# DEWATERING TOPICAL: CHEM-NUCLEAR SYSTEMS, INC

## CNSI-DW-11118-01-NP

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Chem-Nuclear Systems, Inc.
240 Stoneridge Drive, Suite 100
Columbia, South Carolina
29210

8312280451 831223
PDR TOPRP EMVCNSI
B PDR

## ABSTRACT

Research results have certified dewatering of high integrity containers (HIC), steel liners with Ecodex, Powdex, bead resins, diatomaceous earths, celite 454, and Fibra-Cel. Liners and media specifically tested were PL14-195 (HIC), 76" Pressure Vessel, and L14-195 (steel) with bead resin, PL14-195 (HIC), PL8-120 (HIC), and L14-195 (steel) with Ecodex precoat and L14-195 (Steel) with Powdex precoat. Fiberglass Reinforced Plastic Vessels and 24" Pressure Vessels were also tested.

The largest liners, 14-195's with useable cubic feet interior volumes of 157, 150, 186, and 163, were considered the worst case for dewatering. The test procedure required the vessel to be loaded with the useable volume of precoat or resin and filled with water. The liner dewatering cycle was to pump for a certain time interval, stand for a time interval, and be repeated until dewatering was complete.

Bead moisture before and after road testing, as well as bead temperature, were monitored. Atmospheric data such as temperature, dew point, grains of moisture per pound of air, and relative humidity were analyzed for their impact on dewatering capabilities.

## SUMMARY

1. Chem-Nuclear Systems, Inc. (CNSI) has been providing dewatering processes since 1975. Currently, CNSI provides dewatering of Ecodex, Powdex, bead resins, and diatomaceous earth mixtures Celite 454, and Fibra-Cel. The dewatering process can be accomplished in High Integrity Containers and steel liners.

2 The low-level radioactive waste disposal site at Barnwell, South Carolina, requires that free-standing liquids not exceed 0.5% of the volume of waste in containers not designed for stability or 1.0% of the volume of waste in containers that are designed for stability. The Hanford, Washington, site criteria is more restrictive in that it requires no greater than 0.5% or 1 gallon of free-standing liquid, whichever is less.

3. This topical report addresses the certification of liners for dewatering. Larger liners, such as 14-195's, were considered the worst case for dewatering. Production liners of smaller diameter and height but with the same internal design and geometry are certified by testing the worst case.

4. Dewatering bead resin in steel liners is certified by results of testing given in Appendix 2 of CNSI-DW-11118-01-P. Appendix 1 of CNSI-DW-11118-01-P covers the test instructions and report.

5. Dewatering bead resin in high integrity containers is certified by results of testing given in Appendix 3 of CNSI-DW-11118-01-P.

6. Appendix 6 of CNSI-DW-11118-01-P covers the test results for dewatering high integrity containers (PL14-195 and PL8-120) and steel liners (PL14-195) with Ecodex and Powdex precoats. Experience has shown Ecodex and Powdex to be the most difficult precoats to dewater. Certifying these worst-case precoats also certify less difficult to dewater precoats such as diatomaceous earths, celite 545, and Fibra-Cel.

7. The test procedures required the vessel to be loaded to the useable volume with precoat or resin and filled with water. The liner dewatering cycle was to pump for a certain time interval, stand for a certain time interval, and repeat until the dewatering was complete.

8. The dewatering end point was determined to be zero when less than 10 ml was collected over a 24-hour period. At that time, the vessel was loaded on a truck and driven 200 miles over secondary roads. If less than 10 ml was collected following the road test the liner was considered dewatered.

9. Testing and evaluation of extracted test resin showed the moisture content to be less than or equal to equilibrium with the static suspending ability of the resin bed and the amount of moisture contained within the bed. At less than or equal to the point of equilibrium, dynamic forces such as those experienced during transportation, would not cause precipitation of interstitial moisture.

10. Certification of dewatering bead resin in 76" diameter pressure vessels is found in Appendix 10 of CNSI-DW-11118-01-P. Pressure vessels of 24 inches in diameter containing activated carbon, bead, and macroreticular resins have been tested and recertification is in progress due to changes in internal design. The modification is expected to result in increased efficiency in the dewatering process.

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# INTRODUCTION

## 1.0 INTRODUCTION

1.1 On 25 October, 1978 the U.S. Nuclear Regulatory Commission published an Advanced Notice of Proposed Rulemaking (43 FR 49811) regarding the development of specific regulations for the disposal of low-level radioactive wastes (LLW). The regulations affected were 10 CFR Parts 2, 19, 20, 21, 30, 40, 51, 61, 70, 73, and 170. This topical specifically addresses Part 61.56 (a)(3) and (b)(2), Waste Characteristics.

1.2 The low-level radioactive waste disposal site at Barnwell, South Carolina, requires that free-standing liquids not exceed 0.5% of the volume of waste in containers not designed for stability or 1.0% of the volume of waste in containers that are designed for stability. The Hanford, Washington, site criteria is more restrictive in that it requires no greater than 0.5% or 1 gallon of free-standing liquid, whichever is less.

1.3 Chem-Nuclear Systems, Inc. (CNSI) has been providing dewatering processes since 1975. Currently, CNSI provides dewatering of Ecodex, Powdex, bead resins, macroreticular resin, activated carbon, cartridge filters, and diatomaceous earth mixtures. The dewatering process can be accomplished in High Integrity Containers, and steel liners.

# PROCESS DESCRIPTION

## 2.0 PROCESS DESCRIPTION

2.1 Traditionally, precoats such as Powdex, Ecodex, and Diatomaceous Earth (DE) are found in light water reactor waste treatment streams. The precoat in solution deposits on an element that then becomes the filter layer. As the molecules within the fluid stream tend toward the direction of desired flow, there is a gradual buildup of the filter layer. As this filter layer builds up the contaminants are trapped farther from the initial layer. Eventually, the collection of contaminants reduces the overall efficiency of the filter media and the system is backflushed with pressure. The precoat is put back in solution and the process begins anew. Ultimately, it becomes necessary to discard and dewater the precoat because of inefficiency. It then becomes necessary that precoats are disposed in accordance with 10 CFR 61.

2.2 Bead resins are used to demineralize liquid streams at light water reactors. Resins are usually in the hydrogen or hydroxyl form. The liquid stream flows through the bed and the liquid is deionized. When breakthrough occurs (ionic contaminants appear on the clean side) the feed water is discontinued and the bed is regenerated or replaced. When "loaded" bead is replaced, dewatering of the bed is necessary before ultimate disposal.

2.3 The dewatering process uses an air-driven double-diaphram positive displacement pump. For precoat media, there is a 1-1/2" manifold with four 3/4" valved inlet connections and a 1-1/2" outlet connection. Vacuum gauges are provided at each inlet connection and manifold.

2.4 Dewatering occurs when the pump provides a continuous suction on a vessel. This suction removes pumpable liquid to a predetermined quantity or percentage of the waste form. The suction time will vary according to the resin or precoat and container used.

2.5 The water removed from a vessel is returned to the plant's waste treatment system.

# EQUIPMENT DESCRIPTION

## 3.0. EQUIPMENT DESCRIPTION

### 3.1 Filters

The filtration system used by CNSI consists of a shelf-model filter (at varying lengths) a specially engineered CNSI Filter Assembly Type-1, and a special lateral resin filter.

#### 3.1.1 Shelf-Model Filter

3.1.1.1 The shelf filters are made of self-bonded polypropylene fiber and they contain no additives such as resin binders, lubricants, or antistatic agents. The fiber matrix and filter width are randomly oriented. There are four to five hundred layers of fibers which are capable of capturing particles larger than 20 microns in size. The filter has greater density near the center, thereby allowing a gradient of trapped particle sizes. This results in a greater holding capacity before fouling.

3.1.1.2 Maximum fouling and structural deformation occurs at a differential pressure of 40 psi. There is no loss of integrity at maximum fouling, however.

3.1.1.3 The shelf filters have a crush strength of approximately 60 psi (using parallel plate method - 50% core deflection) when subjected to temperature of 200°F. The addition of solvents tends to reduce the strength of fiber-to-fiber bonding and the overall stiffness of fibers.

### 3.1.2 CNSI Filter Assembly Type-1

3.1.2.1 The CNSI Filter Assembly Type-1 was designed by Chem-Nuclear for use with Ecodex precoats. The filter is cylindrical and has 2 stages; primary and secondary. The secondary stage is capable of removing particles 40-60 microns in diameter. Permeability, as measured by a Frazier Test, is over 100 CFM/ft$^3$. Three different lengths are used according to the physical dimensions of liners. The end caps are metal and are coated to inhibit rust and corrosion.

### 3.1.3 Lateral Resin Filter

The lateral resin filters used are available in three basic sizes: small, medium, and large.

3.2 Liners L14-195, PL14-195, PL14-195R, PL14-170, PL14-170R, PL7-100, and PL7-100R have the same internal design and manufacturing specifications. Precoats such as Powdex, Ecodex, SW-10, Diatomaceous Earth, and Solka Floc can be placed in these liners and dewatered. There are four banks of filters and the number of filters per bank varies according to the physical dimensions of the liner. All the banks are interconnected with PVC piping via a common manifold. Each bank can operate independently or in unison. Each bank is offset 90° from the lower bank and appears cross-hatched when viewed from above. There are intermittent holes over the length of PVC pipes. There are no holes in the PVC pipes that do not run through filters. A float switch or Fava level probe indicates the volume of material in the container.

3.3 Internal Equipment description of level 1 of PL14-195 and PL14-170 is proprietary.

3.4 Internal Equipment description of conical bottom liners is proprietary.

3.5 Levels 2-4 on all the containers have 14 CNSI Type 1 filters.

3.5.1 Powdex. Powdex can be dewatered in PL14-195, PL6-80R, PL8-120R, and L14-195 Model "E" containers.

3.6 Steel Liners (See CNSI Drwg. E 334-0200-E01, Rev. G)

3.6.1 Steel liners are available in various sizes and are used to dewater bead resins and precoats. Table 3-3 identifies the overall dimensions of the various liners available. The internal design of all the liners is the same except that the length of pipes, laterals, etc. is scaled up or down according to the geometry of the liner.

3.6.2 The interior preparation for coating liners consists of an application of two coats of paint (nominally 5 mils DFT per coat). Alternative methods may be used if approved by Quality Assurance. The exterior preparation consists of an application of one coat of paint (nominally 3 mils DFT per coat). Alternative methods may be used if approved by Quality Assurance.

Table 3-4 . Manufacturing Specifications of Steel Liners

| Liner | Height (inches) | Diameter (inches) | Empty Wt. (lbs) | Gross Wt. (lbs) | Disposable Volume ($ft^3$) | Used in Cask | Useable Volume ($ft^3$) |
|---|---|---|---|---|---|---|---|
| L-6-80 | 57 | 58 | 975 | 7,500 | 85 | 6-80 | 66 |
| L7-100 | 40 | 74.5 | 1,275 | 8,500 | 101 | 7-100 | 74 |
| L14-195 | 78.5 | 76 | 1,650 | 16,500 | 200 | 14-195 | 163 |
| L21-300 | 107.5 | 82 | 2,225 | 26,000 | 322 | 21-300 | 273 |
| L18-450 | 100 | 83.5 | 2,150 | 25,000 | 308 | 18-450 | 257 |
| L4-85 | 100 | 44 | 925 | 7,500 | 88 | 4-85 | 76 |
| L8-120 | 74.2 | 61 | 1,100 | 10,000 | 126 | 8-120 | 100 |
| L14-170 | 72.5 | 74.5 | 1,575 | 14,000 | 183 | 14-170 | 157 |

3.7 Polyethylene High Integrity Containers (see CNSI Dwg. B-120-D-0008 Rev. B and 120-D-0009 Rev. A). Polyethylene liners are available in various sizes and are used to dewater bead resins and precoats. Tables 3-6 and 3-7 identify the overall dimensions of the various conical and flat-bottom liners available. The internal design of all the liners is the same except that the length of pipes, laterals, etc. is scaled up or down according to the geometry of the liner.

Table 3-6. Manufacturing Specifications of Polyethylene High Integrity Containers (Conical Bottom)

| Liner | Height (inches) | Diameter (inches) | Empty wt. (lbs) | Gross wt. (lbs) | Disposable Volume $ft^3$ | Used in cask | Maximum Internal Volume $ft^3$ |
|---|---|---|---|---|---|---|---|
| PL14-195R | 75.5 | 74 | 480 | 12,200 | 195 | 14-195 | 164 |
| PL14-170R | 70 | 72.5 | 295 | 10,700 | 172 | 14-170 | 144 |
| PL8-120R | 72 | 60 | 235 | 7,500 | 121 | 8-120 | 103 |
| PL7-100R | 38 | 72.5 | 182 | 6,250 | 93 | 7-100 | 68 |
| PL6-80R | 55 | 57 | 230 | 5,000 | 84 | 6-80 | 69 |
| PL4-85R | 98 | 43 | 232 | 5,300 | 88 | 4-85 | 75 |

Table 3-7. Manufacturing Specifications of Polyethylene High Integrity Containers (Flat Bottom)

| Liner | Height (inches) | Diameter (inches) | Empty wt. (lbs) | Gross wt. (lbs) | Disposable Volume $ft^3$ | Used in cask | Maximum Internal Volume $ft^3$ |
|---|---|---|---|---|---|---|---|
| PL14-195 | 75.5 | 74 | 395 | 12,200 | 195 | 14-195 | 171 |
| PL14-170 | 71 | 72.5 | 349 | 10,800 | 172 | 14-170 | 151 |
| PL8-120 | 73 | 60 | 290 | 7,500 | 121 | 8-120 | 107 |
| PL7-100 | 39 | 72.5 | 238 | 6,250 | 93 | 7-100 | 75 |
| PL6-80 | 56 | 57 | 222 | 5,000 | 88 | 6-80 | 72 |
| PL4-85R | 98 | 43 | 232 | 5,300 | 88 | 4-85 | 75 |

## 3.8 76" Pressure Vessel

3.8.1 The 76" Pressure Vessel is so-named because of its diameter. The vessel can be provided to operate at pressures up to 150 psi. The vessel is hydrostatically tested at 1.5 times its rated operating pressure for 30 minutes per ASME Section VIII.

3.8.2 The 76" Pressure Vessels are designed to operate at three purification rates: 50, 100, and 200 gallons per minute. They are referred to as Assembly 1, 2, and 3.

3.8.3 The vessel has 4 outlets on the top. They are: inlet for contaminated water, outlet to remove purified water, dewatering outlet, and a vent used to discharge gas.

3.8.4 Contaminated water flows down through the resin bed and is purified. Purified water is removed via another PVC lateral system called the Lower Sparger Sub-Assembly. This system has the same type and diameter pipe as the distribution laterals.

3.8.5 The purpose of the off-gas vent is to remove gases that may build up during the dewatering processes.

## 3.9 Fiberglass High Integrity Container

3.9.1 The Fiberglass High Integrity Pressure Vessel (FRP), is 79" high, with an maximum outer diameter of 27 inches.

3.9.2 The vessel is designed to operate at a pressure of 100 psi and a temperature of 140°F (200°F maximum). The empty weight is 350 pounds, and the gross weights is 1,600 pounds. Container integrity is hydrostatically tested at 150 psi for 30 minutes as per ASME Section VIII with no visible leakage.

3.9.3 The purpose of the off-gas vent is to remove gases that build up during the demineralization operation and allow air to enter the liner during the dewatering operation.

3.9.4 The vent allows the discharge of gasses that may build up during processing.

3.9.5 The outlet is the dewatering leg. The dewatering flow rate determines pipe diameter.

3.9.6 Flow rate options are 25, 50, and 100 gallons per minute. The laterals are curved according to the geometry of the cylinder bottom. The lateral curvature center point is relative to the vessel center. A series of slots is drilled in each lateral over a five-inch plane.

## 3.10 24-Inch Steel Pressure Vessel

3.10.1 The 24-Inch Steel Pressure Vessel has an outer diameter of 24 inches.

3.10.2 The shipping cask configurations determine the height of this vessel. Typically, the vessels are either 78-7/8, 51, or 72 inches high. The vessel is pressure tested at 150 psig. The interior is prepared by commercial sandblasting per specification SSPC-SP-7 and painted. Typically, two coats (4-5 mils each for a total of 8-10 mils) are required.

3.10.3 The exterior is prepared for coating by commercial sandblasting as per specification SSPC-SP-6 and painted with one coat of paint.

3.10.4 All other 24-Inch Steel Pressure Vessel Specifications are applicable to the 24-Inch Fiberglass High Integrity Container discussed in the previous paragraphs.

## 3.11 Weldment

3.11.1 Welding on liners is accomplished by individuals qualified per ASME, Section IX. Prior to welding, all procedures are approved by Quality Assurance.

3.11.2 All sharp edges are deburred and weld spatter is removed. Welds are free from flux and arc strikes. The quality of the weld is inspected in accordance with AWS D1.1-81, Structural Welding Code, Section 9.25.1.

## 3.12 Dewatering Equipment

3.12.1 Unit Hoses. The pressurized hoses employed in the demineralization system are hydrotested to 225 psig. Hoses that are under continuous pressure are a reinforced non-collapsible type. All hoses are connected to the piping with quick connects.

3.12.2 Accessories. A dewatering skid or an air-driven positive displacement pump is provided with the system. The skid is equipped with positive displacement pumps that are used to dewater spent vessels. Shielding is used to minimize exposure to CNSI personnel.

# PROCESS OPERATION

# 4.0 PROCESS OPERATION

## 4.1 Process Control Program

4.1.1 The "Final Waste Classification and Waste Form Technical Position Papers," by the NRC dated May 11, 1983, states that the requirement of free-standing water not greater than (1.0% for containers not designed for stability or 0.5% for containers that are) a certain percentage of the waste volume can be measured using the method described in ANS 55.1. This method, found in Appendix 2, ANS 55.1-1979, states that there shall be no free liquid visible flowing or dripping from a one-inch square breach. Based on these guidelines and definitions it is interpreted to mean that no more than 1.0% or 0.5% of the free-standing water can be collected at the time of free-standing water measurement. This precise distinction between what is free-standing water and what is not provides the basis for setting an end-point equal to zero and back calculating to verify that no more than a certain quantity of liquid waste remains in the liner.

4.1.2 Chem-Nuclear has generic process control programs for dewatering bead resin and precoats such as Ecodex, Powdex, and diatomaceous earths. Site specific procedures are generated from the generic procedures. The documents are found in section 4.0 CNSI-DW-11118-01-P.

# EQUIPMENT ARRANGEMENT

# 5.0 EQUIPMENT ARRANGEMENT

5.1 All equipment is located and installed to comply with As Low As Reasonably Achieveable (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 when 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. To the greatest extent possible, all operations are remotely performed from the control panel.

5.2 Skids, pumps, etc. are arranged to allow ease of component inspection and maintenance access. The space required for the resin transfer and dewatering skid (RTDS) is determined by the physical layout of the plant's radwaste area and the type of unit utilized.

## 5.3 Utility Requirements

5.3.1 The following support activities are required due to the nature of a mobile service to simplify relations between the CNSI operator and the utility staff.

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

5.3.3 The utility shall make prior arrangements for shipping of the dewatered material.

5.3.4 The utility must be prepared to accempt component (HIC's, P.V.'s, steel liners, etc.) shipments prior to the arrival of the unit on site.

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

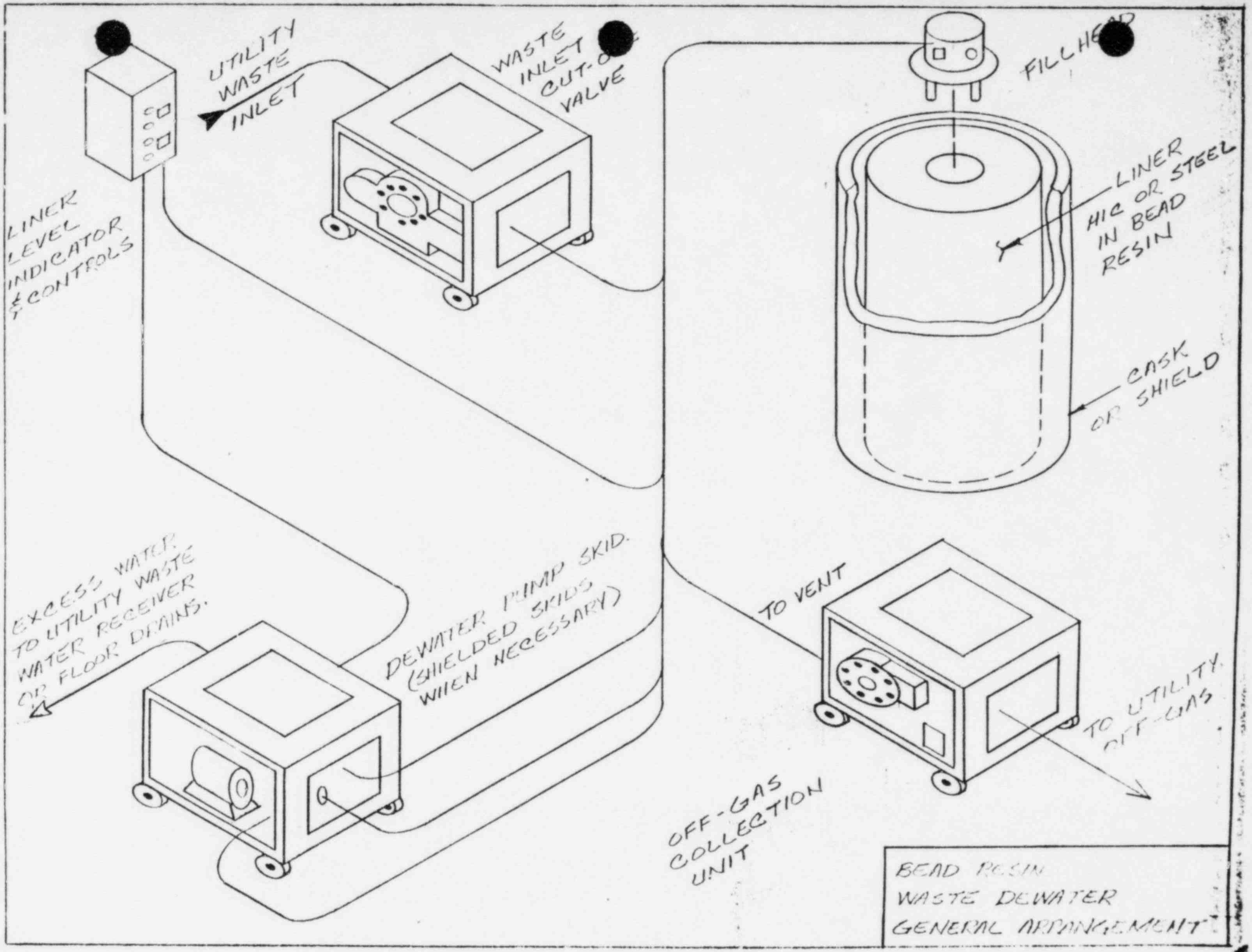
5.3.6 The utility shall provide the CNSI operator with any clothing or equipment for necessary radiation protection.

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

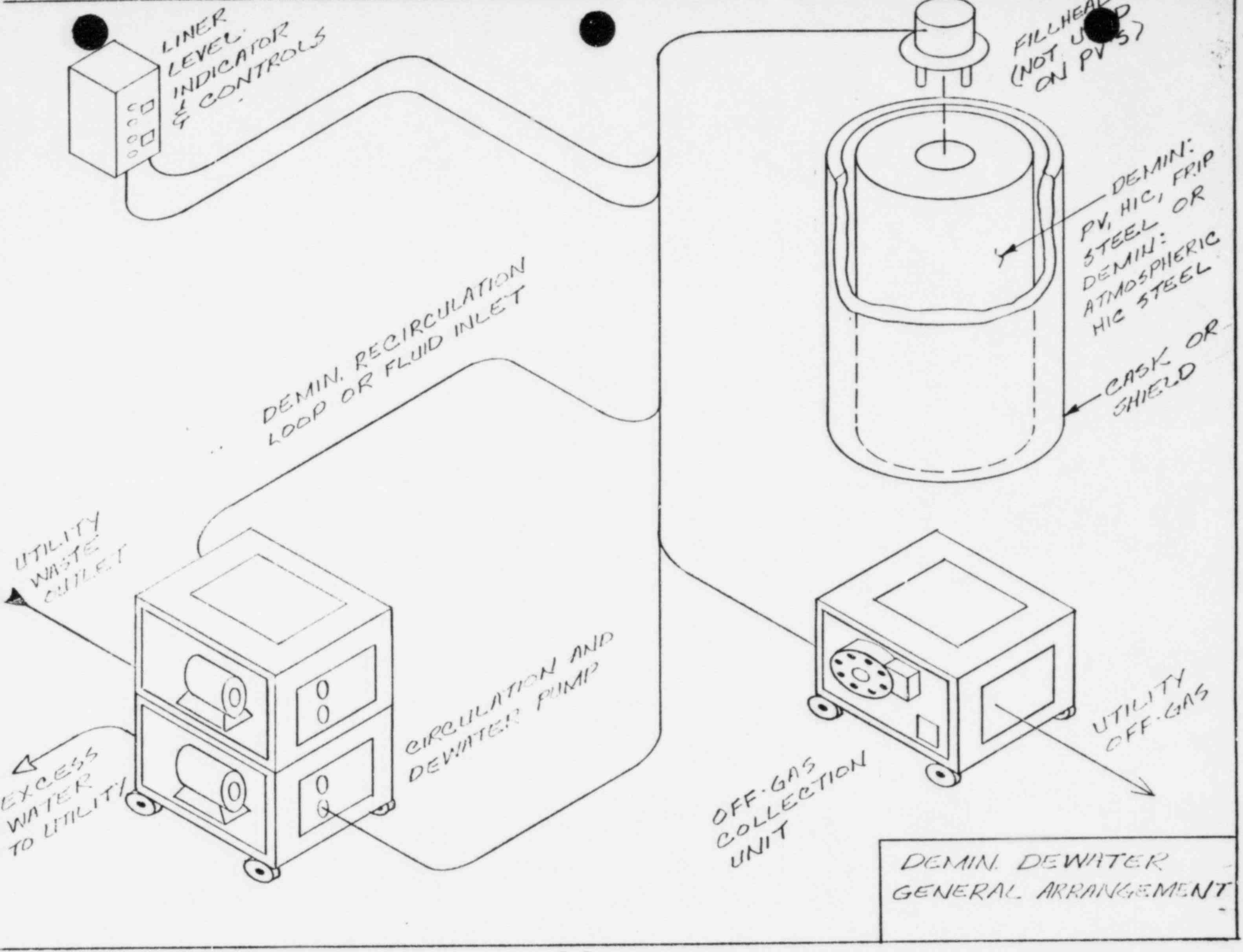
5.3.8 The utility will provide crane services, torque wrenches, and other material necessary for loading the disposable liners and preparing the solidified waste for shipment. (Portable units also require crane service for placing fillhead on the liner on the liner during operation).

5.3.9 The utility will provide a forklift capable of 4,000 pounds at 6 feet moment arm to unload the removable skids and place them in position for full-scale solidification.

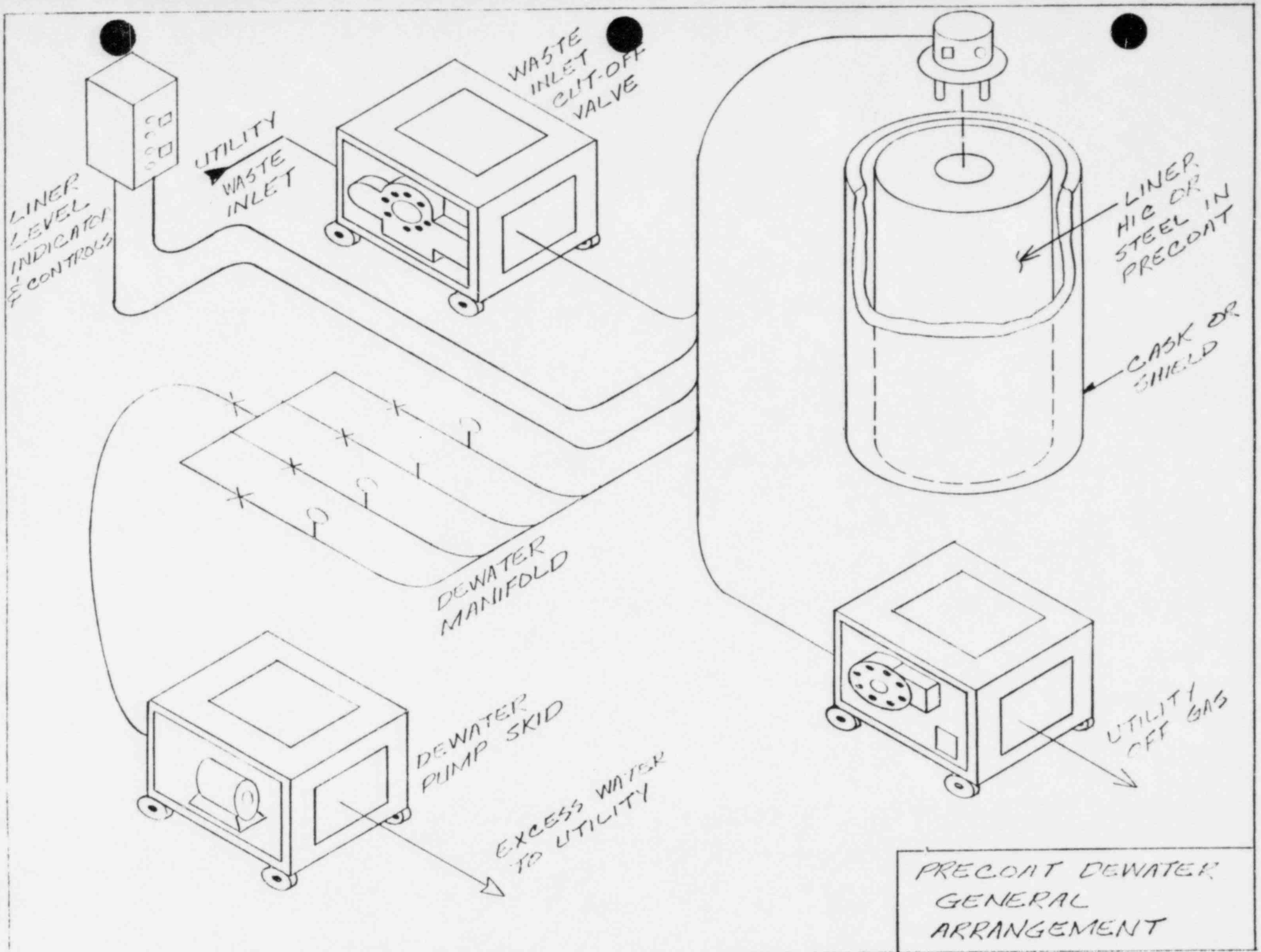
## 5.4 Typical Layout



BEAD RESIN
WASTE DEWATER
GENERAL ARRANGEMENT



DEMIN. DEWATER GENERAL ARRANGEMENT



PRECOAT DEWATER
GENERAL
ARRANGEMENT

# REGULATIONS, CODES, AND STANDARDS

## 6.0 REGULATIONS, CODES, AND STANDARDS

6.1 Design, fabrication, operation, and maintenance of CNSI dewatering technology is performed in accordance with the applicable regulations, codes and standards of the nuclear industry.

6.2 Operating Equipment is designed to meet the following:

6.2.1 10 CFR 20. Standards for Protection Against Radiation. Occupational exposure and contamination controls were coupled with the ALARA concept in the design phase.

6.2.2 Nuclear Regulatory Commission Regulatory Guides

6.2.2.1 Regulatory Guide 8.10. Standing Operating Procedures CN-AD-012, Training and Indoctrination Program; CN-AD-013, Test Control; and CN-AD-019, ALARA Policy; help insure that exposures are kept ALARA. Additional training is provided on the job. Design, operations, and procedures face continual update so that the ALARA philosophy is followed.

6.2.2.2 Regulatory Guide 1.143. In the design phases of the dewatering system, CNSI took account of the applicable objectives in Regulatory Guide 1.143 to assure compatibility with utility radioactive waste streams.

### 6.2.3 American Nuclear Standards Institute

6.2.3.1 ANSI 55.2 (ANSI N199-1976), Liquid Radioactive Waste Processing System for Pressurized Water Reactor Plants. This standard establishes requirements and provides recommendations and guidelines for the design, construction, and performance of pressurized water reactor liquid radioactive waste processing systems. Design requirements and recommendations, as well as quality requirements, are presented. Various process steps and alternate methods of handling and disposing of input quantities of liquid radioactive waste are discussed along with sizing, capacity, arrangement, and redundancy of the system. Instrumentation and control requirements are further provided as well as operating guidance to assure that the performance, safety, and operational objectives of this standard are met. Portions of ANS 55.2 were used to couple equipment design with the operational objectives of this standard.

6.2.3.2 ANS 55.3 (ANSI N197-1976), Boiling Water Reactor Liquid Radioactive Waste Processing System. This standard establishes minimum requirements and provides recommendations and guidelines for the design, construction, and performance with due consideration for operation of boiling water reactor liquid radioactive waste processing systems. Design requirements and recommendations as well as quality requirements are presented. Various process steps and alternate methods of handling and disposing of input quantities of liquid radioactive waste are discussed along with sizing, capacity, arrangement and redundancy of the system. Instrumentation and control requirements are further provided as well as operating guidance to assure that the performance, safety, and operational objectives of this standard are met. Portions of ANS 55.3 were used to couple equipment design with the operational objectives of this standard.

6.3 Operating procedures were developed to meet the following:

6.3.1 Federal Regulations

6.3.1.1 10 CFR 20. Operator training, system design, and operational procedures were developed with emphasis on protection of personnel and the environment against radiation hazards associated with the receiving and processing of low-level radioactive waste. The training program is an auditable, separate activity from CNSI operating divisions.

6.3.1.2 10 CFR 50. All documents, procedures, and drawings used in the fabrication, testing, operation, and maintenance of this equipment are developed and controlled in accordance with the provisions established in V and VI of Appendix B. Actual operation and processing performed with this equipment is accomplished at a licensed facility and thus is subject to the rules and regulations contained in the utility license.

6.3.1.3 10 CFR 71. Provisions are established in the Assembly/Disassembly procedure to ensure that proper precautions and measures are taken to contain potential contamination sources prior to placement into approved shipping containers as required in Section 13 of Appendix E. Actual shipment of LSA material must be accomplished by designated utility staff personnel at the customer's site.

6.3.2 CNSI Standards

6.3.2.1 QA-AD-001 Quality Assurance Program. This equipment is fabricated, tested, operated, and maintained under CNSI's Quality Assurance program which meets or exceeds the appropriate requirements of ASME Boiler and Pressure Vessel Code Section VIII, ANSI N45.2-1977, 10 CFR 50,

Appendix B, 10 CFR 71 Appendix E and Mil. Q. 9858 A. This program was reviewed by the NRC and has approval Number 0231, Revision 1, assigned.

## 6.4 System Processes

6.4.1 10 CFR 20. All operations performed at a customer's site are subject to the provisions of the utility license. A Radiation Work Permit, or equivalent, issued by that facility is required prior to commencement of any waste transfer or processing evolution. All operators receive training in the standards for protection against radiation prior to being sent to any utility. Satisfactory completion of radiation workers training at any facility is also required.

6.4.2 NRC Regulatory Guides 8.10. CNSI provides services to licensed utilities and as such is subject to the rules and regulations enforced at a particular site. The training provided to our operators emphasizes the need to keep operational exposures to radiation as low as reasonably achieveable. This is reinforced by the training programs at various utilities subject to the provisions of this guide.

## 6.5 Compliance with "ALARA"

6.5.1 The system design and arrangement is in compliance with "ALARA" as specified in the NRC Regulatory Guide 8.10. As shown on the CNSI layout drawings, the system arrangement allows remote operation.

All waste-bearing components and piping are provided with a complete flushing capability to insure that the equipment radioactivity levels have been reduced to the maximum extent possible.

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

# QUALITY ASSURANCE PROGRAM

# 7.0 QUALITY ASSURANCE PROGRAM

## 7.1 Program Design

7.1.1 CNSI's Quality Assurance Program is designed to ensure that the systems or components developed by CNSI will perform satisfactorily in service. The Quality Assurance Program has been accepted by the NRC and is auditable by customers and regulatory agencies. The Quality Assurance responsibilities outlined below are specific to Quality Assurance's involvement in the dewatering system. However, they may be extrapolated to other safety-related issues. CNSI's Quality Assurance 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

The inspection program for the dewatering system verifies that quality-related components of the dewatering system conform to design or process requirements. Scheduled and unannounced inspections or audits of field units are routinely performed by CNSI's Quality Assurance inspectors. (Refer to CNSI Document QA-AD-001, Quality Assurance Program.)

### 7.2.2 Drawing and Document Control

The Quality Assurance Program confirms the adequacy and completeness of all Dewatering 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

Quality Assurance inspectors perform preliminary evaluations of potential vendors and makes procurement recommendations to CNSI's Purchasing, Solidification, Demineralization, and Design groups. Inspectors confirm that the supplied items or services conform to the procurement requirements.

### 7.2.4 Component & Material Identification and Control

The Quality Assurance Program confirms that the identification and control of purchased components, materials, parts or assemblies used within the dewatering system meet the established requirements. This applies to all phases of fabrication and installation.

### 7.2.5 Special Process Control

Quality Assurance inspectors confirm that fabrication, installation, and inspection processes associated with the dewatering system are performed in accordance with the applicable CNSI requirements.

### 7.2.6 Test Control

The Quality Assurance test control program confirms that tests associated with dewatering, 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 dewatering equipment is calibrated and traceable to NBS standards.

### 7.2.8 Handling, Storage, and Shipping Control

The Quality Assurance Program confirms that handling, storage, and shipping requirements of any item related to dewatering, including the unit itself, are satisfied.

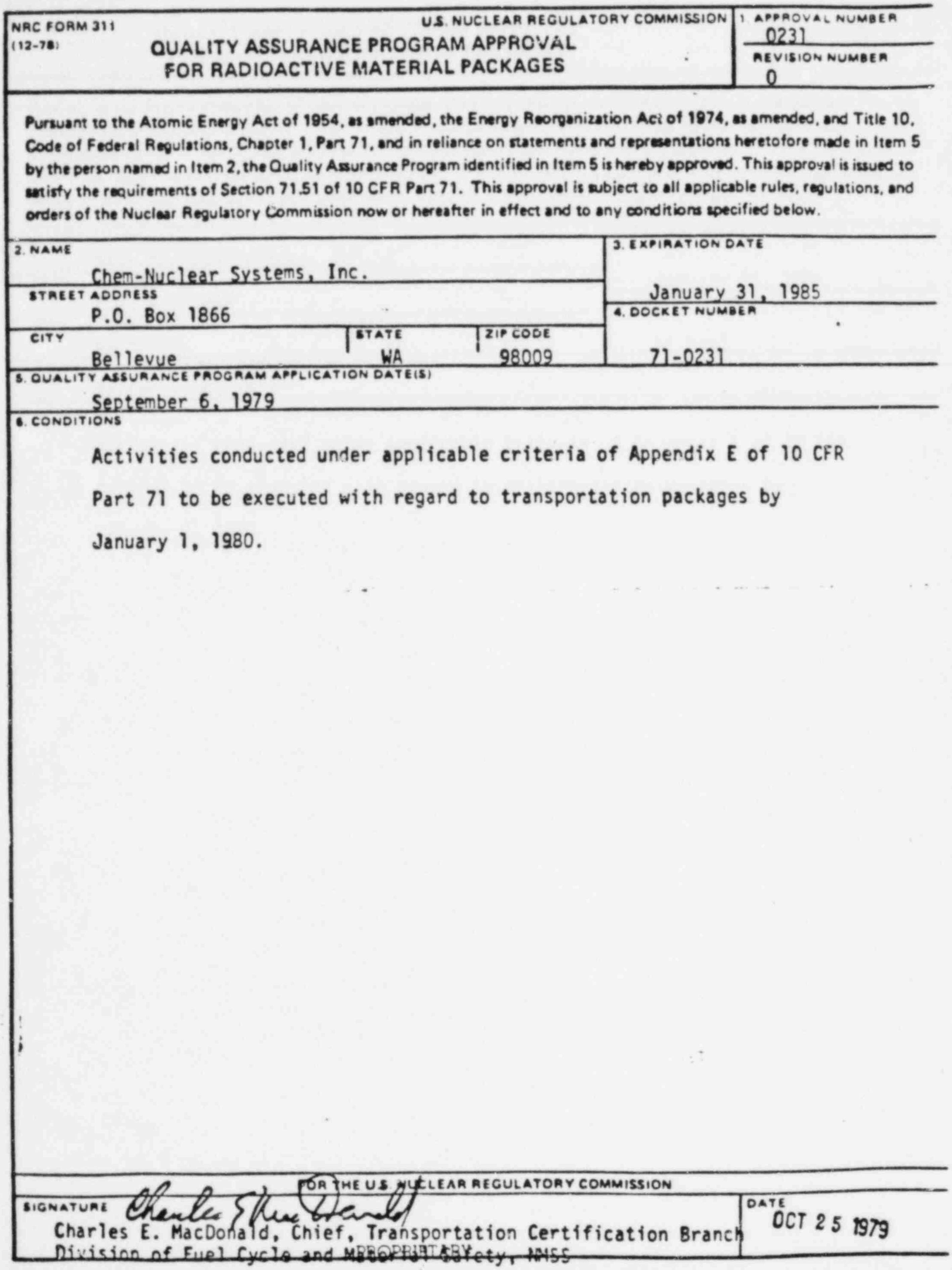
### 7.2.9 Nonconformance Control

Quality Assurance inspectors identify and document nonconforming materials, parts, or processes dealing with dewatering operation.

### 7.2.10 Corrective Action

Quality Assurance inspectors continually monitor materials, processes, and workmanship to ensure that noncomforming items 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.

STREET ADDRESS
P.O. Box 1866

CITY
Bellevue

STATE
WA

ZIP CODE
98009

3. EXPIRATION DATE
January 31, 1985

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

PROPRIETARY

DATE OCT 25 1979

# ACCIDENT EVALUATION

## 8.0 ACCIDENT EVALUATION

### 8.1 Postulated Accident Analysis

8.1.1 The design, fabrication, and operation of the CNSI Resin Transfer and Dewatering Skid is in accordance with the appropriate NRC, ASME, ANSI, and IEEE Codes and Standards to ensure the safe and reliable dewatering of the waste. Nonetheless, accidents are statistically plausible and have the potential for the release of radioactivity to the surrounding area. A description of plausible accidents and an analysis of the releases that may occur are summarized in this section.

### 8.2 Fire

8.2.1 The only source of fire is the electrical power and control system when these components are used. 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. When available, fire fighting equipment is provided to the operator to perform the initial fighting of the fire with backup provided by the station fire brigades.

### 8.3 Pressure Changes

8.3.1 Pressure changes in sealed liners are possible yet are unlikely. Overpressure could result from media temperature reaching 212$^{\circ}$F, thereby causing free water to form steam (experience has shown that media temperature reaching 212$^{\circ}$ is an unlikely event). The overpressure could then cause a rupture and spill the contents.

## 8.4 Equipment Failures

### 8.4.1 Waste Isolation Valve

8.4.1.1 The waste isolation valve is provided with a manual override to enable the opening of the valve should it fail in the closed position. Manual override will allow the completion of the waste fill and flushing cycle so that the dewatering 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 utility operator, i.e., if the valve does not shut when the correct waste volume has been transferred, waste flow can be stopped by the utility staff.

## 8.5 Airborne Release

8.5.1 Dewatering operations do not normally result in airborne release. Safety precautions such as grab air samples or continuous air monitoring are taken at the discretion of the utility. In some instances, the liner opening may be covered with a fillhead or sealed pan, which may be connected to the utility's off-gas system.

## 8.6 Liquid Pathway

8.6.1 There is no credible liquid pathway offsite due to the double barrier of liner and cask and the coupling to the utility drain systems.

## 8.7 Incident Scenarios

8.7.1 Statistically, a release of radioactive material may occur during the transfer operation or while the radioactive waste is in the container prior to dewatering. In this regard, two scenarios are envisaged: a filling hose rupture and a bottom weld rupture of a full liner.

### 8.7.2 Case I

A hose rupture during filling activities is seen to be the least serious of the scenarios. This is because the quantity of radioactivity spilled is a function of operator response time and the quantity of radioactivity in the filling hose at any given time. The operator response time is dependent upon observance of the malfunction and the time necessary for physically closing the waste isolation valve. During operation, the operator is positioned near the control station and visually monitors the transfer process. It is estimated that no more than two minutes would elapse between hose rupture and valve closing. Since flow rates of 25, 50, and 100 gallons per minute are expected, the worst-case scenario is a spill of 200 gallons. Table 8-1 shows that if this scenario happens, Cobalt-58 and -60, Cesium-134 and -137, Iodine-131, and Manganese-54 will contribute 27% of MPC at the site boundary (10 CFR 20, Appendix B, Table II, Column 1, Soluable, 1 Dec. 1978).

### 8.7.3 Case II

A bottom weld rupture of a full liner is seen as the most serious of the incident scenarios but is even less likely than Case I. It is only more serious because the total volume spill is greater. The largest liner dewatered contains a maximum of 1,466 gallons of waste (196 $ft^3$) and, depending on the contact radiation readings, are filled either in or out of a cask. If the waste stream is high activity the liner is inserted into a cask and then filled. Thus, a bottom weld rupture in this operational mode would cause the spill of 1,466 gallons maximum into a cask and the contents would be contained. Therefore, no release to the environment is envisaged.

8.7.3.1 If the waste stream is low activity or the liner is not filled in a cask, then a bottom weld rupture could spill the contents and environmental release is possible. Table 8-1 shows that if this scenario occurred, the listed radionuclides would contribute 36.8% of the MPC allowable under Table II.

## 8.8 ACCIDENT EVALUATION: CASE I, Hose Rupture

### 8.1.1 Co-58 MPC

1. release rate:

$$\frac{1.67\ \text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times \frac{1.2\text{E-}3\ \text{Ci}}{\text{ft}^3} = 2.68\ \text{E-}4\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor 100,000

$$2.68\ \text{E-}4\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+}6\ \frac{\text{uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 2.68\ \text{E-}3\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$7.75\ \text{E-}4\ \frac{\text{sec}}{\text{m}^3} \times 2.68\ \text{E-}3\ \frac{\text{uCi}}{\text{sec}} \times \frac{1\text{E-}6\ \text{m}^3}{1\ \text{ml}} = 2.1\ \text{E-}12\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{2.1\ \text{E-}12\ \frac{\text{uCi}}{\text{ml}}}{3\ \text{E-}8\ \frac{\text{uCi}}{\text{ml}}} \times 100\% = \underline{7.0\ \text{E-}3\%\ \text{of}}\ \text{MPC}$$

### 8.8.2 Co-60

1. release rate

$$1.67\ \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 1.4\text{e-}3\ \frac{\text{Ci}}{\text{ft}^3} = 3.1\ \text{E-}4\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$3.1\ \text{E-}4\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+}6\ \frac{\text{uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 3.1\ \text{E-}3\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$7.75\ \text{E-}4\ \frac{\text{sec}}{\text{m}^3} \times 3.1\ \text{E-}3\ \frac{\text{uCi}}{\text{sec}} \times \frac{1\ \text{E-}6\ \text{m}^3}{1\text{ml}} = 2.4\ \text{E-}12\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{2.4\text{ E-12 }\frac{\text{uCi}}{\text{ml}}}{1\text{ E-8 }\frac{\text{uCi}}{\text{ml}}} \times 100 = \underline{2.4\text{ E-2\% of MPC}}$$

### 8.8.3 Cs-134

1. release rate

$$1.67\ \frac{\text{gal}}{\text{sec}} \times \frac{1\text{ ft}^3}{7.48\text{ gal}} \times 8.5\text{ E-3 }\frac{\text{Ci}}{\text{ft}^3} = 1.9\text{ E-3 }\frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$1.9\text{ E-3 }\frac{\text{Ci}}{\text{sec}} \times 1\text{ E+6 }\frac{\text{uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 1.9\text{ E-2 }\frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$7.75\text{ E-4 }\frac{\text{sec}}{\text{m}^3} \times 1.9\text{ E-2 }\frac{\text{uCi}}{\text{sec}} \times \frac{1\text{ E-6 m}^3}{1\text{ ml}} = 1.47\text{ E-11 }\frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{1.47\text{ E-11 }\frac{\text{uCi}}{\text{ml}}}{1\text{ E-9 }\frac{\text{uCi}}{\text{ml}}} \times 100\% = \underline{1.5\text{ \% of MPC}}$$

### 8.8.4 Cs-137

1. release rate

$$1.67\ \frac{\text{gal}}{\text{sec}} \times \frac{1\text{ ft}^3}{7.48\text{ gal}} \times 1.69\text{ E-2 }\frac{\text{Ci}}{\text{ft}^3} = 3.77\text{ E-3 }\frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$3.77\text{ E-3 }\frac{\text{Ci}}{\text{sec}} \times \frac{1\text{ E+6 uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 3.77\text{ E-2 }\frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$7.75\text{ E-4 }\frac{\text{sec}}{\text{m}^3} \times 3.77\text{ E-2 }\frac{\text{uCi}}{\text{sec}} \times \frac{1\text{ E-6 m}^3}{1\text{ ml}} = 2.92\text{ E-11 }\frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{2.92\ \text{E-11}\ \frac{\text{uCi}}{\text{ml}}}{2\ \text{E-9}\ \frac{\text{uCi}}{\text{ml}}} \times 100\% = 1.5\%\ \text{of MPC}$$

8.8.5 Iodine-131

1. release rate

$$1.67\ \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 1.4\ \text{E-3}\ \frac{\text{Ci}}{\text{ft}^3} = 3.1\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 10,000

$$3.1\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E}\ \frac{6\ \text{uCi}}{\text{Ci}} \times \frac{1}{10{,}000} = 3.1\ \text{E-2}\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$7.75\ \text{E-4}\ \frac{\text{sec}}{\text{m}^3} \times 3.1\ \text{E-2}\ \frac{\text{uCi}}{\text{sec}} \times \frac{1\ \text{E-6 m}}{1\ \text{ml}} = \overset{3}{2}.4\ \text{E-11}\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{2.4\ \text{E-11}\ \frac{\text{uCi}}{\text{ml}}}{1\ \text{E-10}\ \frac{\text{uCi}}{\text{ml}}} \times 100\% = 24\%\ \text{of MPC}$$

8.8.6 Managnese-54

1. release rate

$$1.67\ \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 6\ \text{E-4}\ \frac{\text{Ci}}{\text{ft}^3} = 1.34\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$1.34\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+6}\ \frac{\text{uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 1.34\ \text{E-3}\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$1.34\ \text{E-3}\ \frac{\text{uCi}}{\text{sec}} \times 7.75\ \text{E-4}\ \frac{\text{sec}}{\text{m}^3} \times \frac{1\ \text{E-6}\ \text{m}^3}{1\ \text{ml}} = 1.04\ \text{E-12}\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{1.04\ \text{E-12}\ \frac{\text{uCi}}{\text{ml}}}{1\ \text{E-8}\ \frac{\text{uCi}}{\text{ml}}} \times 100\% = \underline{1.04\ \text{E-2}\ \%\ \text{of MPC}}$$

## 8.9 Case II, Bottom Weld Rupture

### 8.9.1 Cobalt-58

1. release rate:

$$143.3\ \frac{gal}{sec} \times \frac{1\ ft^3}{7.48\ gal} \times 6\ E\text{-}5\ \frac{Ci}{ft^3} = 3.63\ E\text{-}4\ \frac{Ci}{sec}$$

2. partition fraction: 100,000

$$3.63\ E\text{-}4\ \frac{Ci}{sec} \times 1\ E\text{+}6\ \frac{uCi}{Ci} \times \frac{1}{100{,}000} = 3.63\ E\text{-}3\ \frac{uCi}{sec}$$

3. at site boundary

$$3.63\ E\text{-}3\ \frac{uCi}{sec} \times 7.75\ E\text{-}4\ \frac{sec}{m^3} \times \frac{1\ E\text{-}6\ m^3}{1\ ml} = 2.81\ E\text{-}12\ \frac{uCi}{ml}$$

4. % of MPC

$$\frac{2.81\ E\text{-}12\ \frac{uCi}{ml}}{3\ E\text{-}8\ \frac{uCi}{ml}} \times 100\% = \underline{9.38\ E\text{-}3\ \%\ of\ MPC}$$

### 8.9.2 Cobalt-60

1. release rate

$$45.3\ \frac{gal}{sec} \times \frac{1\ ft^3}{7.48\ gal} \times 7\ E\text{-}5\ \frac{Ci}{ft^3} = 4.23\ E\text{-}4\ \frac{Ci}{sec}$$

2. partition factor: 100,000

$$4.23\ E\text{-}4\ \frac{Ci}{sec} \times 1\ E\text{+}6\ \frac{uCi}{Ci} \times \frac{1}{100{,}000} = 4.23\ E\text{-}3\ \frac{uCi}{sec}$$

3. at site boundary

$$4.23\ E\text{-}3\ \frac{uCi}{sec} \times 7.75\ E\text{-}4\ \frac{sec}{m^3} \times \frac{1\ E\text{-}6\ m^3}{ml} = 3.28\ E\text{-}12\ \frac{uCi}{ml}$$

4. % of MPC

$$\frac{3.28\ E\text{-}12\ \frac{uCi}{ml}}{1\ E\text{-}8\ \frac{uCi}{ml}} \times 100\ \% = \underline{3.28\ E\text{-}2\ \%\ of\ MPC}$$

### 8.9.3 Cesium-134

1. release rate

$$45.3 \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 4.25\ \text{E-4} \frac{\text{Ci}}{\text{ft}^3} = 2.57\ \text{E-3} \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$2.57\ \text{E-3} \frac{\text{Ci}}{\text{sec}} \times \frac{1\ \text{E+6 uCi}}{1\ \text{Ci}} \times \frac{1}{100{,}000} = 2.57\ \text{E-2} \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$2.57\ \text{E-2} \frac{\text{uCi}}{\text{sec}} \times 7.75\ \text{E-4} \frac{\text{sec}}{\text{m}^3} \times 1\ \text{E-6} \frac{\text{m}^3}{\text{ml}} = 1.99\ \text{E-11} \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{1.99\ \text{E-11} \frac{\text{uCi}}{\text{ml}}}{1\ \text{E-9} \frac{\text{uCi}}{\text{ml}}} \times 100 = 1.99\ \%\ \text{of MPC}$$

### 8.9.4 Cesium-137

1. release rate

$$45.3 \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 8.45\ \text{E-4} \frac{\text{Ci}}{\text{ft}^3} = 5.12\ \text{E-3} \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$5.12\ \text{E-3} \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+6} \frac{\text{uCi}}{1\ \text{Ci}} \times \frac{1}{100{,}000} = 5.12\ \text{E-2} \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$5.12\ \text{E-2} \frac{\text{uCi}}{\text{sec}} \times 7.75\ \text{E-4} \frac{\text{sec}}{\text{m}^3} \times \frac{1\ \text{E-6 m}^3}{1\ \text{ml}} = 3.96\ \text{E-11} \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{4.63\ \text{E-11} \frac{\text{uCi}}{\text{ml}}}{2.0\ \text{E-9} \frac{\text{uCi}}{\text{ml}}} \times 100 = 1.98\ \%\ \text{of MPC}$$

### 8.9.5 Iodine-131

1. release rate

$$45.3\ \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 7.0\ \text{E-5}\ \frac{\text{Ci}}{\text{ft}^3} = 4.23\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 10,000

$$4.23\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+6}\ \frac{\text{uCi}}{\text{Ci}} \times \frac{1}{10{,}000} = 4.23\ \text{E-2}\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$4.23\ \text{E-2}\ \frac{\text{uCi}}{\text{sec}} \times 7.75\ \text{E-4}\ \frac{\text{sec}}{\text{m}^3} \times \frac{1\ \text{E-6}\ \text{m}^3}{1\ \text{ml}} = 3.28\ \text{E-11}\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{3.83\ \text{E-11}\ \frac{\text{uCi}}{\text{ml}}}{1\ \text{E-10}\ \frac{\text{uCi}}{\text{ml}}} \times 100\ \% = 32.8\ \%\ \text{of MPC}$$

### 8.9.6 Manganese-54

1. release rate

$$45.3\ \frac{\text{gal}}{\text{sec}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times 3\ \text{E-5}\ \frac{\text{Ci}}{\text{ft}^3} = 1.81\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}}$$

2. partition factor: 100,000

$$1.81\ \text{E-4}\ \frac{\text{Ci}}{\text{sec}} \times 1\ \text{E+6}\ \frac{\text{uCi}}{\text{Ci}} \times \frac{1}{100{,}000} = 1.81\ \text{E-3}\ \frac{\text{uCi}}{\text{sec}}$$

3. at site boundary

$$1.81\ \text{E-3}\ \frac{\text{uCi}}{\text{sec}} \times 7.75\ \text{E-4}\ \frac{\text{sec}}{\text{m}^3} \times \frac{1\ \text{E-6}\ \text{m}^3}{\text{ml}} = 1.40\ \text{E-12}\ \frac{\text{uCi}}{\text{ml}}$$

4. % of MPC

$$\frac{1.40\ \text{E-12}\ \frac{\text{uCi}}{\text{ml}}}{1\ \text{E-8}\ \frac{\text{uCi}}{\text{ml}}} \times 100\ \% = 1.40\ \text{E-2}\ \%\ \text{of MPC}$$

8.10 The following information is presented:

1. Case I.

   Maximum spill rate: 100 gallons per minute
   1.67 gallons per second

2. Chi/Q: 7.75 E-4 $\frac{\text{sec}}{\text{m}^3}$ (see note 3)

3. Partition factors: (see note 1)

   Iodine-131 10,000
   other radionuclides 100,000

4. Maximum liner size: 196 $\text{ft}^3$ (approximately 1,466 gallons)

5. Useable liner volume: 186 $\text{ft}^3$ (1,391 gallons)

6. Case I and II

   No consideration is made for material absorbed on surfaces for the following reasons:

   a. calculated percent of MPC shows a small instantaneous value for all radionuclides

   b. calculated values are considered conservative by a cummulative value of at least 100

   c. these scenarios have a small probability of occurrence

   d. Case I release is easily corrected and of short-term duration

## 8.11 NOTES

1. Iodine Partitonary Factor = 10,000 (P.F.)

   Effluent source terms were conservatively developed by assuming entrainment from liquid phase to vapor phase would occur on the same basis as a system operating on the principle of evaporation. Gray, et al., 1979, BNFP, 1976 reports entrainment factors of $10^{-6}$ for such a system (P.F. = 1,000,000). In the case of evaporation by boiling, a higher rate of release of radionuclides with off-gas vapors occurs than would be expected from routine operation of pumps, valves, and water transfer, and certainly from the case in question. Therefore, assumption of a factor of 10,000 is considered to be extremely conservative for iodine, especially considering the solution will be basic and force the iodine present towards the ionic form. The partitioning factor is also supported in the literature by data presented in WASH 1258, Volume 2, USAEC, July 1973.

2. Partitionary Factor - Other Isotopes = 100,000

   For calculation purposes, partitionary factors for isotopes other than iodine (these radionuclides are less volatile than iodine) was chosen as 100,000. Again, this value is conservative (see above) and with industry experience.

3. Chi/Q = $7.75 \times 10^{-4}$ sec/$m^3$

   This factor was calculated as an average of worst case Chi/Q values from six typical operating nuclear plants. Since a generic application of site-specific Chi/Q values is necessary for a typical application, an additional conservative factor of 5 was inserted.

4. Isotopic Content

   Data presented in this document was calculated from data given in +CAEC-007, March 1978. Table 8.3 (p. 251, CAEC-007) was utilized to calculate the percentage of radionuclides in the process waste. Additionally, CAEC-007 was utilized to calculate the isotopic waste content based on reported specific activity of pressurized and boiling water reactors and is reported in Table 8-1 under the waste stream specific activity. A telephone survey of several nuclear plants was conducted to ascertain the validity of the isotopic content used in the evaluation. In all cases sampled, the values used are conservative in relation to actual reported values.

5. Since Case II deals with low activity waste, typical radiation levels of 150-250 mR/hr were scaled down by a factor of 20. These values still remain conservative when compared to actual reported values.

6. Total Maximum Permissible Concentration is determined by:

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \frac{C_c}{MPC_c} \ldots\ldots + \frac{C_n}{MPC_n} = \text{less than unity}$$

7. Spill rate calculations are:

$R = A\ 2[gh]^{1/2}$ where:

R = volume of liquid discharged per unit time

A = area of orifice (2.8 E-2 $m^2$)

g = gravitational constant (9.8 $m/s^2$)

h = height of liquid above orifice (1.92m)

7.8 E-2 $m^2$ X 6.13

$$.17\ \frac{m^3}{sec} \times 264.2\ \frac{gal}{m^3}$$

$$45.3\ \frac{gal}{sec}$$

8. Time required to empty liner

$$\frac{1390\ gal}{45.3\ \frac{gal}{sec}} = 30.7\ sec$$

Table 8-1. Case I and II Incident Scenarios and the Resulting Percent Contribution to Table II MPC

| [1]Radionuclide | [2]Table II MPC (uCi/ml) | S.A. Waste Stream [3]Case I (Ci/$ft^3$) | S.A. Waste Stream [4]Case II (Ci/$ft^3$) | [5]S.A. in 200 gal (uCi) | [6]Concentration at Site Boundary Case I (uCi/ml) | [6]Concentration at Site Boundary Case II (uCi/ml) | Percent of MPC Case I | Percent of MPC Case II |
|---|---|---|---|---|---|---|---|---|
| Cobalt-58 | 3 E-8 | 1.2 E-3 | 6.0 E-5 | 3.2 E-4 | 2.1 E-12 | 2.81 E-12 | 7.0 E-3 | 9.38 E-3 |
| Cobalt-60 | 1 E-8 | 1.4 E-3 | 7.0 E-5 | 3.7 E-4 | 2.4 E-12 | 3.28 E-12 | 2.4 E-2 | 3.28 E-2 |
| Cesium-134 | 1 E-9 | 8.5 E-3 | 4.25 E-5 | 2.3 E-5 | 1.47 E-11 | 1.99 E-11 | 1.5 | 1.99 |
| Cesium-137 | 2 E-9 | 1.69 E-2 | 8.45 E-4 | 4.5 E-5 | 2.92 E-11 | 3.96 E-11 | 1.5 | 1.98 |
| Iodine-131 | 1 E-10 | 1.4 E-3 | 7.0 E-5 | 3.7 E-4 | 2.4 E-11 | 3.28 E-11 | 24 | 32.8 |
| Manganese-54 | 1 E-8 | 6.0 E-4 | 3.0 E-5 | 1.6 E-4 | 1.04 E-12 | 1.40 E-12 | 1.04 E-2 | 1.40 E-2 |
| [7]Percent of MPC | | | | | | | .270 | .368 |

---

[1] From CABC-007, 1978

[2] 10 CFR 20, Appendix B, Table II, Column I, soluable

[3] calculated from CABC-007, 1978

[4] scaled down by a factor of 20 to accound for lower level waste (see Note 5)

[5] see Note f

[6] see calculations Case I & II

[7] see Note 6

# OPERATING EXPERIENCE AND RESEARCH RESULTS

## 9.0 OPERATING EXPERIENCE AND RESEARCH RESULTS

### 9.1 Operating Experience

9.1.1 Chem-Nuclear Systems, Inc. has been actively involved in the safe transport and disposal of dewatered/demineralized radioactive waste for the past eight years.

9.1.2 On-site dewatering has been performed at nuclear facilities where experience in the design and operation is used as a basis for continual improvement with regards to safety and operation. Table 9-1 shows the partial experience list to date:

Table 9-1. A Partial List of Dewatering Operating Experience at Nuclear Power Plants

---

Arkansas
Big Rock Point
Brunswick
Crystal River
Davis-Besse
Fitzpatrick
H.B. Robinson
Hatch
Millstone
Mississippi
Nine-Mile Point
North Anna
Oconee
Oyster Creek
Point Beach
Salem

---

## 9.2 Exposure to Dewatering Operations Personnel

9.2.1 Based on design features of the CNSI Dewatering System and temporary shielding in the form of portable shields, personnel dose during normal operation is estimated to be less than four rem per year.

9.2.2 Exposure to radiation during system maintenance has been kept as low as practical by separation of process equipment that does not contain radioactive residues from those that 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 portable equipment can be moved for maintenance to a low radiation area so that further operator exposure is minimized.

9.2.3 CNSI experience with mobile and portable systems for several years with various media has formed the basis for the equipment design. The control panel, when used, is normally located in a non-radiation area and operators receive little or no exposure while processing.

9.2.4 Currently, there are two operators involved in purely dewatering projects. Their estimated dose per month, based on TLD's, is 0.356 rem (10.5 months of 1983) and 0.163 rem (7 months of 1983). The total average dose for the dewatering and demineralization unit where N = 18 persons (based on January - November 17, 1983 operating data) is 0.159 rem. Individual doses range from 0.002 to 0.356 rem per month.

## 9.3 Waste Characteristics

9.3.1 Typical PWR and BWR waste types dewatered are mixed resins bed, precoats, and solka floc. Descriptions are:

### 9.3.1.1 Mixed Bead Resins

| | |
|---|---|
| Average particle size | 0.54 mm |
| Retained on 50 mesh screen | about 98% |
| Particle density | |
| anion | 1.1 gm/cc |
| cation | 1.3 gm/cc |
| Bulk density | 45 lbs/ft$^3$ |

### 9.3.1.2 Cellulose Fibers (Solka Floc)

| | |
|---|---|
| Solids concentration slurry | 1-3% by wt. |
| Or centrifuged waste | 50% water |
| 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 |

### 9.3.1.3 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% by wt. |
| Or centrifuged waste | 50% water |
| Particle size | 350 mesh |
| Bulk density, lb/ft$^3$ (solids dry) | 24 |

Table 9-2 describes the type and volume of wastes normally encountered.

Table 9-2. Summary of Light Water Reactor Waste Streams*

| Type | Volume Produced (ft$^3$)* PWR | BWR |
|---|---|---|
| Resin | 3,100 | 3,100 |
| Concentrated Liquids | 4,775 | 8,600 |
| Filter Sludges | 75 | 6,900 |
| TOTALS | 7,950 + | 18,600 + |

* Untreated wastes delivered to CNSI
\+ Experience shows totals are exceptionally high

## 9.4 Bead Resin Test Material Description

9.4.1 Test material in Standard I consists of mixed bed spent anion-cation bead resin. The resin is in poor physical condition as the beads have experienced damage due to forces encountered during centrifugation.

9.4.2 The majority of resin is Dowex, ion exchange resin, mixed bed, nuclear grade, Type MR-3. Type MR-3 consists of 58% by weight SBR-OH and 42% by weight of HCR-S. Appendix 6 provides manufacturer specifications of MR-3 bead resin.

9.4.3 Category I mixture is considered to be an average example of actual representative bead resin waste as encountered for disposal. The manufacturer states the average new material water retention capacity is 57%. Emperically, CNSI has found that extensive bead handling results in increased moisture-absorbing ability.

## 9.5 Process Control Program

9.5.1 Generally, the PCP states that liners are filled and then pumped for a given time interval. The contents are allowed to stand and the pump cycle is restarted. After a given number of cycles, the liner is considered dewatered and the process stopped.

## 9.6 Testing

9.6.1 The test procedures required the vessel to be loaded with the useable volume of precoat or resin and filled with water. The liner dewatering cycle was to pump for a certain time interval, stand for a certain time interval, and repeat until the dewatering was complete.

9.6.2 The dewatering end point was determined to be zero when less than 10 ml was collected over a 24-hour period. At that time, the vessel was loaded on a truck and driven 200 miles over secondary roads. If less than 10 ml was collected following the road test the liner was considered dewatered.

9.6.3 Larger liners, such as 14-195's, were considered the worst case for dewatering. Production liners of smaller diameter and height but with the same internal design can be certified by testing the worst case.

9.6.4 Testing and evaluation of extracted test resin showed the moisture content to be less than or equal to equilibrium with the static suspending ability of the resin bed and the amount of moisture contained within the bed. At less than or equal to the point of equilibrium, dynamic forces, such as those experienced during transportation, would not cause precipitation of interstitial moisture.

9.6.5 A typical L14-195 (steel) and PL14-195R (High Integrity Container) were chosen for testing the dewatering capability when filled with resin beads. These containers are five degrees conical in shape at the bottom. The selected liners were chosen from a group that would normally be used for commercial purposes. They were retrofitted to meet the demands of a test liner by the installation of sampling ports. Positioning was the same as that normally expected in commercial operation.

9.6.6 CNSI developed specific test instructions and reports that were used to successfully dewater resin to zero free-standing water. All tests were instituted using non-radioactive waste streams. These instructions and report are found in Appendix 1 of CNSI-DW-11118-01-P.

9.7 L14-195 Barrel Top Resin Conical [BTRC (Steel)]

9.7.1 Appendix 2 of CNSI-DW-11118-01-P is the test results that certify dewatering of resin beads in L14-195 BTRC (Steel) liners.

9.7.2 Tests No. 1 and 2 with the new lateral design show that Barnwell Site Criteria were met after six pump cycles. Hanford criteria was met after 12 pump cycles, while zero free-standing water was obtained after 14. Road testing did not affect bead equilibrium and cause liquid precipitation.

9.7.3 Tests No. 1 and 2 with old lateral design show that two pump cycles were necessary to meet the requirements of 10 CFR 61. Five and eight pump cycles were necessary to meet Hanford criteria. Zero free-standing water was obtained after 14 cycles. Road testing did not cause liquid precipitation.

9.7.4 The moisture content of the extracted test resin samples indicate an equilbrium has been established between the static suspending ability of the test resin bed and the amount of moisture contained within the bed. The point of equilibrium for the test has been established such that the dynamic forces experienced will not cause liquid precipitation.

9.7.5 The Process Control program calls for six and twelve pump cycles to meet 10 CFR 61 and Hanford requirements.

### 9.8 PL14-195 R (HIC)

9.8.1 Appendix 3 of CNSI-DW-11118-01-P is the test results that certify dewatering of PL14-195 R (High Integrity Containers) liners and smaller sized liners.

9.8.2 Test No. 1 shows that Barnwell Site Criteria was met after the second pump cycle. Hanford criteria was met after the fourth pump cycle. Zero free-standing water was met after 14 pump cycles. Road testing did not affect bead equilibrium and cause liquid precipitation.

9.8.3 Test No. 2 shows that 3, 11, and 14 pump cycles were needed to meet 10 CFR 61, Hanford, and zero free-standing water requirements. Road testing did not affect bead equilibrium and cause liquid preciptitation.

9.8.4 Test No. 3 shows that 3, 8 and 14 pump cycles were needed to meet 10 CFR 61, Hanford, and zero free-standing water requirements.

9.8.5 Road testing was done 14, 17, and 27 days following the completion of 14 pump cycles on Test No. 3. Dynamic forces encountered did not affect bead equilibrium and cause liquid precipitation.

9.8.6 The moisture content of the extracted test resin samples indicate an equilibrium has been established between the static suspending ability of the test resin bed and the amount of moisture contained within the bed. The point of equilibrium for the test has been established such that the dynamic forces experienced will not cause liquid precipitation.

9.8.7 The Process Control Program calls for three and 11 pump cycles to meet Barnwell Site Criteria and Hanford requirements.

## 9.9 Precoat Test Instructions

9.9.1 Appendix 4 of CNSI-DW-11118-01-P covers the precoat test instructions and report. The liners chosen were L14-195 (Steel), PL14-195 (Poly-Processing), PL8-120 (Poly-Processing), and PL8-120R (Poly-Processing), and PL14-195R (Crown Rotational). Each container was rigged and the intervals installed as would normally be used during commercial operation. Additionally, each container was converted to a test liner by the installation of sample ports.

9.9.2 The test procedure is to fill the liner with slurry. Upon completion of filling, the slurry may stand for a certain interval. After standing, all four banks may be dewatered consecutively or simultaneously. The dewatering ability is measured by a vacuum reading. Generally speaking, the liner is dewatered from the top filter bank downward. When one filter bank is turned off attention is directed toward the remaining banks. The dewatered bank is allowed to stand for a certain time interval and then is rechecked. If the recheck affirms the earlier reading, attention is directed toward the remaining banks. If the recheck is not affirmed, dewatering is begun again until further checks affirm dewatering.

9.9.3 After three dewatering cycles the liner is subjected to a 200-mile road test over secondary roads. After the road test low point drains are opened and the volume of water is recorded. Precoat samples for moisture analyses from the port and low point drains were taken. This data is found in Appendix 4, CNSI-DW-11118-01-P.

9.9.4 Another dewatering method is to dewater for a certain number of continuous hours. Dewatering is complete at that time.

9.9.5 Experience has shown that Ecodex is more difficult to dewater than Powdex, Diatomaceous Earth, Celite 545, and Fibra-Cel (SW 70). For these reasons, Powdex and Ecodex were chosen as representative of difficult-to-dewater media. A description of the test material follows.

9.9.5.1 Ecodex The Ecodex material was obtained from Zimmer Nuclear Station and is representative of an actual waste streeam. The material was depleted and saturated.

9.9.5.2 Powdex The Powdex material was obtained from Graver Chemical and is representative of actual waste streams expected for disposal. The material has contaminants of less than 100 ppm Fe as iron, less than 10 ppm Cu as copper, less than 50 ppm Al as aluminum, and less than 25 ppm Pb as lead (Appendix 7 is the manufacturer's specifications).

9.9.5.3 The Ecodex precoat used in these dewatering tests is considered to be the "worst case" for dewatering. It has the greatest potential for suspended solid loading (crud saturation), which results in increased water retention. Since Ecodex has the lowest permeability and the highest water retention of all commercially available precoats, tests with other common precoats should give better dewatering results.

9.9.6 The large size precoat internals described by CNSI Drawing No. B-372-E-0001 contains an internal system functionally identical to the small size internals described by Drawing No. B-0372-E-0002. Testing of the largest size liner is considered to be the worst case for a size group. The scientific acceptability of this paragraph is proprietary and is described in paragraphs 9.9.6.1-4 in CNSI-DW-11118-01-P.

9.9.7 Three complete and successful full-scale tests were conducted with the large size internals in three different type containers.

9.9.8 One test was conducted with the largest container in the category of small liners with the small size internals. The purpose of this test was to demonstrate the small geometry of the internals is functionally equal to the proportionally larger size combination.

9.9.9 The moisture content of the extracted test samples indicate an equilibrium has been established between the static suspending ability of the test material and the amount of moisture contained within the container. Dynamic forces experienced during transportation and changing weather conditions will not cause precipitation of suspended moisture.

9.9.10 As a precoat material becomes laden with impurities during the normal in-plant cycles, the water retention capability increases. The equilibrium point for saturated precoat waste is higher than new material. If the moisture content of the waste is equal to or less than the moisture content of new material, it is reasonable to assume equilibrium has been more than established. At this point, the matrix of material is capable of absorbing additional moisture without precipitation.

9.9.11 If a mixture of precoat materials is received as waste, the relative combination of moisture content is proportional to the combination of the materials. (Example: 50% by weight Ecodex at 70% moisture and 50% Powdex at 60% moisture, new material equilibrium equals 65% moisture.)

9.9.12 The average moisture content for the Ecodex matrix as dewatered:

| L14-195 (Old) | L14-195 (New) | PL14-195 | PL14-195R | PL8-120R |
|---|---|---|---|---|
| | 67.24% - 2nd Road | 59.81% | 57.5% | |
| | 68.5% 1st | | | |
| | | Powdex = 51.0% | | |

The equilibrium point for new Ecodex, according to the manufacturer, is 65-70% at 100% humidity.

9.9.13 Therefore, if the average moisture content for Ecodex matrix is equal to or less than 65% moisture, the matrix is capable of absorbing additional moisture.

9.9.14 When dewatering Fibracell, Solka-Flok, diatomaceous earth or Celite, the new model precoat internals perform more efficiently than the old style system. All precoats other than Powdex should be dewatered with Ecodex type filter assemblies.

9.9.15 Powdex may be dewatered in an Ecodex liner, resulting in a Powdex matrix with a very low percentage of moisture. Any combined mixtures should be dewatered in an Ecodex liner. The Powdex liner is available for relatively (90%) pure Powdex waste only. (The Powdex liner assembly costs approximately 30% less than the Ecodex liner, at this time).

9.9.16 Testing has demonstrated that precoats of the type equal to Ecodex, Fibracell, Solka-Flok, diatomaceous earth, and Celite may be dewatered with "Ecodex" type liners conforming to CNSI Drawing No. B372-E-0001 and B-372-E-0002.

9.9.17 Powdex and similar precoats may be dewatered with "Powdex" type liners conforming to CNSI drawing number B-372-E-0001 and B-372-E-0002.

9.9.18 When dewatering any precoat with the above-mentioned liners, a three-stage cycle dewatering procedure, or a continuous dewatering method must be used to obtain zero FSW.

## 9.10 Precoat Test Results

9.10.1 Appendix 5 of CNSI-DW-11118-01-P shows the test results for dewatering liners with precoats.

9.10.2 Test results indicate that three cycles are adequate to meet zero free-standing water requirements. Alternatively, this criteria may be met by pumping for a certain number of continuous hours.

9.10.3 Bead moisture content data indicate an equilibrium has been established between the static suspending ability of the test precoat and the amount of moisture contained within the bed. The point of equilibrium for the test material has been established such that dynamic forces experienced will not cause liquid precipitation.

9.10.4 The process control program calls for three pump cycles or a continuous pumping cycle to meet the dewatering requirements.

## 9.11 76" Diameter Pressure Vessel

9.11.1 Appendix 4 of CNSI-DW-11118-01-P, Test Results, covers the test summary and results that certify dewatering of the 76" diameter pressure vessel with bead resin.

9.11.2 The ambient air temeperature recorded for the duration of the three tests ranged from 29-79°F. The humidity ranged from 30-100%.

9.11.3 Test results show that 9 ml of water was collected after several pump cycles. Setting this point to zero on a relative scale and adding the area under the curve, it is shown that the Hanford criteria of less than 1 gallon was met in the second pump cycle.

9.11.4 The 0.5% limit of 10 CFR 61 was met during the second pump cycle.

9.11.5 It is interesting to note that the volume collected following the road test was 636 ml (0.168 gal). It can be stated that road testing is unlikely to result in additional free-standing water from that which would have been normally encountered in the first place.

9.11.6 In summary, the Hanford Site Criteria and 10 CFR 61 limits were met during the second pump cycle. Currently, additional tests are being conducted that will provide supporting data.

## 9.12 24" Diameter Pressure Vessel

9.12.1 Pressure vessels of 24" in diameter containing activated carbon, bead, or macroreticular resins have been tested at various intervals since 1981. Recertification is in progress due to changes in internal piping design. The modifications are expected to result in increased efficiency of the dewatering process.

9.12.2 Field experience with dewatering over 500 24" pressure vessels indicates that current process control programs are effective in removing free-standing water. The volumes collected from the last two pumping steps have been consistently less than established acceptance criteria.

## 9.13 Atmospheric Results

9.13.1 A summary of ambient atmospheric data is given in Table 9-8. Analysis indicates that atmospheric data does not appear to significantly affect bead or precoat dewatering capabilities. Complete atmospheric data is found in Appendix 9.

Table 9-8. Atmospheric Data During Test Periods

| Period | Average Temperature °F Hi | Lo | Dew Point | Grains of Moisture/ Lb of Air | Relative Humidity |
|---|---|---|---|---|---|
| 11-22 Jun 83 | 91 | 59 | 72 | 121 | 54 |
| 19-31 Jul 83 | 97 | 68 | 78 | 150 | 56 |
| 17-29 Aug 83 | 100 | 69 | 77 | 142 | 50 |
| 7-24 Sep 83 | 84 | 59 | 70 | 115 | 64 |
| 26-31 Oct 83 | 68 | 42 | 50 | 55 | 53 |
| 1- 8 Nov 83 | 67 | 40 | 54 | 65 | 64 |

## 9.14 Hydrostatic Testing

9.14.1 Appendix 10 results found in CNSI-DW-11118-01-P, CNSI procedure for Hydrostatic Testing of Field Equipment, indicate the test units are functioning properly and provide accurate readings.

Appendix 10.1 is Proprietary

Appendix 10.2 is Proprietary

Appendix 10.3 is Proprietary

Appendix 10.4 is Proprietary

Appendix 10.5 is Proprietary

# APPENDIX 10.6

# DESCRIPTION OF TEST BEAD

# THE DOW CHEMICAL COMPANY QUALITY ASSURANCE
# SALES SPECIFICATION

23110

PAGE: 1

PRODUCT CODE: 23110 EFFECTIVE: 18 OCT 76

NAME: DOWEX (R) MR-3 NUCLEAR GRADE ION EXCHANGE RESIN

DESC: MIXED ION EXCHANGE RESIN
APPL GOVT/IND STDS: FDA

| TEST ITEM | UNIT | LIMITS | TEST METHODS |
|---|---|---|---|
| COLUMN CAPACITY, MIN. | KGS/CU FT | 12 | DOWEX RESIN MD 36 |

PI: 1693118 SAMPLE
PI: 1693126 1 CU FT FBR DRUM (NET 45 LB)
PI: 2256709 1 CU FT FBR DRUM/MYL (NET 45 LB)
PI: 1693134 5 CU FT FBR DRUM (NET 225 LB)
PI: 1874411 5 CU FT FBR DRUM/MYL (NET 225 LB)

SALES NOTE:
(1) THE HYDROXIDE FORM SHALL MEET THE REQUIREMENTS OF SPECIFICATION 23136.
(2) THE HYDROGEN FORM SHALL MEET THE REQUIREMENTS OF SPECIFICATION 23087
(3) CATION AND ANION RESINS SHALL BE MIXED IN A RATIO OF 1 H ION EQUIVALENT TO 1 OH ION EQUIVALENT.

READ PRECAUTIONARY INFORMATION AND MATERIAL SAFETY DATA SHEETS. THIS PRODUCT IS SHIPPED IN COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS REGARDING CLASSIFICATION, PACKAGING, SHIPPING, AND LABELING.

(R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

LAST PAGE

57% water retention capacity

THE DOW CHEMICAL COMPANY QUALITY ASSURANCE 23087
SALES SPECIFICATION
PAGE: 1

PRODUCT CODE: 23087 EFFECTIVE: 23 MAR 78 SUPERSEDES: 20 OCT 76

NAME: DOWEX (R) HCR-S, NUCLEAR GRADE, H CATION EXCHANGE RESIN

DESC: A STRONG ACID CATION EXCHANGE RESIN IN THE HYDROGEN FORM.
APPL GOVT/IND STDS: FDA

| TEST ITEM | UNIT | LIMITS | TEST METHODS |
|---|---|---|---|
| TOTAL WET VOLUME CAPACITY, MIN | MEQ/ML | 1.8 | DOWEX RESIN MD. 1 |
| WATER RETENTION CAPACITY | % | 50-56 | DOWEX RESIN MD. 4 |
| WET SIEVE ANALYSIS: | | ---- | DOWEX RESIN MD.5 |
| ON NO. 16, MAX. | % | 5 | DOWEX RESIN MD.5 |
| THRU NO. 40, MAX. | % | 5 | DOWEX RESIN MD.5 |
| THRU NO. 50, MAX. | % | 0.5 | DOWEX RESIN MD.5 |
| SPHERICITY, MIN | % | 90 | DOWEX RESIN MD.6 |
| CONVERSION TO H FORM, MIN. | % | 99 | DOWEX RESIN MD.1 |
| SOLUBLES, MAX. | PPM | 400 | BEING DETERMINED |
| METALS (DRY BASIS) | | ---- | ATOMIC ABSORPTION |
| SODIUM, MAX. | PPM | 100 | ATOMIC ABSORPTION |
| IRON, MAX. | PPM | 200 | ATOMIC ABSORPTION |
| COPPER, MAX. | PPM | 50 | ATOMIC ABSORPTION |
| ALUMINUM, MAX. | PPM | 50 | ATOMIC ABSORPTION |
| HEAVY METALS (AS LEAD), MAX. | PPM | 50 | ATOMIC ABSORPTION |

PI: 1692961 SAMPLE
PI: 1692979 1 CU FT FBR DRUM (NET 50 LB)
PI: 1692987 5 CU FT FBR DRUM (NET 250 LB) STD CONTAINER
PI: 1874387 5 CU FT FBR DRUM, MYLAR LINED (NET 250 LB)
PI: 2393478 1 CU FT PAPER BAG (NET 50 LB)
PI: 2393239 1 CU FT FBR DRUM, MYLAR LINED (NET 50 LB)

SALES NOTE:
(1) ANYTHING BUT THE STANDARD CONTAINER LISTED WILL REQUIRE LONG LEAD TIME.

READ PRECAUTIONARY INFORMATION AND MATERIAL SAFETY DATA SHEETS. THIS PRODUCT IS SHIPPED IN COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS REGARDING CLASSIFICATION, PACKAGING, SHIPPING, AND LABELING.

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LAST PAGE

THE DOW CHEMICAL COMPANY QUALITY ASSURANCE 23136
SALES SPECIFICATION
PAGE: 1

PRODUCT CODE: 23136 EFFECTIVE: 20 OCT 76

NAME: DOWEX (R) SBR, NUCLEAR GRADE, OH ANION EXCHANGE RESIN

DESC: STRONG BASE ANION EXCHANGE RESIN - TYPE 1
APPL GOVT/IND STDS: FDA

| TEST ITEM | UNIT | LIMITS | TEST METHODS |
|---|---|---|---|
| TOTAL WET VOLUME CAPACITY, MIN. | MEQ/ML | 1.1 | DOWEX RESIN MD.33C |
| WATER RETENTION CAPACITY, MAX | % | 60 | DOWEX RESIN MD. 4 |
| WET SIEVE ANAL THRU NO. 50, MAX | % | 0.5 | DOWEX RESIN MD. 5 |
| HYDROXIDE, MIN. | EQUIV. % | 90 | DOWEX RESIN MD.33C |
| CHLORIDE, MAX. | EQUIV. % | 3 | DOWEX RESIN MD.33C |
| CARBONATE, MAX. | EQUIV. % | 7 | DOWEX RESIN MD.33C |

PI: 1761667 SAMPLE
PI: 1693399 1 CU FT FBR DRUM (NET 41 LB)
PI: 2256642 1 CU FT FBR DRUM, MYLAR LINED (NET 41 LB)
PI: 2256634 5 CU FT FBR DRUM (NET 205 LB)
PI: 2256626 5 CU FT FBR DRUM, MYLAR LINED (NET 205 LB)

READ PRECAUTIONARY INFORMATION AND MATERIAL SAFETY DATA SHEETS. THIS PRODUCT IS SHIPPED IN COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS REGARDING CLASSIFICATION, PACKAGING, SHIPPING, AND LABELING.

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LAST PAGE

Appendix 10.6.3

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN 48640

## ANALYTICAL METHOD

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May 21, 1969

DOWEX* Resin
Method 4
(Supersedes Method D)

# WATER RETENTION CAPACITY

## 1. Scope

This method is applicable to the determination of the water retention capacity of Dowex ion exchange resins.

## 2. Principle

The water retention capacity is determined from the loss in weight of the conditioned resin by drying under vacuum at an elevated temperature or on a moisture balance.

## 3. Apparatus

(a) Centrifuge, International Clinical Model CL-417, or equivalent, equipped with four-place head (No. 215), 50-ml centrifuge tubes (No. 320) and a Truscon ring (No. 325). The centrifuge is operated at 2,000 rpm. (7a).

(b) Vacuum drying oven, capable of operating at 100 to 105°C and capable of maintaining a pressure equal to about two inches of mercury.

(c) Vacuum pump, capable of maintaining a pressure equal to about two inches of mercury.

(d) Filtering crucible (special), coarse fritted glass Buchner funnel (No. 15C), Corning Glass Works Catalog No. 36060 (cut off 1/4-inch below the frit). See Figure 1.

(e) Cenco Moisture Balance, or equivalent, equipped with a 125-watt infrared lamp and a five-gram torsion wire.

## 4. Sample Preparation

(a) Cation Resins. Transfer 10 to 15 ml of resin (as received) to a column. Convert completely to the hydrogen form (7b) by passing approximately 500 ml of 5% hydrochloric acid through the column with a minimum

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*Trademark of The Dow Chemical Company.

time of 30 minutes. Wash the column of resin with distilled water until the effluent is above pH of 3.5. Transfer the conditioned resin to the special filtering crucible. Centrifuge at 2,000 rpm for five minutes (7a).

(b) Cation Resins, sodium form. Transfer 10 to 15 ml of resin (as received) to a charging column. Wash with 200 ml of distilled water. Transfer the conditioned resin to the special filtering crucible. Centrifuge at 2000 rpm for five minutes (7a).

(c) Anion Resins, chloride form. Transfer 5 to 10 ml of the resin (as received) to a recharging column and convert completely to the chloride form by passing 150 ml of 5% hydrochloric acid through the column with a minimum time of 20 minutes. When the acid has drained through, wash the resin in the same manner with distilled water until the wash water is neutral to litmus paper. Transfer the conditioned resin to the special filtering crucible. Centrifuge at 2000 rpm for five minutes (7a).

## 5. Procedure

(a) Oven Drying Procedure. Transfer the centrifuged resin to a tared weighing bottle, reweigh, and place in the vacuum oven at 100 to 105°C. Reduce the pressure to about two inches of mercury. After 16 hours, admit air to the oven and remove the crucible. Cool in a dessicator to room temperature and obtain the weight.

(b) Moisture Balance Procedure. The procedure followed is that described in the operating instructions. Establish the reference point by turning the scale-adjusting knob, which is located on the right side of the unit, until the 100 percent mark coincides with the index. Rotate the pointer to the index by turning the pointer adjusting knob, which is located on the left side of the unit. Rotate the scale until the 0 percent mark coincides with the index. Raise the lamp housing and distribute the sample, approximately five grams of the centrifuged resin, evenly upon the pan until the pointer coincides with the index. Lower the lamp housing and turn on the infrared lamp. The proper setting of the variable transformer or resistor will vary with the type of resin. Avoid a setting which will cause charring of the resin. The percentage reduction of weight at any instant is determined by rotating the scale adjusting knob, on the right, until the pointer returns to the index. Read the percentage directly from the scale. To assure complete drying, wait until the weight is constant for three minutes. Record this value as the water retention capacity.

6. Calculation

(a) Oven Drying Procedure

$$\frac{(\text{loss of weight})}{(\text{wet resin weight})} \times 100 = \%\ \text{Water Retention Capacity}$$

(b) Moisture Balance Procedure

The reading obtained is numerically the same as the % Water Retention Capacity.

7. Notes

(a) If the centrifuge head and tubes used yield an effective radius differing from 3.5 inches, the speed of rotation should be varied to compensate for the difference. Centrifugal force varies directly with radius and with the square of the angular velocity. To find the velocity in rpm needed for a different value of the radius (r), the following expression may be used:

$$\text{rpm} = \sqrt{\frac{3.5 \times (2000)^2}{r}}$$

The effective radius is measured from the center of rotation to the fritted glass in the crucible.

(b) The detailed procedure for conditioning the resin is described in DOWEX Resin Method 1 and 2.

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C-48710 (314-054)

vfm

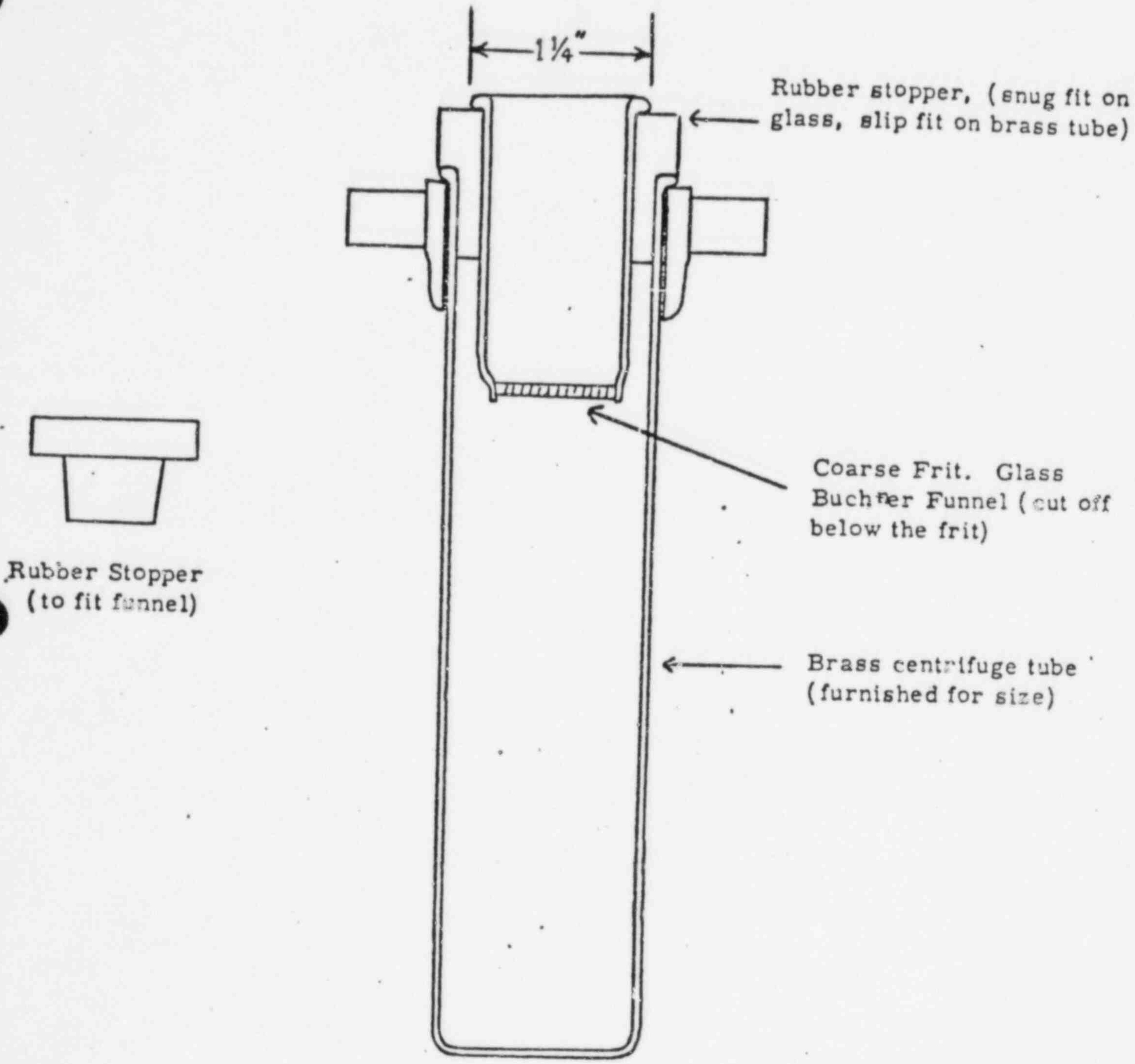
1¼"
Rubber stopper, (snug fit on glass, slip fit on brass tube)
Coarse Frit. Glass Buchner Funnel (cut off below the frit)
Brass centrifuge tube (furnished for size)
Rubber Stopper (to fit funnel)

FIGURE 1

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN 48640

ANALYTICAL METHOD

October 25, 1978

DOWEX* Resin Method 4-1

# WATER RETENTION CAPACITY OF HYDROXIDE FORM ANION EXCHANGE RESIN

## 1. Scope

This method is applicable to the determination of water retention capacity of anion exchange resin in the hydroxide form.

## 2. Safety

Hydroxide form anion exchange resin may be irritating to the skin and precautions must be taken to avoid eye and skin contact. Methanol and Karl Fischer reagent are flammable solvents and should be used in areas free of ignition sources.

## 3. Principle

The resin is centrifuged to remove all water except that retained in the resin. The water is then extracted with dry methanol and an aliquot of the methanol is titrated with Karl Fischer reagent to determine the water retention capacity of the resin.

## 4. Apparatus

(a) Centrifuge with rotor and shield to hold the filtering crucible 4(b) capable of 2000 rpm with an effective radius of 3.5 inches. An acceptable unit is International Clinical Model IEC-428 equipped with four place Rotor (IEC-215), 50 ml shield (IEC-320) and a Trunnion Ring (IEC-325) available from VWR Scientific Inc., Midland, MI 48640.

(b) Filtering crucible (special), course fritted glass Buchner funnel, 15-ml capacity (cut off and modified as shown in Figure 1). Available before modification, Corning No. 36060, from (VWR No. 30295-060) VWR Scientific Inc., Midland, MI 48640.

(c) Bottle, 2 oz., glass with polyseal cap.

(d) Pipet, 50-ml volumetric, Class A.

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*Trademark of The Dow Chemical Company

(e) Pipet, 5-ml volumetric, Class A.

(f) Shaker, Reciprocating.

(g) Karl Fischer Titrater, Metrohm Model E547 or equivalent. Available from Brinkmann Instruments, Inc., Westburg, NY 11590.

## 5. Reagents

(a) Methanol, distilled in glass, dry. Available from Brudick and Jackson Laboratories, Inc., Muskegon, MI 49442.

(b) Karl Fischer Reagent, available from VWR Scientific Inc., Midland, MI 48640.

## 6. Calibration

(a) Make the following calibration in duplicate each day when performing this analysis.

(b) With methanol in the vessel allow the Karl Fischer apparatus to come to its endpoint using a time delay of 30 seconds.

(c) Place an eyedropper of water in a small test tube and hang on balance and weigh the gross weight to the nearest 0.0001 g.

(d) Add one drop (.04-.10 g) of the water to the Karl Fischer titration vessel and start titration. Reweigh the eyedropper for tare weight. Record net ml Karl Fischer Reagent to the endpoint.

(e) Determine the factor for each of the duplicate runs as follows:

$$\text{Factor} = \frac{\text{g of water}}{\text{ml of Karl Fischer}}$$

(f) If the duplicate factors agree within 1%, average them. If they do not, repeat the calibration.

## 7. Procedure

(a) Transfer 10 to 15 ml of resin (as received) to a beaker. Cover the resin with deionized water. Transfer the resin to the special filtering crucible and cover with the rubber stopper. Centrifuge at 2000 rpm for five minutes.

(b) Discard approximately the top quarter of the resin from the crucible.

(c) Weigh 1.0-1.2 g to the nearest 0.001 g of the centrifuged resin into a dry 2-oz. bottle.

(d) With a dry pipet add 50 ml of distilled methanol, cap, and shake for 15 minutes.

(e) Allow the Karl Fischer apparatus to come to its endpoint and with a dry pipet add 5.0 ml of the distilled methanol. Determine the ml of Karl Fischer reagent to bring to the endpoint and record as "Blank ml KF".

(f) Rinse the 5-ml pipet once with the methanol extract of the resin sample and then add 5.0 ml of the extract (avoid getting resin) to the Karl Fischer apparatus which is at endpoint. Determine ml of Karl Fischer reagent to bring to the endpoint and record as "Gross ml KF".

## 8. Calculation

$$\text{\% Water Retention Capacity} = \frac{A - B}{C} \times \frac{50\ \text{ml}}{5\ \text{ml}} \times D \times 100$$

Where: A = gross ml of KF reagent
B = blank ml of KF reagent
C = sample weight in grams
D = factor from 6(c)

## 9. Precision

Data obtained by this procedure indicate a relative standard deviation of 1.42%. The values obtained may be expected to vary from the average by not more than ±2.8% relative at the 95% confidence level. This precision is also improved with sampling identical spots in the centrifuged resin (i.e. middle).

## 10. Accuracy

A series of five samples were analyzed by this method and DOWEX Resin Method 4 and agreement within the precision of the methods was obtained. Spikes of water were made to samples in addition to the water retained in the resin and recoveries ranged from 99.7 to 100.6%. Accuracy can be expected to be the same as the precision.

## 11. Note

If the centrifuge head and tubes used to yield an effective radius differing from 3.5 inches, the speed of rotation should be varied to compensate for the difference. Centrifugal force varies directly with radius and with the square of the angular velocity. To find the velocity in rpm needed for a different value of the radius (r), the following expression may be used:

$$\text{rpm} = \frac{3.5 \times (2000)^2}{r}$$

The effective radius is measured from the center of rotation to the fritted glass in the crucible.

## 12. Literature Reference

1973 Annual Book of ASTM Standards Part 23, American Society for Testing and Materials, D2187, "Standard Methods of Test for Physical and Chemical Properties of Particulate Ion-Exchange Resins".

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

The analytical procedures given herein have been adapted from literature sources or developed upon the basis of experimental data believed to be reliable. In the hands of a qualified analyst, they are expected to yield results of sufficient accuracy for their intended purposes, but recipients are cautioned to confirm the suitability of the methods by appropriate tests. Recipients are also cautioned that The Dow Chemical Company makes no representation or warranty that the practice of the method described herein does not infringe third party patents. Anyone wishing to reproduce or publish the materials in whole or in part should request written permission from The Dow Chemical Company.

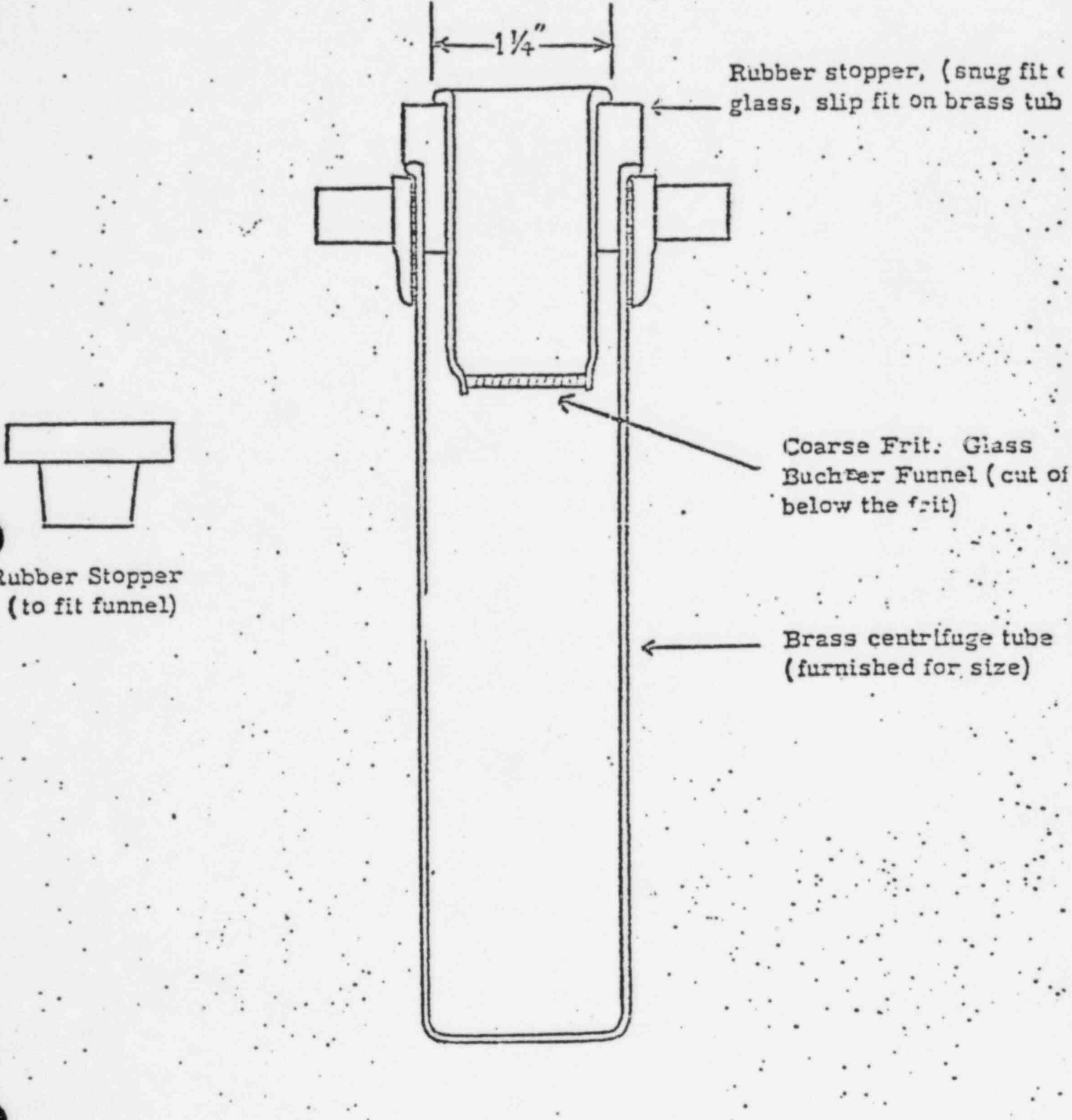

1¼"
Rubber stopper, (snug fit o
glass, slip fit on brass tub
Coarse Frit: Glass
Buchner Funnel (cut of
below the frit)
Brass centrifuge tube
(furnished for size)
Rubber Stopper
(to fit funnel)

FIGURE 1

# DOWEX* Ion I

# GENERAL

| | | RESIN | TYPE COPOLYMER PHYSICAL FORM | ACTIVE GROUP | †GRADE | IONIC FORM AS SHIPPED | APPROXIMATE SHIPPING WEIGHT lb/cu ft | STANDARD MESH SIZE-WET MAXIMUM % +16 | +20 | FINE | PRESSURE DRO AT 25°C APPROXIMATE psi/ft at 5 GPM/ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANION EXCHANGE RESINS | GEL | DOWEX SBR | STRONG BASE TYPE I<br>STYRENE-DVB<br>SPHERICAL BEADS | $-N^+(CH_3)_3$ | S | $Cl^-$ | 44 | 5% | | 3%-50 | 0.4 |
| | | | | | C/N | $Cl^-$ | 44 | 2% | 20% | 1%-45 | 0.35 |
| | | | | | C/N | $OH^-$ | 41 | 2% | 20% | 1%-45 | 0.3 |
| | | | | | S | $OH^-$ | 41 | | | 0.5%-50 | 0.35 |
| | | DOWEX SBR-P | STRONG BASE POROUS TYPE I<br>STYRENE-DVB<br>SPHERICAL BEADS | $-N^+(CH_3)_3$ | S | $Cl^-$ | 43 | 2% | | 2%-50 | 0.4 |
| | | | | | C/N | $Cl^-$ | 43 | 2% | 20% | 1%-45 | 0.35 |
| | | | | | C/N | $OH^-$ | 40 | 2% | 20% | 1%-45 | 0.3 |
| | | DOWEX 11 | DITTO SBR-P<br>UNIQUE POROSITY | DITTO SBR-P | S | $Cl^-$ | 42 | 3% | | 2%-50 | 0.4 |
| | | DOWEX SAR | STRONG BASE TYPE II<br>STYRENE-DVB<br>SPHERICAL BEADS | $-N^{\pm}(CH_3)_2(CH_2CH_2OH)$ | S | $Cl^-$ | 44 | 5% | | 3%-50 | 0.4 |
| | MACROPOROUS | DOWEX MSA-1 | STRONG BASE TYPE I<br>MACROPOROUS<br>STYRENE-DVB<br>SPHERICAL BEADS | $-N^+(CH_3)_3$ | S | $Cl^-$ | 42 | 2% | | 3%-50 | 0.45 |
| | | | | | C | $Cl^-$ | 42 | 2% | | 1%-45 | .32 |
| | | DOWEX MSA-2 | STRONG BASE TYPE II<br>MACROPOROUS S-DVB<br>SPHERICAL BEADS | $-N^{\pm}(CH_3)_2(CH_2CH_2OH)$ | S | $Cl^-$ | 42 | 2% | | 3%-50 | 0.45 |
| | | DOWEX MWA-1 | WEAK BASE<br>MACROPOROUS S-DVB<br>SPHERICAL BEADS | $-N-(CH_3)_2$ | S | FREE AMINE | 40 | 2% | | 3%-50 | 0.45 |
| | EPI-$NH_3$ | DOWEX WGR | WEAK BASE<br>EPOXY AMINE<br>HARD PARTICLES | $-N(R)_2$, $-NHR$<br>$-NH_2$ | S | FREE AMINE | 43 | 10% | | 5%-40 | 0.45 |
| | | DOWEX WGR-2 | INTERMEDIATE BASE<br>EPOXY AMINE<br>HARD PARTICLES | $-N(R)_2$, $-NHR$<br>$-NH_2$, $-N^+(R)_3$ | S | FREE AMINE | 43 | 10% | | 5%-40 | 0.45 |
| CATION EXCHANGE RESINS | GEL | DOWEX HCR-S | STRONG ACID<br>CATION EXCHANGER<br>STYRENE-DVB<br>SPHERICAL BEADS | $-SO_3^-$ | S | $Na^+$ | 53 | 5% | | 1%-50 | 0.4 |
| | | | | | S | $H^+$ | 50 | 5% | | 1%-50 | 0.4 |
| | | | | | N | $H^+$ | 50 | 5% | | 0.5%-50 | 0.4 |
| | | | | | N | $Li^+$ | 50 | — | | 0.5%-50 | 0.4 |
| | | | | | S | $NH_4^+$ | 51.5 | 5% | | 1%-50 | 0.4 |
| | | DOWEX HGR | STRONG ACID<br>CATION EXCHANGER<br>STYRENE-DVB<br>SPHERICAL BEADS | $-SO_3^-$ | S | $Na^+$ | 54.0 | 5% | | 1%-50 | 0.4 |
| | | | | | S | $H^+$ | 51.0 | 5% | | 1%-50 | 0.4 |
| | | DOWEX HCR-W2 | STRONG ACID<br>CATION EXCHANGER<br>STYRENE-DVB<br>SPHERICAL BEADS | $-SO_3^-$ | S | $Na^+$ | 53 | 2% | | 1%-40 | 0.32 |
| | | | | | C/N | $H^+$ | 50 | 2% | | 1%-40 | 0.32 |
| | | DOWEX HGR-W2 | | | S | $Na^+$ | 54 | 2% | | 1%-40 | 0.4 |
| | | | | | C/N | $H^+$ | 51 | 2% | | 1%-40 | 0.4 |
| | MACROPOROUS | DOWEX MSC-1 | STRONG ACID<br>CATION EXCHANGER<br>MACROPOROUS S-DVB<br>SPHERICAL BEADS | $-SO_3^-$ | S | $Na^+$ | 50 | 8% | | 5%-40 | 0.4 |
| | | | | | C | $Na^+$ | 50 | 2% | | 1%-40 | 0.32 |
| | | | | | S | $H^+$ | 47 | 8% | | 5%-40 | 0.4 |
| | | | | | C | $H^+$ | 47 | 2% | | 1%-40 | 0.32 |
| | ACRYLIC | DOWEX CCR-2 | WEAK ACID<br>CATION EXCHANGER<br>SPHERICAL BEADS | $-C(=O)OH$ | S | $H^+$ | 47 | 10% | | 5%-50 | 0.5 |

†GRADES S = STANDARD; C = CONDENSATE POLISHING; N = NUCLEAR

| MIXED RESINS NUCLEAR GRADE | RESIN | MIXTURE STRONG ACID CATION: STRONG BASE ANION | GRADE | IONIC FORMS C:A | SHIPPING WT. lb/ft³ | COMPONENT DOWEX RESIN AND GRADE ( ) FROM ABOVE | OPERATING CAPACITY KgrCaCO₃ PER FT.³ |
|---|---|---|---|---|---|---|---|
| | MR-3 | 1:1 EQUIVALENTS | C-N | H:OH | 45 60% | HCR-W2-H(C/N):SBR-OH(C/N) AT | 43-48 — [illegible] |
| | | 1:1 EQUIVALENTS | S | H:OH | 45 30% | HCR-S-H(S):SBR-OH(S) <AT | 49-48 ~ 12 |
| | MR-5 | 1:1 EQUIVALENTS | N | Li:OH | 45 | HCR-S-Li(N):SBR-OH(C/N) | 12 |
| | MR-6 | 1:1 EQUIVALENTS | N | Li:OH | 45 | HCR-S-Li(N):SBR-OH(C/N) | 12 |
| | MR-7 | 1:1 EQUIVALENTS | N | $NH_4$:OH | 45 | HCR-S-$NH_4$(N):SBR-OH(C/N) | 12 |
| | MR-12 | 2:1 VOLUME | N | H:OH | 47 | HCR-W2-H(C/N):SBR-P-OH(C/N) | — |

Mike A.t.mill

ate
anion
capacity

1" W2
R HYDR

48% MOISTURE
BY WEIGHT
INSIDE

Appendix 10.6.13

# xchange Resins
# ROPERTIES

| BED EXPANSION AT 25°C APPROXIMATE % | AT GPM/Ft² | WATER RETENTION CAPACITY % RANGE | TOTAL WET VOLUME EXCHANGE CAPACITY MINIMUM EQUIVALENTS/LITER | VOLUME CHANGE % SWELLING | REMARKS | DETAILED DATA SOURCE T.D. INDEX |
|---|---|---|---|---|---|---|
| 80 | 4 | 43-48 | 1.4 | Cl ⟶ OH ≅ +15% | Standard, high sphericity resin suite; for water demineralization where organic fouling problems are minimal. Silica, weak acid, and strong acid removal. Excellent oxidative stability. "C" Grades primarily designed for high flow rate applications and where maximum oxidative stability is required. "C" Grade bead strength averages > 350 grams/bead | 220.01<br>530.01 |
| 80 | 4.2 | 43-48 | 1.4 | | | |
| 80 | 3.2 | MAX 60% | 1.1 | | | |
| 80 | 3.4 | 55-65 | 1.1 | | | |
| 80 | 4 | 53-60 | 1.2 | Cl ⟶ OH ≅ 20% | Standard gel resin with porous gel structure to improve resistance to organic fouling and removal of mineral acids during regeneration. Highest regeneration efficiency of Type I resin. "C" Grade is widely used for deep bed condensate polishing. "C" Grade bead strength averages > 350 grams/bead. | 230.01<br>534.01 |
| 80 | 4.2 | 50-57 | 1.2 | | | |
| 80 | 3.1 | 60-70 | 1.0 | | | |
| 80 | 4.0 | 55-60 | 1.1 | Cl ⟶ OH ≅ 20% | Best organic fouling resistance. Recommended for highest purity water production in mixed beds. | 240.01<br>535.01 |
| 80 | 4.0 | 38-45 | 1.4 | Cl ⟶ OH ≅ 14% | High efficiency resin for general demineralizing service. Better efficiency than Type I for chloride and sulfate removal with high physical strength but lower thermal stability. | 210.01<br>533.01<br>560.00 |
| 80 | 3.0 | 56-64 | 1.0 | Cl ⟶ OH ≅ 18% | Exceptional physical and osmotic shock stability make this resin most useful in systems using moving bed contactor and where high osmotic forces are involved, such as in chemical processing applications. | 250.01<br>536.01 |
| 80 | 3.2 | 56-64 | 1.0 | | | |
| 80 | 3.0 | 53-60 | 1.0 | Cl ⟶ OH ≅ 14% | High capacity, excellent regenerant efficiency and good silica removal in counter current regeneration systems. Limited thermal stability. | |
| 80 | 3.0 | 50-60 | 1.0 | FREE AMINE TO HCl ≅ 20% | Highly stable physically, thermally, oxidatively, and osmotically. Ideal for chemical processing applications and plating waste processing. | 320.01 |
| 80 | 80 | ≅ 50% | MINIMUM OPERATING CAPACITY AT 5 lb NaOH/Cu Ft ≈ 1.14 | FREE AMINE TO HCl FORM ≅ 25% | Very high operating capacity at near theoretical regeneration efficiency combined with low taste and odor throw make this resin excellent for potable water deionization. | 310.01 |
| 80 | 60 | ≅ 50% | | | High capacity, high regenerant utilization efficiency. Stability to oxidation provides long term low rinse making resin ideal in three bed systems. Good organic acid removal. | 330.01 |
| 50 | 7.0 | 44-48 | 2.0 | Na ⟶ H ≅ 8% | Standard cation resin with good physical characteristics. Ideally suited for water softening and makeup demineralizers. Nuclear grade and special ionic forms are applicable to radwaste demineralizers. Also available as components of the mixed resins listed below. Structure based on styrene with 8% divinylbenzene crosslinkage for optimum cost/property balance. | 110.01 |
| 50 | 6.5 | 50-56 | 1.8 | | | |
| 50 | 6.5 | 50-56 | 1.8 | | | |
| 50 | 6.5 | 55 MAX | 1.8 | | | |
| 50 | 7.0 | 42-46 | 2.0 | | | |
| 50 | 8.0 | 38-43 | 2.2 | Na ⟶ H ≅ 8% | 10% divinylbenzene crosslinked version of HCR-S. Particularly applicable to systems requiring somewhat greater resistance to oxidative degradation, both softening and deionization applications. | 130.01 |
| 50 | 8.5 | 46-51 | 2.0 | | | |
| 50 | 8.0 | 44-48 | 2.0 | Na ⟶ H ≅ 8% | Premium 8% divinylbenzene resin. Higher bead strength and purity suitable for nuclear applications. Particle size distribution is controlled for optimum operation in deep bed condensate polishers and mixed beds. | 120.04 |
| 50 | 7.0 | 50-55 | 1.8 | | | |
| 50 | 8.0 | 38-43 | 2.2 | | Premium 10% divinylbenzene version of the above, offering improved stability to oxidative degradation. Higher density for optimum separation in a mixed bed with DOWEX SBR resin. | 140.02 |
| 50 | 8.5 | 46-49 | 2.0 | | | |
| 50 | 8.4 | 44-50 | 1.7 | Na ⟶ H ≅ 4% | Provides excellent osmotic shock and oxidative degradation resistance in aqueous chemical processing and water treatment applications, including hot process softeners. Hydrogen form is also recommended for catalytic applications requiring an acid catalyst at temperatures to 120°C. Resin suitable for processing non-aqueous solutions. | 180.01 |
| 50 | 7.4 | 44-50 | 1.7 | | | |
| 50 | 6.0 | 50-56 | 1.6 | | | |
| 50 | 7.4 | 50-56 | 1.8 | | | |
| 50 | 4.2 | 48-58 | 3.0 | H ⟶ Ca + 15%<br>H ⟶ Na + 45-60% | Recommended for dealkalization of water for steam flooding or cooling tower applications as well as adjunct to strong acid cation in deionization processes. | 171.01<br>563.01 |

## Additional Information

REGENERATION: Strong Acid Cation Resins — typically 10-26% NaCl for sodium cycle; 4-10% HCl or 2-8% $H_2SO_4$ stepwise for hydrogen cycle.

Weak Acid Cation Resins — typically 4-10% HCl or 1-5% $H_2SO_4$ stepwise for hydrogen cycle; stepwise regeneration with sulfuric acid is need to control $CaSO_4$ precipitation.

Strong Base Anion Resins — typically 4% NaOH solution.

Weak Base Resins — typically 2-4% NaOH solution. Other bases such as $NH_4OH$ and $Na_2CO_3$ can be used at equivalent concentrations.

THERMAL STABILITY: Strong Acid Cation Exchange Resins — good to 150°C.
Weak Acid Cation Exchange Resins — good to 120°C.
Strong Base Type I Anion Resin — Cl form good to 100°C; OH⁻ form to 50°C.
Strong Base Type II Anion Resin — Cl form good to 77°C; OH⁻ form good to 35°C.
Weak Base Anion Resins (Epoxy Amine Type) good to 60°C (macroporous type) good to 100°C.

DOWEX resins listed except DOWEX WGR-2 meet the FDA requirements of Title 21, Subpart A, 173.25.

Warning: Nitric Acid and other oxidizing agents [illegible] reactions when mixed with organic materials such as ion

# APPENDIX 10.7

# MANUFACTURER SPECIFICATION OF POWDEX

**GRAVER CHEMICAL**
Division of The Graver Company

## POWDEX SPECIFICATIONS

## HYDROXIDE FORM ANION

| | |
|---|---|
| DESIGNATION | ANION (PAO) |
| RESIN TYPE | STRONG BASE |
| TOTAL CAPACITY | $\geq$4.0 MEQ/DRY GRAM |
| IONIC FORM | HYDROXIDE |
| MOISTURE | 57% (AVERAGE) |
| AVERAGE SIZE | 35 - 45 MICRONS |
| PARTICLE SIZE | IRREGULAR |
| SITE COMPOSITION | $>$92% $OH^-$<br>$<$2% $Cl^-$<br>$<$5% $CO_2$<br>$<$5% $SO_4$ |
| CONTAMINANTS (METALS) | $<$100 ppm Fe as Fe<br>$<$10 ppm Cu as Cu<br>$<$50 ppm Al as Al<br>$<$25 ppm Pb as Pb |
| PERCENT WHOLE BEADS (maximum) | $\leq$5% |

Rev. 3/3/83

GRAVER CHEMICAL
Division of The Graver Company

## POWDEX SPECIFICATIONS

## HYDROGEN FORM CATION

| | |
|---|---|
| DESIGNATION | CATION (PCH) |
| RESIN TYPE | STRONG ACID |
| TOTAL CAPACITY | ≥4.8 MEQ/DRY GRAM |
| IONIC FORM | HYDROGEN |
| MOISTURE | 60% (AVERAGE) |
| AVERAGE SIZE | 35-45 MICRONS |
| PARTICLE SHAPE | IRREGULAR |
| SITE COMPOSITION | >99% H+ |
| CONTAMINANTS (METALS) | <50 ppm Fe as Fe<br><10 ppm Cu as Cu<br><100 ppm Na as Na<br><25 ppm Pb as Pb |
| PERCENT SODIUM SITES | <0.25% |
| PERCENT WHOLE BEADS (maximum) | ≤5% |

Rev. 3/3/83

GRAVER CHEMICAL
Division of The Graver Company

# ECODEX SPECIFICATIONS

| | |
|---|---|
| *DESIGNATION | ECODEX |
| RESIN TYPE | STRONG BASE/STRONG ACID |
| IONIC FORM | HYDROGEN/HYDROXIDE OR AMMONIUM/HYDROXIDE |
| %MOISTURE | 65% (AVERAGE) |
| PARTICLE SHAPE | IRREGULAR |
| PERCENT WHOLE BEADS (maximum) | 2% |
| TURBIDITY | $\leq 3$ NTU |
| SETTLED VOLUME - $V/V_{15}$ | 55-80% |

*Resins in P grade Ecodex products conform to PAO, PCH, PCN specifications.

The mixed powdered resin/fiber precoat material must be a homogeneous mixture which is applied as a single component precoat. Chemical or material additives for adjustment of precoat floc or supernatant turbidity <u>shall</u> <u>not</u> be required.

Rev. 3/3/83

# TOTAL MOISTURE OF ANION POWDEX .

## APPLICATION:

This method determines the total (as packaged) moisture of hydroxide form Powdex anion resin.

## PRINCIPLE:

The hydroxide form Powdex anion is converted to the chloride form by slurrying with a solution of hydrochloric acid. After filtering off the acid and rinse water, the sample is transferred to a microwave oven and dried. The moisture content is determined by calculating the dry weight versus the wet weight.

## APPARATUS:

1 - beaker, 250 ml.
1 - laboratory balance
1 - graduated cylinder, 200 ml.
1 - magnetic stirrer
1 - spin bar, 1"
1 - timer
1 - glass fibered filter paper, 15.0 CM Whatman 934 AH
1 - buchner funnel, 12.5 CM I.D.
1 - vacuum source
1 - microwave oven (CEM Corporation Model MDS 81)

## REAGENTS:

1.0 N $NH_4Cl$
D.I. water

## PROCEDURE:

1. Approximately 10 grams of the Powdex anion are weighed into a tared 250 ml. beaker. Record the weight.

2. Add 160 mls. of 1.0 N $NH_4Cl$ to the beaker.

3. Stir for 10 minutes at a moderate mixing speed. Weigh the filter paper and record the weight.

4. The filter paper is moistened and then placed into the funnel. The edges of the filter paper are molded around the inside circumference of the funnel, so as to form a lip all the way around.

## TOTAL MOISTURE OF ANION POWDEX (CONT'D)

5. The contents of the 250 ml. beaker (excluding the spin bar) are poured into the buchner funnel/vacumm assembly and filtered.

6. After filtration of the acid, the resin cake is rinsed with 300 mls. of D.I. water.

7. The filter paper holding the resin cake is carefully removed from the funnel and placed on top of another filter paper. The traces of resin left in the funnel are carefully scraped out and transferred to the filter paper.

8. The two filter papers are then transferred to the microwave oven and dried for five minutes at 100% power. After drying, the filter paper holding the resin cake is weighed. Record the weight.

CALCULATION:

$$\text{Percent Moisture}=1-\left[\frac{(.928)\ (Cl^{-}RW-FP)}{\text{Weight of Wet OH Resin}}\right]\ X\ 100$$

$Cl^{-}RW$=Weight of Dry Chloride Resin cake
FP=Filter Paper Weight

NOTES:

A. The conversion factor of 0.928 assumes an anion capacity of 4.20 meq./dry gm. OH form.

B. Make sure that all excess rinse water is filtered off before removing the filter paper from the funnel.

C. Do not rinse the traces of resin from the funnnel, just scrape these out as quantitatively as possible.

D. Apply vacuum prior to filtering to ensure a good seal.

# TOTAL MOISTURE OF CATION POWDEX

## APPLICATION:

This method determines the total (as packaged) moisture of hydrogen and ammonium forms of Powdex cation resins.

## PRINCIPLE:

A sample of the material is transferred to a microwave oven and dried. The moisture content is determined by calculating the dry weight versus the wet weight.

## APPARATUS:

1 - beaker, 125 ml.
1 - laboratory balance
1 - watch glass, 90 mm. diameter
1 - microwave oven (CEM Corporationn Model MDS 81)

## PROCEDURE:

1. Approximatley 8 grams of the Powdex cation are weighed onto the tared watch glass. Record the weight.

2. The watch glass is transferred to the microwave oven and placed on top of the 125 ml. beaker. Dry for 5 minutes at 100% power.

3. After drying, the dried resin is weighed. Record the weight.

## CALCULATION:

$$\text{Percent Moisture} = \frac{A - B}{A} \times 100$$

Where A = weight of wet Powdex cation
Where B = weight of dry Powdex cation

NOTES:

A. Spread the sample over the surface of the watch glass so as to obtain a thin, uniform layer.

# TOTAL MOISTURE OF ECODEX

## APPLICATION:

This method determines the total (as packaged)moisture of all H and N forms of Ecodex.

## PRINCIPLE:

The hydroxide component of the Ecodex is converted to the chloride form after conversion and rinsing. The sample is transferred to a microwave oven and dried. The moisture content is determined by calculating the dry weight versus the wet weight.

## APPARATUS:

1 - beaker, 250 ml.
1 - laboratory balance
1 - graduated cylinder, 200 ml.
1 - magnetic stirrer
1 - spin bar, 1"
1 - timer
1 - glass fibered filter paper, 15.0 CM Whatman No. 934 AH
1 - buchner funnel, 12.5 CM I.D.
1 - vacuum source
1 - vacuum flask, 500 mls.
1 - microwave oven (CEM) Corp. Model MDS 81)

## REAGENTS:

1.0N HCl
1.0N $NH_4Cl$

1. Approximately 10 wet grams of the Ecodex are weighed into a tared 250 ml. beaker. Record the weight.

2. Add 160 mls. of either 1.0N HCl or 1.0N $NH_4Cl$ to the beaker. (use HCl for Ecodex hydrogen forms and $NH_4Cl$ for Ecodex ammonia forms).

3. Stir for 10 minutes at a moderate mixing speed.

4. Weigh the filter paper and record the weight.

## TOTAL MOISTURE OF ECODEX (cont'd)

5. The filter paper is moistened then placed into the funnel. The edges of the filter paper are molded around the inside circumference of the funnel so as to form a lip all the way around.

6. The contents of the 250 ml. beaker (excluding the spin bar) are filtered. The resin cake is then rinsed with 300 mls.of D.I. water.

7. The filter paper holding the resin cake is carefully removed from the funnel and placed on top of another filter paper. The traces of resin left in the funnel are carefully scraped out and transferred to the filter paper.

8. The two filter papers are then transferred to the microwave oven and dried for 5 minutes at full power. After drying, the filter paper holding the resin cake is weighed. Record the weight.

CALCULATIONS:

For 1111 Ratios:

Dry weight Cl form Ecodex = weight of dry resin cake - weight of filter paper.
Dry weight OH form Ecodex = (0.25) (dry wt. Cl Ecodex) (.928) + (0.75) (dry wt. Cl Ecodex)

For 1245 Ratios:

Dry weight Cl form Ecodex = weight of dry resin cake - weight of filter paper.
Dry weight Powdex component = (dry wt. Cl form Ecodex) (0.67)

Dry weight fiber component = (dry wt. Cl form Ecodex) (0.33)

Dry weight OH anion = (dry wt. Powdex component) (0.56)(0.928)

Dry weight cation = (dry wt. Powdex component) (0.44)
Dry weight OH form Ecodex = (dry wt. of fiber) + (dry wt.of cation) + (dry wt. OH anion)

Percent Moisture:

$$1-\left(\frac{\text{grams of dry OH form Ecodex}}{\text{grams of wet OH form Ecodex}}\right) \times 100$$

## TOTAL MOISTURE OF ECODEX (cont'd)

NOTES:

1. One moisture is run for each sample collected. Report the average moisture of the individual samples.

2. The conversion factor of 0.928 assumes an anion capacity of 4.20 meq./dry grams hydrogen form.

3. Make sure that all excess rinse water is filtered off before removing the filter paper from the funnel.

4. Apply vacuum prior to filtering to ensure a good seal.

Form Approved
OMB No. 44-R1387

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

# MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

## SECTION I

| | |
|---|---|
| MANUFACTURER'S NAME<br>Ecodyne - Graver Water Division | EMERGENCY TELEPHONE NO.<br>(201) 964-2400 |
| ADDRESS *(Number, Street, City, State, and ZIP Code)*<br>2720 U.S. Highway, Union, New Jersey 07083 | TELEX 230-138215 |
| CHEMICAL NAME AND SYNONYMS<br>Powdered Ion Exchange Material | TRADE NAME AND SYNONYMS<br>Powdex Anion PAO |
| CHEMICAL FAMILY Organic Co-Polymer | FORMULA Styrene - Divinylbenzene |

## SECTION II - HAZARDOUS INGREDIENTS

| PAINTS, PRESERVATIVES, & SOLVENTS | | % | TLV (Units) | ALLOYS AND METALLIC COATINGS | | % | TLV (Units) |
|---|---|---|---|---|---|---|---|
| PIGMENTS | None | | | BASE METAL | None | | |
| CATALYST | None | | | ALLOYS | None | | |
| VEHICLE | None | | | METALLIC COATINGS | None | | |
| SOLVENTS | None | | | FILLER METAL PLUS COATING OR CORE FLUX | None | | |
| ADDITIVES | None | | | OTHERS | None | | |
| OTHERS | None | | | | | | |

| HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES | % | TLV (Units) |
|---|---|---|
| | | |
| None | | |
| | | |
| | | |

## SECTION III - PHYSICAL DATA

| | | | | |
|---|---|---|---|---|
| BOILING POINT (°F.) | N.A. | SPECIFIC GRAVITY ($H_2O$=1) | 1.1 | |
| VAPOR PRESSURE (mm Hg.) | 0 | PERCENT, VOLATILE BY VOLUME (%) | 55-60 | (Water) |
| VAPOR DENSITY (AIR=1) | N.A. | EVAPORATION RATE (_________ =1) | | 0 |
| SOLUBILITY IN WATER | 0 | Density | 30-35 | $lbs/ft^3$ |
| APPEARANCE AND ODOR | Moist, Beige Powder, Amine Odor | | | |

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

| | | | | |
|---|---|---|---|---|
| FLASH POINT (Method used) | >500° F (Open Cup) | FLAMMABLE LIMITS | Lel<br>N.A. | Uel<br>N.A. |
| EXTINGUISHING MEDIA | $H_2O$; $CO_2$; Sand | | | |
| SPECIAL FIRE FIGHTING PROCEDURES | None | | | |
| UNUSUAL FIRE AND EXPLOSION HAZARDS | None | | | |

Appendix 10.7.10

## SECTION V - HEALTH HAZARD DATA

RESHOLD LIMIT VALUE
N.A.

FECTS OF OVEREXPOSURE
May remove essential anions from body fluids (CL, $SO_4$, $PO_4$)
May act as a mild caustic on exposed body tissues.

EMERGENCY AND FIRST AID PROCEDURES

Wash thoroughly with water if skin irritation occurs.
Use Water in eyecup if eye irritation occurs.

## SECTION VI - REACTIVITY DATA

| | | | |
|---|---|---|---|
| STABILITY | UNSTABLE | | CONDITIONS TO AVOID |
| | STABLE | X | Fire or Extreme Heat |

INCOMPATABILITY *(Materials to avoid)* Strong Concentrated Oxidizing Agents i.e. $HNO_3$

HAZARDOUS DECOMPOSITION PRODUCTS Trimethylamine; Styrene; Nitrogen Oxides

| | | | |
|---|---|---|---|
| HAZARDOUS POLYMERIZATION | MAY OCCUR | | CONDITIONS TO AVOID |
| | WILL NOT OCCUR | X | |

## SECTION VII - SPILL OR LEAK PROCEDURES

PS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep up or wash away with water.

WASTE DISPOSAL METHOD

Burial

## SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)* Not normally necessary

| | | | | |
|---|---|---|---|---|
| VENTILATION | LOCAL EXHAUST | Not required | SPECIAL | None |
| | MECHANICAL *(General)* | Not required | OTHER | None |

| | | | |
|---|---|---|---|
| PROTECTIVE GLOVES | Not required | EYE PROTECTION | Safety Goggles |

OTHER PROTECTIVE EQUIPMENT If dust is present, use suitable respirator.

## SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

void hand to eye contact while working with material.

OTHER PRECAUTIONS

Spilled material may be slippery; do not walk on.

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

# MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing,
Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

## SECTION I

**MANUFACTURER'S NAME** Ecodyne - Graver Water Division

**EMERGENCY TELEPHONE NO.** (201) 964-2400

**ADDRESS** *(Number, Street, City, State, and ZIP Code)* 2720 U.S. Highway 22, Union, New Jersey 07083

TELEX 230-138215

**CHEMICAL NAME AND SYNONYMS** Powdered Ion Exchange Material

**TRADE NAME AND SYNONYMS** Powdex Cation PCH

**CHEMICAL FAMILY** Organic Co-Polymer

**FORMULA** Styrene - Divinylbenzene

## SECTION II - HAZARDOUS INGREDIENTS

| PAINTS, PRESERVATIVES, & SOLVENTS | | % | TLV (Units) | ALLOYS AND METALLIC COATINGS | | % | TLV (Units) |
|---|---|---|---|---|---|---|---|
| PIGMENTS | None | | | BASE METAL | None | | |
| CATALYST | None | | | ALLOYS | None | | |
| VEHICLE | None | | | METALLIC COATINGS | None | | |
| SOLVENTS | None | | | FILLER METAL PLUS COATING OR CORE FLUX | None | | |
| ADDITIVES | None | | | OTHERS | None | | |
| OTHERS | None | | | | | | |

| HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES | % | TLV (Units) |
|---|---|---|
| | | |
| None | | |
| | | |
| | | |

## SECTION III - PHYSICAL DATA

| | | | | |
|---|---|---|---|---|
| BOILING POINT (°F.) | N.A. | SPECIFIC GRAVITY ($H_2O$=1) | 1.3 | |
| VAPOR PRESSURE (mm Hg.) | 0 | PERCENT, VOLATILE BY VOLUME (%) | 55-65 | (Water) |
| VAPOR DENSITY (AIR=1) | N.A. | EVAPORATION RATE (________ =1) | | 0 |
| SOLUBILITY IN WATER | 0 | Density | 50-55 | lbs/ft$^3$ |

**APPEARANCE AND ODOR** Moist Brown Powder, Odorless

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

**FLASH POINT** (Method used) >500° F (Open Cup)

**FLAMMABLE LIMITS** Lel N.A. Uel N.A.

**EXTINGUISHING MEDIA** $H_2O$; $CO_2$ ; Sand

**SPECIAL FIRE FIGHTING PROCEDURES**
None

**UNUSUAL FIRE AND EXPLOSION HAZARDS**
None

## SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE N.A.

CTS OF OVEREXPOSURE

May remove essential cations from body fluids. (Ca; Mg; Na; K.)

May act as a mild acid on exposed body tissues.

EMERGENCY AND FIRST AID PROCEDURES

Wash thoroughly with water if skin irritation occurs.

Use water in eyecup if eye irritation occurs.

## SECTION VI - REACTIVITY DATA

| | | | |
|---|---|---|---|
| STABILITY | UNSTABLE | | CONDITIONS TO AVOID |
| | STABLE | X | Fire or Extreme Heat |

INCOMPATABILITY *(Materials to avoid)* Strong Concentrated Oxidizing Agents i.e. $HNO_3$

HAZARDOUS DECOMPOSITION PRODUCTS Styrene; Sulfur Oxides; Nitrogen Oxides.

| | | | |
|---|---|---|---|
| HAZARDOUS POLYMERIZATION | MAY OCCUR | | CONDITIONS TO AVOID |
| | WILL NOT OCCUR | X | |

## SECTION VII - SPILL OR LEAK PROCEDURES

S TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep up or wash away with water.

WASTE DISPOSAL METHOD

Burial

## SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)* Not normally necessary.

| | | | | |
|---|---|---|---|---|
| VENTILATION | LOCAL EXHAUST | Not required | SPECIAL | None |
| | MECHANICAL *(General)* | Not required | OTHER | None |

PROTECTIVE GLOVES Not required

EYE PROTECTION Safety Goggles

OTHER PROTECTIVE EQUIPMENT If dust is present, use suitable respirator.

## SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Avoid hand to eye contact while working with material.

OTHER PRECAUTIONS

Spilled material may be slippery; do not walk on.

Form Approved
OMB No. ~~44~~-R1387

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

# MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

## SECTION I

| | |
|---|---|
| MANUFACTURER'S NAME<br>Ecodyne - Graver Water Division | EMERGENCY TELEPHONE NO.<br>(201) 964-2400 |
| ADDRESS (Number, Street, City, State, and ZIP Code)<br>2720 U.S. Highway 22, Union, New Jersey 07083 | TELEX 230-138215 |
| CHEMICAL NAME AND SYNONYMS<br>Powdered Ion Exchange Filter Material | TRADE NAME AND SYNONYMS<br>Ecodex |
| CHEMICAL FAMILY<br>Organic Co-Poymer | FORMULA<br>Styrene - Divinylbenzene + Fiber |

## SECTION II - HAZARDOUS INGREDIENTS

| PAINTS, PRESERVATIVES, & SOLVENTS | | % | TLV (Units) | ALLOYS AND METALLIC COATINGS | | % | TLV (Units) |
|---|---|---|---|---|---|---|---|
| PIGMENTS | None | | | BASE METAL | None | | |
| CATALYST | None | | | ALLOYS | None | | |
| VEHICLE | None | | | METALLIC COATINGS | None | | |
| SOLVENTS | None | | | FILLER METAL PLUS COATING OR CORE FLUX | None | | |
| ADDITIVES | None | | | OTHERS | None | | |
| OTHERS | None | | | | | | |

| HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES | % | TLV (Units) |
|---|---|---|
| None | | |

## SECTION III - PHYSICAL DATA

| | | | |
|---|---|---|---|
| BOILING POINT (°F.) | N.A. | SPECIFIC GRAVITY ($H_2O$=1) | 1.2 |
| VAPOR PRESSURE (mm Hg.) | 0 | PERCENT, VOLATILE BY VOLUME (%) | 65-70 (Water) |
| VAPOR DENSITY (AIR=1) | N.A. | EVAPORATION RATE (______ =1) | 0 |
| SOLUBILITY IN WATER | 0 | Density 40-42 | lbs/ft$^3$ |
| APPEARANCE AND ODOR | Moist, Beige Powder, Odorless | | |

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

| | | | |
|---|---|---|---|
| FLASH POINT (Method used)<br>>500° F (Open Cup) | FLAMMABLE LIMITS | Lel<br>N.A. | Uel<br>N.A. |

EXTINGUISHING MEDIA $H_2O$; $CO_2$; Sand

SPECIAL FIRE FIGHTING PROCEDURES
None

UNUSUAL FIRE AND EXPLOSION HAZARDS
None

Appendix 10.7.14

(Continued on reverse side)

Form OSHA-20

## SECTION V - HEALTH HAZARD DATA

HRESHOLD LIMIT VALUE N.A.

ECTS OF OVEREXPOSURE

Ion exchange portion may remove essential cations or anions from body fluids.

Inhalation or eye contact may produce irritation.

EMERGENCY AND FIRST AID PROCEDURES

Wash thoroughly with water if skin irritation occurs.

Use water in eyecup if eye irritation occurs.

## SECTION VI - REACTIVITY DATA

| | | | |
|---|---|---|---|
| STABILITY | UNSTABLE | | CONDITIONS TO AVOID |
| | STABLE | X | Fire or Extreme Heat |

INCOMPATABILITY (Materials to avoid) Strong Concentrated Oxidizing Agents i.e. $HNO_3$

HAZARDOUS DECOMPOSITION PRODUCTS Styrene: Sulfur and Nitrogen Oxides; Trimethylamine

| | | | |
|---|---|---|---|
| HAZARDOUS POLYMERIZATION | MAY OCCUR | | CONDITIONS TO AVOID |
| | WILL NOT OCCUR | X | |

## SECTION VII - SPILL OR LEAK PROCEDURES

PS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep up or wash away with water.

WASTE DISPOSAL METHOD

Burial

## SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) Not normally necessary

| | | | | |
|---|---|---|---|---|
| VENTILATION | LOCAL EXHAUST | Not required | SPECIAL | None |
| | MECHANICAL (General) | Not required | OTHER | None |

PROTECTIVE GLOVES Not required

EYE PROTECTION Safety Goggles

OTHER PROTECTIVE EQUIPMENT If dust is present, use suitable respirator.

## SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Avoid hand to eye contact while working with material.

OTHER PRECAUTIONS

Spilled material may be slippery; do not walk on.

# APPENDIX 10.8

# ATMOSPHERIC DATA

# APPENDIX

## ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ______________ Date 12-5-83.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 6-11-83 | 91.2 | 49.46 | 50 | 54 | 25% |
| 6-12-83 | 90 | 50 | 64 | 90.61 | 42% |
| 6-13-83 | 91 | 52 | 70 | 109.7 | 50% |
| 6-14-83 | 88.86 | 54.12 | 70 | 109.7 | 55% |
| 15-83 | 92.85 | 61.37 | 72 | 119.5 | 53% |
| 6-16-83 | 98 | 60 | 77 | 140 | 51% |
| 6-17-83 | - | - | 74 | 129.4 | - |
| 6-18-83 | 95.89 | 61.99 | 77 | 141.8 | 55% |
| 6-19-83 | 97.23 | 66.45 | 76 | 139.9 | 53% |
| 6-20-83 | 91 | 67 | 75 | 134.9 | 61% |
| 6-21-83 | - | - | 76 | 137.7 | - |
| 6-22-83 | 78.48 | 67 | 77 | 141.6 | 98% |
| AVERAGE | 91 | 59 | 72 | 121 | 54 |

## APPENDIX

## ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ______________________________ Date ______________________.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 7-19-83 | 100.4 | 70.79 | 79 | 148.4 | 51% |
| 7-20-83 | 102.1 | 70.89 | 80 | 157.1 | 51% |
| 7-21-83 | 101.1 | 74.55 | 82 | 168.9 | 55% |
| -22-83 | 104.4 | 72.30 | 83 | 173.4 | 54% |
| 7-23-83 | 103.4 | 73.38 | 86 | 181.1 | 56% |
| 7-24-83 | 102.7 | 75.39 | 82 | 166.3 | 53% |
| 7-25-83 | 77.09 | 70.65 | 81 | 161.3 | 100% |
| 7-26-83 | 91.82 | 61.73 | 74 | 127.1 | 58% |
| 7-27-83 | 97.55 | 61.06 | 75 | 133.4 | 50% |
| 7-28-83 | 97.79 | 64.05 | 75 | 134.5 | 48% |
| 7-29-83 | 95.43 | 59.42 | 72 | 121.9 | 48% |
| 7-30-83 | 90.34 | 60.21 | 73 | 123.8 | 58% |
| 7-31-83 | 99.14 | 65.92 | 78 | 149.1 | 52% |
| AVERAGE | 97 | 68 | 78 | 150 | 56 |

## APPENDIX

## ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ________________________ Date ________________.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 8-17-83 | 95.15 | 60.54 | 72 | 121.9 | 47% |
| 8-18-83 | 98.45 | 63.39 | 75 | 132.5 | 48% |
| 8-19-83 | 102.8 | 67.62 | 79 | 151.1 | 49% |
| 20-83 | 106.4 | 71.19 | 80 | 157.1 | 45% |
| 8-21-83 | 108.4 | 71.46 | 79 | 153.8 | 42% |
| 8-22-83 | 106.9 | 70.95 | 81 | 162.4 | 45% |
| 8-23-83 | 106.9 | 76.63 | 81 | 161 | 45% |
| 8-24-83 | 97.75 | 70.57 | 80 | 157.2 | 59% |
| 8-25-83 | 88.4 | 70.57 | 79 | 153.9 | 75% |
| 8-26-83 | 92.85 | 67.52 | 77 | 139.4 | 61% |
| 8-27-83 | 97.67 | 67.57 | 78 | 145.1 | 55% |
| 8-28-83 | 97.23 | 69.72 | 59 | 79.49 | 30% |
| 8-29-83 | 96.36 | 69.91 | 75 | 135.1 | 52% |
| AVERAGE | 100 | 69 | 77 | 142 | 50 |

# APPENDIX

## ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ______________ Date 12-5-83.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 9-7-83 | 91.42 | 68 | 77 | 141.4 | 64% |
| 9-8-83 | 94.61 | 68.91 | 77 | 141.2 | 58% |
| 9-9-83 | 93.48 | 67.57 | 79 | 152.3 | 63% |
| 9-10-83 | 92.48 | 67.62 | 80 | 157.8 | 69% |
| 11-83 | 94.46 | 66.9 | 80 | 158.8 | 65% |
| 9-12-83 | 95.96 | 66.7 | 75 | 130.6 | 52% |
| 9-13-83 | 74.44 | 67.36 | 72 | 120.6 | 97% |
| 9-14-83 | 71.03 | 57.84 | 66 | 96.82 | 84% |
| 9-15-83 | 78.81 | 57.98 | 65 | 93.94 | 62% |
| 9-16-83 | 80.97 | 54.46 | 66 | 97.4 | 63% |
| 9-17-83 | 88.3 | 54.23 | 71 | 117.2 | 59% |
| 9-18-83 | 88.39 | 60.27 | 76 | 137 | 68% |
| 9-19-83 | 87.75 | 59.56 | 74 | 129.3 | 66% |
| 9-20-83 | 81.99 | 69.22 | 70 | 111.6 | 69% |
| 9-21-83 | 81.99 | 49.45 | 73 | 124.1 | 78% |
| 9-22-83 | 70.04 | 41.13 | 49 | 51.53 | 48% |
| 9-23-83 | 75.43 | 44.95 | 51 | 56.42 | 42% |
| 24-83 | 73.79 | 44.26 | 53 | 60.57 | 50% |
| AVERAGE | 84 | 59 | 70 | 115 | 64 |

## APPENDIX

### ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ______________ Date 12-5-83.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 10-26-83 | 67.67 | 37.13 | 52 | 57.98 | 60% |
| 10-27-83 | 64.39 | 33.75 | 45 | 44.84 | 50% |
| 10-28-83 | 70.76 | 33.14 | 50 | 53.34 | 49% |
| 10-29-83 | 76.31 | 41.63 | 55 | 63.5 | 48% |
| -30-83 | 61.78 | 53.11 | 47 | 49.27 | 49% |
| 10-31-83 | 67.95 | 50.72 | 53 | 61.31 | 60% |
| AVERAGE | 68 | 42 | 50 | 55 | 53 |

# APPENDIX

## ATMOSPHERIC DATA-PAGE 1

The following atmospheric data was gathered from a location approximately five miles Northeast of Aiken, South Carolina.

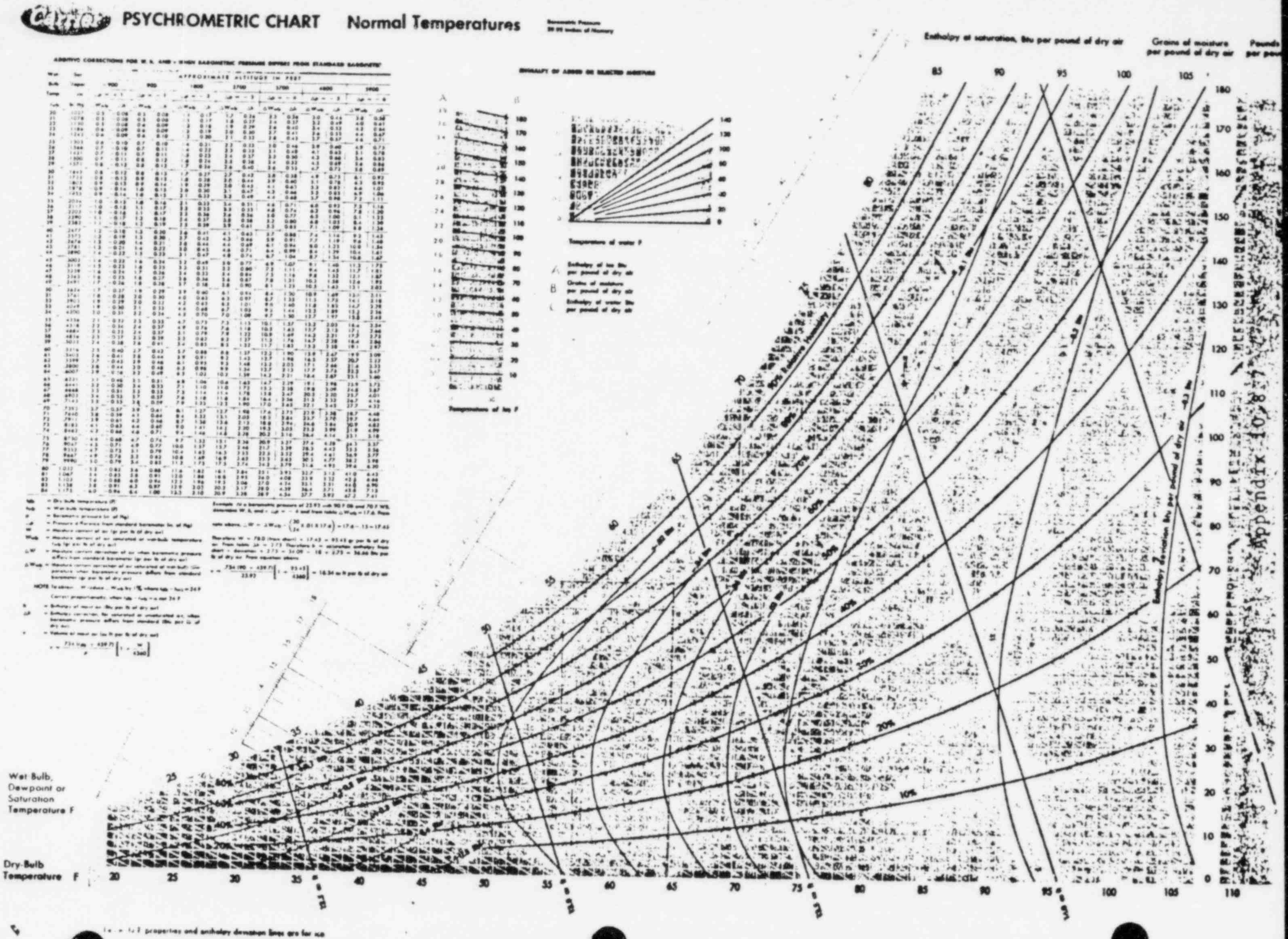
Barnwell, South Carolina is approximately 30 nautical miles Southeast of Aiken, South Carolina.

The data presented is considered to be accurate and representative of conditions in Barnwell for purpose of evaluation in reference to the dewatering tests conducted.

Project Manager ______________________________ Date ______________________.

| DATE | °F HIGH TEMPERATURE | °F LOW TEMPERATURE | WET BULB DEW POINT | GRAINS OF MOISTURE/LB.AIR | RELATIVE HUMIDITY |
|---|---|---|---|---|---|
| 11-1-83 | 70.46 | 42.13 | 60 | 77.72 | 70% |
| 11-2-83 | 69.43 | 37.75 | 57 | 71.77 | 68% |
| 11-3-83 | 74.32 | 38.83 | 61 | 80.95 | 62% |
| 1-4-83 | 67.49 | 46.96 | 62 | 84.45 | 82% |
| 11-5-83 | 59.33 | 30.57 | 30 | 24 | 31% |
| 11-6-83 | 62.62 | 30.59 | 43 | 42.19 | 50% |
| 11-7-83 | 62.96 | 39 | 56 | 68.98 | 81% |
| 11-8-83 | 70.41 | 53.63 | 59 | 73.73 | 68% |
| AVERAGE | 67 | 40 | 54 | 65 | 64 |

# PSYCHROMETRIC CHART Normal Temperatures



Appendix 10.8.7

Carrier®

# PSYCHROMETRIC CHART

## LOW TEMPERATURES

**Barometric Pressure 29.92 In. Hg**

ADDITIVE CORRECTIONS FOR W, h, AND v WHEN BAROMETRIC PRESSURE DIFFERS FROM STANDARD BAROMETER

| Sat Vapor Press In. Hg | APPROXIMATE ALTITUDE IN FEET | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | −900 | | 900 | | 1800 | | 2700 | | 3700 | | 4800 | | 5900 | |
| | Δp = +1 | | Δp = −1 | | Δp = −2 | | Δp = −3 | | Δp = −4 | | Δp = −5 | | Δp = −6 | |
| | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh | $\Delta W_{wb}$ | Δh |
| 0.013 | −0.06 | −0.01 | 0.06 | 0.01 | 0.12 | 0.02 | 0.20 | 0.03 | 0.28 | 0.04 | 0.36 | 0.05 | 0.47 | 0.07 |
| 0.014 | −0.07 | −0.01 | 0.07 | 0.01 | 0.14 | 0.02 | 0.23 | 0.03 | 0.32 | 0.05 | 0.41 | 0.06 | 0.52 | 0.08 |
| 0.016 | −0.07 | −0.01 | 0.08 | 0.01 | 0.16 | 0.02 | 0.26 | 0.04 | 0.36 | 0.05 | 0.46 | 0.07 | 0.58 | 0.09 |
| 0.018 | −0.08 | −0.01 | 0.09 | 0.01 | 0.18 | 0.03 | 0.29 | 0.04 | 0.40 | 0.06 | 0.52 | 0.08 | 0.65 | 0.10 |
| 0.020 | −0.09 | −0.01 | 0.10 | 0.01 | 0.21 | 0.03 | 0.32 | 0.05 | 0.44 | 0.07 | 0.58 | 0.09 | 0.72 | 0.11 |
| 0.022 | −0.10 | −0.02 | 0.11 | 0.02 | 0.23 | 0.03 | 0.36 | 0.06 | 0.50 | 0.07 | 0.64 | 0.10 | 0.81 | 0.12 |
| 0.025 | −0.12 | −0.02 | 0.12 | 0.02 | 0.26 | 0.04 | 0.40 | 0.06 | 0.55 | 0.08 | 0.72 | 0.11 | 0.90 | 0.13 |
| 0.027 | −0.13 | −0.02 | 0.14 | 0.02 | 0.29 | 0.04 | 0.46 | 0.07 | 0.62 | 0.09 | 0.80 | 0.12 | 1.00 | 0.15 |
| 0.030 | −0.14 | −0.02 | 0.15 | 0.02 | 0.32 | 0.05 | 0.50 | 0.07 | 0.69 | 0.10 | 0.89 | 0.13 | 1.12 | 0.17 |
| 0.034 | −0.16 | −0.02 | 0.17 | 0.02 | 0.35 | 0.05 | 0.55 | 0.08 | 0.76 | 0.11 | 0.99 | 0.15 | 1.24 | 0.19 |
| 0.038 | −0.18 | −0.03 | 0.19 | 0.03 | 0.39 | 0.06 | 0.61 | 0.09 | 0.85 | 0.12 | 1.10 | 0.17 | 1.38 | 0.21 |
| 0.042 | −0.20 | −0.03 | 0.21 | 0.03 | 0.44 | 0.07 | 0.68 | 0.10 | 0.94 | 0.14 | 1.22 | 0.19 | 1.53 | 0.23 |
| 0.046 | −0.22 | −0.03 | 0.23 | 0.03 | 0.48 | 0.07 | 0.75 | 0.11 | 1.05 | 0.16 | 1.36 | 0.21 | 1.70 | 0.26 |
| 0.051 | −0.24 | −0.04 | 0.26 | 0.04 | 0.54 | 0.08 | 0.83 | 0.13 | 1.16 | 0.18 | 1.51 | 0.23 | 1.89 | 0.29 |
| 0.057 | −0.27 | −0.04 | 0.29 | 0.04 | 0.58 | 0.09 | 0.93 | 0.14 | 1.29 | 0.19 | 1.67 | 0.25 | 2.09 | 0.32 |
| 0.063 | −0.30 | −0.04 | 0.32 | 0.05 | 0.66 | 0.10 | 1.03 | 0.16 | 1.42 | 0.22 | 1.85 | 0.28 | 2.31 | 0.35 |
| 0.069 | −0.33 | −0.05 | 0.35 | 0.05 | 0.73 | 0.11 | 1.13 | 0.17 | 1.57 | 0.24 | 2.04 | 0.31 | 2.56 | 0.39 |
| 0.077 | −0.36 | −0.05 | 0.39 | 0.06 | 0.81 | 0.12 | 1.26 | 0.19 | 1.74 | 0.25 | 2.26 | 0.34 | 2.83 | 0.43 |
| 0.085 | −0.40 | −0.06 | 0.43 | 0.06 | 0.89 | 0.14 | 1.38 | 0.21 | 1.92 | 0.29 | 2.49 | 0.38 | 3.12 | 0.48 |
| 0.093 | −0.44 | −0.07 | 0.47 | 0.07 | 0.98 | 0.15 | 1.52 | 0.23 | 2.13 | 0.32 | 2.76 | 0.43 | 3.44 | 0.53 |
| 0.103 | −0.49 | −0.08 | 0.52 | 0.08 | 1.08 | 0.17 | 1.68 | 0.26 | 2.33 | 0.38 | 3.03 | 0.46 | 3.79 | 0.58 |
| 0.113 | −0.5 | −0.08 | 0.6 | 0.09 | 1.2 | 0.18 | 1.9 | 0.29 | 2.6 | 0.40 | 3.4 | 0.52 | 4.2 | 0.64 |
| 0.124 | −0.6 | −0.09 | 0.6 | 0.10 | 1.3 | 0.20 | 2.1 | 0.32 | 2.8 | 0.43 | 3.7 | 0.57 | 4.6 | 0.71 |
| 0.137 | −0.7 | −0.10 | 0.7 | 0.11 | 1.4 | 0.22 | 2.3 | 0.35 | 3.1 | 0.48 | 4.1 | 0.63 | 5.1 | 0.78 |
| 0.150 | −0.7 | −0.11 | 0.8 | 0.12 | 1.6 | 0.24 | 2.5 | 0.38 | 3.4 | 0.53 | 4.5 | 0.69 | 5.6 | 0.86 |
| 0.165 | −0.8 | −0.12 | 0.8 | 0.13 | 1.7 | 0.27 | 2.7 | 0.42 | 3.8 | 0.58 | 4.9 | 0.75 | 6.1 | 0.92 |
| 0.180 | −0.8 | −0.13 | 0.9 | 0.14 | 1.9 | 0.29 | 3.0 | 0.45 | 4.1 | 0.63 | 5.3 | 0.82 | 6.6 | 1.01 |
| 0.197 | −0.9 | −0.14 | 1.0 | 0.16 | 2.1 | 0.32 | 3.3 | 0.49 | 4.4 | 0.68 | 5.7 | 0.88 | 7.2 | 1.11 |
| 0.212 | −1.0 | −0.15 | 1.1 | 0.17 | 2.2 | 0.34 | 3.5 | 0.53 | 4.8 | 0.74 | 6.2 | 0.96 | 7.8 | 1.20 |
| 0.229 | −1.1 | −0.17 | 1.2 | 0.18 | 2.4 | 0.37 | 3.8 | 0.58 | 5.2 | 0.80 | 6.8 | 1.05 | 8.4 | 1.30 |
| 0.248 | −1.2 | −0.18 | 1.3 | 0.20 | 2.6 | 0.41 | 4.1 | 0.63 | 5.7 | 0.88 | 7.4 | 1.14 | 9.2 | 1.42 |
| 0.268 | −1.3 | −0.20 | 1.4 | 0.21 | 2.8 | 0.44 | 4.4 | 0.68 | 6.1 | 0.94 | 8.0 | 1.23 | 10.0 | 1.54 |
| 0.289 | −1.4 | −0.22 | 1.5 | 0.23 | 3.1 | 0.47 | 4.8 | 0.74 | 6.7 | 1.04 | 8.7 | 1.34 | 10.8 | 1.67 |
| 0.312 | −1.5 | −0.23 | 1.6 | 0.26 | 3.3 | 0.51 | 5.2 | 0.80 | 7.2 | 1.11 | 9.4 | 1.48 | 11.7 | 1.81 |
| 0.336 | −1.6 | −0.25 | 1.8 | 0.27 | 3.6 | 0.56 | 5.6 | 0.87 | 7.8 | 1.21 | 10.2 | 1.66 | 12.6 | 1.96 |

= Dry-bulb temperature (F).
= Wet-bulb temperature (F).
= Barometric pressure (in. of Hg).
= Pressure difference from standard barometer (in. of Hg).
= Moisture content of air (gr per lb of dry air).
= Moisture content of air saturated at wet-bulb temperature $t_{wb}$ (gr per lb of dry air).
= Moisture content correction of air when barometric pressure differs from standard barometer (gr per lb of dry air).
= Moisture content correction of air saturated at wet-bulb temperature when barometric pressure differs from standard barometer (gr per lb of dry air).

NOTE: To obtain $\Delta W$ reduce value of $\Delta W_{wb}$ by 1% where $t - t_{wb} = 24$ F and correct proportionally when $t - t_{wb}$ is not 24 F.

= Enthalpy of moist air (Btu per lb of dry air).
= Enthalpy correction when barometer pressure differs from standard barometer, for saturated or unsaturated air (Btu per lb of dry air).
= Volume of moist air (cu ft per lb of dry air).

$$v = \frac{.754\,(t_{db} + 459.7)}{p}\left[1 + \frac{W}{4360}\right]$$

PROPERTIES OF SATURATED AIR
−20 to −100 F

| Temp. F | Vapor Press. In. Hg | Moisture Content Grains* | Volume cu ft* | Enthalpy Btu* |
|---|---|---|---|---|
| −20 | .0126 | 1.82 | 11.08 | −4.52 |
| −22 | .0112 | 1.63 | 11.03 | −5.03 |
| −24 | .0100 | 1.48 | 10.99 | −5.54 |
| −26 | .0089 | 1.29 | 10.93 | −6.04 |
| −28 | .0079 | 1.18 | 10.88 | −6.55 |
| −30 | .0070 | 1.02 | 10.83 | −7.05 |
| −32 | .0062 | 0.90 | 10.78 | −7.54 |
| −34 | .0055 | 0.80 | 10.73 | −8.04 |
| −36 | .0049 | 0.71 | 10.68 | −8.53 |
| −38 | .0043 | 0.62 | 10.63 | −9.02 |
| −40 | .0038 | 0.55 | 10.58 | −9.52 |
| −42 | .0033 | 0.48 | 10.53 | −10.01 |
| −44 | .0029 | 0.43 | 10.48 | −10.50 |
| −46 | .0026 | 0.38 | 10.43 | −10.98 |
| −48 | .0023 | 0.33 | 10.38 | −11.47 |
| −50 | .0020 | 0.29 | 10.33 | −11.96 |
| −52 | .0017 | 0.25 | 10.28 | −12.44 |
| −54 | .0015 | 0.22 | 10.23 | −12.93 |
| −56 | .0013 | 0.19 | 10.18 | −13.41 |
| −58 | .0012 | 0.17 | 10.13 | −13.89 |
| −60 | .0010 | 0.15 | 10.08 | −14.38 |
| −62 | .0009 | 0.13 | 10.03 | −14.86 |
| −64 | .0008 | 0.11 | 9.98 | −15.34 |
| −66 | .0007 | 0.10 | 9.93 | −15.82 |
| −68 | .0006 | 0.08 | 9.87 | −16.31 |
| −70 | .0005 | 0.07 | 9.83 | −16.79 |
| −72 | .0004 | 0.06 | 9.77 | −17.27 |
| −74 | .0004 | 0.05 | 9.73 | −17.75 |
| −76 | .0003 | 0.05 | 9.67 | −18.23 |
| −78 | .0003 | 0.04 | 9.62 | −18.71 |
| −80 | .0002 | 0.03 | 9.57 | −19.19 |
| −82 | .0002 | 0.03 | 9.52 | −19.68 |
| −84 | .0002 | 0.03 | 9.47 | −20.16 |
| −86 | .0001 | 0.02 | 9.42 | −20.64 |
| −88 | .0001 | 0.02 | 9.37 | −21.12 |
| −90 | .0001 | 0.02 | 9.32 | −21.60 |
| −92 | .0001 | 0.01 | 9.27 | −22.08 |
| −94 | .0001 | 0.01 | 9.22 | −22.56 |
| −96 | .0001 | 0.01 | 9.17 | −23.04 |
| −98 | .0001 | 0.01 | 9.12 | −23.52 |
| −100 | .0000 | 0.01 | 9.07 | −24.00 |

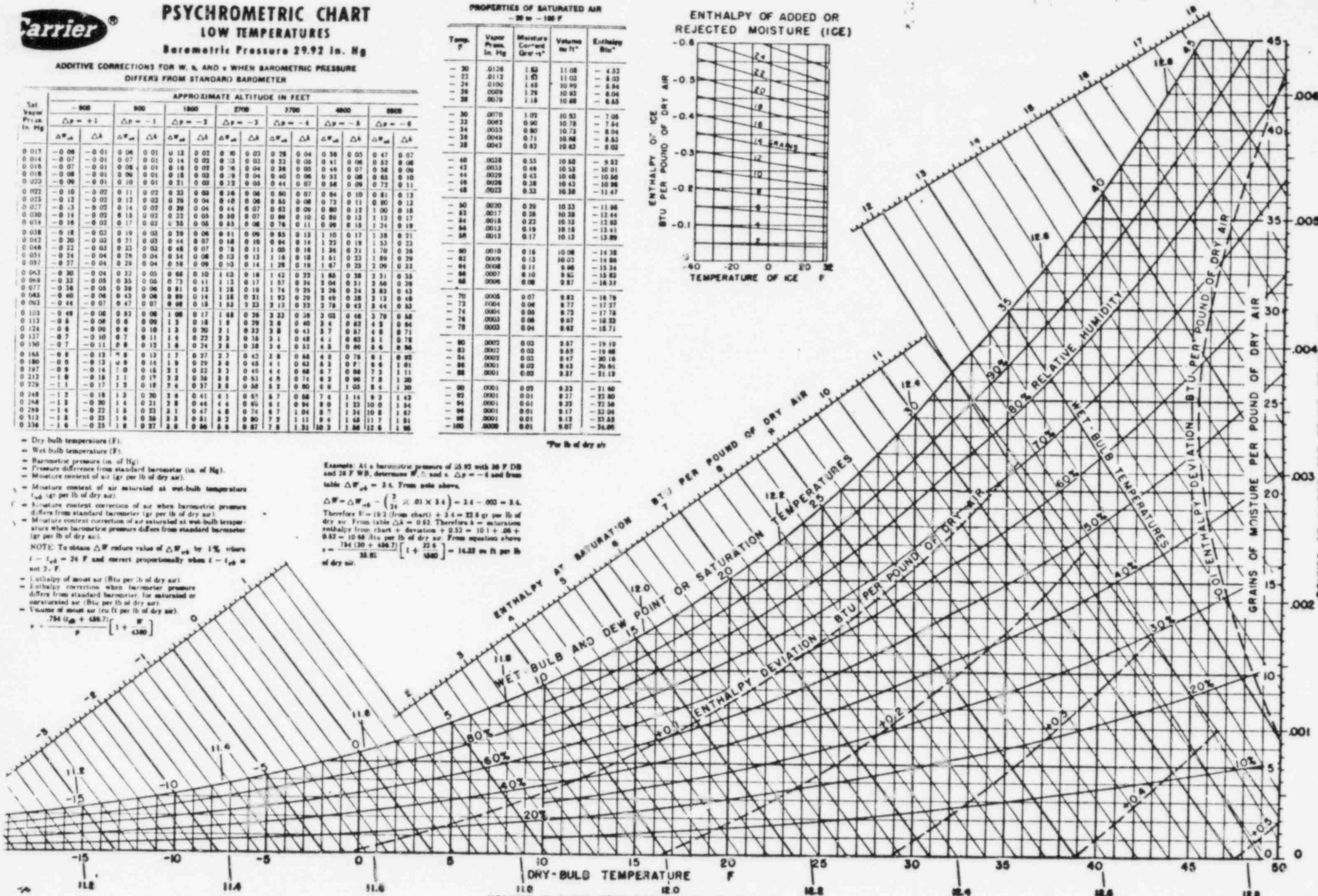
*Per lb of dry air

**Example:** At a barometric pressure of 25.92 with 30 F DB and 28 F WB, determine W, h and v. $\Delta p = -4$ and from table $\Delta W_{wb} = 3.4$. From note above,

$$\Delta W = \Delta W_{wb} - \left(\frac{2}{24} \times .01 \times 3.4\right) = 3.4 - .003 = 3.4.$$

Therefore W = 19.2 (from chart) + 3.4 = 22.6 gr per lb of dry air. From table Δh = 0.52. Therefore h = saturation enthalpy from chart + deviation + 0.52 = 10.1 + .06 + 0.52 = 10.68 Btu per lb of dry air. From equation above

$$v = \frac{.754\,(30 + 459.7)}{25.92}\left[1 + \frac{22.6}{4360}\right] = 14.33 \text{ cu ft per lb of dry air.}$$


ENTHALPY OF ADDED OR REJECTED MOISTURE (ICE)

[COPYR]IGHT 1946, 1960, CARRIER CO[RPORATI]ON

BELOW 32 F PROPERTIES ARE FOR ICE

# APPENDIX 10.9

# HYDROSTATIC TESTING

**REVISIONS**

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|---|---|---|
| PREPARED | DATE 3-30-82 | **CHEM – NUCLEAR SYSTEMS, INC.** |
| CHECKED | 3-30-82 | TITLE<br>HYDROSTATIC TEST PROCEDURE FOR THE FIELD EQUIPMENT MAINTENANCE SHOP |
| ENGINEER | 3-30-82 | |
| QUALITY | 4-5-82 | |
| APPROVED | 4/5/82 | |

| CONTRACT NO. | DOCUMENT NO. | REV. | SHEET |
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| | S20-OP-016 | — | 1 |

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## 1.0 SCOPE

### 1.1 Purpose

The purpose of this instruction is to insure the hydrostatic testing of hoses and piping systems are performed in a safe and satisfactory manner.

### 1.2 Applicability

This instruction is applicable to the hydrostatic testing of all hoses and piping systems manufactured and assembled in the Field Equipment Maintenance Shop.

## 2.0 REFERENCES

2.1 CN-AD-003, Procedure For Document Preparation

## 3.0 DETAILED INSTRUCTIONS

### 3.1 Prerequisites

3.1.1 Hydrostatic test equipment is located in a space designated by the Shop Supervisor/Manager.

3.1.2 All gauges used on test equipment have valid calibration stickers and certification papers.

### 3.2 Precautions

**CAUTION: HOSES AND OTHER PRESSURE RETAINING COMPONENTS MAY BE PRESSURIZED DURING DISASSEMBLY. FACE SHIELDS AND APPROPRIATE PROTECTIVE CLOTHING SHALL BE WORN DURING DISASSEMBLY OF THIS EQUIPMENT.**

3.2.1 All personnel using hydro test equipment shall be qualified by the Shop Supervisor on correct use and shall have a valid copy of this instruction available.

3.2.2 The item to be tested will be placed in a position to avoid injury to personnel and equipment in case of a component rupture during the test.

3.2.3 All personnel who operate the hydro test equipment shall wear either safety glasses, goggles, or face shields and shall remain in back of the test equipment during testing.

3.2.4 During testing, pressure changes should be made in 50 psig increments. The average pressure change should not exceed 10 psig per second.

### 3.3 Hydrostatic Testing

3.3.1 Install a high point bleed-off valve on the equipment to be tested.

3.3.2 Elevate the bleed-off valve. This will allow venting of the air in the component during the initial filling.

3.3.3 Connect the equipment to the hydro tester and connect the air supply to test equipment.

3.3.4 Check to insure the bleed-off valve (B-1) on the hydro tester is closed.

3.3.5 Open water supply valve on the hydro tester to allow water flow.

3.3.6 Open the air valve (SA-1) slowly to increase water flow until flow is observed out of the bleed valve. Continue venting until all air is forced out, then close the vent valve.

3.3.7 Operate the test equipment and raise the component pressure to the required test pressure.

**CAUTION: THE OPERATOR SHALL OBSERVE THE LIMITS OF SECTION 3.2.4 ABOVE.**

3.3.8 Close the air supply valve SA-1.

3.3.9 Inspect the test piece carefully for any visible leaks. Hold test pressure for a full 30 minutes.

**NOTE: IF HYDROSTATIC PRESSURE CANNOT BE MAINTAINED, LOCATE THE SOURCE OF THE LEAK. BLEED THE PRESSURE OFF USING SECTION 3.3.10 BELOW. REPAIR THE LEAK AND RETEST STARTING WITH SECTION 3.3.1 ABOVE.**

3.3.10 When test is completed, open bleed-off valve (B-1) on hydro tester to release pressure. Remove test piece from tester.

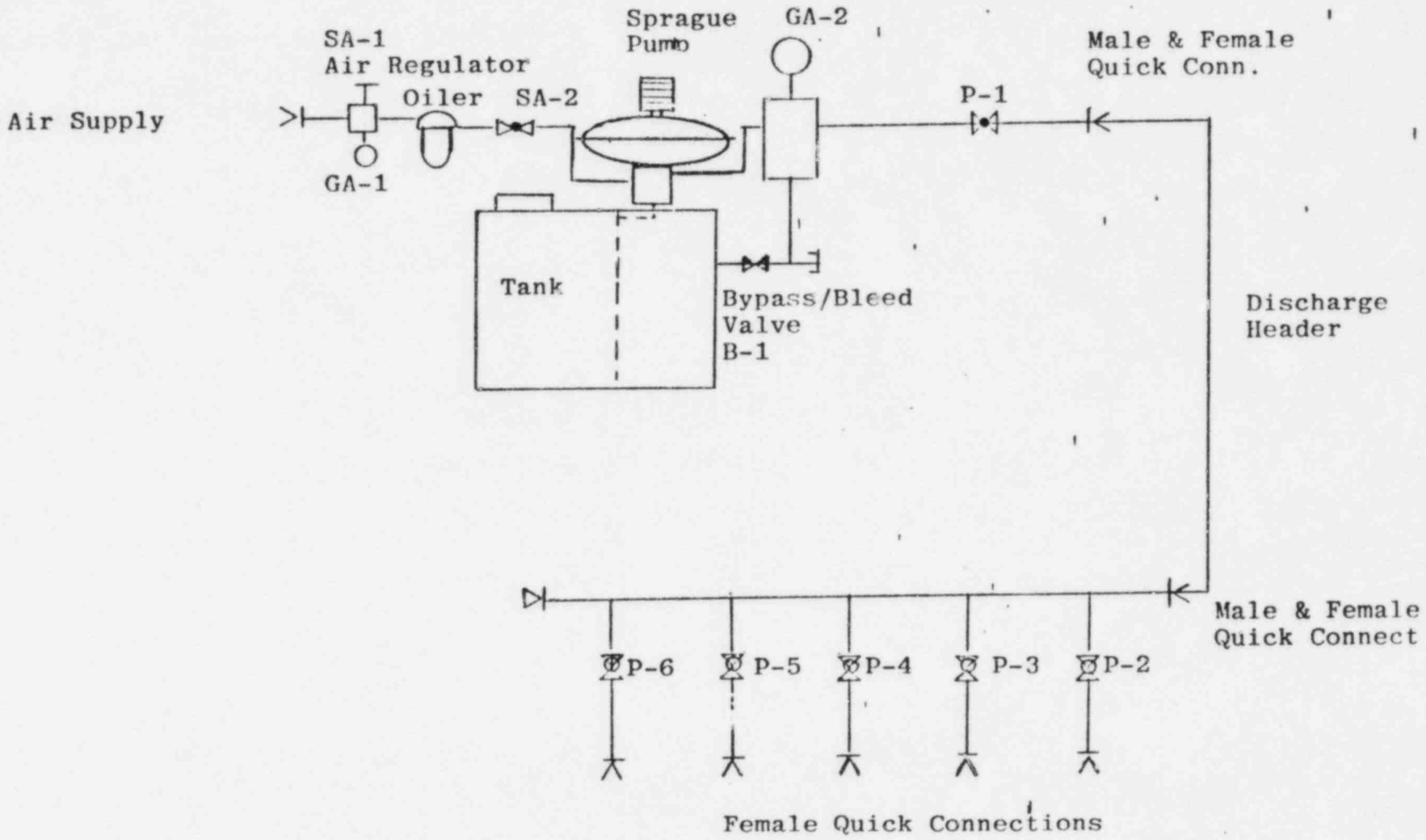
3.3.11 Open bleed-off valve on the test piece to remove water.

## 4.0 DOCUMENTATION

4.1 Once the test is complete all results must be entered in the Hydro Test Log Book on Form No. MMS-11 (See attached sheet).

4.2 The serial number assigned to the test component shall be etched on the item. A metal tag may be used on items where vibro-etching is not feasible and/or desired.

FIGURE 1
HYDRO TESTER



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| | | |
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| PREPARED | DATE 3-30-82 | CHEM – NUCLEAR SYSTEMS, INC. |
| CHECKED | 3-30-82 | TITLE GAUGE COMPARISON PROCEDURE FOR THE FIELD EQUIPMENT MAINTENANCE SHOP |
| ENGINEER | 3-30-82 | |
| QUALITY | 4-5-82 | |
| APPROVED | 4/5/82 | |

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FIGURE 1 6

FIELD EQUIPMENT MAINTENANCE SHOP TEST RECORD FORM 7

## 1.0 SCOPE

1.1 This procedure provides guidance for the initial comparison and re-acceptance of pressure gauges and switches using the Portable Live Pressure Tester, Model 3112 manufactured by King Nutronics.

### 1.2 Applicability

This procedure may be used for mechanical and/or mechanical electrical instruments carrying gas or liquid.

## 2.0 REFERENCES

2.1 Quality Assurance Program, QA-AD-001

2.2 ASME Code Section V

## 3.0 REQUIREMENTS

3.1 Gauges requiring comparison shall be rechecked every 12 months or sooner if accuracy is in doubt.

3.2 Reference gauges shall be calibrated semi-annually by an outside instrument shop. Calibration certification shall be traceable to National Bureau Of Standards

3.3 Gauges shall be tested by a qualified operator to maximum system design pressure and/or maximum gauge design pressure, whichever is less.

3.4 Gauge comparison may be accomplished either installed or bench tested.

3.5 A Gauge Comparison Record Form shall be maintained for each gauge tested and shall have a signature verifying that the test has been completed.

## 4.0 PRE-OPERATIONAL CHECKS

4.1 Place the portable pressure tester on a stable level surface.

4.2 Depress relief value core on tester case to equalize internal pressure and open case lid.

4.3 Check unit to ensure internal nitrogen bottle has adequate pressure to accomplish the desired test. If supply pressure is low, charge tester as described below.

### 4.3.1 Charging Portable Live Pressure Tester Cylinder

4.3.1.1 Connect test hose to tester fill port coupling, connect opposite end of test hose to external nitrogen supply source.

4.3.1.2 Open vent valve and close pressure control valve.

4.3.1.3 Open supply cylinder shut off valve and charge tester internal cylinder to 2250 psig as indicated on the supply pressure gauge.

4.3.1.4 When cylinder is fully charged, bleed off pressure from test hose assembly. Disconnect assembly from fill port coupling and external nitrogen supply source.

## 4.4 Gauge Comparison

CAUTION: HOSES AND OTHER PRESSURE RETAINING COMPONENTS MAY BE PRESSURIZED DURING DISASSEMBLY. FACE SHIELDS AND APPROPRIATE PROTECTIVE CLOTHING SHALL BE WORN DURING DISASSEMBLY OF THIS EQUIPMENT.

4.4.1 Close vent pressure control valves.

4.4.2 Connect test hose to <u>Test</u> port opening, connect opposite end to item being tested.

4.4.3 If pressure switch is to be tested, connect electrical test leads between output terminals of the pressure switch and electrical test plugs on tester.

4.4.4 Gradually open pressure control valve and very slowly approach the test point while observing appropriate master gauge.

NOTE: THE TESTER IS DESIGNED TO PROTECT THE LOW RANGE GAUGE SO THAT NO DAMAGE WILL OCCUR WHEN IT GOES TO FULL SCALE.

4.4.5 Close pressure control valve when test point has been reached. If desired pressure is exceeded, open vent control valve to bleed off pressure as necessary. Allow time at each test point for gas temperature to stabilize before taking pressure reading.

4.4.6 If pressure switch is being tested, neon indicator lamp will extinquish when pressure switch activates.

4.4.7 Repeat Steps 4.4.4 and 4.4.5 as necessary for higher test pressures.

NOTE: THE GAUGE BEING CALIBRATED MUST BE WITHIN ± 10% OF THE MASTER GAUGE.

4.4.8 To check test points in a descending order, reduce pressure by slightly opening the vent control valve, and very slowly bleeding off pressure until the desired test point is reached.

4.4.9 After completion of tests, close pressure control valve and open vent valve to reduce pressure in the tester circuit to zero.

## 5.0 ACCEPTANCE CRITERIA

5.1 If the gauge being calibrated reads greater than ± 10% of the master gauge within the normal operating band or at zero, the gauge is not acceptable and shall not be used.

## 6.0 MARKING

6.1 If gauge is within ± 10% of master gauge at 1/2 test pressure in the normal operating band or at zero, proceed as follows:

6.1.1 Fill out gauge acceptance sticker with:

6.1.1.1 Calibration Date

6.1.1.2 Date Due for Re-Calibration

6.1.1.3 Signature of Personnel Performing Calibration

6.1.1.4 QA Inspectors Initial

6.1.2 Ensure gauge serial number is vibro etched on gauge.

6.1.3 Place calibration sticker on an exposed portion of the gauge if possible. On enclosed gauges, place calibration sticker on the panel face directly below associated gauge.

## 7.0 POST-OPERATING PROCEDURE

7.1 After completion of tests, perform the following post-operating procedures:

7.1.1 Disconnect test hose and electrical leads and stow in lid of case.

7.1.2 Install dust caps on test and fill port couplings.

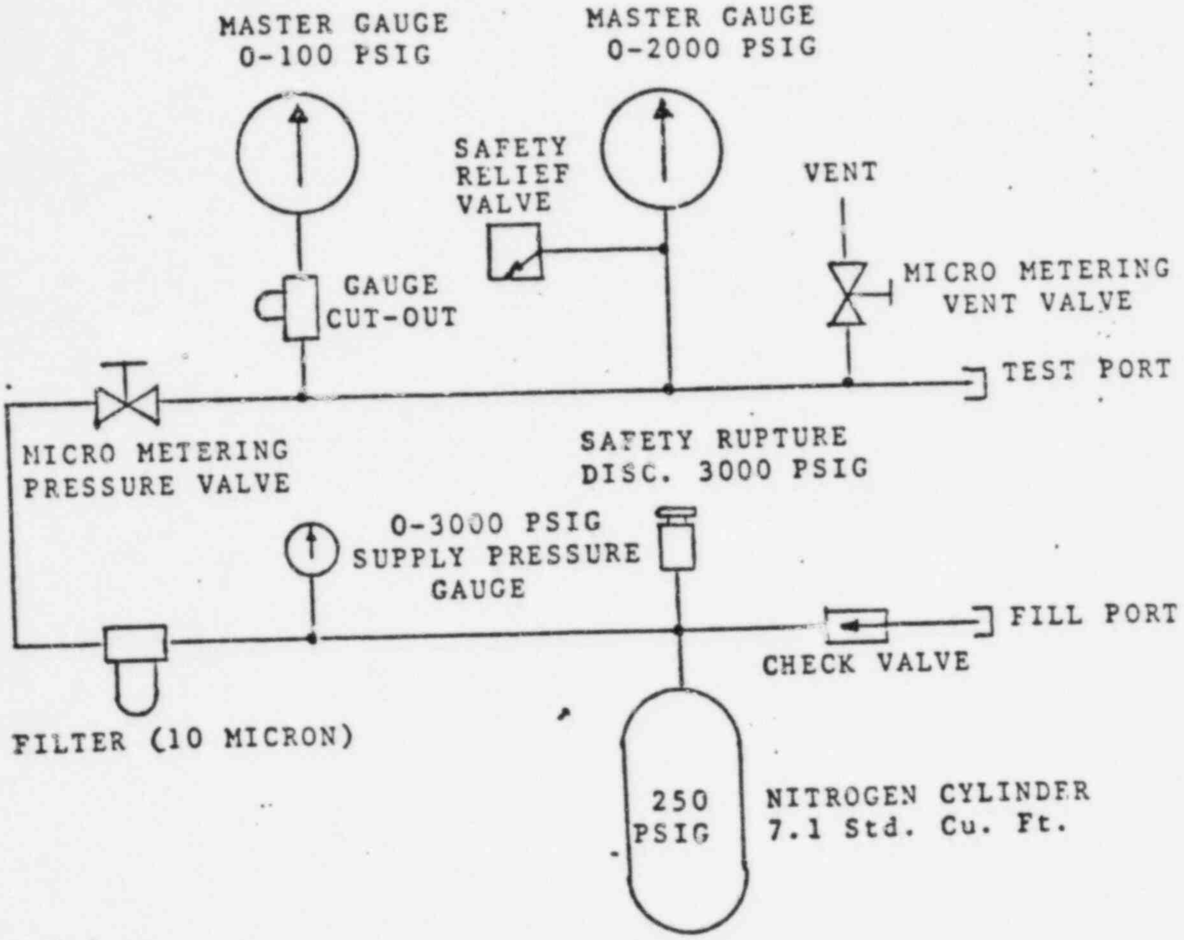
7.1.3 Close case lid and place unit in safe storage.

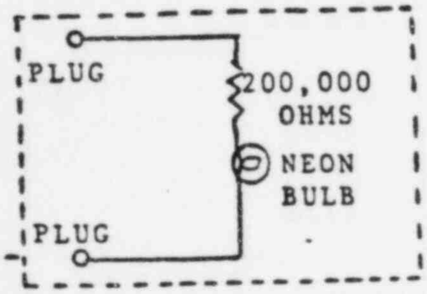
## 8.0 RECORDS

8.1 The Gauge Comparison Record Form shall be filled out and signed.

8.2 The Gauge Comparison Record Form shall be filed with the Test/Acceptance Records package for the unit in which the gauge is installed.

## FIGURE 1





ELECTRIC TEST CIRCUIT

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 1 1/2" x 10' Hydrolic Hose w/ S.S. Female Kamlocks e/E

Hydro Test Pressure: 225 P.S.I.

Duration of Test: 30 min.

Project Number: 11118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 2408

Comments:

Name of Person Performing Test: RD Sullivan Initials: DWJ

Quality Assurance Signature:

CNSI
8

Appendix 10.9.11

Form No. MMS-12
4-28-80

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 3/4" x 25' Hydrolic Hose w/ S.S. Kamlocks E/E

Hydro Test Pressure: 225 p.s.i.

Duration of Test: 30 min

oject Number: 11118

Intended Use of Item Being Tested: Waste

Serial Number Assigned to Item Tested: 2410

Comments:

Name of Person Performing Test: RD Sullivan Initials:

Quality Assurance Signature:

CNSI
8

Form No. MMS-12
4-28-80

Appendix 10.9.12

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 3/4" x 25' Hydrolic Hose w/ S.S. Female Kamlock E/E

Hydro Test Pressure: 225 p.s.I.

Duration of Test: 30 min.

Project Number: 11118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: ~~2413~~ ~~2403~~ 2411

Comments:

Name of Person Performing Test: RD Sullivan Initials: DWJ

Quality Assurance Signature:

CNSI
8

Form No. MMS-12
4-28-80

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 3/4" x 25' Hydrolic Hose w/ S.S. Female Kamlock E/E

Hydro Test Pressure: 225 P.S.I.

Duration of Test: 30 min.

Project Number: 11118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 24 2407

Comments:

Name of Person Performing Test: R.D. Sullivan Initials:

Quality Assurance Signature:

CNSI 8

Form No. MMS-12
4-28-80

Appendix 10.9.14

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 3/4" x 25' Hydrolic Hose w/ S.S. Female Kamlocks E/E

Hydro Test Pressure: 225 p.s.i.

Duration of Test: 30 Min.

Project Number: 11118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 2412 2406

Comments:

Name of Person Performing Test: R D Sullivan Initials:

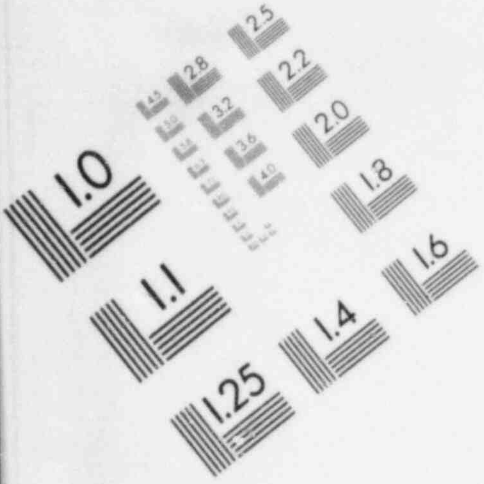
Quality Assurance Signature:

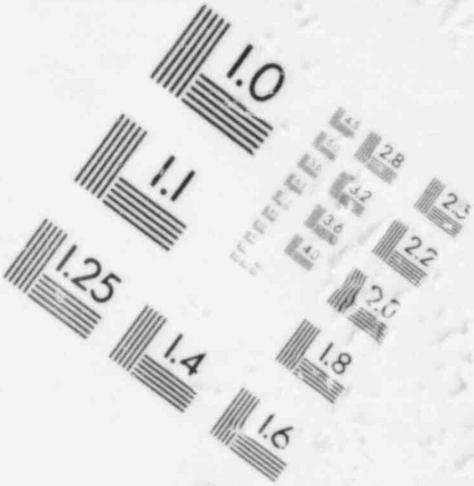
CNSI 8

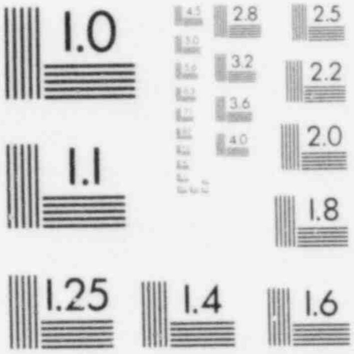
Form No. MMS-12
4-28-80

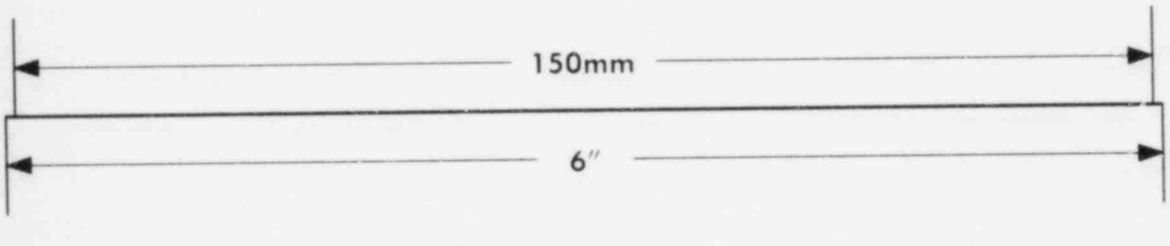
Appendix 10.9.15

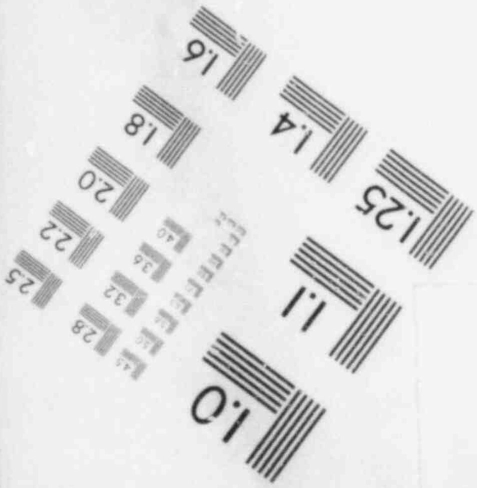
IMAGE EVALUATION
TEST TARGET (MT-3)

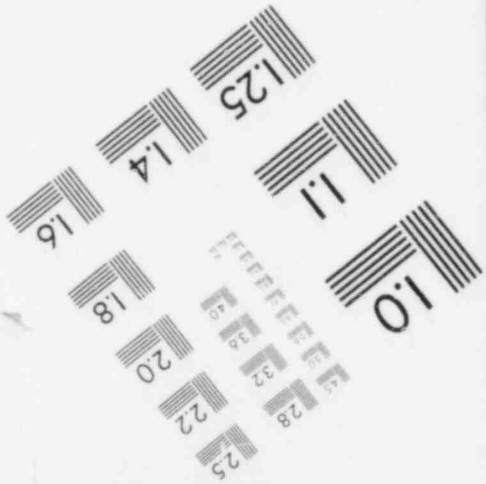




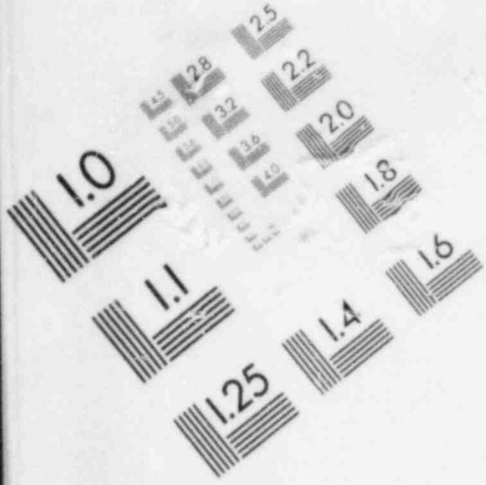


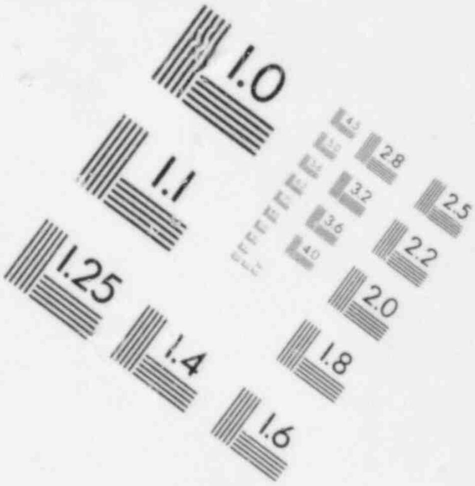


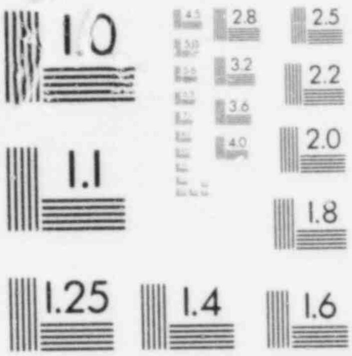


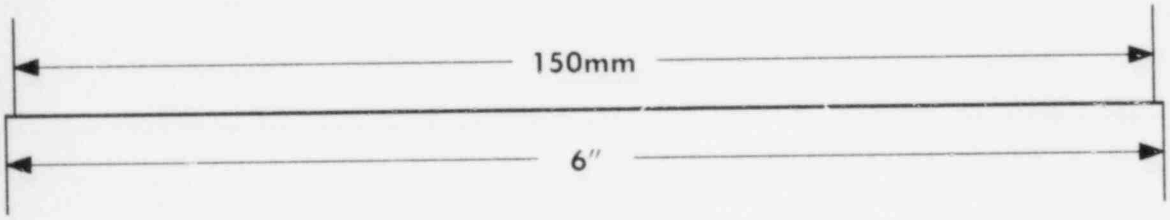


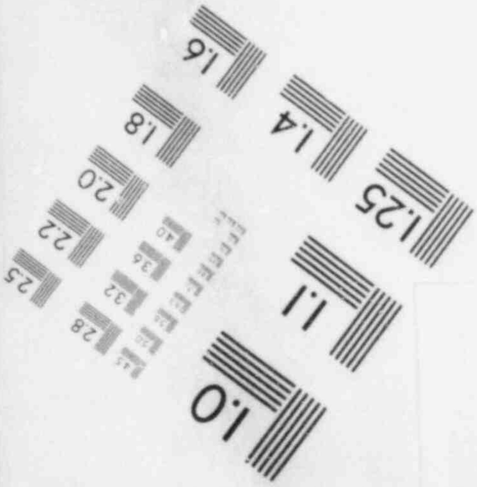
# IMAGE EVALUATION
# TEST TARGET (MT-3)

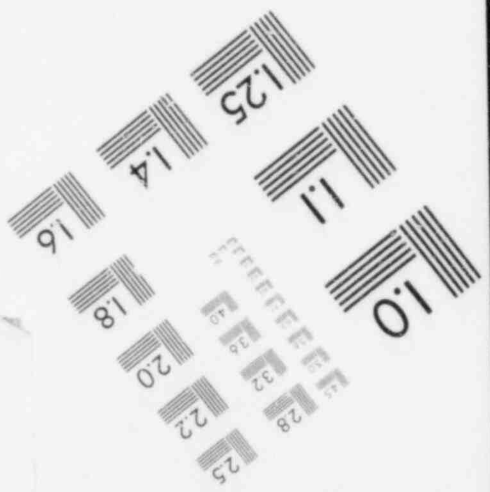












CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 1 1/2" x 50' Hydrolic Hose w/ Male + Female S.S. Kamlock

Hydro Test Pressure: 225 p.s.i.

Duration of Test: 30 min

Project Number: 11118

Intended Use of Item Being Tested: Waste

Serial Number Assigned to Item Tested: 2405

Comments:

Name of Person Performing Test: BD Sullivan Initials

Quality Assurance Signature:

CNSI
6

Form No. MMS-12
4-28-80

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 1 1/2" x 50' Hydrolic Hose w/ S.S. Female Kamlocks E/E

Hydro Test Pressure: 225 p.s.I.

Duration of Test: 30 Min.

Project Number: 11118

Intended Use of Item Being Tested: Waste

Serial Number Assigned to Item Tested: 2404

Comments:

Name of Person Performing Test: LD Sull Initials: DNS

Quality Assurance Signature:

CNSI 8

Form No. MMS-12
4-28-80

Appendix 10.9.17

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6/23/83

Description of Item Being Tested: 1 1/2" x 50' Hydrolic Hose w/S.S. Female Kamlocks e/e

Hydro Test Pressure: 225 p.s.i.

Duration of Test: 30 min.

Project Number: 1118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 2403

Comments:

Name of Person Performing Test: R.D. Sullivan Initials:

Quality Assurance Signature:

CNSI
8

Form No. MMS-12
4-28-80

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

## HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

Date of Hydro: 6 | 23 | 83

Description of Item Being Tested: 1½" x 60 Hydrolic Hose w/ S.S. Female and Male Kamlock

Hydro Test Pressure: 225 p.s.c.

Duration of Test: 30 Min!

-ject Number: 11118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 2402

Comments:

Name of Person Performing Test: R.D. Sull Initials: DWJ

Quality Assurance Signature:

Form No. MMS-12
4-28-80

CHEM-NUCLEAR SYSTEMS, INC.
Mobile Maintenance Shop

HYDROSTATIC TEST REPORT FORM

**PURPOSE:** This form shall be utilized whenever a hydrostatic test that is not otherwise required on any other form or document is required on a piece of equipment, hose, etc. This form will be retained in file for a period of one (1) year.

Destination:

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Date of Hydro: 6/23/83

Description of Item Being Tested: 1 1/2" x 50' Hydrolic Hose w/ S.S. Female Kamlocks E/E

Hydro Test Pressure: 225 p.s.i.

Duration of Test: 30 min

Project Number: 1118

Intended Use of Item Being Tested: WASTE

Serial Number Assigned to Item Tested: 2401

Comments:

Name of Person Performing Test: RD Sullivan Initials: DW

Quality Assurance Signature:

CNSI 8

Form No. MMS-12
4-28-80

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | |
|---|---|---|
| | INCREASING | DECREASING |
| 20 | 20 | 20 |
| 40 | 40 | 40 |
| 60 | 60 | 60 |
| 80 | 80 | 80 |
| 100 | 103 | 102 |
| 120 | 122 | 124 |
| 140 | 144 | 144 |
| 160 | N/A | N/A |
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|---|---|
| Gauge Serial Number | BW-160-269 |
| Date Compared | 6-23-83 |
| Comparison Due Date | 6-23-84 |
| Destination | Eng. 1118 |
| Test Gauge Serial Number | BW-100-037 / BW-2000-036 |
| Test Gauge Calibration Due Date | 9-2-83 |
| Test Conducted By | Mike Riley |
| Quality Assurance Representative | |

CNSI
5

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | |
|---|---|---|
| | INCREASING | DECREASING |
| 20 | 18.5 | 20.0 |
| 40 | 38.0 | 40.0 |
| 60 | 59.0 | 60.0 |
| 80 | 80.0 | 80.0 |
| 100 | 105.0 | 105.0 |
| 120 | 122.0 | 124.0 |
| 140 | 138.0 | 140.0 |
| 160 | N/A | N/A |
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|---|---|
| Gauge Serial Number | BW-160-268 ~~28~~ |
| Date Compared | 6-23-83 |
| Comparison Due Date | 6-23-84 |
| Destination | Eng - 1111 8 |
| Test Gauge Serial Number | BW-100-037/BW-2000-036 |
| Test Gauge Calibration Due Date | 9-2-83 |
| Test Conducted By | Mike Riley |
| Quality Assurance Representative | CNSI<br>5 |

## GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | |
|---|---|---|
| | INCREASING | DECREASING |
| 20 | 20 | 20 |
| 40 | 40 | 40 |
| 60 | 59 | 60 |
| 80 | 79 | 80 |
| 100 | 102 | 102 |
| 120 | 123 | 123 |
| 140 | 143 | 144 |
| 160 | 163 | 163 |
| [illegible] | | |
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|---|---|
| Gauge Serial Number | Bw - 0-160 - 270 |
| Date Compared | 6-24-83 |
| Comparison Due Date | 6-24-84 |
| Destination | FRANK B Eng 1111E |
| Test Gauge Serial Number | Bw-100-037 / Bw 1000-036 |
| Test Gauge Calibration Due Date | 9-2-83 |
| Test Conducted By | |
| Quality Assurance Representative | |

CNSI

CNSI 5

## GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (Hg) | (PSI) | (Hg) | (PSI) |
| 5 | - 6. | 5. | - 6. | 5. |
| 10 | - 11. | 10. | - 11. | 10. |
| 15 | - 16. | 15. | - 16. | 15. |
| 20 | - 20.5 | 20. | - 21. | 20. |
| 25 | - 26.5 | 25 | - 26. | 25. |
| 30 | - 31. | 30. | - 31. | 30. |
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|---|---|---|
| Gauge Serial Number | BW - 30 - 030 - 271 | |
| Date Compared | 6 - 24 - 83 | |
| Comparison Due Date | 6 - 24 - 84 | |
| Destination | Eng. FRank B. 1111 S | |
| Test Gauge Serial Number | 0/338 (HG) | BW. 100. 037 |
| Test Gauge Calibration Due Date | 6 - 9 - 84 | 9-2-83 |
| Test Conducted By | | |
| Quality Assurance Representative | | |

CNSI
5

GAUGE COMPARISON
WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (Hg) | (PSI) | (Hg) | (PSI) |
| 5. | - 6 | 5 | - 6 | 5 |
| 10 | - 11 | 10 | - 11.5 | 10 |
| 15 | - 16 | 15 | - 16 | 15 |
| 20 | - 21 | 20 | - 22 | 20 |
| 25 | - 26 | 25 | - 26 | 25 |
| 30 | - 31 | 30 | - 31 | 30 |
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|---|---|
| Gauge Serial Number | BW-30-0-30-272 |
| Date Compared | 6/24/83 |
| Comparison Due Date | 6/24/84 |
| Destination | En. Bldg. B. 1111 S |
| Test Gauge Serial Number | ~~BW-70~~ 0/338 (HG) \| BW-100-037 |
| Test Gauge Calibration Due Date | 6/9/84 \| 9/2/83 |
| Test Conducted By | H. B. Fuchs |
| Quality Assurance Representative | CNSI 5 |

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | (HG) | INCREASING (PSI) | (HG) | DECREASING (PSI) |
| 5 | -6 | 5 | -6.5 | 5 |
| 10 | -11 | 10 | -11 | 11 |
| 15 | -16.5 | 15 | -16.5 | 16 |
| 20 | -21.5 | 20 | -22 | 21 |
| 25 | -26.5 | 26.5 | -26.5 | 25.5 |
| 30 | -31.5 | 31.5 | -31.5 | 31.5 |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-273 | |
| Date Compared | 6/24/83 | |
| Comparison Due Date | 6/24/84 | |
| Destination | Eng. Frank B. [illegible] | |
| Test Gauge Serial Number | D/338 (HG) | BW-100-037 |
| Test Gauge Calibration Due Date | 6/9/84 | 9/2/83 |
| Test Conducted By | H.B. Fischer Jr. | |
| Quality Assurance Representative | | |

CNSI
5

## GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (HG) | (PSI) | (HG) | (PSI) |
| 5 | -6 | 5 | -6 | 5 |
| 10 | -11 | 10 | -11 | 10 |
| 15 | -16 | 15 | -16 | 15 |
| 20 | -21 | 20 | -21 | 20 |
| 25 | -26 | 25.5 | -26 | 25 |
| 30 | -31 | 30.5 | -31 | 30.5 |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-274 | |
| Date Compared | 6/24/83 | |
| Comparison Due Date | 6/24/84 | |
| Destination | E-N.3 . Frank B 111'8 | |
| Test Gauge Serial Number | D/338 (HG) | BW-100-037 |
| Test Gauge Calibration Due Date | 8/9/84 | 9/2/83 |
| Test Conducted By | H.B. Fuchs | |
| Quality Assurance Representative | CNSI 5 | |

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | (HG) INCREASING | (PSI) | (HG) DECREASING | (PSI) |
| 5 | -5.5 | 5 | -6 | 5 |
| 10 | -10.5 | 10 | -11 | 10 |
| 15 | -15.5 | 15 | -16.5 | 15 |
| 20 | -20.5 | 20 | -20.5 | 20 |
| 25 | -25.5 | 25 | -25 | 25 |
| 30 | -30.5 | 30 | -30.5 | 30 |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-275 | |
| Date Compared | 6/24/83 | |
| Comparison Due Date | 6/24/84 | |
| Destination | i Eng. Fenl. B 11118 | |
| Test Gauge Serial Number | D/338 (HG) | BW-100-037 |
| Test Gauge Calibration Due Date | 6/9/84 | 8/2/83 |
| Test Conducted By | H. B. Fi[illegible] | |
| Quality Assurance Representative | CNSI 3 | |

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | |
|---|---|---|
| | INCREASING | DECREASING |
| 20 | 18 | 20 |
| 40 | 38 | 40 |
| 60 | 58 | 60 |
| 80 | 78 | 80 |
| 100 | 101 | 102 |
| 120 | 121 | 121 |
| 140 | 141 | 142 |
| 160 | 161 | 161 |
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|---|---|
| Gauge Serial Number | BW- 0-160-283 |
| Date Compared | 6-24-83 |
| Comparison Due Date | 6-24-84 |
| Destination | Eng- Front B. 11118 |
| Test Gauge Serial Number | Bw-100-037 / Bw1000-036 |
| Test Gauge Calibration Due Date | 9-2-83 |
| Test Conducted By | |
| Quality Assurance Representative | |

# GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (Hg) | (PSi) | (Hg) | (PSi) |
| 5 | -6. | 5, | -6.5 | 5 |
| 10 | -11.5 | 10. | -11. | 10 |
| 15 | -17. | 15 | -17. | 15 |
| 20 | -22. | 20. | -22, | 20 |
| 25 | -27.5 | 25 | -27.5 | 25 |
| 30 | -32.5 | 30 | -32.5 | 30 |
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|---|---|---|
| Gauge Serial Number | BW-30-030-264 | |
| Date Compared | 6-23-83 | |
| Comparison Due Date | 6-23-84 | |
| Designation | FRANK. B. | |
| Test Gauge Serial Number | 17343<br>160-80769 (Hg) | (PSi)<br>BW-100-037 |
| Test Gauge Calibration Due Date | 6-9-84 | 9-2-83 |
| Test Conducted By | | |
| Quality Assurance Representative | CNSI | |

## GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (HG) | (PSI) | (HG) | (PSI) |
| 5 | - 6. | 5. | - 5.5 | 5.5 |
| 10 | - 11. | 10. | - 10.5 | 10.5 |
| 15 | - 16.5 | 15.5 | - 16. | 15.5 |
| 20 | - 21.5 | 20.5 | - 21. | 20.5 |
| 25 | - 26.5 | 25.5 | - 26. | 25.5 |
| 30 | - 31.5 | 30.5 | - 31.5 | 30.5 |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-265 | |
| Date Compared | 6-23-83 | |
| Comparison Due Date | 6-23-84 | |
| Destination | FRank - B. | |
| Test Gauge Serial Number | 4/3+3<br>#16A-80969 (HG) | (PSI)<br>BW-100-037 |
| Test Gauge Calibration Due Date | 6-9-84 | 9-2-83 |
| Test Conducted By | J.L.B. [illegible] | |
| Quality Assurance Representative | CNSI 12 | |

Appendix 10.9.31

# GAUGE COMPARISON
## WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING | | DECREASING | |
| | (Hg) | (psi) | (Hg) | (psi) |
| 5 | -5.5 | 5.5 | -5.5 | 5 |
| 10 | -10.5 | 10. | -10.5 | 10 |
| 15 | -16. | 15.5 | -15.5 | 15.5 |
| 20 | -21. | 20. | -21. | 20.5 |
| 25 | -26. | 25.5 | -25.5 | 25.5 |
| 30 | -31. | 29.5 | -31 | 29.5 |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-266 | |
| Date Compared | 6-23-83 | |
| Comparison Due Date | 6-23-84 | |
| Destination | Frank B. | |
| Test Gauge Serial Number | D/343 (Hg)<br>#1GA-80769 | (psi)<br>BW-100-037 |
| Test Gauge Calibration Due Date | 6-9-84 | 9-2-83 |
| Test Conducted By | | |
| Quality Assurance Representative | CNSI<br>12 | |

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | (HG) INCREASING | (PSI) | (HG) DECREASING | (PSI) |
| 5 | -6. | 6. | -6. | 5.5 |
| 10 | -10.5 | 11. | -11. | 11. |
| 15 | -17. | 16. | -16.5 | 16.5 |
| 20 | -22. | 21 | -22. | 21.5 |
| 25. | -27.5 | 27. | -27. | 27 |
| 30. | -32.5 | 32 | -32.5 | 32. |
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|---|---|---|
| Gauge Serial Number | BW-30-0-30-267 | |
| Date Compared | 6·23 83 | |
| Comparison Due Date | 6·23·84 | |
| Destination | Frank B | |
| Test Gauge Serial Number | D/343 (HG)<br>#IGM-80769 | (PSI)<br>BW-100-037 |
| Test Gauge Calibration Due Date | 6-9-84 | 9-2-83 |
| Test Conducted By | HB Fischer Jr | |
| Quality Assurance Representative | CNSI 12 | |

Appendix 10.9.33

# GAUGE COMPARISON
# WASTE PROCESSING SUPPORT FACILITY

| TEST GAUGE VALUE | INDICATED VALUE | | | |
|---|---|---|---|---|
| | INCREASING (Hg) | (P.S.I.) | DECREASING (Hg) | (P.S.I.) |
| 5 | - 5. | 5. | - 5. | 5 |
| 10 | - 11. | 10. | - 11. | 10.5 |
| 15 | - 15.5 | 15.5 | - 15. | 15.5 |
| 20 | - 21. | 20. | - 21. | 21. |
| 25 | - 26. | 25.5 | - 26. | 26. |
| 30 | - 31. | 31. | - 31. | 31. |
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|---|---|---|
| Gauge Serial Number | BW - 30 - 0 - 30 - 263 | |
| Date Compared | 6 - 23 - 83 | |
| Comparison Due Date | 6 - 23 - 84 | |
| Destination | Frank. B. | |
| Test Gauge Serial Number | D/3W (Hg)<br>H ICA - 80769 | (PSI)<br>BW - 100 - 037 |
| Test Gauge Calibration Due Date | 6 - 9 - 84 | 9 - 2 - 83 |
| Test Conducted By | W. B. Fischer | |
| Quality Assurance Representative | 21 CNSI | |

Appendix 10.10 is Proprietary