camera for remote closed circuit television viewing.

2.2.6 Radiation Monitoring

Radiation level detectors are located 1) adjacent to the Plant Connection Stand, 2) at the container Fillhead Assembly and 3) at the Main Control Panel. Remote readout from each detector is displayed on the main control panel.

2.2.7 Miscellaneous

The hydraulic unit powers the mixer motor located on the fillhead. It is located in the trailer or on a separate skid with the skid mounted unit. The disposable liner is maintained at a negative pressure with a blower which evacuates the disposable container through a venturi scrubber or bag house. An electric crane is provided with the trailer mounted unit to allow loading/unloading of portable equipment and fillhead installation and removal.

2.3 System Operation

2.3.1 Mobile System Assembly

The assembly of the MCSS is conducted in accordance with written procedures to ensure that connections are made properly between the components and between the MCSS and the utility. Piping and hose connections for the waste transfer, and vent connections are made and tested as required by the procedure. Connections for power, telephone communications, compressed air, and flush water are made to the utility so that operation of the system can begin. A typical procedure for the assembly of a MCSS is provided as Appendix 4 to this Topical Report.

2.3.2 Waste Conditioning and Transfer

A sample of the waste is supplied by the utility staff for use in the Process Control Procedure (PCP) to verify cement and additive quantities required for acceptable solidification. After completion of the PCP, the required quantity of waste is transferred from the utility's waste collection tanks to the shipping container through the waste hose. Indication of waste transferred is provided by container level indication which is confirmed by the utility's instrumentation. An automatic shutoff valve is provided on the waste feed hose which prevents overfilling of the container.

Waste streams consisting of contaminated expended resins can be dewatered to remove any excess water required to transport the resin to the shipping container. Dewatering is accomplished through a disposable dewatering connection which separates the resin from the transport water. The removed water is returned to the utility for sampling and re-use or disposal as required.

Additive chemicals are added to the waste in the waste container as determined from the PCP. Agitation of waste/additive mixture is accomplished by means of a disposable mixing blade driven by a hydraulic motor.

A typical PCP is provided as Appendix 2 to this Topical Report and a typical Operating Procedure is provided as Appendix 3 to this Topical Report.

2.3.3 Cement Addition

The required quantity of cement is transferred to the shipping container by means of a pneumatic cement transfer system. During this transfer, the speed of the agitator is controlled to ensure a uniform and complete mixture of the waste with the cement. An electronic load cell assures that the proper quantity of the cement was transferred. The transfer system is designed to eliminate any cement dusting.

At the completion of the mixing, the agitator is stopped, and the cemented waste is allowed to solidify. The fillhead is removed and replaced with a ventilation fillhead which provides the path for gases generated during the cure of the cement to vent back to the utility ventilation system. The fillhead is then available for solidification of the next batch of waste.

2.3.4 Flushing and Disassembly

After completion of each waste transfer and solidification operation, the components in contact with the waste are flushed to remove any residual contamination. Disassembly of the MCSS is accomplished using the prescribed procedure (Appendix 4 of this Topical Report). The appropriate radiological precautions are taken to prevent the spread of activity during disassembly, storage or transportation of the equipment.

2.3.5 Post Solidification Operation

After completion of the cure of the cemented wastes the ventilation head is removed from the shipping container and the container is manually or remotely capped by the operator depending on waste activity. If solidification took place within the shielded cask on the transport trailer the cask lid is installed and the cask is shipped for disposal. On the other hand, if solidification occurred in a temporary shield, the shipping container can be remotely loaded in the cask by the utility crane.

2.4 MCSS Control Panel

The MCSS Control Panel is divided into an electric control panel and a pneumatic control panel. Operation of the MCSS is primarily conducted from this panel. Indications of system operation, system alarm conditions and interlock activation are displayed on the MCSS Control Panel along with displays for the radiation monitoring system and the closed circuit TV monitor. A list of the alarms and indications located at the MCSS Control Panel are located in Table 2-1.

Table 2-1

MCSS CONTROL PANEL ALARMS AND INDICATIONS

Electric Control Panel

- control power
- main power on indication
- clock
- radiation monitor
- fillhead presure alarm
- fillhead position alarm
- high level alarm
- cement level alarm
- waste level alarm
- high-high level alarm
- liner level indication
- TV monitor
- fillhead light
- waste valve control and position indication
- mixer speed indication
- mixer low speed alarm
- low oil temperature alarm
- high oil temperature alarm
- fillhead temperature alarm
- cement weight scale
- hydraulic motor controls
- conditioning chemical pump counter
- conditioning chemical pump controls
- main air controls
- waste vent blower controls
- camera flush controls
- aeration blower and cement blower controls
- liner temperature recorder
- liner size selector switch
- low oil level alarm
- mixer motor controls
- dewater pump controls
- emergency stop
- closed circuit TV Monitor

Pneumatic Control Panel

- main air pressure indication
- vessel pressure indication
- supply air pressure indication
- waste vent filter differential pressure indication
- control valve air pressure regulator and indication
- dewater pump air pressure regulator and indication
- conditioning chemical pump air pressure regulator and indication
- camera air indication and controls
- fillhead cooling air indication and controls

2.5 Interface Service Requirements

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

Electrical:	120A, 460V/3 Phase/60 Hz
Service Water:	25 gpm at 80 psi, minimum
Service Air:	75 SCFM at 80 psi, minimum
Waste:	1-1/2" 150 lb ANSI flange connection.
Dewater:	1-1/2" 150 lb ANSI flange connection Return flow to plant: 25 gpm at 100 psi maximum
Vent:	2-1/2" vent hose discharge to plant off gas system
Lift Capacity:	Forklift capable of lifting 4000 lb at a 6 ft. moment arm during assembly and disassembly

2.6 Fail Safe Features Incorporated in Control System

All critical equipment provided within the system is designed to fail in the safe position. The Waste Isolation Valve is an air operated open and spring closed valve. This valve closes on electrical signal or loss of control air pressure. The dewater pump also stops on loss of air pressure. The dewater pump will not discharge more than 100 psi with maximum allowable supply air pressure. Any loss of control air will shut down the entire system. There is an emergency shut-down button on the control panel to shut-down the entire system, electrically and pneumatically.

2.7 Piping and Instrument Diagram

A typical Piping and Instrumentation drawing for the Mobile Cement Solidification System is included as Appendix 5 of this Topical Report.

3.0 EQUIPMENT DESCRIPTIONS

3.1 Design Features

3.1.1 General

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

3.1.1.2 The skids, shell supports, cradles, and base plates are carbon steel. The skids are equipped with a stainless steel drip-lip type base for collecting the leakage from the pump and other sources. The skid drain lip is designed to contain or collect small amounts of leakage. The intent of the skid drain lip is to confine any leakage to a small area and to permit drainage to a collection tank.

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

3.1.1.4 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.

3.1.2 Surface Preparation and Cleaning

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

3.1.3 Painting

The carbon steel surfaces of the waste solidification system are painted. Stainless steel parts are not painted.

3.2 Bulk Cement Storage Bin

3.2.1 Cement Storage Bin (where used)

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 is 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 are anchored to a skid.

3.2.2 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. The utility supplies 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.

3.2.3 Cement Storage Trailer (Alternate Storage Method)

Cement storage trailers for bulk cement may be provided for a more easily moved unit. The bulk trailer may be one of several types of readily available commercial trailers and serves the same function as the storage bin.

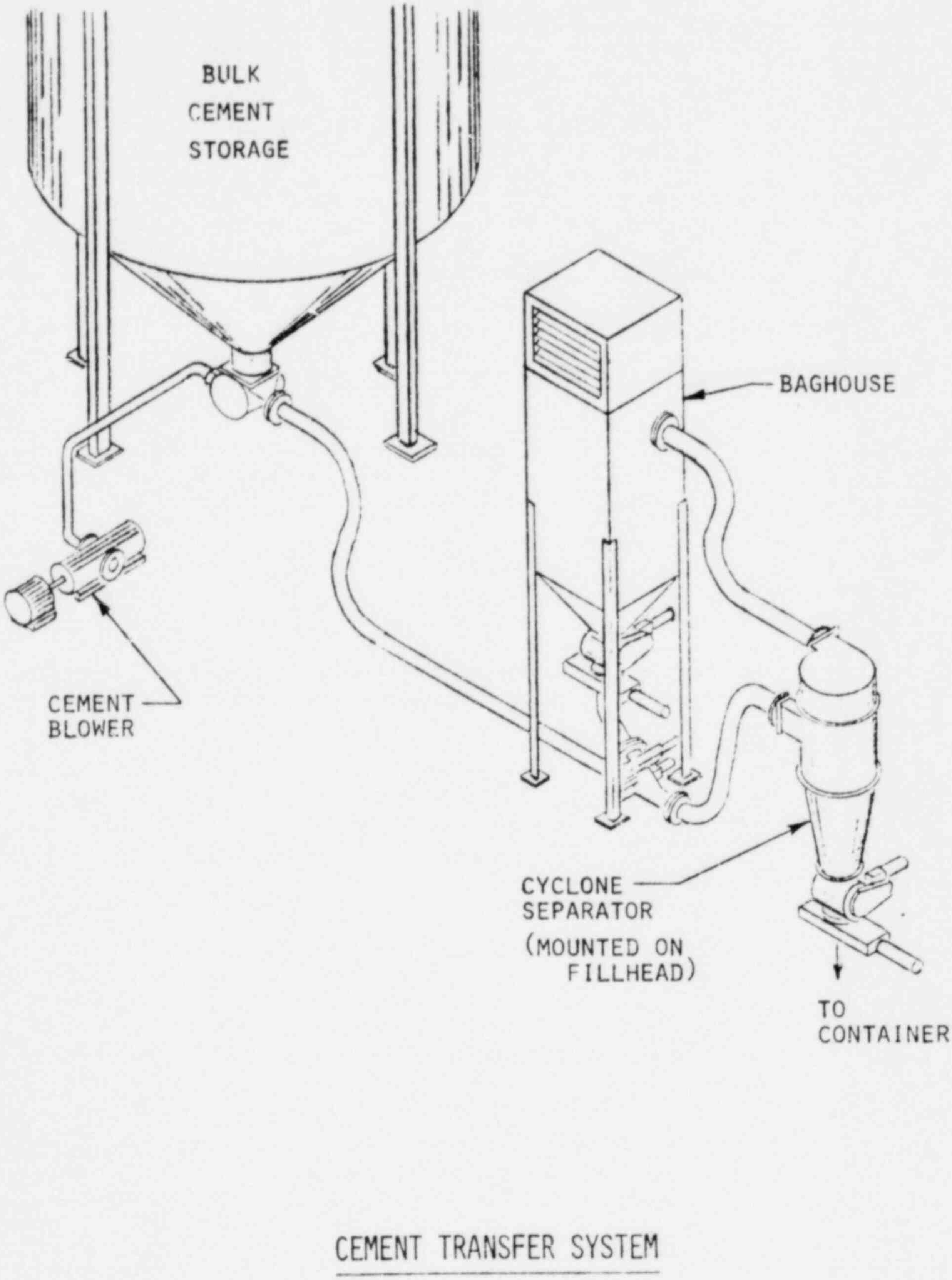
3.3 Cement Feed

3.3.1 Cement Conveying System

The cement is transferred to the fillhead from the Bulk Cement Storage Bin or the Cement Storage Trailer, by a pneumatic transfer system. The cement is dropped into an air stream by a rotary feed valve and transferred to a cyclone separator mounted on the fillhead. The cement is transferred to the liner through a rotary feed valve. The transport air is filtered in a bag house and vented to the atmosphere. Cement dust removed from the transport air stream in the bag house is returned to the cyclone separator through a third rotary feed valve. A knife valve separates the cyclone hopper from the fillhead to provide positive shutoff of cement. The quantity of cement transferred to the fillhead and the shipping container is verified by means of a load cell mounted on the cement trailer frame. This system is shown in Figure 3-1.

3.3.2 Alternate Cement Conveying System

The cement is transferred to the fillhead from the Bulk Storage Bin or Cement Storage Trailer by a pneumatic conveying system. A bulk transfer conveyor is supplied from the cement storage unit and loads approximately 175 pounds of cement per batch. When the level sensing device is reached by the fluidized cement, the conveyor automatically shifts to the discharge mode and air conveys this batch to the fillhead and container of radwaste. This process is automatically (or manually) repeated until the preset number of batches (calculated from PCP) has been added.



CEMENT TRANSFER SYSTEM

FIGURE 3-1

An aeration blower provides fluidizing air to the bulk storage unit. A cement blower provides the motive power for the actual cement movement. The transport air vented from the container is passed through a scrubber to remove any entrained cement dust and exhausted to the utility ventilation system. The quantity of cement transferred by the conveyor is automatically weighed by a load cell and computer and displayed on a printout or LED display. The operator must compare this total with the number of batches transferred and actual cement/waste level for redundant measuring capabilities. This system is shown in Figure 3-2.

3.4 Control Panel

3.4.1 Solidification System Main Control Panel

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

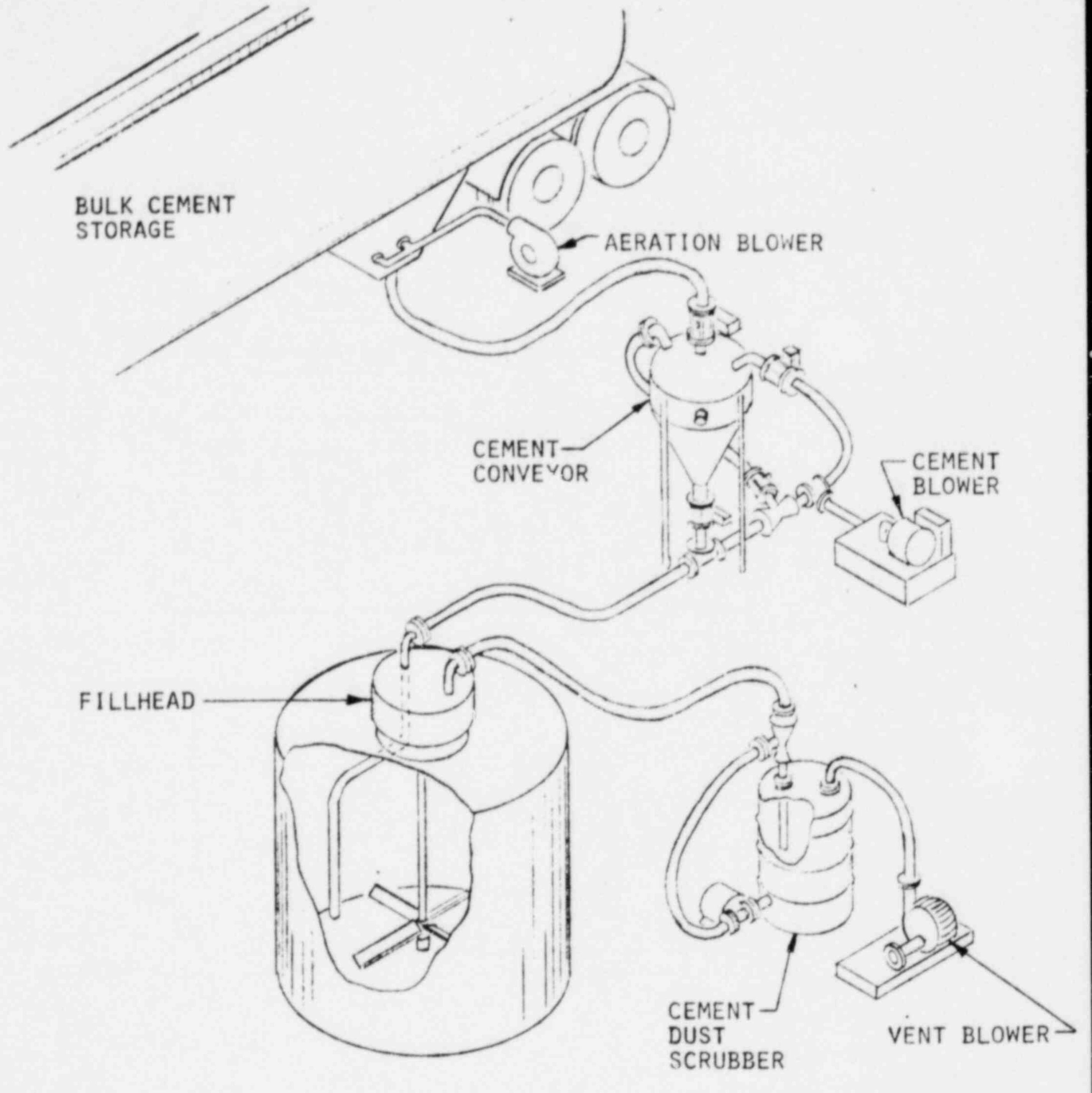
Functional automatic controls are provided in which the operator actuates controls sequentially. The control system has been designed to simplify the operator's job and also to preclude the possibility of making an error.

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 display of the system with running lights, pilot lights, and indicators to clearly show the operating condition (including valve positions) of the entire system. A monitor for the closed circuit TV system is mounted on the control panel to provide the operator with a visual indication of the solidification process. The running lights, readout devices and pushbutton starters for manual operation are located adjacent to the pertinent component illustrated in the 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 3-3.

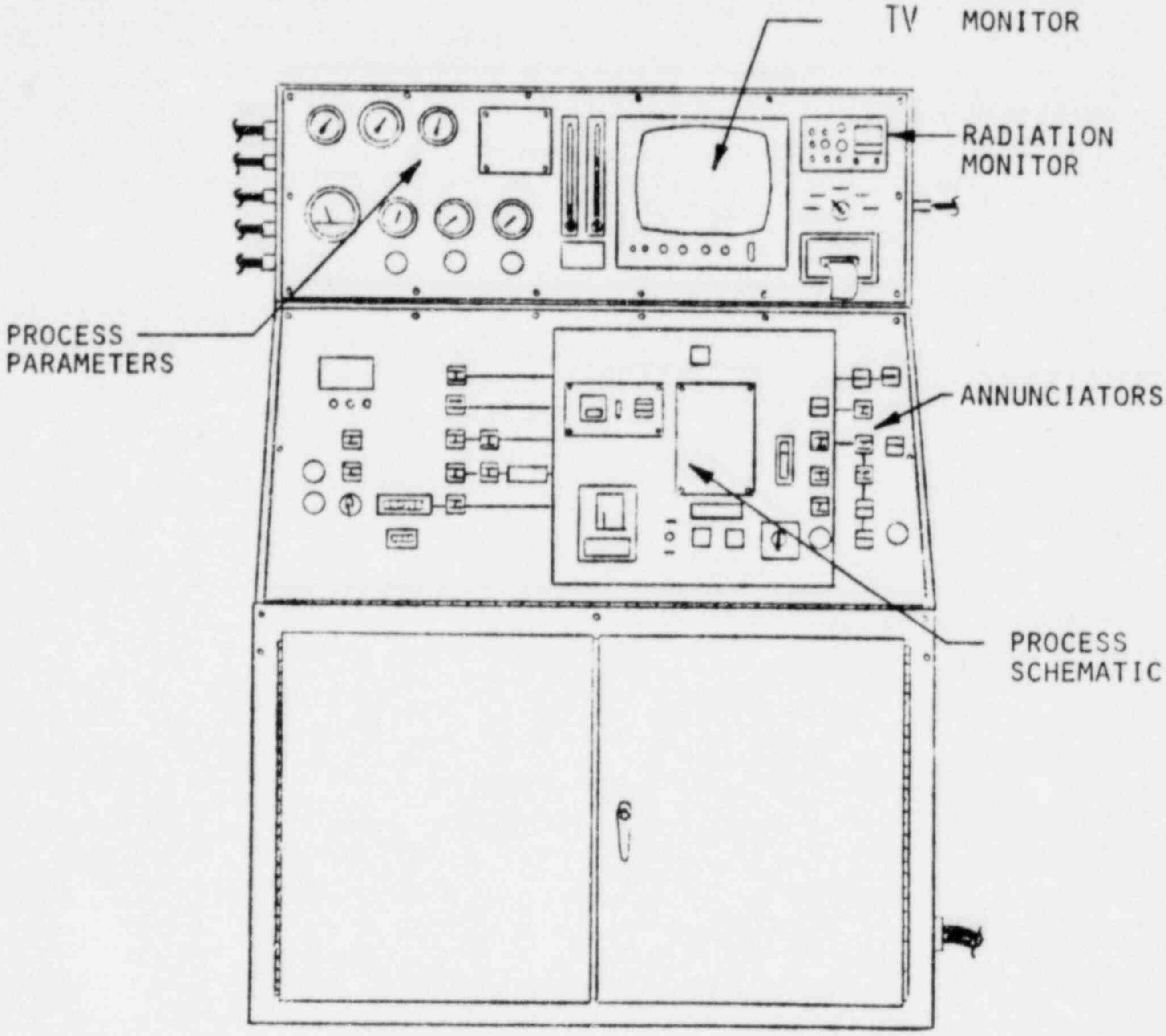
3.4.2 Fail Safe Features and Analysis of Malfunctions

All equipment provided within the CNSI Mobile Cement Solidification 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.



ALTERNATE CEMENT TRANSFER SYSTEM

FIGURE 3-2



MAIN CONTROL PANEL

FIGURE 3-3

3.5 Piping and Valves

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

Line Sizes: Flush water lines are 3/4 inch schedule 40.

Resin Piping: 1 1/2 inch, 304 or 316 SS, schedule 40, line sizes are normally used. All pipe bends are five times the pipe diameter; that is, no elbows and sharp turns are permitted.

Liquid Waste Piping: 1 1/2 inch, 304 or 316 SS, schedule 40, line sizes are used.

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 are constructed from stainless steel.

3.5.1 Knifegate Valve (if used)

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 the 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.

3.5.2 Plug Valves (if used)

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 on each valve.

3.5.3 Butterfly Valves (if used)

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 on the valve.

Valve construction consists of an ASTM-A-351CF8M 316 SS body and disc. 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.

3.5.4 Rotary Feed Valves (if used)

The rotary feed valves are used to provide a positive seal between the cement or lime and the transport air. All major parts are of cast iron construction with polished surfaces to provide a better air seal. The rotors contain blades which conform with the housing walls within close tolerances. The rotor drive motors are typically less than 1/2 horsepower. The valves can be designed to allow impulse air to assist the flow of cement or lime through the valve and attached hoses.

3.6 Fillhead and Extension Skirt Assembly

The CNSI Fillhead and Extension Skirt Assembly is provided to permit remote introduction of solidification and waste materials into the waste container and remote in-container mixing of these materials to provide a completely homogeneous mixture.

The stainless steel fillhead is capable of being hoist mounted to provide vertical movement and also removal for storage. A series of spray nozzles are located beneath the extension skirt enabling remote decontamination with water. The advantage of the extension skirt design is that waste filling is performed under a gasketed sealed and vented condition, thereby reducing splatter. The fillhead is lowered onto a 55 gallon drum sized fill port on the container and is sealed by a rubber gasket. The fillhead is then secured by air operated locking devices or by quick disconnect chain binders. Proper positioning of the fillhead is detected by a proximity switch and indicated on a control panel illuminator. Interlocks are provided to assure the fill process takes place only when the fillhead is properly engaged.

Mixing of the waste and binder is accomplished using a disposable in-container mixing blade assembly coupled to a hydraulic drive. Coupling of the mixer shaft to the drive is by means of a collar which connects to the splined shaft. The hydraulic power supply is remotely located to allow ease of maintenance.

1. Materials of Construction: Stainless Steel 304 or equal.

2. Closure and Seal Design: A Stainless Steel Extension Skirt with a rubber seal provides a dust-free environment. Sealing is accomplished by lowering the Extension Skirt onto the container opening.

3. Lubrication Requirements: None.

4. Hydraulic Drive Assembly - Remote drive power pack for maintenance considerations. The hydraulic motor is either 30 or 50 horse power.

3.7 Container Sealing

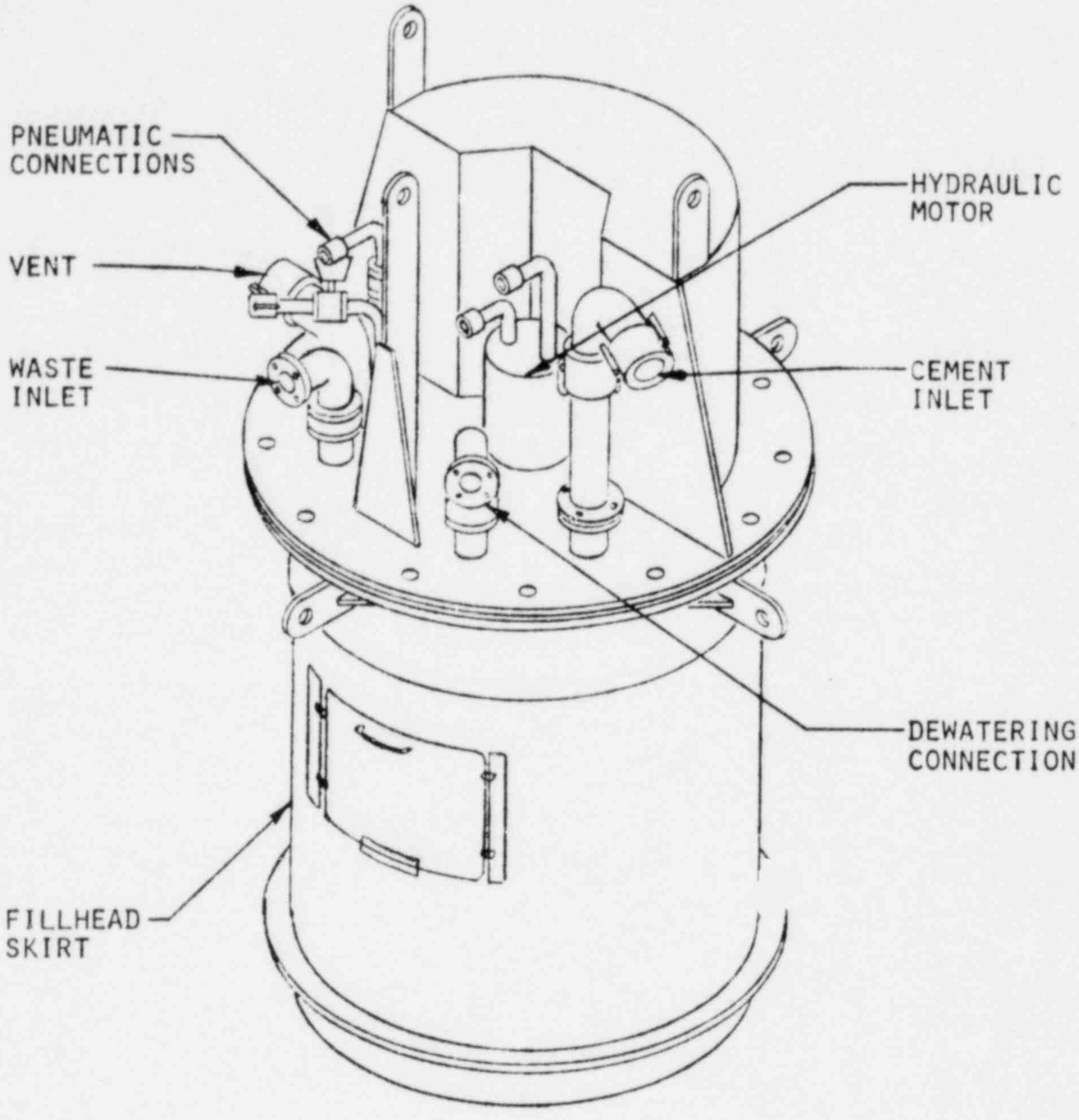
Two methods of sealing the containers are used to prepare the solidified waste for shipment and disposal. A remote capping device is used for solidified resins or other high activity wastes. The device used is the CNSI Crimp-A-Cap which utilizes a pneumatic crimper to seal the lid on the container remotely. Containers which contain low activity wastes, normally concentrates, are sealed manually using a standard 55 gallon drum bolting ring.

3.8 Plant Connection Stand

The transfer of utility services to the MCSS is accomplished at the Plant Connection Stand. At this one mainfold, the waste feed, flush water, compressed air, and ventilation connection to the utility piping system is made for convenience to the operators. Instruments for the measuring of the flow, temperature and pressure of these streams are provided on the MCSS Main Control Panel for use in operating the systems.

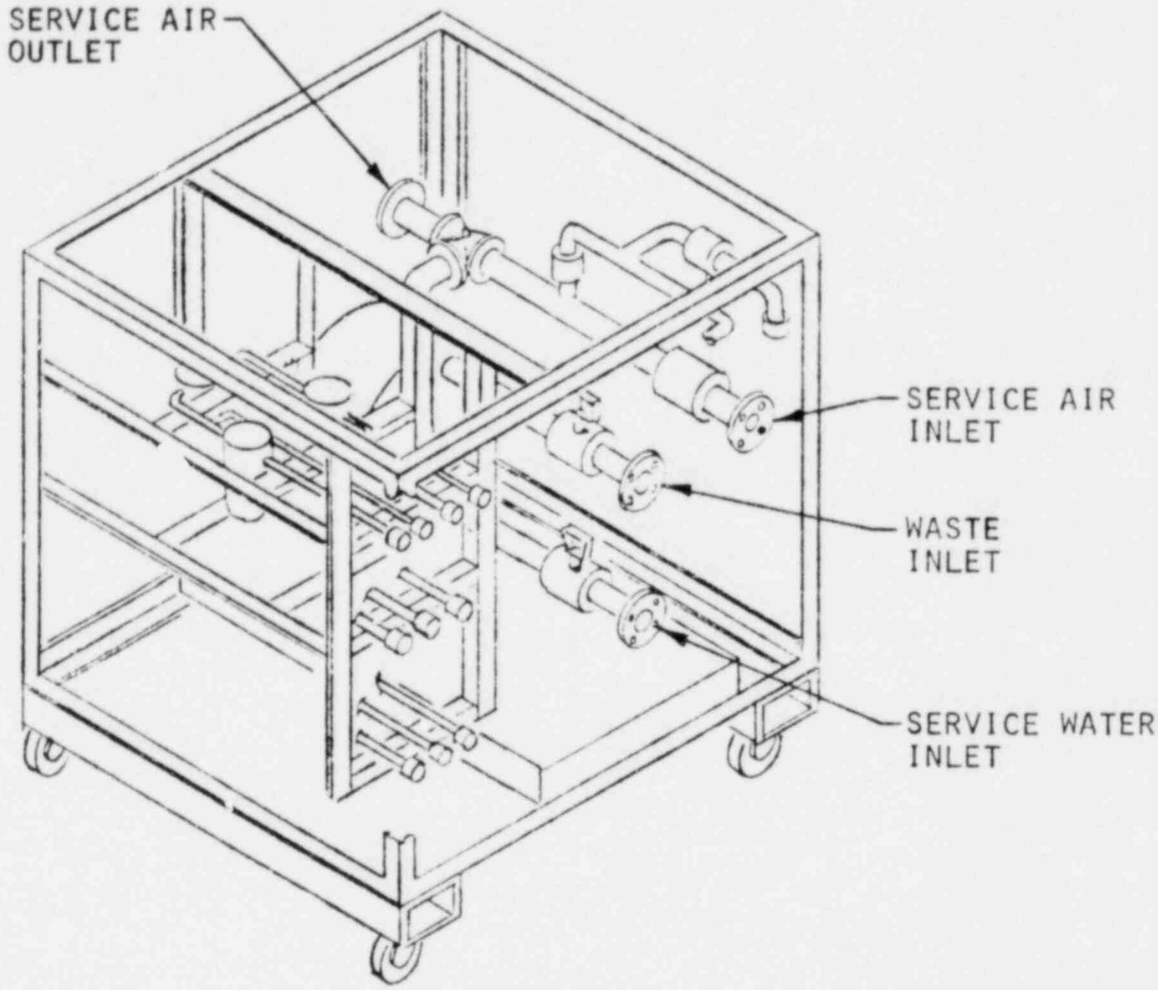
3.9 Television Camera

The Closed Circuit TV Camera mounted on the Fillhead allows the operator to have a view of the solidification operations including waste fill and cement addition. This provides a backup to the operator for the remote instrumentation and allows the operator to view the solidification operation. A flush connection is provided for the TV Camera window to maintain the window free of splatter.



MOBILE SOLIDIFICATION SYSTEM FILLHEAD

FIGURE 3-4



PLANT CONNECTION STAND

FIGURE 3-5

4.0 SYSTEM OPERATION

This section further defines the processes necessary to support the operation of the mobile solidification system. Among the topics discussed are the Process Control Program (PCP), the waste feed characteristics experienced, the waste loadings achievable and the time necessary to process each batch of waste.

4.1 Process Control Program

Chem-Nuclear's Mobile Cement Solidification System uses Portland Type I Cement and various pretreatment additives for solidification control in the process unit. Waste batches of up to 66% of the container volume are common. This quantity, however, may vary and will be determined by an approved Process Control Program (PCP).

The PCP is designed to ensure that each batch of radioactive waste received by the process unit is capable of being solidified into the desired end product: a monolithic solid containing no free water.

Chem-Nuclear utilizes specific additives in the Process Control Program, chemical compounds which control pH, increase the waste-to-end-product ratios, reduce the heat generated, prevent "bleed" liquid, and are instrumental in controlling and adjusting cement setting times. What's more, the process control program is normally run on actual radwaste, not on cold simulated waste.

4.1.1 Description of the PCP

A waste sample, typically 200 ml or less in volume, is taken from the utility's waste storage tanks prior to the full-scale solidification of the waste in the shipping container.

This sample is solidified according to a specific sample verification procedure from which are calculated the amounts of waste, cement and any additives required for complete solidification of the waste. These process parameters are documented by the operator and kept on record for that specific waste material. A typical PCP is included as Appendix 2 to this Topical Report.

The acceptance tests for the sample test solidification are:

1) Acceptable visual inspection of the mixture after cement addition which confirms that the mixture is uniform with no free water on the surface.

2) Acceptable visual inspection of the end product after hardening proving that it is a uniform, liquid-free and free-standing monolith.

3) Acceptable penetration testing of the end product with a pencil-sized probe.

If there is no change in the chemical composition of the waste as verified by the utility, these test results and full scale solidifications will be considered reproducible for wastes of the same composition. However, actual large scale solidification on any batch of radwaste will take place only when the operator is assured that the variables present will allow the same desired end product to be produced. That assurance may require testing of each batch or every few.

4.1.2 Solidification Strategy

The basic simplicity of Chem-Nuclear's cement solidification technology eliminates the need for pretreatment of waste outside of the disposable liner. Except for dewatering of particulate wastes, the radioactive stream is fully contained in the solidification vessel and does not contaminate other areas. The solidification parameters that are observed to ensure successful waste treatment are as follows:

4.1.2.1 pH

Cement does not set satisfactorily under acid conditions, so that waste material is adjusted with lime as necessary to a basic pH prior to cement addition. The Process Control Program pre-determines additive requirements.

4.1.2.2 Waste Chemical Solubility

Waste chemicals in the form of soluble borates and sulfates can cause wide variations in the setting rate and stability of cement matrices. Appropriate chemical addition converts these chemicals to relatively insoluble salts that do not influence cement setting reactions nearly as much, and may actually form stable mineral structures, improving process efficiency and water leachability.

4.1.2.3 Ion-Exchange Activity

Ion-exchange resins or powdex waste can interfere with the chemistry of cement set by taking calcium ions from solution as replacements for hydrogen or sodium ions on the resin material. The chemical pretreatment of these resins assures that the normal cement reaction will be completed, and that the final product will better resist destructive expansion during water immersion.

4.1.2.4 Water to Cement Weight Ratio

It is well established by the construction industry that the compressive strength of cement is directly affected by the weight ratio of the water contained in the mix. By using a high water/cement ratio compressive strengths in the area of 1000 pounds per square inch can still be achieved for solidified waste. This high level of water in the mix prevents excessive exotherm development and allows very favorable waste volume efficiencies of up to 75% to be achieved. The use of the additives provides the plasticity control to prevent "bleeding" during set. For dewatered particulate wastes, the amount of cement relative to water may be increased to assure greater strength, particularly for resistance to extended aqueous immersion. No exothermic difficulties result from the higher cement concentration, since the waste particles act as "heat sinks" to dissipate the increased hydration energy.

4.1.2.5 Oil

The maximum allowable volume of insoluble oil contained in aqueous waste liquid has been administratively set at 1%, and such solidified wastes are acceptable for burial in the State of South Carolina. Higher levels of oil contamination are considered abnormal, and would require physical removal of the oil prior to solidification. Chem-Nuclear has developed a separate technology for cement solidification of hydrocarbon-type lubricating oils and is offering this specialized service for routine disposal of radioactive lubricant wastes.

4.1.2.6 Undefined Contaminants

It has been demonstrated that the chemical constituents in typical utility waste streams have not prevented acceptable cement solidification results. It is considered unlikely that troublesome new or undefined contaminants would be encountered where the necessary treatment would not be determined by applying the formulation versatility of Chem-Nuclear's Process Control Program for the cement solidification process.

4.2 Waste Feed Characteristics

Typical P.W.R. and B.W.R. waste types solidified by the Chem-Nuclear's Mobile Cement Solidification System are described as follows:

4.2.1 Mixed Bed Resins

These are expended or partially expended mixed bed demineralizer resins, such as Dow Anion SBR-OH and Dow Cation HCR-S in various volume blends. Resin beads are usually ion-activated copolymers of styrene and divinyl benzene with the following typical physical properties after dewatering.

Average Particle Size:	0.54 mm
Retained on 50 Mesh Screen:	About 98%
Particle Density:	1.1 gm/cc (Anion)
	1.3 gm/cc (Cation)
Bulk Density:	45 lbs./Ft^3

4.2.2 Waste Filter and Floor Drain Filter Sludge

Both the Waste Filters and the Floor Drain Filters are normally of a pressure precoat type, using cellulose fibers (Solka Floc).

4.2.3 Cellulose Fibers (Solka Floc)

Solids Concentration Slurry:	1-3% by Wt.
Or Centrifuged Waste:	50% Water Removed
Average Particle Size - Length:	96 Micron
Thickness: 18 Micron	
% Retained on 100 Mesh:	45%
Particle Density gm/cc:	1.58
Bulk Density, lb/ft^3(Solids:Dry)	18

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

The sludge comes from the Reactor Water Clean-up Filter/Demineralizer and the Fuel Pool Filter/Demineralizer. The wet solid slurry is primarily Powdered Demineralizer (Powdex-type) resins, mixed 0.9 Cation (PCH-S) and 0.1 anion (PAO) such as manufactured by Graver Water Conditioning Co.

Solids Concentration:	0.5%-5% by wt.
Or Centrifuged Waste:	50% Water Removed
Particle Size:	350 Mesh
Bulk Density, lb/ft^3(Solids: Dry):	24

4.2.5 Evaporator Concentrates Bottoms consisting of:
12% by Wt. boric acid or 25% by Wt. sodium sulfate with other contaminants present.

4.2.6 Floor Drains and Miscellaneous Wastes

Wastes in this category include the wastes produced by the leakage of pump and valve seals and tank overflows and these wastes could include some lubricating oil. Other wastes such as laboratory wastes and laundry wastes are included under the miscellaneous wastes. The pH of these wastes are usually in the range of 5 to 10.

4.3 Waste Ratios Achievable

The following waste/binder ratios are expected in cement solidification using the CNSI Mobile Cement Solidification System. The figures given are typical and it is possible the actual waste volume which could be solidified within the container could be higher.

Waste:	boric acid Concentrates, 6-12% by weight or sodium sulfate concentrates, 6-20% by weight
Liner used:	L14-195
Shipping cask used:	21-300
Waste volume:	125 cubic feet
Binder and Additive volume:	60 cubic feet
Total weight:	21,000 lbs. (inc. disposable liner)

Due to the density of the final product, new liners have been developed to maximize waste volume and minimize burial volumes. For example, a 170-cubic-foot disposable container/liner could contain 120 cubic feet of actual waste and yet be shipped in a 14-195 cask.

It is important to note that densities vary with waste forms and that the above is only an example. An evaluation under the guidelines set forth in the Process Control Program is necessary to precisely define the ratios, volumes, and densities for each specific waste type.

4.4 System Processing Times

Typical times necessary to process each liner using cement solidification are shown on Table 4-1. Assumptions used in determining these times are that the solidification proceeds in an ideal fashion without delays such as shift change and crane non-availability. A single CNSI operator using the CNSI Mobile Cement Solidification System can process 360 to 400 cubic feet of wastes in one week. The system can process up to 650-750 cubic feet of wastes per week if additional operators and sufficient space and shielding to store 3 or more "curing" liners are available. Cure time for solidified boric acid based wastes typically range from 36 to 60 hours and range from 36 to 48 hours for the sodium sulfate and Resin Wastes.

Table 4-1 TYPICAL OPERATING TIMES

	ACTIVITY	PWR OR BWR CONCENTRATES	RESINS
1.	Liner Inspection	60 min	60 min
2.	Fillhead Installation	30 min	30 min
3.	Waste Transfer (including resin dewatering)	30 min (variable)	90 min (variable)
4.	Chemical Addition	45 min	45 min
5.	Cement Addition	90 min	90 min
6.	Fillhead Removal/Ventilation Head Installation	45 min	45 min
		300 min	360 min

4.5 Estimated Exposure to Personnel

Based on design features of the CNSI Mobile Cement Solidification System and temporary shielding in the form of portable shields is such that personnel exposure to radiation during normal operation is minimal and is estimated to be less than 3 rem per year.

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. Those portions of the system which are required to contain and process radioactive waste have been designed to minimize radioactive material retention. The equipment, being portable, can be moved for maintenance to a low radiation area to further minimize operator exposure.

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, for example, is located outside the waste process areas. All operations are remotely performed from the control panel, to the greatest extent possible.

Skids, pumps, etc. are arranged to allow ease of component inspection and maintenance access.

The space required for the Mobile Cement Solidification System is determined by the physical layout of the plant's radwaste area and the type of unit utilized, trailer or skid-mounted. As a general rule, the skid-mounted unit (PSU) requires about 300 square feet, excluding the bulk cement storage vessel. The trailer-mounted unit (MSU) requires more space, since the trailer itself may be up to 26 feet long. With the trailer-mounted unit, the space required outside the trailer is about 150 to 200 square feet. The bulk storage trailer may be a standard 1200 cubic foot trailer, or a small upright silo which takes up only 60 square feet with a height of up to 20 feet. The bulk storage vessel must be able to be located within 150 feet of the solidification fillhead.

It is important to note that the fillhead and skirt assembly add about 4-1/2 feet to the top of the disposable container. When solidifying inside a radwaste building or other location where the installed crane is utilized, crane and building clearances must allow for installation and removal of this assembly.

5.1 Utility Interface Requirements

The location selected for the assembly of the MCSS must be such that the following services can be provided to the solidification system.

Electrical:	120A, 480V/3 Phase/60 Hz
Service Water:	25 gpm at 80 psi, minimum
Service Air:	75 SCFM at 80 psi, minimum
Waste:	1-1/2" 150 lb ANSI flange connection
Dewater:	1-1/2" 150 lb ANSI flange connection
Vent:	2-1/2" vent hose discharge to plant off-gas system

In addition to these physical requirements the following support activities are required due to the nature of a mobile service to simplify the interfaces between the CNSI operator and the utility staff.

5.1.1 Telephone communication between the plant operator and the CNSI mobile unit operator must be provided by the utility.

5.1.2 The utility shall make prior arrangements for shipping of the solidified material.

5.1.3 The utility must be prepared to accept cement shipments prior to the arrival of the unit on site.

5.1.4 The utility shall issue a Radiation Work Permit (RWP) to the CNSI operator before operations begin (according to its radiation protection procedures).

5.1.5 The utility shall provide the CNSI operator with any clothing or equipment for necessary radiation protection.

5.1.6 A controlled area must be established around the processing area.

5.1.7 Utility personnel shall designate an area to be used for test solidifications (PCP).

5.1.8 The utility will provide crane services, torque wrenches, and other material necessary for loading the disposable liners and preparing the solidified waste for shipment. (Portable units also require crane service for placing fillhead on the liner during operation).

5.1.9 The utility will provide a forklift capable of 4000 pounds at 6 foot moment arm to unload the removable skids and place them in position for full-scale solidification.

5.2 Recommended Layout

Figures 5-1 and 5-2 illustrate typical arrangements of the Mobile Cement Solidification Systems. The entire system is located to provide maximum utilization of available space.

5.3 Compliance with "ALARA"

The system design and arrangement is in compliance with "ALARA" as specified in the USNRC Regulatory Guide 8.10. As shown on the CNSI layout drawings (Figure 5-1 and 5-2), the system arrangement allows remote operation. The hydraulic drive for the agitator motor is located remotely from the fillhead to minimize exposure to the operator during maintenance on the equipment. All waste bearing components and piping are provided with a complete flushing capability to insure tnat the equipment is clean prior to servicing.

The length of pipe and hose runs are minimized to the shortest possible and practical distance between two points.

CNSI's scope of supply is to include valving and piping to permit flushing of all waste lines. Further, CNSI utilizes 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 CNSI's interface is provided by the customer upon CNSI's recommendation. All waste lines and valves have butt weld end connections except for flanged connections required for the mobile applications.

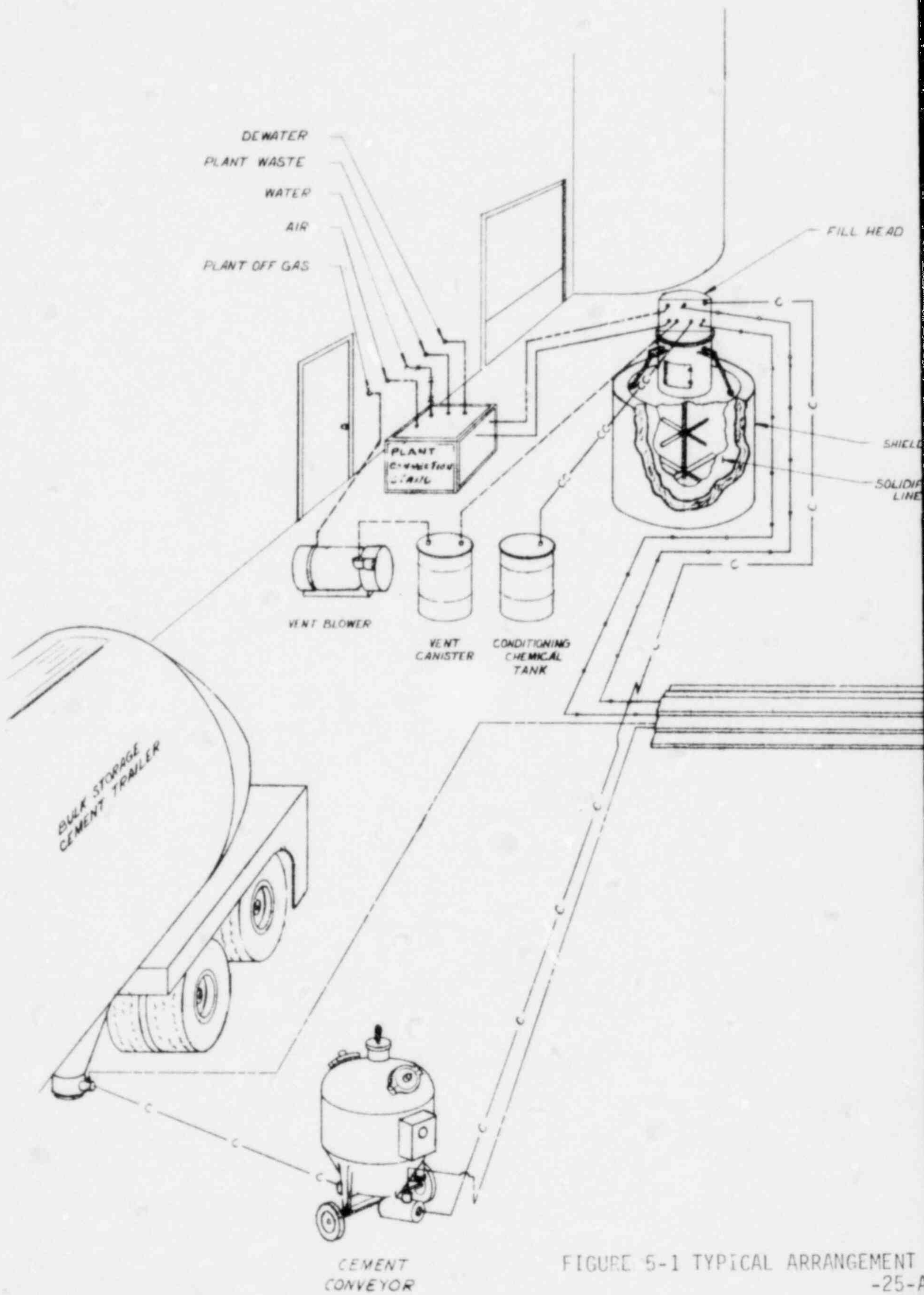
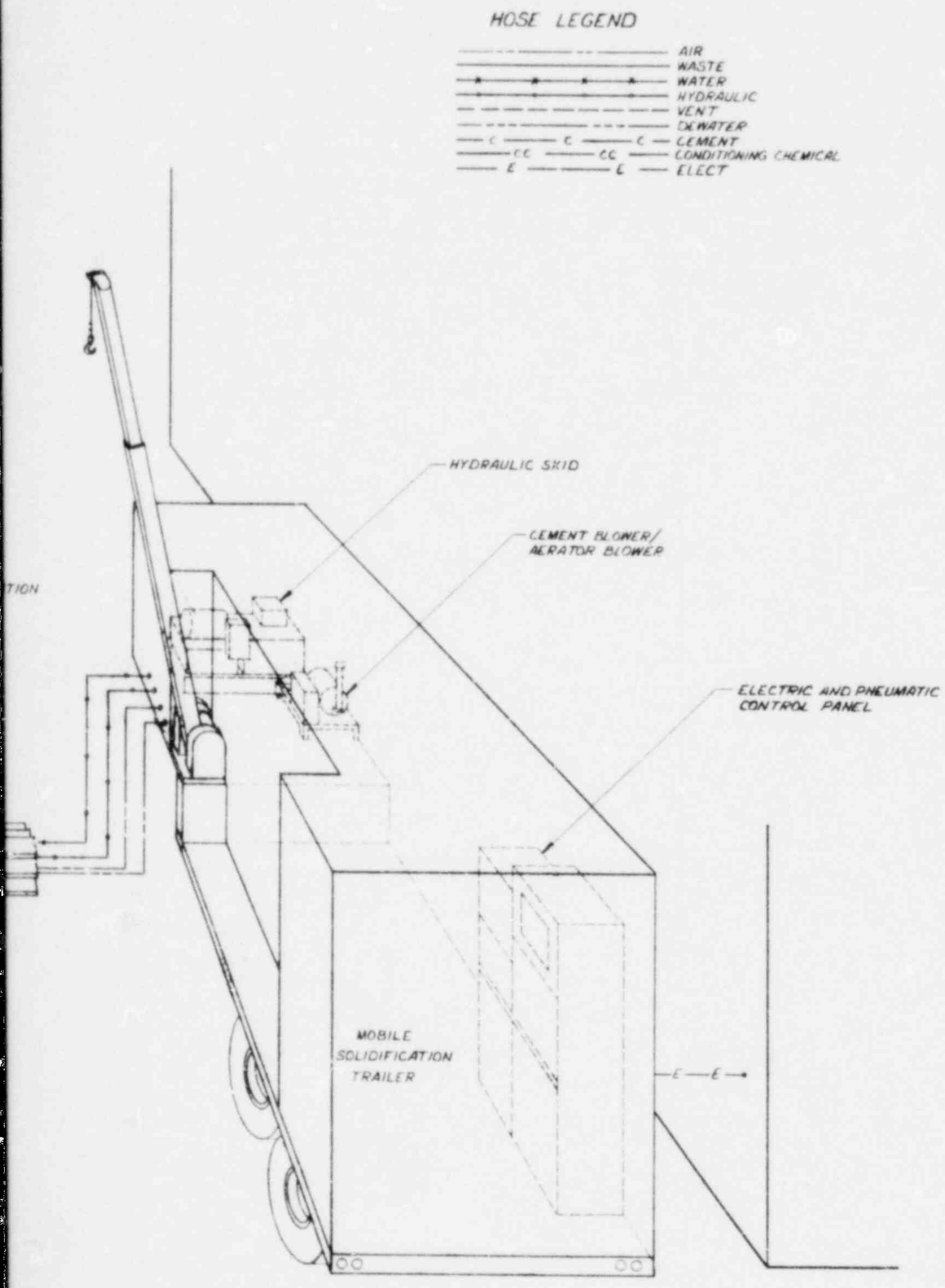


FIGURE 5-1 TYPICAL ARRANGEMENT



MOBILE SOLIDIFICATION UNITS

CHEM-NUCLEAR SYSTEMS INC.

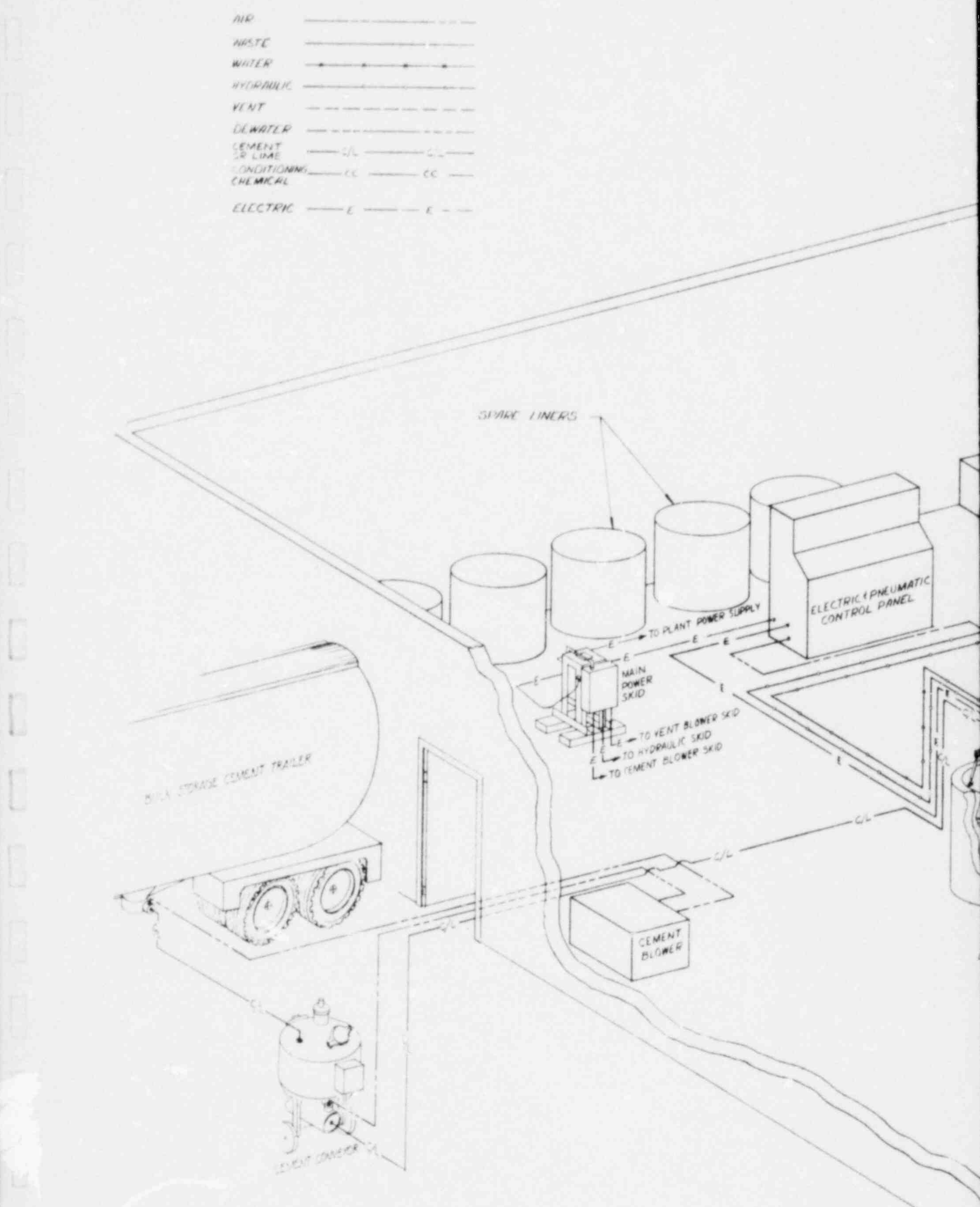
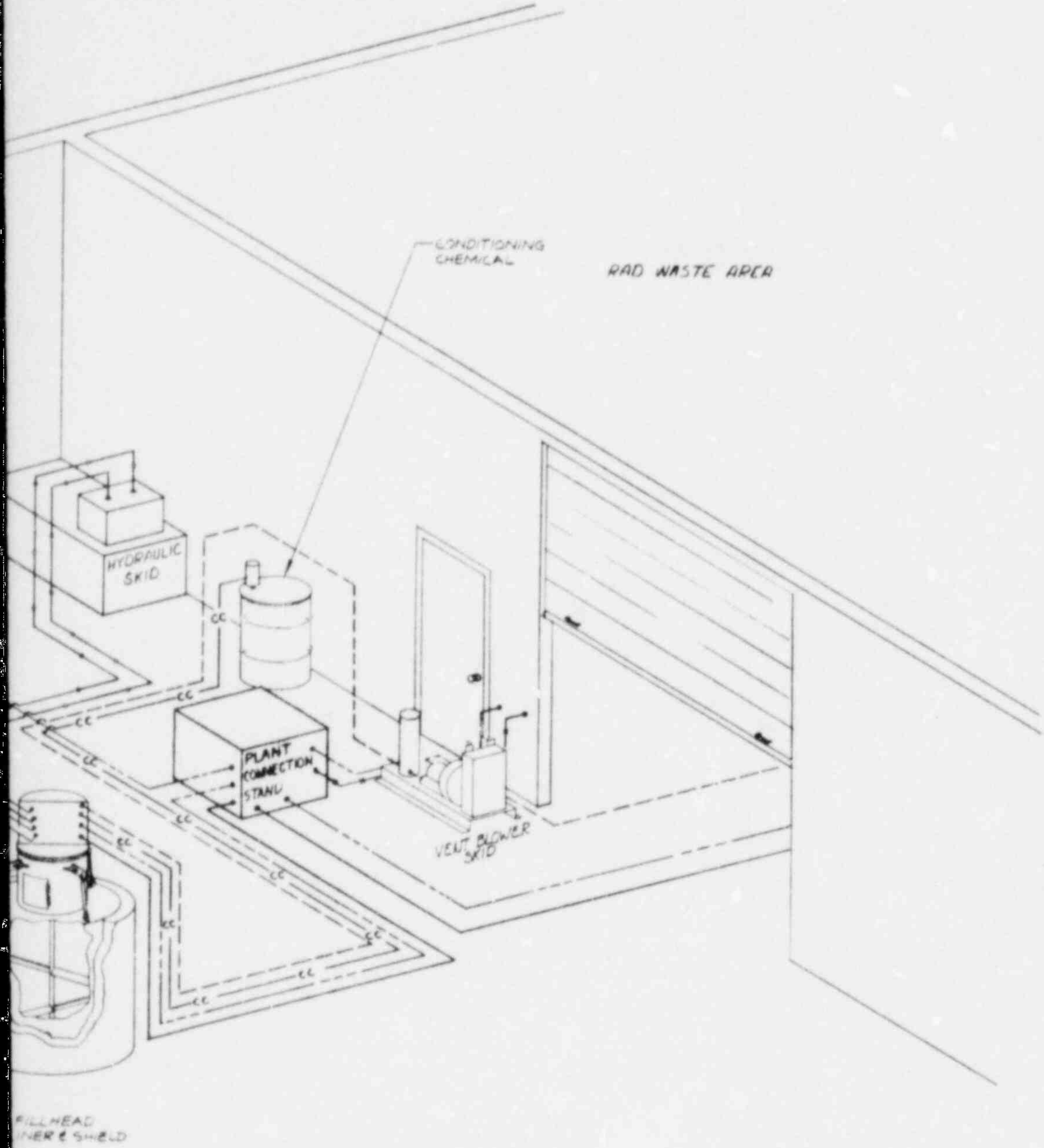


FIGURE 5-2 TYPICAL ARRANGEMENT -



PORTABLE SOLIDIFICATION UNITS

CHEM-NUCLEAR SYSTEMS INC.

6.0 REGULATIONS, CODES AND STANDARDS

Design, fabrication, operation, and maintenance of the CNSI Mobile Cement Solidification System is consistant with the applicable regulations, codes, and standards of the nuclear industry as identified below.

6.1 Operating Equipment

6.1.1 10 CFR 20 — Standards for protection against radiation

6.1.2 Regulatory Guides

. R.G. 1.143	Design guides for radioactive waste management systems, structures, and components installed in light-water cooled nuclear utilities.
. R.G. 8.10	Information relevant to ensuring that occupational radiation exposures at nuclear power utilities will be as low as reasonably achievable.

6.1.3 ANSI Standards

. ANSI B31.1	Power piping
. ANSI/ANS 55.1	Design, construction and performance requirements for systems used to solidify low level radwaste.

6.1.4 ASTM Standards

. E84	Test for surface burning characteristics of building materials.

6.1.5 Other Standards

. IEEE/NEMA	Electrical Codes - Intent met
. NFPA	Fire Protection Codes - cement system is not flammable. NFPA Codes met.
. AWS D1.1	Welding Standards
. ASME, Sec. IX	ASME Boiler and Pressure Vessel Code Welding and Brazing Qualifications.

6.2 Operating Procedures

6.2.1 NRC Regulations

. 10 CFR 20	Standards for protection against radiation
. 10 CFR 50 Appendix B	Quality Assurance criteria for nuclear utilities and fuel reprocessing plants.
. 10 CFR 71 Appendix E	Quality Assurance criteria for shipping packages for radioactive materials.

6.2.2 CNSI Standards

. QA-AD-001	Quality Assurance Program.

6.3 System Processes

6.3.1 NRC Regulations

. 10 CFR 20	Standards for protection against radiation.

6.3.2 Regulatory Guides

. RG. 8.10	Information relevant to ensuring that occupational radiation exposures at nuclear power utilities will be as low as reasonably achievable.

6.4 Applicable equipment codes for CNSI 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 Stds.	ASME IX	ANSI B31.1
Valves	ANSI B31.1	ASTM Stds.	ASME IX	ANSI B31.1
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.
Equip. Skids	Mfrs. Stds.	ASTM Stds.	ASME IX	CNSI Stds.
Crimp-A-Cap	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.	Mfrs. Stds.

7.0 QUALITY ASSURANCE PROGRAM

7.1 Program Design

CNSI's Quality Assurance (Q.A.) Program is designed to ensure that the systems or components developed by CNSI will perform satisfactorily in service. The Q.A. Program has been accepted by the NRC as auditable by customers and regulatory agencies. The Q.A. responsibilities outlined below are specific to Q.A.'s involvement in the CEMENT SOLIDIFICATION SYSTEM. However they may be extrapolated to other safety related issues. CNSI's Q.A. program meets the requirements of 10 CFR 50 Appendix B and 10 CFR 71 Appendix E.

7.2 Quality Assurance Responsibilities

7.2.1 Inspection Control

Q.A.'s inspection program for the CEMENT SOLIDIFICATION SYSTEM is designed to verify that quality related activities within the system conform to design or process requirements. Scheduled and unannounced inspections or audits of field units are routinely performed by CNSI's Q.A. inspectors. Refer to CNSI Document QA-AD-001, Quality Assurance Program.

7.2.2 Drawing and Document Control

Q.A. confirms the adequacy and completeness of all Solidification Unit drawings, procedures and instructions. All changes to drawings or documents are subject to the same confirmation. These controls are detailed in the CNSI Drawing Control and CNSI Document Storage and Control Procedures.

7.2.3 Purchased Material, Equipment of Service Control

Q.A. performs preliminary evaluations of potential vendors and makes procurement source recommendations to CNSI's Purchasing, Solidification, and Design Groups. Q.A. also confirms that the supplied items or services conform to the procurement requirements.

7.2.4 Component & Material Identification and Control

Q.A. confirms that the identification and control of purchased components, materials, parts or assemblies used within the CEMENT SOLIDIFICATION SYSTEM meet the established requirements. This applies to all phases of fabrication and installation.

7.2.5 Special Process Control

Q.A. confirms that fabrication, installation and inspection processes associated with the CEMENT SOLIDIFICATION SYSTEM are performed in accordance with the applicable CNSI requirements.

7.2.6 Test Control

Q.A.'s test control program confirms that tests associated with Solidification Unit's fabrication, checkout, operation and maintenance are performed in accordance with the applicable CNSI requirements.

7.2.7 Measuring and Test Equipment Control

Equipment used for testing of Mobile Unit equipment is calibrated to NBS Standards.

7.2.8 Handling, Storage and Shipping Control

Q.A. confirms that handling, storage and shipping requirements of any item related to the Solidification Unit, including the Unit itself, are satisfied.

7.2.9 Nonconformance Control

Q.A. identifies and documents nonconforming materials, parts or processes dealing with Solidification Unit operation.

7.2.10 Corrective Action

Q.A. continually monitors materials, processes or workmanship to ensure nonconformances are corrected and the corrective action is documented.

FIGURE 7-1

NRC FORM 311 (12-78)

U.S. NUCLEAR REGULATORY COMMISSION

QUALITY ASSURANCE PROGRAM APPROVAL FOR RADIOACTIVE MATERIAL PACKAGES

1. APPROVAL NUMBER: 0231

REVISION NUMBER: 0

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and Title 10, Code of Federal Regulations, Chapter 1, Part 71, and in reliance on statements and representations heretofore made in Item 5 by the person named in Item 2, the Quality Assurance Program identified in Item 5 is hereby approved. This approval is issued to satisfy the requirements of Section 71.51 of 10 CFR Part 71. This approval is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

2. NAME Chem-Nuclear Systems, Inc.			3. EXPIRATION DATE January 31, 1985
STREET ADDRESS P.O. Box 1866			
CITY Bellevue	STATE WA	ZIP CODE 98009	4. DOCKET NUMBER 71-0231

5. QUALITY ASSURANCE PROGRAM APPLICATION DATE(S)

September 6, 1979

6. CONDITIONS

Activities conducted under applicable criteria of Appendix E of 10 CFR Part 71 to be executed with regard to transportation packages by January 1, 1980.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

SIGNATURE Charles E. MacDonald

Charles E. MacDonald, Chief, Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS

DATE OCT 25 1979

8.0 OPERATING EXPERIENCE AND RESEARCH AND DEVELOPMENT PROGRAM

8.1 Operating Experience

Chem-Nuclear Systems, Inc. has been actively involved in the safe transport and disposal of radioactive waste using solidification methods for the past eight years.

On-site processing of radioactive waste has been efficiently and effectively performed using various media, primarily urea formaldehyde and Dow process solidification, and demineralization. Over the past eight years CNSI has processed radwaste at 19 nuclear utilities using these processes gaining considerable experience in the design and operation of mobile radioactive waste solidification systems.

Solidification of radwaste using cement is the newest process added to the CNSI line of services. The prototype mobile solidification system using cement was released early in 1981 and has been in service processing liquid radwaste at a nuclear utility since that time. This unit is housed in a 24 foot trailer which serves as an operator station as well as the transport vehicle. As experience has been gained using this new process, the first unit has been updated and modernized.

Mobile cement solidification units have incorporated design changes based on the operating experience with the first unit. Portable, skid-mounted units have also been developed for use within a utilities' radwaste building. The solidification function and basic operational design of both trailer and skid units are identical. There are two mobile and four portable units currently in operation servicing nuclear utilities. The prototype unit is also currently in service at a nuclear utility.

Table 8-1 shows the experience to date with the Mobile Cement Solidification Systems.

8.2.2 Cement Chemistry Testing

The technical objectives of CNSI's Cement Waste Solidification Program recognized the need for investigation of the cement chemistry best suited to accommodate safe and thorough immobilization of a variety of waste materials. Chemically, it was necessary to determine a reliable and practical cement composition along with the appropriate additives providing controllable setting reactions. Of particular importance was the formation of a dry solidification product with superior mechanical strength and integrity. The testing program was built upon the experiences of ATCOR Engineered Systems, Inc., a subsidiary of CNSI, to develop and obtimize the waste/binder/additive ratios used in the MCSS. Further discussion of the testing is provided in Appendix 1 - Solidification Chemistry of Processing Nuclear Waste With Cement.

TABLE 8-1

MCSS Experience List

Company	Waste	Quantity	Dates
1. Florida Power Corp. Crystal River	Boric Acid & Resins	Four 195 ft^3 liners/Mo (Conc) and one 120 ft^3 liner/Mo (Resin)	Jan. 1981 to present
2. Northern States Power Monticello	Powdered Resins	Two 170 ft^3 Liners /Month	July 1981 to present
3. Portland General Electric/Trojan	Bead Resins	Seven 120 ft^3 liners	July and August, 1981
4. PASNY Fitzpatrick	BWR Wastes	Four 170 ft^3 liners /Month	October 1981 to present
5. Niagara Mohawk 9 Mile Point	BWR Wastes	Four 170 ft^3 liners /Month	December 1981 to present
6. Duke Power Oconee 1,2,3	PWR Wastes	Eight 195 ft^3 liners /Month	October 1981 to Present
7. Carolina P & L Brunswick 1 & 2	PWR	-	Start March, 1982
8. So. Calif. Edison San Onofre	PWR/Resin/ Filter Wastes	-	December 1981 to present
9. SMUD Ranch Seco	PWR Wastes	Twenty-three 195 ft^3 liners (concentrates) and Four 170 ft^3 liners (resins) anticipated	Start March, 1982
10. PG & E Diablo Canyon	PWR Wastes	as requested	under contract on request.
11. Mississippi P & L Grand Gulf	PWR Wastes	-	Start April, 1982

9.0 POSTULATED ACCIDENT ANALYSIS

The design, fabrication and operation of the CNSI MCSS is in accordance with the appropriate NRC, ASME, ANSI and IEEE Codes and Standards to ensure the safe and reliable solidification of the waste. Nonetheless accidents can occur which have the potential for the release of contamination to the surrounding area. These accidents, the features which are incorporated to minimize the effects of the accident, and an analysis of the releases which may be expected are summarized in this section.

9.1 Fire

The only source of fire is the electrical power and control system. Even in the event of an electrical fire, the fail-safe control system is designed to prevent leakage of radioactive materials or spread of the fire to non-electrical components. Fire fighting equipment is provided to the operator to perform the initial fighting of the fire with backup provided by the station fire brigades.

9.2 Waste Spill

The possibility of a release of liquid radioactive material exists during waste transfers to the waste container and while waste is being stored in the container prior to solidification. A line rupture during a waste transfer is considered to be the least serious of the potential accidents. The total curie content of the spilled material in a line rupture depends on the specific activity and the quantity of the waste material being transferred. In turn, the quantity of the waste material spilled depends on the flow rate and response time of the operator. Flow rates depend on the capacity of the utility transfer pumps, but flow rates of 50 gpm are typical, while maximum rates of 100 gpm can be anticipated. The response time of the operator depends on how quickly the operator observes the failure and shuts the waste isolation valve. Once actuated, the waste isolation valve closes within 3 - 4 seconds. During a waste transfer, the operator is positioned at the control station, visually monitoring the transfer process. It is estimated that no more than two minutes would expire prior to closing the waste control valve. A spill considering maximum flow rate and maximum response time, then, would generate about 200 gallons of liquid or resin slurry waste.

The estimated volume of waste spilled considering the rupture of a liner after both waste and solidification agent transfer to the liner is 2,100 gallons. Therefore, CNSI considers the maximum credible accident to be the rupture of a filled liner prior to solidification. A postulated accident analysis was performed using the following assumptions:

- The liner contains approximately 2,100 gallons of waste and solidification agent in liquid state at atmospheric pressure.

- The iodine partition factor is 10,000 between the liquid and vapor phases once the liquid escapes from the liner.

- There is a total escape of all noble gases upon rupture of the liner.

- The worst case chi/Q is 7.6×10^{-4} s/m^3. (site boundary)

The accident considered was the rupture of approximately 1/3 of the circumference of the liner's bottom weld (approximately 90 inches x 0.5 inches or 45 Square inches). The liner was considered outside the utility's radwaste building. The results of the analysis were:

- escape rate of approximately 57 gallons per second

- time for liner to empty is appr ximately 40 seconds

- maximum instantaneous radgas concentration at the site boundary (worst case only):

I-131	=	17 % MPC
I-133	=	0.1 % MPC
I-135	=	0.04% MPC
Xe-133	=	0.1 % MPC
Kr-88	=	11 % MPC

Waste transfer lines, hoses, and connections are hydrostatically tested on installation, after maintenance, and periodically during the installation to verify the structural integrity of these lines. Appropriate radiological controls, such as bagging the mechanical connections, are taken to minimize the possibility of leakage. The shipping containers are normally contained in a shielded cask or a portable shield during the solidification cycle which would assist in containing the release if the lines were to leak. Also the time that the unsolidified wastes remain in the shipping container is typically less than 30 minutes prior to the addition of the cement. All of the above tend to mitigate the possibility and effects of a waste leak during transfer or storage of the liquid wastes.

9.3 Pressure Buildup in Shipping Container

A pressure buildup in the shipping container is possible due to the heat of the solidification reaction as the cement billet cures. The heat of reaction can raise the temperature of the billet to greater than 212°F causing any free water to form steam, which could then overpressure and split the shipping liner.

The temperature of the cement billet is monitored during the solidification cure period to determine the progress of the solidification reaction. The shipping liner is not tightly capped until after the reaction has passed the point of maximum heat generation and the temperature of the billet has decreased below 180^{o} F. Ventilation and pressure relief of the liner is

through the fillhead or the ventilation head to the plant ventilation system. Additionally, one of the purposes of the chemical addition steps is to place the waste in a chemical form in which the peak billet temperature is minimized.

9.4 Equipment Failures

9.4.1 Waste Isolation Valve

The waste isolation valve is provided with a manual override to enable the opening of the valve should it fail closed. Manual override will allow the completion of the waste fill and flushing cycle so that the solidification of the current waste batch can proceed and allow repairs to be made between batches under relatively low exposure conditions. Failure of the waste isolation valve in the open position is backed up by the telephone communications with the station operator, i.e. if the valve does not shut when the correct waste volume has been transferred, waste flow can be stopped by the station staff.

9.4.2 Shipping Container Level Instrumentation

The hi-hi level sensor is interlocked to prevent further addition of any material into the waste tank by stopping all inlet feeds. Additional level verification is available by means of the closed circuit TV camera located in the fillhead, and by the operator who can monitor the volume of waste transferred. No remedial action is associated with this condition except to determine and repair the cause of hi-hi level instrument failure.

9.4.3 Fillhead Hydraulic Drive

The failure of the hydraulic drive is not considered a problem except after the start of the addition of cement. Historically, the packaged hydraulic motor and drive system has proven to be reliable and this failure is considered to be improbable. Duplication of this failure has been conducted during the testing program. If the mixer failed early in the cement addition stage, a repair is all that has been demonstrated to be necessary. If the failure occurs after most of the cement has been added, the lower portion of the cement/waste matrix will solidify leaving the less dense waste liquid on the surface. This liquid would need decanting to another liner.

9.4.4 Cement Feed

Cement transfer is verified by the reading of the load cell. This measurement can be compared to the output of the pneumatic cement transfer system to verify that the proper amount of cement had been transferred. The level in the waste container is also monitored by level detectors.