START

Volume V

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Conceptual Design
for the

Waste Receiving And Processing Facility Module 2A

System Descriptions

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Prepared by

United Engineers & Constructors
A Raytheon Company
Western Operations

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ABBREVIATIONS & ACRONYMS

ACDR	ADVANCED CONCEPTUAL DESIGN REPORT
AEA	ATOMIC ENERGY AGENCY
AGV	AUTOMATED GUIDED VEHICLE
AI	ANALOG INPUTS
ALARA	AS LOW AS REASONABLY ACHIEVABLE
AMU	AQUEOUS MAKE UP
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
AO	ANALOG OUTPUTS
ARM	AREA RADIATION MONITORING
ASILS	AMBIENT SOURCE IMPACT LEVELS
AS/RS	AUTOMATIC STORAGE/RETRIEVAL SYSTEM
BACT	BEST AVAILABLE CONTROL TECHNOLOGY
BARCT	BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY
BDAT	BEST DEMONSTRATED AVAILABLE TECHNOLOGY
BFS	BLAST FURNACE SLAG
BNFL	BRITISH NUCLEAR FUELS LIMITED, INC.
C	AMPLIFICATION FACTOR
CAM	CONTINUOUS AIR MONITOR
CASS	COMPUTER AUTOMATED SURVEILLANCE SYSTEM
CBR	CALIFORNIA BEARING RATIO
CCTV	CLOSED CIRCUIT TELEVISION
CDR	CONCEPTUAL DESIGN REPORT
CFR	CODE OF FEDERAL REGULATIONS
CH	CONTACT HANDLED
CHLLMW	CONTACT HANDLED LOW LEVEL RADIOACTIVE MIXED WASTE
DB	DRY BULB
DBA	DESIGN BASIS ACCIDENT
DCG	DERIVED CONCENTRATION GUIDE
DCS	DISTRIBUTED CONTROL SYSTEM
DI	DIGITAL INPUT
DMS	DATA MANAGEMENT SYSTEM
DO	DIGITAL OUTPUTS
DOE	U.S. DEPARTMENT OF ENERGY
DOE-RL	U.S. DEPARTMENT OF ENERGY FIELD OFFICES, RICHLAND
DOT	DEPARTMENT OF TRANSPORTATION
DSHS	DEPARTMENT OF SOCIAL AND HEALTH SERVICES
ECOLOGY	WASHINGTON STATE DEPARTMENT OF ECOLOGY
EEE	INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
EMP	ENVIRONMENTAL MONITORING PLAN
EPA	ENVIRONMENTAL PROTECTION AGENCY
EPRI	ELECTRICAL POWER RESEARCH INSTITUTE
ES&H	ENVIRONMENT, SAFETY & HEALTH
FACP	FIRE ALARM CONTROL PANEL
FDC	FUNCTIONAL DESIGN CRITERIA
FM	FACTORY MUTUAL
GEA	GAMMA ENERGY ASSAY
HCWC	HANFORD CENTRAL WASTE COMPLEX
HDW-EIS	HANFORD DEFENSE WASTE ENVIRONMENTAL IMPACT

ABBREVIATIONS & ACRONYMS

HEPA	HIGH EFFICIENCY PARTICULATE AIR
HFD	HANFORD FIRE DEPARTMENT
HLAN	HANFORD LOCAL AREA NETWORK
HP	HORSEPOWER
HSWA	HAZARDOUS SOLID WASTE AMENDMENTS
I	IMPORTANCE FACTOR
IES	ILLUMINATING ENGINEERING SOCIETY
IMC	INTERMEDIATE METAL CONDUIT
IMT	INTEGRATED MANAGEMENT TEAM
IVDTS	INTEGRATED VOICE AND DATA TELECOMMUNICATIONS SYSTEM
KEH	KAISER ENGINEERS HANFORD
LCC	LIFE CYCLE COST
LDR	LAND DISPOSAL RESTRICTIONS
LETF	LIQUID EFFLUENT TREATMENT FACILITY
LI&LO	LOOP INPUT/OUTPUT
LLMW	LOW-LEVEL RADIOACTIVE MIXED WASTE
LLW	LOW-LEVEL WASTE
MCC	MOTOR CONTROL CENTERS
MRP	MANAGEMENT REQUIREMENTS & PROCEDURES
MR/YR	MILLIREM PER YEAR
MS	MILITARY SPECIFICATION
MW	HAZARDOUS AND RADIOACTIVE MIXED WASTE
NACE	NATIONAL ASSOCIATION OF CORROSION ENGINEERS
NBS	NATIONAL BUREAU OF STANDARDS
NCI/G	NANOCURIES/GRAM
NDA	NON-DESTRUCTIVE ASSAY
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NESHAP	NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOCS	NOTICES OF CONSTRUCTION
NSPS	NEW SOURCE PERFORMANCE STANDARDS
OPC	ORDINARY PORTLAND CEMENT
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
PA	PERFORMANCE ASSESSMENT OR PUBLIC ADDRESS
PAN	PASSIVE ACTIVE NEUTRON
PC	PERSONAL COMPUTER
PCB	POLYCHLORINATED BIPHENYL
PCS	PLANT CONTROL SYSTEM
PELS	PERMISSIBLE EXPOSURE LIMITS
PFA	PULVERIZED FLY ASH
pH	POTENTIAL OF HYDROGEN
PLC	PROGRAMMABLE LOGIC CONTROLLER
PMS	PLANT MANAGEMENT SYSTEM
PSD	PREVENTION OF SIGNIFICANT DETERIORATION
PSE	PRELIMINARY EVALUATION SAFETY
RAM	RANDOM ACCESS MEMORY
RCRA	RESOURCE CONSERVATION AND RECOVERY ACT
RFAR'S	RADIO FIRE ALARM REPORTERS

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ABBREVIATIONS & ACRONYMS

RH	REMOTE-HANDLED
RO	REVERSE OSMOSIS
ROD	RECORD OF DECISION
RPT	RADIATION PROTECTION TECHNICIAN
R_w	FORCE REDUCTION FACTOR
RWP	RESTRICTED WORK PERMIT
SCFM	STANDARD CUBIC FOOT PER MINUTE
SMA	SAMPLE MANAGEMENT AREA
SSW	SOUTH SOUTH WEST
SWITS	SOLID WASTE INFORMATION TRACKING SYSTEM
SWP	SPECIAL WORK PERMIT
T-BACT	BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS
TAPS	TOXIC AIR POLLUTANTS
TCAPCA	TRI-COUNTY AIR POLLUTION CONTROL AUTHORITY
TCLP	TOXICITY CHARACTERISTIC LEACHING PROCEDURE
TEC	TOTAL ESTIMATED COST
TLVS	THRESHOLD LIMIT VALUES
TPC	TOTAL PROJECT COST
TRU	TRANSURANIC
TSDF	TREATMENT, STORAGE AND DISPOSAL FACILITY
UBC	UNIFORM BUILDING CODE
UCRL	UNIVERSITY OF CALIFORNIA RESEARCH LABORATORY
UE&C	UNITED ENGINEERS & CONSTRUCTORS
UK	UNITED KINGDOM
UL	UNDERWRITERS LABORATORIES
UPS	UNINTERRUPTIBLE POWER SUPPLY
VCR	VIDEO CASSETTE RECORDERS
VES	VINYL ESTER STYRENE
VGA	VIDEO GRAPHICS ARRAY
VOCS	VOLATILE ORGANIC COMPOUNDS
WAC	WASHINGTON ADMINISTRATIVE CODE OR WASTE ACCEPTANCE CRITERIA
WB	WET BULB
WDOE	STATE OF WASHINGTON DEPARTMENT OF ECOLOGY
WG	WATER GAUGE
WHC	WESTINGHOUSE HANFORD COMPANY
WINTER	WNW
WIPP	WASTE ISOLATION PILOT PLANT
WIPP-WAC	WIPP WASTE ACCEPTANCE CRITERIA
WSW	WEST SOUTH WEST
WNW	WEST NORTH WEST
WRAP	WASTE RECEIVING AND PROCESSING

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1.0 PROCESS SYSTEM DESCRIPTIONS

1.1 Shipping/Receiving

1.1.1 Introduction

1. The Shipping and Receiving area accepts incoming LLW waste drums (55, 83 and 110 gallon) and boxes transferred from W-112 via the W-112 transfer corridor. In this area, transfers of waste drums are received on a daily basis and boxes are received once a month. The incoming waste is transferred to WRAP 2A in "lots" of similar type waste. The shipping and receiving area also prepares treated and immobilized 55-gallon waste drums for on-site LLW disposal via transfer back to W-112. A new drum receipt and storage space is provided immediately south of the main Shipping and Receiving area to support two weeks of operations.

1.1.2 Feeds and Throughput

1. The shipping and receiving area houses the equipment to receive 5,259 waste drums (55, 83 and 110 gallon) per year and one box per month. This new drum area provides the equipment to receive and store 9,515 new 55-gallon drums per year. The waste drums and boxes arrive through the W-112 transfer corridor from W-112 and the new drums arrive on trucks. The waste drums are delivered on pallets, four drums to the pallet. In the shipping and receiving area 9,515 55-gallon waste drums are prepared for transfer back to W-112 for on-site disposal.

1.1.3 Design Requirements

1. The shipping and receiving area contains the facilities and equipment for the safe receipt, inspection and weighing of LLW waste containers consisting of 55-gallon drums, 83-gallon drums, 110-gallon drums and waste boxes up to a maximum size of 5'W x 5'H x 9'L.

2. The facility provides one day of storage for incoming waste containers. Lag storage for waste containers awaiting shipping is provided in the main lag storage area.

3. The shipping and receiving area provides equipment for the simultaneous packaging and loading of 55-gallon drums for transfer back to W-112 for future on-site disposal.

4. It provides equipment to generate and read bar code labels on each waste container. The bar code label shall be attached on the top and sides of each waste container.

5. Each incoming and outgoing waste container will be visually surveyed for surface condition, radiation dose rate and removable contamination levels.

6. Provision will be made for receipt and temporary storage of hard copies and electronic copies of all documentation, reviewing shipping and packaging documentation, and entering applicable information into the Data Management System (DMS).

7. Equipment is provided to handle drums weighing up to 3,000 pounds and boxes weighing up to 12,000 pounds.

1.1.4 Process Selection

1. The equipment and process selected for the shipping and receiving area were based on the design and engineering studies from WRAP Module 1.

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1.1.5 Process Description

1.1.5.1 Waste Drum Handling

1. A battery powered Forklift Truck (FT-09-101) is used to unload pallets of four waste drums and boxes from the W-112 transfer vehicle. The design load capacity and travel speed for the forklift used to transport containers is 12,000 pounds and 8.0 mph unloaded (6.7 mph loaded).

2. Each pallet of waste drums is transferred from the forklift to the Pallet Accumulation Conveyor (CV-09-101). At the front of the conveyor, the drums and pallets are radiologically surveyed for surface contamination. The pallet accumulation conveyor provides storage for six pallets of waste drums. This conveyor storage plus the drums awaiting to be transferred to the drum size reduction area provides the one day of required storage. This gravity powered conveyor can accumulate pallets weighing up to 12,000 pounds each. A concrete shield wall is provided along the length of the conveyor in accordance with ALARA requirements.

3. Once the pallet has reached the end of the pallet accumulation conveyor, the waste drums are depalletized. Depalletization is accomplished by an operator using a manual controlled Drum Jib Crane (CR-09-101), which has a capacity of 2 tons. After removing the pallet straps, an individual waste drum is placed onto the Drum Scale/Conveyor (CV-09-105). At this point, the bar code label is read on the drum or attached if not present, and the information concerning the incoming waste drum is entered into the DMS. Sensors detect the drum on the scale/conveyor and the scale weighs the drum. The weight of the drum is shown on an L.E.D. display and the amount is recorded. The operator signals via a push button to release the drum from the scale/conveyor to the Drum Feed Conveyor (CV-09-102). At the discharge end of the conveyor, sensors detect the drum, which initiates a signal to the automatic control system to open the airlock door and transfer the drum to the Airlock (AL-05-101).

1.1.5.2 New Drum Handling

1. New empty 55-gallon drums used for repacking waste are delivered to the WRAP 2A facility at the new drum storage and receiving area dock. The new drums are delivered by flatbed trucks nonpalletized. The battery powered forklift attached with a fork truck Dual Drum Gripper (X-09-101) unloads two new drums at a time off the flatbed truck, adds a bar code label to the drums and places them into storage. The storage area can accommodate sufficient new 55-gallon drums, stacked three high and four high, to provide storage for two weeks operations.

2. After the truck is unloaded, the forklift transfers the new drums to the new Drum Feed Conveyor (CV-09-103). The conveyor includes two sections connected at a right angle and a 90 degree chain transfer device between the two sections. The drum feed conveyor detects the drums and conveys them to the end of the first section. The 90 degree chain transfer device transfers a drum to the second section which conveys the drum to the discharge end. At the discharge end, a sensor detects the drum and transfers it to the processing area via the Airlock Conveyors (CV-08-501 and CV-08-502).

1.1.5.3 Waste Box Handling

1. Waste boxes are unloaded from the W-112 transfer vehicle using the battery powered forklift. Each waste box is transported via the forklift to the Airlock (AL-05-561) and the bar code label is read. At this point, the waste box is transferred into the box size reduction area for processing.

1.1.5.4 Waste Drum Shipping

1. Waste drums (55 gallon) are transported out of the processing area into the shipping and receiving area by the AGV (GV-08-102) and Airlock Transfer Conveyors (CV-08-503 and CV-08-504). At the discharge end of the airlock conveyor, the conveyor initiates a signal to the automatic control system to open the airlock door and transfer the drum to the Drum Discharge Conveyor (CV-09-104).

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2. At the drum discharge conveyor, each waste drum is radiologically surveyed for external contamination and its bar code label is read. The drum is conveyed to the discharge end and transferred to the Drum Scale/Conveyor (CV-09-106) where it is weighed. A Drum Jib Crane (CR-09-102) equipped with a drum gripper is used by a local operator to remove a drum from the scale/conveyor and places it on a pallet. The drums are palletized (4 waste drums per pallet) and rebanded by the operator. After the drums are palletized, the forklift picks up the pallet and transfers the pallet to the W-112 transfer corridor. The forklift transfers the pallet to the W-112 vehicle which takes the pallet back to W-112 for future on-site disposal.

3. Provision will be made within the lag storage area to segregate all lots before and after treatment. Campaign status and shipping of treated "lots" will be controlled from these segregated lots.

1.1.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.10, 3.8, 5.0, 7.0

DOE Orders

2. DOE Order 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement
   0110-13, Physical Protection
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities
   1300, Special Facilities, General Requirements
   1324, Radioactive Solid Waste Facilities
   1400, Conveying Systems

   DOE Order 5400.3, Hazardous and Mixed Waste Program
   DOE Order 5820.2A, Radioactive Waste Management

WHC Manuals

3. Hanford Plant Standards Design Criteria:

   WHC-CM-6-4 Hoisting and Rigging Manual
   WHC-CM-4-10 Radiation Protection
   WHC-CM-2-14 Hazardous Material Packing and Shipping

1.1.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140670	Receiving/Shipping Process Flow Diagram (RC-3)
H-2-140671	Receiving/Shipping Equipment General Arrangement (RC-1)
H-2-140672	Receiving/Shipping Sections (RC-2)

1.2 Drum Size Reduction and Repack

1.2.1 Introduction

1. Within the WRAP 2A facility there is a requirement for incoming drummed LLRMW to be opened, size reduced and repacked into new drums prior to being immobilized in a grout or polymer matrix at further processing stations within the plant. This section of the CDR report describes the process by which size reduction and repacking of drums is achieved.

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1.2.2 Feeds and Throughput

1. The Functional Design Criteria (FDC) for WRAP 2A (Reference 4) specifies the plant is required to process 29,000 cubic feet of incoming waste per year, this equates to approximately 30 drums per day for single shift operation five days per week. All waste which enters the plant will be processed in the size reduction and repack cell. Some of this waste will be processed in the special waste enclosure. A description of this waste together with anticipated individual throughputs can be found in **Table 6-1** (Volume I). As a number of routes are available by which waste can be processed within the size reduction and repack cell, wastes associated with individual processes are listed as part of the respective process descriptions. Waste which enters the plant in 55- to 85-gallon drums will enter the size reduction and repack cell from the receipt area. Waste which enters the plant in containers larger than 85-gallon drums will be processed in the Box Breakdown Cell such that it can be fed to the size reduction and repack cell in 55-gallon drums inside 85-gallon drum overpacks. The maximum weight of 85-gallon drums to be processed in the size reduction and repack cell is 3000 lb.

2. Waste which enters the size reduction and repack cell will be processed in one of four separate process enclosures depending on the specific nature of the waste, these are briefly described as follows:

a. Shredding and repacking enclosure	-	Processing of primarily dry wastes (described in Section 1.2.5)
b. Pug Mill enclosure	-	Processing of sludge materials (described in Section 1.2.5)
c. Special waste enclosure 1	-	Processing of lead and mercury contaminated waste and reactive metals (described separately in Section 1.6).

3. The product from each of these enclosures will be repacked waste in new 55-gallon drums.

1.2.3 Design Requirements

1. The FDC (Reference 4) specifies that WRAP 2A shall have a capability to condition waste for treatment as per the following:

a. Open and sorting capability of all materials that will require conditioning (e.g., shredding, segregation) to permit treatment and remove items not to be treated. The design shall account for the existence of sharp objects present in the waste.

b. Screening of all particulate waste to remove lumps and foreign objects.

c. Shredders capable of shredding a wide range of debris including concrete, metal, paper, plastic, etc. to meet final waste form criteria.

d. Packaging capability for transport out of the enclosure of items found during sorting that will not be treated in WRAP Module 2A.

e. Disposal of waste containers by size reducing and treating for disposal as waste.

f. Capability to shred and process drums that have already been immobilized and drums that have been supercompacted.

2. The Drum Size Reduction and Prepack area is designed to meet the following requirements:

a. The principle design goal is to provide cost effective and safe designs to carry out the size reduction of large waste items in WRAP 2A.

b. The system shall be designed to ensure that size reduction operations are carried out in suitable high integrity enclosures to prevent the egress of radioactive and hazardous particulates.

c. The system shall utilize an integrated design approach to ensure a compatible interface between the other process areas of the WRAP 2A facility.

d. The size reduction equipment shall be designed to minimize maintenance and decommissioning requirements.

e. The system shall be designed to minimize generation of secondary waste and the lifetime occupational radiation exposure to personnel working on the equipment.

f. Mechanical drives and other components will be located outside of the product confinement area as much as possible to limit contamination of equipment and maintain worker exposure to radioactive and hazardous waste ALARA.

g. Incorporate the principles of human factors, ALARA principals and decontamination and decommissioning throughout all design phases.

3. These requirements have been taken into consideration in arriving at the proposed design for the size reduction and repacking area of WRAP 2A.

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1.2.4 Process Selection

1. The proposed process design for the Size Reduction and Repack area is based on five main considerations:

a. Selection of three process lines for handling the waste.

b. Placing each process line inside a containment enclosure.

c. Utilization of equipment designed for WRAP 1.

d. Selection of shredding equipment for carrying out size reduction.

e. Areas requiring further assessment/development.

Selection of Three Process Lines

2. The decisions which lead to the selection of the three process lines Repack, Shredding and Pug Mill are based on the following logic:

a. The size reduction and repack cell of WRAP 2A is scheduled to receive 16 different waste feedstreams and process these for either grout or polymer treatment. Clearly it is unrealistic to assume that all feedstreams can be satisfactorily processed by the same equipment, neither can it be economically justified that one process line can be provided to treat each individual feedstream.

b. When considering the fundamental options of how the waste could be treated, it is logical that if essentially dry items are processed in equipment which has previously handled moist or wet material then either the equipment has to be cleaned after each campaign or the equipment becomes heavily clogged with dry waste stuck to the moist equipment. This subsequently leads to clean up costs and personnel radiation exposure. Furthermore the type of equipment best suited to processing dry and wet material is likely to be fundamentally different. Hence the decision to specify a "dry" and a "wet" line was made.

c. When assessing the requirement to process dry materials, together with the recognition that some materials required size reduction it was considered prudent that materials which did not require size reduction and were susceptible to producing airborne contamination should be processed separately from the size reduction equipment and repacked directly into new drums. This decision was backed by the fact that most of the waste that entered the size reduction and repack area is dry and does not require size reduction.

d. Based on the logic described in a, b, and c above the provision of three separate process lines a) dry no size reduction, b) dry size reduction and c) wet material processing seemed to achieve as satisfactory balance between the extreme options of one single universal process line and 16 individual process lines. It was also considered that this would provide a sound basis for allowing operational flexibility.

e. Within each of these process lines the requirement to open the incoming drum and load the waste into new drums is based on two criteria

1) it is unlikely that the incoming drums will be in a suitable condition for long term storage of waste, and

2) the incoming waste has to be repacked into drums in measured quantities in order to be compatible with the grout and polymer processes.

f. A separate entry enclosure has been provided for the pug mill and the shred/repack lines in order to:

1) Provide redundancy in order to allow one line to be operated if maintenance is required to either of the entry facilities.

2) Simplify ventilation requirements.

3) Provide operational flexibility.

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Placing each Process Line Inside A Containment Enclosure

3. Each process line was placed inside a containment enclosure for the following reasons:

a. To minimize the spread of contamination.

b. To reduce the volume of free space around the equipment and hence reduce ventilation running costs.

c. To allow personnel to be able to work around the enclosure, for operational or maintenance purpose, while working in SWP clothing.

d. The principle of using process enclosures is in line with the FDC (Reference 4).

Utilization of Equipment Designed for WRAP 1

4. When it was established that the WRAP 2A Size Reduction and Repack equipment would be housed inside process enclosures and that a large proportion of this equipment involved the handling of drums and drummed waste it is clear that the WRAP 2A design should accommodate design features and equipment already established on WRAP 1 in order to reduce the overall design and development costs of the project.

Selection of Shredding Equipment

5. The justification for selecting shredding equipment to achieve size reduction is based on the requirement that LLMW has to be uniformally immobilized in a void free matrix. If compaction equipment was employed to size reduce the feed drums then it is unlikely that the immobilizing

medium would penetrate into the free voids within the compact, hence not complying with disposal criteria. The selection of shredding equipment is also in line with the FDC (Reference 4).

Areas Requiring Further Assessment/Development

6. Areas of the Size Reduction and Repacking area within WRAP 2A which require further assessment are listed as follows:

a. Shredders

1) The ability to produce a required waste form size of 2" x 2" x 2" for such a wide variety of wastes.

2) The capacity (HP) of shredding equipment to shred incoming wastes.

3) The general safe operation of shredders in an active environment (i.e., dust generation, fire explosion, requirement for inerting, etc.).

4) The integration of shredders into an active process enclosure (engineering, maintenance, decontam, etc.).

b. Pug Mill

1) The determination of whether, and if so how much, of an appropriate fluid is required to assist sludge, crystalline solid and absorbed chemicals to be processed in the pug mill.

2) The ability of pug mill to process plastic bags.

3) The integration of a pug mill into an active process environment (engineering, maintenance, decontam etc.).

c. Weigh Hoppers (Waste Load Out)

1) The accuracy to which the weight of waste can be measured in a weight hopper when being continuously fed from a vibrating conveyor or pug mill.

2) The performance of a simple double lid seal/lift table rigidity, under the dynamic loading of a fixed mass of waste being deposited from a weigh hopper.

3) How special features such as antifloatation devices are fitted into drums when loaded with waste.

d. Drum Handling

1) How the drum clamp band is removed from new drums before being loaded with waste from the weigh hoppers.

2) The requirement for transporting drums around the plant once loaded with waste (i.e., sealing, clamp band etc.) and how this is to be achieved.

3) How drums which contain non shreddable and non pug mill processable waste are transferred from the hand pallet truck onto the inlet conveyor for transportation to the receipt area prior to being shipped to W-112.

1.2.5 Process Description

1. The process description for size reduction and repacking is described in three sections as follows:

a. Size Reduction and Repack Cell

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b. Shredding and Repack Enclosure

c. Pug Mill Enclosure

2. Each of these processes are illustrated on the Process Flow Diagram (Reference 4). The layout of the size reduction and repacking area within WRAP 2A is shown on the General Arrangement drawings H-2-140631 and 140632. Reference should be made to these drawings when reading the following process descriptions.

Size Reduction and Repack Cell

3. 55- to 85-gallon drums are transported from the receipt and shipping area (Reference 5) into the size reduction and repack cell through double airlock door (AL-05-501) on roller conveyor (CV-05-501). This allows drums to be transferred from the Zone 3 receipt area into the Zone 2 size reduction cell.

4. Drums are then transported from conveyor (CV-05-501) onto a conveyor mounted transfer car (TC-05-501) using a further roller conveyor (CV-05-502). The transfer car has the ability to transfer drums to any one of the three process enclosures shredding and repack, pug mill or special waste. The transfer car also has the capability of transferring redrummed waste from the Box Breakdown area (H-2-140628 Sht. 2) via simple Double Lid Door (DO-05-562) and the hydraulic lift table (LT-05-561).

Shredding and Repack Enclosure

Drum Entry

5. Drums which are to be processed in the shredding and repack enclosure (GB-05-521) are transported on the transfer car (TC-05-501) to be in line with the hydraulic lift table (LT-05-521) located at the entry position of the enclosure. The drum is then transferred from the car onto the lift table and elevated to interface with the simple double lid entry port (DO-05-521). Entry of a 55-gallon drum from within an overpack is achieved by enabling the simple double lid mechanism for lid removal. This engages onto the overpack lid which is removed as the door opens. The drum lifter (DH-05-521) is lowered between the two drums to clamp onto the 55-gallon drum which is raised into the process enclosure by the drum hoist (CR-05-521). Closing of the double lid door after entry of the 55-gallon drum replaces the lid onto the overpack which is then lowered from the entry port. Drums for processing which are not within overpacks, follow the same procedure but the lid removal mechanism is disabled.

6. The simple double lid allows the drum to be transferred from the Zone 2 size reduction cell into the Zone 1 process enclosure. Once inside the entry enclosure the drum is transferred to be above sliding hatch (DO-05-522), the hatch door is opened and the drum lowered into the lid removal area. The sliding hatch is then closed.

Lid Removal

7. Having transferred through the sliding hatch the drum rests on the supporting conveyors of the drum pusher unit (CY-05-521). The drum pusher then transfers the drum to be positioned adjacent to the drum handler/tipper (DH-05-522), the band saw (RT-05-521) and the drum lid remover (RT-05-522). With the drum in position, the grabber on the handler/tipper clamps the drum around its rolling rings, the band saw then cuts through restraining clamp band thus exposing the drum lid which is then be removed by the lid remover. Lids and clamp bands will be stored in the enclosure adjacent to the removal equipment for subsequent loading into an empty drum for disposal. At this point in the process the drum is lifted by the drum handler/tipper to either the Repack line or the Shredder line depending on the type of waste contained in the drum.

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Repack

8. The following categories of drummed waste will be lifted by the drum handler to be processed in the repack line:

Feedstream	Description	Drums per day (averaged over the lifetime of the plant)
2A	Ammonium Sulfate	8.08
2B	Ion Exchange Resin	1.66
2C	Metal Sludge	2.36
7	Ash for Treatment	1.78
8	Contaminated Soil	0.53
Total		14.41

9. When the drum is lifted to the repack line the waste sorting table (ST-05-521B) traverses horizontally to position itself underneath the drum handler/tipper. The drum grabber, on the handler tipper, then rotates to empty the drum contents onto the sorting table. When all the waste has been tipped from the drum, the sort table traverses back to position itself adjacent to an operating face in the process enclosure. In this position the waste is visually inspected on the sort table and any items which are not considered suitable for direct repacking are removed using manipulators (EM-05-521B) and loaded back into the empty drum held in the handler tipper, this waste together with the empty drum itself is subsequently lifted to the shredding line for processing.

10. Once the waste held on the sorting table is judged, after visual inspection, suitable for direct repacking, the sort table tips the waste onto vibrating conveyor (CV-05-521). The purpose of the vibrating conveyor is to feed waste into one of two hoppers (T-05-521A or B), depending upon the future processing requirement of the waste at a controlled rate. Waste is fed to either weigh hopper A or B using a diverter tray (X-05-522). The vibrating table feeds waste into the weigh hopper until the required mass of waste is recorded on the load cells of the weigh hopper. When this desired mass is achieved, the weigh hopper sends a feedback signal to stop the drive to the vibrating conveyor thus preventing further depositing of waste into the weigh hopper, within a given tolerance. At this point the respective simple double lid door (DO-05-524 A or B) opens and the waste is deposited from the weigh hopper into a new drum which is correctly positioned on lift table (LT-05-523 A or B) underneath the simple double lid door aperture, any fixtures such as waste antifloatation devices are then fitted to the drum. The simple double lid door is then closed, the drum lid replaced and secured onto the drum. The lift table then descends and the drum is fed onto an AGV using the conveyor on the lift table. The AGV then transports the repacked drum of waste for further processing within the plant.

Shredding

11. The following categories of drummed waste will be lifted by the drum handler to be processed in the shredding line:

Feedstream	Description	Drums per day (averaged over the lifetime of the plant)
1A	183 H Solidified Liquid	0.64
1D	183 H Miscellaneous Clean Up Waste	0.30
2D	RO Filter Elements	0.27
3	Compactable Solids	1.63
4	Non Compactable Solids	0.90
5D	Miscellaneous Metals	1.56
	Empty used Waste Drums	24.64
	Waste from Box Breakdown	0.66
Total		30.60

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12. When the drum is lifted to the shredding line the waste sort table (ST-05-521A) traverses horizontally to position itself underneath the drum handler/tipper. The drum grabber, on the handler/tipper, then rotates to empty the drum contents onto the sorting table. When all the waste has been tipped from the drum, the sort table traverses back to position itself adjacent to an operating face in the process enclosure. Where waste can not be displaced from the drum, the drum and its contents are loaded onto the sorting table as a single item awaiting shredding. With the sort table adjacent to the operating face the waste is visually inspected and any items which are not considered suitable for shredding are removed using manipulators (EM-05-521A) and loaded out of the shredding and repack enclosure using the glovebox Hoist (CR-05-522), the waste transfer tray (X-05-521), the simple double lid (DO-05-523) and the lift table (LT-05-522). These drums containing non shreddable items are then transported on the hand pallet truck (FT-05-501) to conveyor (CV-05-501) for removal of the drum to W-112 via the receipt area. It is possible that feedstream 1A could contain liquors. If liquids are detected by visual inspection while on the sort table, they are absorbed by absorbent discharged from weigh hopper (T-05-522).

13. Once the waste which is held on the sorting table is certified as suitable for shredding, the sort table tips the waste into the coarse shredder (SH-05-521) which subsequently allows the coarse shredded waste to feed by gravity into the fine shredder to be sized to a nominal maximum size of 2" x 2" x 2". This maximum envelope size is achieved using a close fitting screen at the output of the fine shredder. If the waste has not been shredded to the specified dimensions after the first shredding cycle waste is picked up by the shredder rollers and re-fed through the fine shredder until the desired waste size is achieved.

14. Having shredded waste to the specified maximum size the waste is deposited onto the vibrating table (CV-05-501) and processed in an similar manner to waste which only requires repacking, as described in Section 1.2.5.10.

Pug Mill Enclosure

15. The following categories of drummed waste will be processed in the pug mill enclosure:

Feedstream	Description	Drums per Day (averaged over the lifetime of the plant)
1B	183 H Crystalline Solids	1.01
1C	183 H Sludge	1.09
6	Absorbed Chemicals/Solidified Liquids	1.32
Total		3.42

Drum Entry

16. Drums which are to be processed in the pug mill enclosure (GB-05-541) are transported on the transfer car (TC-05-501) to be in line with the hydraulic lift table (LT-05-541) located at the entry position to the enclosure. The drum is then transferred from the car onto the lift table and elevated to interface with the simple double lid entry port (DO-05-541).

17. With the drum in position the simple double lid is activated and the double lid door opened. Drums are then lifted through the double lid door aperture into the process enclosure using the drum lifter (DH-05-541) and the drum hoist (CR-05-541), the simple double lid door is then closed. The simple double lid allows the drum to be transferred from the Zone 2 size reduction cell into the Zone 1 process enclosure. Once inside the entry enclosure the drum is transferred to be above sliding hatch (DO-05-522), the hatch door is opened and the drum is lowered into the lid removal area. The sliding hatch is then closed.

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Lid Removal

18. Having transferred through the sliding hatch the drum rests on the supporting conveyors of the drum pusher unit (CY-05-541). The drum pusher then transfers the drum to be positioned adjacent to the drum handler/tipper (DH-05-542), the Band Saw (RT-05-541) and the drum lid remover (RT-05-542). With the drum in position, the grabber on the handler/tipper clamps the drum around its rolling rings, the band saw then cuts through restraining clamp band thus exposing the drum lid which is then be removed by the lid remover. The drum is then lifted by the drum handler tipper to the pug mill process line.

19. When the drum is lifted to the pug mill line the waste sort table (ST-05-541) traverses horizontally to position itself underneath the drum handler tipper. The drum grabber, on the handler/tipper, then rotates to empty the drum contents onto the sorting table. When all the waste has been tipped from the drum, the sort table traverses back to position itself adjacent to an operating face in the process enclosure. With the sort table adjacent to the operating face the waste is visually inspected on the sort table and any items which are not considered suitable for pug mill processing are removed using manipulators (EM-05-542) and loaded out of the pug mill enclosure using the glovebox hoist (CR-05-542), the waste transfer tray (X-05-541), the simple double lid (DO-05-543) and the lift table (LT-05-542). These drums containing non processable items from the pug mill enclosure are then transported on the hand pallet truck (FT-05-501) to conveyor (CV-05-501) for removal of the drum to W-112 via the receipt area. Empty used drums are then lowered on the drum handler and transferred onto a transfer car (TC-05-521) housed in a containment enclosure (GB-05-522) provided for the transfer of empty drums to be shredding and repack enclosure (GB-05-521). On receipt at the shredding and repack enclosure the empty drum is transferred to the shred and repack drum handler (DH-05-522) and the drum is transferred to be shredded as described in Section 1.2.5.11.

20. Once the waste held on the sort table is certified as suitable for processing, the sort table tips the waste into the pug mill (SH-05-541) within which it is simultaneously homogenized and transported to the weigh hopper (T-05-541) at a controlled rate. The pug mill feeds waste into the weigh hopper until the required mass of waste is recorded on the load cells of the weigh hopper. When this desired mass is achieved, the weigh hopper sends a feedback signal to stop the drive to the pug mill thus preventing further depositing of waste to the weigh hopper, within a given tolerance. At this point the simple double lid door (DO-05-544) opens and the waste is deposited from the weigh hopper into a new drum which is correctly positioned on lift table (LT-05-543) underneath the simple double lid door aperture, any fixtures such as waste antifloatation plates are then fitted to the drum. The simple double lid door is closed, the drum lid replaced and secured onto the drum. The lift table then descends and the drum is fed onto an AGV using the conveyor on the lift table. The AGV then transports the repacked drum of waste for further processing within the plant.

Process Sampling Within Enclosures

21. Each of the three main process lines repack, shredding and pug mill, will be fitted with a purged port bagless transfer units (DO-05-525B), (DO-05-525A) and (DO-05-545) respectively which will allow samples of waste to be transferred from each process line for sample analysis.

1.2.6 Key DOE/WHC Criteria

1. The Drum Size Reduction and Repack area is designed to meet the following criteria and standards.

a. WRAP 2A FDC Sections 2.2.1, 2.2.3, 3.8, 5.0, 7.0.

b. DOE 6430.1A General Design Criteria, sections:

0110-9, Operation, Maintenance, Repair, and Replacement.
0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
1161, Enclosure.
1300, Special Facilities.
1324, Radioactive Solid Waste Facilities.

DOE Order 5400.5, Radiological Protection of the Public and the Environment.
DOE Order 5820.2A, Radioactive Waste Management.
DOE Order 5400.3, Hazardous and Mixed Waste Program

c. Hanford Plant WHC Standards Design Criteria:

d. WHC-CM-4-9, Radiological Design Criteria:

Sections -	3.0	Contamination Control
	5.0	Selecting Workplaces
	6.0	Gloveboxes
	8.0	Shielding
	10.0	Sampling and Monitoring
	11.0	Waste Handling, Storage and Disposal **Appendix A**

2. These requirements have been taken into consideration in arriving at the proposed design for the size reduction and repacking area of WRAP 2A.

1.2.7 References Drawings

Drawing Number	Drawing Title
H-2-140628 (Sht. 1)	Process Flow Diagram Size Reduction and Repack (Drums)
H-2-140631	General Arrangement (Plan) Size Reduction and Repack
H-2-140632	General Arrangement (Elevation) Size Reduction and Repack
H-2-140628 (Sht. 2)	Process Flow Diagram Size Reduction and Repack (Box Breakdown)

1.3 Box Breakdown

1.3.1 Introduction

1. Within the WRAP 2A Facility, there is a requirement for incoming boxed LLRMW to be opened, size reduced and repacked into new drums prior to being immobilized in either a grout or polymer matrix at further processing stations within the plant. This section of the CDR report describes the process by which size reduction and repacking of boxes is achieved.

1.3.2 Feeds and Throughput

1. The Box Breakdown area within WRAP 2A will process a total of 34 existing boxes **Table 6-1** (Volume I) plus 1 box per month of newly generated boxes (Reference 5) over the lifetime of the plant. It is anticipated that 20 of the existing boxes contain lead and 14 contain 183 H miscellaneous clean up waste and that the newly generated boxes contain mainly HEPA filters. The maximum sized box to be processed is 5' X 5' X 9' and weighing 12,000 pounds (Reference 3). The box breakdown area will also process drums which cannot be processed in the drum size reduction and repack area including deterioration drums whose physical strength and containment integrity would cause handling and containment problems using the normal process route; these drums can be up to 110-gallons weighing 3,000 pounds. The box breakdown cell is designed for single shift operation five days per week.

2. The product of the box breakdown area will be waste that is of a suitable size that can be transported in a 55-gallon drum, inside a 85-gallon overpack, to the size reduction and repack cell. The overpack drum remains outside the box breakdown area and is positioned below the

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exit port to receive the 55-gallon waste drum for transfer to the process enclosures. An overpack is considered necessary to prevent spread of contamination which may be on the exterior of the 55-gallon drum as a result of filling operations within the Box Breakdown area.

1.3.3 Design Requirements

1. The FDC (Reference 4) specifies that WRAP 2A shall:

   a. Have the capability to receive, handle and exit boxes as large as 5' x 5' x 9' weighing 12,000 pounds. The box handling capability provided shall include opening the box, segregating the waste, size reducing the waste for treatment and transporting the waste to the treatment processes. Large metal waste, with the exception of lead, and containers shall be size reduced on a case by case basis. The capability to exit the waste and containers which will not be size reduced shall be provided.

2. The Box Breakdown area is designed to meet the following requirements.

   a. The principle design goal is to provide cost effective and safe designs to carry out the size reduction of large waste items in WRAP 2A.

   b. The system shall be designed to ensure that size reduction operations are carried out in suitable high integrity enclosure to prevent the egress of radioactive and hazardous particulates.

   c. The system shall utilize an integrated design approach to ensure a compatible interface between the other process areas of the WRAP 2A facility.

   d. The size reduction equipment shall be designed to minimize maintenance and decommissioning requirements.

   e. The system shall be designed to minimize generation of secondary waste and the lifetime occupational radiation exposure to personnel working on the equipment.

   f. Mechanical drives and other components will be located outside of the product confinement area as much as possible to limit contamination of equipment and maintain worker exposure to radioactive and hazardous waste ALARA.

   g. Incorporate the principles of human factors, ALARA principals and decontamination and decommissioning throughout all design phases.

3. The Box Breakdown area is also designated as the maintenance area for ad hoc maintenance of equipment for which an in-situ solution may not have been possible.

1.3.4 Process Selection

1. The proposed process design for the box breakdown cell is based on knowledge that the majority of the boxes being fed to the cell are regular sized and contain a regular waste form namely HEPA filters. The throughput of this cell is low, typically one box per month, and off line from the main drum size reduction and repack cell thus reducing the pressure to provide equipment to size reduce boxed waste quickly.

2. The principle of using a power manipulator to size reduce the box and its waste is based on the probable requirement to carry out mechanical cutting operations which will result in reactionary forces transmitted to the manipulator. The manipulator will also be required to carry relatively heavy items of waste within the cell. Hence the requirement for a heavy duty manipulator.

3. The logic behind mounting the power manipulator on a telescopic mast, which in turn is mounted on a traveling bridge and crab, is based on the requirement to deploy and operate the

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manipulator around a maximum sized box of 5' X 5' X 9' and to transfer size reduced waste within the cell. This calls for equipment which will allow the manipulator to cover the full envelope of the cell.

Areas Requiring Further Assessment/Development

4. Areas of the box breakdown cell within WRAP 2A which require further assessment are listed as follows:

a. The tooling required for the power manipulator to size reduce the boxes and waste.

b. The equipment required to crush HEPA filters such that they can be loaded into a 55-gallon drum.

c. The workpiece handling requirements for the box such that it can be stabilized during breakdown.

1.3.5 Process Description

1. The following process description should be read in conjunction with the Process Flow Diagram for box breakdown (H-2-140628 Sht. 2). The layout of the Box Breakdown area within WRAP 2A is shown on the General Arrangement drawings H-2-140631 and 140632. Reference should be made to these drawings when reading the following process description.

2. Boxes and oversized drums enter the box breakdown cell through airlock (AL-05-501) on conveyors (CV-05-561A,B,C) the airlock allows the waste to be passed from a Zone 3 to a Zone 1 area.

3. When in the box breakdown cell, the overhead crane (CR-05-561) picks the box off the conveyor (CV-05-561C) and places it on the floor of the cell. The overhead telescopic mounted power manipulator (EM-05-561) then cuts through the restraining clamp which holds the lid on the box. The overhead crane then lifts the lid off the box and places it on the floor of the cell. Both overhead crane and power manipulator have the ability to cover the full envelope volume of the box breakdown cell.

4. The power manipulator then returns to either:

a. Lift small items of waste from the box and place them inside a 55-gallon drum, itself contained within an 85-gallon drum overpack, through the simple lid door (DO-05-561).

b. Size reduce large items of waste, using tools provided at a remote tool change station, and place the size reduced waste into the 55-gallon drum described in 4a above, through door (DO-05-561).

c. Lift HEPA filters from the box, place them in the filter press (C-05-561) and after compression, lift and place the filter into the 55-gallon drum described in 4a above, through door (DO-05-561).

5. Upon complete removal and size reduction of the waste, the power manipulator size reduces and disposes of the box itself, into a 55-gallon drum through door (DO-05-561).

6. If the manipulator encounters waste outside its capability to size reduce and process, a subchange facility is provided through which personnel can enter in protective clothing, to carry out size reduction and processing as required.

7. Within the box breakdown cell there is the option to decontaminate the box, once the waste contents have been removed, either remotely or manually. The power manipulator will be used for remote decontamination of the boxes. In the event that further local decontamination is required, access into the Box Breakdown area will be made through the subchange room to

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manually decontaminate as required. Then the box is removed from the box breakdown cell using the overhead crane, conveyors and the airlock. The box can then be reused.

8. Once the door lid is closed, the 55-gallon drum inside the 85-gallon drum overpack is lowered form the simple double lid on lift table (LT-05-561) and then transported onto transfer car (TC-05-501) inside the size reduction cell. The transfer car then transports the drum to the Size Reduction and Repack cell for processing in the same manner as drummed waste described in Section 1.2, Drum Size Reduction and Repacking.

Process Sampling

9. The Box Breakdown area will be fitted with a purged port bagless transfer Unit (DO-05-562) which will allow samples of waste to be transferred from the cell for process sampling.

10. The facility also exists to send waste from the box breakdown cell for lot verification sampling using the overpacked 55-gallon drum.

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1.3.6 Key DOE/WHC Criteria

1. The Box Breakdown area is designed to meet the following criteria and standards:

   a. WRAP 2A FDC Sections 2.2.1, 2.2.3, 3.8. 5.0, 7.0.

   b. DOE 6430.1A General Design Criteria, sections:

      0110-9, Operation, Maintenance, Repair, and Replacement.
      0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
      1161, Enclosure.
      1300, Special Facilities.
      1324, Radioactive Solid Waste Facilities.

      DOE Order 5400.5, Radiological Protection of the Public and the Environment.
      DOE Order 5820.2A, Radioactive Waste Management.
      DOE Order 5400.3, Hazardous and Mixed Waste Program

   c. Hanford Plant WHC Standards Design Criteria:

   d. WHC-CM-4-9, Radiological Design Criteria:

Sections -	3.0	Contamination Control
	5.0	Selecting Workplaces
	6.0	Gloveboxes
	8.0	Shielding
	10.0	Sampling and Monitoring
	11.0	Waste Handling, Storage and Disposal **Appendix A**

2. These requirements have been taken into consideration in arriving at the proposed design for the size reduction and repacking area of WRAP 2A.

1.3.7 Reference Drawings

Drawing No.	Drawing Title
H-2-140628 (Sht. 2)	Size Reduction and Repack Process Flow Diagram (Box Breakdown)
H-2-140631	Size Reduction, Repack and Box Breakdown--Equipment General Arrangement (Plan)
H-2-140632	Size Reduction, Repack and Box Breakdown--Equipment General Arrangement (Elevation)

1.4 Grout Treatment

1.4.1 Introduction

1. A substantial proportion of the waste in WRAP 2A will be immobilized using a cementitious grout matrix. **Table 6-1** (Volume I) in the design basis identifies those wastes which can be incorporated into grout and any pretreatment which may be necessary.

2. Waste for grouting will arrive fully packaged and prepared for grout addition in new 55-gallon drums. This operation will have taken place in the empty/sort/repack enclosure. In addition to this preparation all drums of weighed waste will have been assayed (NDA) and will arrive at the grout facility in lots with full bar code history and characterization.

3. Appropriate grout formulations using standard ingredients such as Ordinary Portland Cement (OPC), Blast Furnace Slag (BFS), and Pulverized Fly Ash (PFA) will be mixed in a nonactive environment and added to drums held in an environmentally controlled cell or enclosure.

4. The grout facility will cater for two generic types of waste in two distinct process lines and both lines will use an in-drum mixing method to achieve the final product.

5. After grouting, the product from each process line will be stored within the enclosure for a minimum of 48 hours for curing.

6. Waste entering the grout process will be treated in campaigned lots and this segregation will be maintained during subsequent sampling and storage prior to certification and disposal.

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1.4.2 Feeds and Throughput

1. All feeds destined for the grout treatment process are included in the "Waste Feed Throughput and Design Basis Derivation" document **Table 6-1** (Volume I).

2. These feeds are briefly described:

a. 1D - 183H Miscellaneous Clean Up Waste

- This waste is described as a collection of miscellaneous solids arising from the clean up and collection of the 183H basin sludge. It will include plastic liners, polythene bags, sand blast grit and other equipment used to collect and contain the sludges for transport.

- An estimated total volume of 11,550 cubic feet of this waste is awaiting treatment. The waste will be shredded and repacked into new 55-gallon drums before being grouted in the vibro-grout process line.

b. 2C - Metal Sludge

- This waste is described as a dewatered metal sludge arising from a future Liquid Effluent Treatment Facility (LETF), L-045. It is presently characterized as a sludge with 65 percent wt water with unknown chemical breakdown.

- A projected total volume of 10,500 cubic feet is anticipated over a 30 year period. This waste will be repacked into new 55-gallon drums within the WRAP 2A facility and be grouted using the agitated grout process line.

c. 2D - Treatment Media Waste (RO Filter Elements)

- This waste is described as the solid materials emanating from a reverse osmosis (RO) plant within the future LETF, C-018. The elements are expected to be organic solids (plastics).

- A projected total volume of 10,500 cubic feet is anticipated over a 30 year period. This waste will be shredded and repacked into new 55-gallon drums prior to being grouted in the vibro-grout line.

d. 3 - Dry Active Waste

- This waste is described as compactible solids contaminated by routine operations. It will typically comprise clothing, plastic wrap, containers, wipe rags and other related items.

- An estimated total volume of 63,000 cubic feet is anticipated over a 30 year period. This waste will be shredded and repacked into 55-gallon drums prior to grouting in the vibro-grout line.

e. 4 - Construction Debris

- This waste is described as non-compactible construction debris which has been contaminated. It will typically comprise glass, metal, wood and masonry composites.

- An estimated volume of 34,650 cubic feet is anticipated over a 30 year period. This waste will be shredded and repacked into 55-gallon drums prior to grouting in the vibro-grout line.

f. 5D - Miscellaneous Metals

- This waste is described as a blend of miscellaneous metals including copper, silver, chromium, cadmium, barium and uranium hexafluoride and will contain compounds of copper and aluminum.

- An estimated total volume of 3,035 cubic feet is anticipated as requiring treatment. This waste will be shredded and repacked into 55-gallon drums prior to being grouted in the vibro-grout system.

g. 7 - Ash from Thermal Treatment

- This waste is described as contaminated ash residue from a future thermal treatment facility (W242). It will be pozzolanic in nature and so will provide excellent assistance toward a quality grout product.

- A projected total volume of 69,000 cubic feet is anticipated over a 30 year period. This waste will be repacked into new 55-gallon drums prior to being grouted in the agitated grout process.

h. 8 - Contaminated Soils

- This waste is described as soil collected from contaminated sites (i.e., leaking tanks). The nature of contamination is, as yet, unknown but it is assumed that the soils can be successfully grouted.

- An estimated total volume of 20,400 cubic feet is anticipated as requiring treatment over a period of 30 years. This waste will be repacked into 55-gallon drums and then grouted in the agitated grout system.

3. The Design Basis Derivation table summarizes the above waste streams along with all the other waste streams and derives annual and daily throughputs. By considering the throughput, for each waste the average throughput for the grout facility was calculated as 8.32 drums per day through the vibro grout line and 9.34 drums per day through the agitated grout line. A design contingency was added to provide a design throughput of 20 drums per day. **Table 1.1** gives an indication of how the average daily throughput might vary according to campaigning of wastes.

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TABLE 1.1
DAILY THROUGHPUT

Feedstream	Input (Note 1)		Output (Note 3)		Approximate Waste Loading (Wt%)
	Drums/day	Vol. ft^3/day	Drums/day	Vol. ft^3/day	
1D	0.3	2.2	0.3	2.2	45
2C	2.36	17.4	4.72	34.8	38
2D	0.3	2.0	0.3	2.0	40
3	1.63	12.0	1.63	12.0	60
4	0.9	6.6	0.9	6.6	55
5D	1.56	3.5	1.56	3.5	65
7	1.78	13.1	3.56	26.2	55
8	0.53	3.9	1.06	7.8	45
Old Drum (Note 2)	3.63	26.9	3.63	26.9	65
	12.99	87.6	17.66	122.0	

Note 1: Waste data refers to drums entering the facility before sort and repack.
Note 2: Totals include a drum equivalent of 3.63 drums for all size reduced drums and boxes.
Note 3: Output data includes volume of grout.

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1.4.3 Design Requirements

1. The grout facility will provide the following capabilities.

   a. Storage, distribution and mixing systems for bulk powder ingredients to be used in grout production.

   b. Operational and equipment flexibility to enable the control of grout formulations to suit a variety of wastes.

   c. The extraction of samples to support process operation and a one liter (minimum) sample of the product to verify successful treatment.

   d. The packaging of waste into new 55-gallon drums.

   e. Cure storage capacity of 48 hours within the enclosure to ensure primary cure.

   f. Visual inspection of the cured treated waste.

   g. The removal, if necessary, of free liquid which may accumulate at the surface of the grout.

   h. The capability to destructively examine a minimum of 1 percent of the treated waste drums.

   i. Minimization of secondary wastes during the grout process.

   j. Minimize dose up-take to personnel for operational or maintenance activities.

   k. Maximize human factor considerations as well as ALARA principles by the design.

   l. Enable the facility to be decontaminated and eventually decommissioned with maximum efficiency.

   m. A design life of 30 years on a single shift basis, 5 days per week and a 70 percent facility availability.

1.4.4 Process Selection

1. Justification:

a. Preconceptual design work (Reference 1) aimed at characterizing the wastes identified for WRAP 2A and developing an overall waste management strategy, concluded that not all wastes could be easily immobilized by cementitious grouts. Cement grout had originally been regarded as the most appropriate wasteform matrix for the disposal of CH LLMW and substantial work has been done at various DOE sites to try and treat a variety of wastes by this route. Recorded experience (Reference 1) shows that in may areas especially where the waste contained soluble salts the results were less than satisfactory.

b. An analysis of WRAP 2A wastes (Reference 1) prior to the CDR identified that approximately 45 - 50 percent of them would be candidates for cementitious grout. The remainder could also be grouted but not without significant pretreatment. Pretreatment processes were often complicated and hazardous (i.e., decomposition of ammonium sulfate) and sometimes generated secondary waste streams which required additional collection and treatment.

c. It was decided at that stage to pursue the grout option only for those wastes which could be immobilized with a minimum, and ideally no, pretreatment. Wastes which could not easily be grouted were the subject of further work. This work concluded that a polymer encapsulated process should be pursued for the non-groutable waste.

d. The decision process which led to the selection of waste streams considered suitable for grout treatment is recorded in **Table 6-1** (Volume I). This table also converts base data on waste arising into daily throughputs and uses assumed densities to make possible a mass balance for all processes including grout.

e. A review of international experience with the problem of immobilizing radioactive wastes indicates that most agencies utilize the grout option as part of their overall waste management strategy. In the UK, cementitious grout was chosen as the preferred immobilization matrix from a field of some twenty candidates which included polymers, gypsum based materials and bitumen (asphalt). The UK currently operates a grout facility at Sellafield called EP1 which has been successfully immobilizing 'magnox swarf' (solid pieces of fuel cladding) and is nearing the commissioning phase of a second facility, EP2, which will utilize the two-system approach planned for WRAP 2A. The choice of the grout matrix for EP1 wastes was the result of an extensive five year program of development work which included subjecting the candidate processes to a Kepner-Treygoe analysis.

2. In-Drum Mixing

a. The recommended process for the grout treatment of wastes in WRAP 2A involves the use of an in-drum mixing technique. The prime reason for this approach is to minimize the transport of radioactive waste and hence its proliferation within the facility. Waste enters the WRAP 2A facility in various types of containers. (Predominately old 55-gallon drums) and must exit the facility in new 55-gallon drums. This dictates that all in-coming waste must be repacked. It follows that since waste is already being removed from drums for repacking there is a case to consider a mixing technique which mixes the waste with grout ingredients in a vessel prior to drum filling.

b. Before selecting the in-drum technique, the merits of both methods were considered. The advantages of in-drum mixing were perceived as follows:

- In-drum mixing minimizes the spread of activity by adding the grout ingredients to a drum which already contains a measured quantity of waste. This allows the radioactive cell or enclosure to be as small as possible with no additional mixing vessels.

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- It allows waste to be accurately pre-measured into drums for which the appropriate grout can also be carefully weighed and mixed.
- It minimizes the possibility of grout setting-up in large vessels during operational problems.
- It allows the prepackaged waste drum to be assayed by NDA prior to mixing.
- It minimizes secondary wastes by avoiding the need to wash out active equipment.

c. The disadvantages of in-drum mixing were perceived as follows:

- Two distinct process methods become necessary in order to cope with the variety of known wastes. A vibro-grout process which uses a vibrator to mix wet grout with dry shredded material and an agitated grout process which uses a 'lost paddle' agitator to mix powder or sludge like waste with water and dry grout. (See Section 1.4.4.5)
- It is necessary to use (and sacrifice) drum internals (lost paddle) in order to achieve a successful product.
- It may be argued that it is more difficult to ensure homogeneity of product or at least more difficult to prove without destructive examination.

d. The advantages of mixing prior to drum filling are as follows:

- One universal mixing system could be used for all wastes.
- The use of standard industrial rotating-drum mixing systems promote confidence of efficient grout/waste mixing.
- The subsequent filling of empty drums would be relatively simple with no need for inserts.

e. The disadvantages of mixing prior to drum filling were perceived as follows:

- Additional radioactively contaminated equipment would be necessary in order to store the waste awaiting mixing and in order to mix the waste and grout. This equipment would also require additional cell space.
- The mixer would represent a maintainable item which would require regular maintenance. Malfunction of the mixing process with potential solidification of active cement would seriously suspend operation, and create large dose up-take problems.
- The need for a waste storage vessel may compromise the facility requirement to segregate lots. Remnants from a 'lot' may need to be cleared out to avoid cross contamination.
- Washout requirements of the active vessels would give rise to significant quantities of secondary <u>active</u> wastes.
- Varying physical characteristics of wastes will create the need to have a variety of waste storage/distribution systems i.e., it is unlikely that 183H basin sludge could be stored in the same container type or conveyed in the same manner as, say, ash from thermal treatment.
- NDA of waste would be made extremely difficult since the waste could not easily be assayed until it was immobilized.

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f. After consideration of the advantages and disadvantages of each system, the grout program in the UK chose to proceed with the in-drum method of mixing. The final decision was made on the grounds of dose up- take benefits and a substantial development program that established the integrity of grout matrices for a variety of wastes using the vibro and agitated processes. On this basis the same process is chosen for WRAP 2A.

Note: A further option was considered which looked at the addition of waste into drums containing fresh grout but this was rejected because of uncertainty in terms of accurate waste loading measurements and excessive splashing during waste addition. This technique warrants further investigation for the polymer filling system.

3. Grout Capping

a. Most traditional grout processes, especially those developed to immobilize higher levels of waste, employ the addition of a grout cap which seals the freeboard space above the grouted matrix.

b. The purpose of the cap is to provide an inactive layer above the active grout. For intermediate level waste it is argued that surfacing air bubbles before and during the grout setting period can cause migration to the surface of active particulates. These form a surface layer of higher activity.

c. Secondly the cap fills the void or freeboard space in the drum top. This is sometimes required for regulatory compliance.

d. For low active waste such as those experienced in WRAP 2A it was argued that such a cap was not required. If freeboard exclusion is required this will be achieved by the addition of a diatomaceous earth or other inert substance. The deletion of this requirement substantially reduced the equipment and enclosure needs of the grout process.

4. Waste Minimization

a. The principles of waste minimization as applied in DOE 5820.2A (Radioactive Waste Management) are complied with in the design of the grout facility.

b. The filling of waste drums with grout and the subsequent mixing procedures are carried out remotely in enclosures. During this process splashing of waste and grout onto the exterior of drums has previously necessitated a drum exterior decontamination stage using high pressure water jets to remove contamination. In the UK grout facility, EP1, a large quantity of secondary waste water is generated by this procedure which requires treatment by ion exchange systems.

c. For the WRAP 2A facility the conception of inner enclosures which protect the drum exterior thus avoiding the need for decontamination has been introduced.

d. The agitated grout process provides a means of recycling some of the generated secondary waste. Active liquid waste can be recycled by providing the water required to mix grout in-drum. In order to access the final activity inventory for each drum mixed by this process, it will be necessary to add the activity of each drum addition to the NDA analysis.

5. Two Grout Trains

a. The process decision to base the design of the grout facility on In-Drum Mixing brings with it the need to have two distinct types of grout mixing. The principal requirements that the final monolith should be as homogeneous as possible with no voids or fissures in its structure, dictates that a very efficient mixing system is essential. The wastes which have been designated as groutable fall into two distinct categories:

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- large pieces of dry active materials
- particulate materials

b. The "large pieces" category is exemplified by the dry active wastes described in **Table 6A** as feedstreams 3 and 4. This type of waste must be shredded prior to grouting and will typically be in the form of 2 inch pieces. Substantial development work in the UK explored the in-drum mixing of this type of waste with grout and showed that it cannot be efficiently mixed by orthodox agitator methods. The main problem being that since the waste must be prepacked around an in-situ agitator (for in-drum mixing), the initial impeller rotation is invariably impaired. The development work explored other methods of in-drum mixing including drum rotation and adding waste to a grout mix already in the drum. Both of those methods possessed merit but they determined significant operational problems which placed them behind the chosen method in an overall comparison. The chosen method was called vibro-mixing and involved using an external vibrating device to impart a vertical oscillation to the filling drum. The effect of this vibration was to allow the flowing grout to fill itself into all void spaces within the waste. The development program refined grout formulations to improve the flow properties of grout mixtures to achieve very high standards of homogeneity.

c. The particulate-type wastes such as contaminated soils and ash from thermal treatment represent a much simpler mixing problem. Mixing these with grout is achieved easily using a "lost-paddle" technique. Drums pre-filled with waste and including a built-in agitator are first mixed with water to form a slurry. Dry grout which has been pre-blended is added to the agitated slurry in carefully controlled quantities.

d. By this rationale, the grout facility for WRAP 2A is designed with two trains. Currently the raw material distribution to each train is kept separate and dedicated because of the expectation that grout formulations will be unique to each train. However, during the development of acceptable formulation envelopes for various wastes, it may be possible to rationalize the storage and distribution system to optimize layout.

6. Cure Storage

a. The grout enclosure includes capacity to provide a curing store of 48 hours. The current design (as shown on layout drawings), using only roller conveyors, allows for a cure storage of thirty (30) drums. In order to provide 48 hour capacity, it will be necessary to rationalize the transport and space allowance of drums within the enclosure. This will be achieved by replacing some roller conveyors with a crane hoist system. This design change concept will be explored at a later design phase, but the estimated cost impact of this change has been included in the TEC.

1.4.5 Process Descriptions

1.4.5.1 Bulk Powder Storage and Distribution

1. Provision is made to store bulk quantities of dry solids in silos external to the facility.

- Ordinary Portland Cement (OPC)
- Blast Furnace Slag (BFS)
- Pulverized Fly Ash (PFA)
- Grout Additive (such as gypsum)

2. Bulk powder is supplied by road tanker. Each of the four powders will be transferred from the tanker into the appropriate silo by means of compressed air.

- Grout additive will be received in silo T-05-101
- PFA will be received in silo T-05-102
- BFS will be received in silo T-05-103
- OPC will be received in silo T-05-104

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3. Each silo is served by an automatic dust bag filter which will minimize dust vented during powder transfer.

4. Powder will be transferred from outside storage to internal day-silos by means of a dense phase pneumatic pump (P-05-102). This pump will serve the transfer for all powder requirements. Powder will be delivered in 12.5 cubic feet batches to all six day silos on demand.

5. Provision is made for a liquid polymer grout additive to be pumped (P-05-101) into the grout mix from the drum storage area. For the vibro-grout process the polymer, if required, will be metered into the wet grout mixing tank (T-05-212). For the agitated grout process the polymer, if required, will be pumped directly into the drum being filled.

1.4.5.2 Equipment Design Basis

1. Large outside silos were sized for one month of full production in the grout facility. Storage volume for each powder was based on the assumption that standard formulations of grout would be used, 3:1 (by weight) BFS to OPC and 3:1 (by weight PFA to OPC).

2. An additional silo was provided to accommodate an alternative pozzolanic material or solidification binder.

3. The internal silos were sized for a daily production of 20 drums of grouted waste. Allowance is made such that for some lot campaigns it may be necessary to produce all 20 drums using only one grout line.

4. Instrumentation and control are shown on the Mechanical Flow Diagrams **(See section 1.4.7)**. The facility will be operated entirely from the central control room with some local control provisions. Local control will typically be limited to raw material receipt and maintenance operations.

1.4.5.3 Vibro-Grout System

1. 55-gallon drums containing weighed shredded waste will be transferred from lag storage to the grout facility. The drum will be placed on a powered roller conveyor (CV-05-212A) awaiting cell entry. When required for grouting the drum will be automatically brought through an airlock (AL-05-203) into the facility.

2. In preparation for filling, the lid fastener is removed from the drum remotely and retained. The drum then proceeds to a lift table. The drum is positioned exactly and lifted through the conveyor by a device which clamps and lifts the drum to the mouth of an inner enclosure. A loose seal is achieved around the drum top and its lid is removed by the simple-double-lid device which exposes the entire drum top for filling.

3. A differential pressure between cell and inner enclosure is continuously maintained to ensure a constant inward air flow. This in-flow of air ensures against outward diffusion of radioactive particles during the lid off period. The door mechanism will be designed to ensure guaranteed air flow from less to more contaminated enclosures.

4. The drum gripping mechanism is attached to a vertical vibrating device (M-05-201) which is used during wet grout addition to achieve a homogeneous product.

5. A known volume of process water is measured into the wet grout mixing tank (T-05-212) and is circulated back to this tank using the pump/mixer (P-05-201 A/B). During recirculation, measured quantities of BFS and OPC are transferred to T-05-212 from weigh hoppers.

- OPC is measured in via weigh hopper T-05-202
- BFS is measured in via weigh hopper T-05-204
- PFA is measured in via weigh hopper T-05-211

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The grout formulation for the vibro-grout system is unlikely to vary and a standard mix of BFS/OPC or PFA/OPC is anticipated for all shredded waste.

6. Accurate deliveries are achieved by first weighing the appropriate material in the weigh hopper and then delivering it to the mixing tank by screw conveyor.

7. Batches of powder are metered into weigh hoppers by rotary feeders below each day silo.

a. OPC is metered from day silo T-05-201 into weigh hopper T-05-202 by rotary feeder Y-05-201.

b. BFS is metered from day silo T-05-203 into weigh hopper T-05-204 by rotary feeder T-05-203.

c. PFA is metered from day silo T-05-210 into weigh hopper T-05-211 by rotary feeder Y-05-210.

8. Batches made up in the wet grout mixing tank will be calculated to provide the waste drum with exactly the amount of grout to fill each drum to 90 percent by volume.

9. If polymer additive is required to improve the quality of the grout,it will be metered into the mixing tank, T-05-212, directly from drum storage via pump, P-05-101.

10. With the waste drum in position and its lid opened the drum filling can begin. A three way valve on the grout recirculation line is actuated allowing the grout to begin filling the drum. The rate of filling will be carefully monitored by the operator who will start the drum vibrator (M-05-201) soon after the grout addition starts. A camera and an ultrasonic level detection system will enable him to control the grout addition and avoid overfilling.

11. When the grout addition is complete the mixing tank will be empty. The vibrator will be stopped and the line from the mixing tank will be cleared using a pneumatic pig.

12. The three way valve is returned to its recirculation position and the next charge of process water will be added to the mixing tank to clean the vessel and await the next grout mix.

13. The full drum of grout is now re-lidded and set down again on the roller conveyor. The curing, inspection, monitoring and decontamination of vibro-grout drums is identical to agitated grout drums and is described in a combined Section 1.4.5.5.

1.4.5.4 Agitated Grout System

1. 55-gallon drums containing weighed repacked waste, and a built in agitator will be transported from lag interim storage to the grout facility. The drum will be placed on a powered roller conveyor (CV-05-212B) awaiting cell entry. When required for grouting the drum will be automatically brought through an airlock (AL-05-201) into the facility.

2. In preparation for filling, the lid fastener is removed from the drum which then proceeds to a lift table. The drum is positioned exactly and lifted through the conveyor by a device which clamps and lifts the drum to the mouth of an inner enclosure. A loose seal is achieved around the drum top and its lid is removed by the simple-double-lid device which exposes the entire drum top for filling.

3. A differential pressure between cell and inner enclosure is continuously maintained to ensure a constant inward air flow. This in-flow of air ensures against outward diffusion of radioactive particles during the lid off period. The door mechanism will be designed to ensure guaranteed air flow from less to more contaminated enclosures.

4. When the drum is in position the agitator will be automatically coupled to the agitator drive assembly.

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5. As with the vibro-grout system the process is designed to blend and deliver the required mix and volume of grout to enable the filling of only one drum at a time. For the agitated system however a dry grout is added to the drum. Each drum will be filled to 90 percent level.

6. The grout formulation for the agitated grout system is likely to vary and acceptable formulation 'envelopes' will be established which will be applicable to each campaign lot.

7. Weighed fractions of OPC, BFS, and PFA (or other additives are conveyed from day silos (T-05-209, T-05-205 and T-05-206) by screw conveyors (CV-05-209, CV-05-205 and CV-05-206) into a blender/hopper (T-05-207).

8. When the powders have been adequately mixed they are measured into a final weigh hopper (T-05-208) which, in turn, delivers the dry grout to the waiting drum. This addition takes place only when the operator is satisfied that the contents of the drum have been mixed adequately.

9. In order to prepare the drum for grouting the following sequence is completed. With the drum in position and the agitator coupled to the drive, a measured amount of water is added to the drum. The water used for this purpose will be recycled active water where possible. The agitated grout process represents a means of minimizing secondary wastes by re-using active water. If no active water is available, process water is used. The agitator is now started and the water and waste is blended together. When the waste and water have been sufficiently mixed the dry blended powder is added slowly to the drum while the agitator is still running. The addition of powder will continue until the drum is full. A TV camera and level detection equipment will allow the operator to control the drum filling.

10. If a polymer additive is required to improve grout quality, it will be metered into the drum during the fill stage.

11. The full drum of grout is now re-lidded and set down again on the roller conveyor. The curing, inspection, monitoring and decontamination of drums from the agitated system is identical to those from the vibro system and is described in 1.4.5.5.

1.4.5.5 Curing, Inspection, Monitoring and Decontamination of Grouted Drums

1. After drums have been filled at the two grout fill points and they have been relidded, they are conveyed to two staging lines where they are allowed to cure for 48 hours. At the end of their cure period they undergo a series of checks before they exit the enclosure. One by one, they are brought to another lift table which lifts them to another small internal enclosure. Here their lid is removed once more by a double lid system (DO-05-203) which will expose the grout surface.

2. The surface is inspected using a TV camera which is primarily looking for the presence of free liquid. If liquid is detected it will be removed by a suction device coupled to a pump (P-05-203) which will pump the liquid to a tank (T-07-201) in the water treatment area. After the removal of water the drum is relidded and the clip, which was removed before filling is re-applied.

3. The drum is now monitored for external contamination. The station is equipped with a turntable which allows the drum to rotate while an operator collects a contact-swab by wiping the exterior of the drum. The operator achieves this contact through gloveports adjacent to the drum. The swab is then introduced into a shielded gamma monitor within the enclosure and a count taken. The result of this gamma count will determine the degree of contamination on the exterior surface.

4. If excessive external contamination is detected a decontamination procedure is initiated to remove it. Firstly, a manual wipe method is performed to remove external contamination. If this is unsuccessful, pressurized water is applied to the surface of the drum at close range using an enclosed jacket wash system. After decontamination the monitor check is repeated.

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5. It is expected that precautions taken during the filling operation will protect the drum exterior in most cases and that regular decontamination will be unnecessary.

6. Once cleared for exit the product drum will have its lid refastened and be passed through the exit airlock (AL-05-202) and will be ready for pick-up by AGV from roller conveyor (CV-05-227).

7. A minimum of 1 percent of each lot exiting the facility will be routed to the sampling enclosure for core sampling.

1.4.5.6 Equipment Considerations

1. The grout facility will include three day silos for each grout line and a series of weigh hoppers and mixing equipment sized to provide each waste drum with exactly the correct amount of formulated grout.

2. The day-silos are sized to provide the equivalent of 20 drums of grouted waste assuming that a campaigned waste could utilize only one of the grout lines per day. At present the process is designed to maintain segregation of the fill heads for the two grout systems but because of the layout it will be a simple task to modify the pipe work and equipment as required to make both fill heads operate on vibro or agitated systems.

3. Small weigh-hoppers are provided and sized to mix batches of grout which are carefully measured to fill one drum at a time. All silos and hoppers within the grout mixing area are provided with load cells and rotary feeders to allow accurate measurement of powder ingredients.

4. All movement of drums within the enclosure will be by powered conveyor. Hydraulically operated lift tables will be used to lift the drum up to each inner enclosure. Simple double lid devices will be used to swing back the drum lids while providing a soft seal to the open drum.

5. Cameras (CCTV) and level detection instruments will provide the central control room with accurate level and surface information during all filling and inspection operations.

6. Airlocks provide the barrier between Zone 2 (outside the enclosure) and Zone 1 (inside the enclosure) operations.

1.4.5.7 Layout Considerations

1. The layout for the grout facility was developed to comply with good nuclear engineering principles. (DOE Order 6430.1A General Design Criteria).

a. Environmental Control

1) The radioactive operation of drum filling is carried out in an enclosure which will operate as a Zone 1 area. Entry and exit and from the facility are by standard airlocks. The entry and exit airlocks separate the Zone 1 enclosure from the Zone 2 exterior, where material handling AGVs supply and remove drums, to and from lag storage.

2) The inactive grout mixing area, Zone 3 is immediately above the grout enclosure and is separated by shielding walls.

b. Gravity Feed

1) The plant is laid out to take advantage of gravity flow wherever possible. The waste drum filling points are sited at grade level and all mixing and distribution of grout ingredients are cascaded by gravity to this point. The layout also endeavors to ensure that the final pipe length which connects the inactive mixing area to the active enclosure is as short and straight as possible to minimize blockage.

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c. Maintenance

1) Where possible maintainable equipment will be installed outside the Zone I enclosure or be housed in bulges which can be accessed without entering the enclosure. Where access becomes essential aisles have been provided adjacent to the roller runs. Inner enclosures have been provided for each position of drum opening. Soft seals and control airflows will ensure that the outer enclosure remains as clean as possible and although these outer enclosures are designated at Zone 1 areas, the design intent is to maintain them as Zone 2 operable.

d. Process Requirements

1) Two grout lines are supplied as dictated by the need to perform two different types of mixing (see Section **Appendix 1.4.4.5**). Grout filling points are sited close together to facilitate future modification to achieve greater flexibility.

2) Dedicated entry airlocks are provided for each process to assist operational simplicity. Time and Motion analysis (Witness) may reveal that a single entry system will be adequate to service both fill points.

3) Cure lag storage is provided within the enclosure for a total of 30 drums. This is achieved on staged roller conveyors. This storage provision only allows for one shift operation and would have to be extended for additional operations.

4) After grout filling, the process is identical for all drums and the layout provides a common capability in terms of lag store, inspection, monitoring and decontamination.

5) Proximity of outside bulk storage of solids is not crucial to the layout but some advantage is gained by adjacent positioning.

e. Facility Integration

1) The grout facility is sited in close proximity to the area which supplies it with drums and stores its product; the lag storage area. The entry and exit points to the facility are sited on AGV paths which link the overall facility. At present the entry and exit points are on the same line of AGV travel but these exists a potential improvement to this layout which may reduce waste travel within the enclosure to only one 90° turn.

1.4.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.1, 2.2.3, 2.2.5, 3.8, 5.0, 7.0.

2. DOE 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement.
   0110-99, Special Facilities, Nonreactor Nuclear Facilities.
   1161. Enclosures.
   1300, Special Facilities.
   1324, Radioactive Solid Waste Facilities.
   DOE 5400.5, Radiation Protection of the Public and the Environment.
   DOE 5820.2A, Radioactive Waste Management.
   DOE 5400.3, Hazardous and Mixed Waste Program.

3. Hanford Plant Standards Design Criteria.

4. WHC-CM-4-9, Radiological Design Criteria:
   WHC-CM-4-10, "Radiation Protection".
   WHC-CM-4-11, "ALARA Protection Program".
   WHC-EP-0063, "Hanford Solid Waste Acceptance Criteria".

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1.4.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140606 BFD	Shred Grout Facility
H-2-140607 BFD	Bulk Powder Storage
H-2-140608 BFD	Vibro Grout System
H-2-140609 BFD	Agitated Grout System
H-2-140610 MFD	Bulk Powder Storage
H-2-140611 MFD	Vibro Grout System
H-2-140612 MFD	Agitated Grout System

1.5 Polymer Encapsulation System

1.5.1 Introduction

1. The polymer encapsulation system is used to physically immobilize a number of waste forms that are incompatible with the grouting immobilization technique. All waste entering the polymer encapsulation area is prepacked in new 55-gallon drums in the open/sort/repack area or special waste area. Some pretreatment of the waste may occur in these areas to adhere to BDAT and allow conformance to Hanford Solid Waste Acceptance Criteria after encapsulation.

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1.5.2 Feeds and Throughput

1. Waste feedstreams which are processed in the polymer encapsulation area include the following:

Feedstream 1A: Basin 183H Solidified Liquid
Feedstream 1B: Basin 183H Crystalline Solid
Feedstream 1C: Basin 183H Sludge
Feedstream 2A: LETF Ammonium Sulfate
Feedstream 2B: LETF Ion Exchange Resins
Feedstream 5A: Mercury/Mercury Contaminated Solids
Feedstream 5B: Reactive Metals
Feedstream 5C: Lead/Lead Contaminated Solids
Feedstream 6: Absorbed Chemicals

2. A detailed physical and chemical characterization of each feedstream is given in the Task V follow-on Activities Report (Reference 1). However, the characterization table represents the "as-received" waste properties. As mentioned previously, most incoming waste will be pretreated, to some extent, prior to encapsulation in polymer. Feedstreams 1B, 1C, 2A and 6 are wet or dry particulate sludges or solids which are simply homogenized and repacked for encapsulation by stirred mixing techniques. Feedstreams 1A, 5A and 5C are large or irregular bulk solids which must be size reduced. In addition, Feedstreams 5A and 5C, as well as 5B, must be further treated in the special waste area to allow conformance to BDAT technology for treatment of toxic or reactive metals. Feedstream 2B is merely redrummed to allow simultaneous dewatering and encapsulation of ion exchange resins.

3. The following is a summary of the input waste feedstream quantities and treated waste quantities for each feedstream processed in the polymer encapsulation area:

Feedstream	Campaign Life Years	Waste/ Loading Wt%	Input Drums/Day	Input Ft^3/Day	Output Drums/Day	Output Ft^3/Day
1A	30	60	1.82	8.07	1.82	12.10
1B	30	60	1.82	7.47	1.82	12.12
1C	30	60	2.07	8.07	2.07	13.79
2A	30	60	17.13	59.79	17.13	114.09
2B	30	33	1.66	12.28	1.66	7.74
5A (Amalgam)	3	60	1.41	1.79	1.41	9.39
5A (Shredded)	3	70	2.51	13.20	2.51	16.72
5C (Sized)	14	70	4.91	4.85	4.91	27.64
5C (Shredded)	14	70	0.25	0.50	0.25	1.67
5B (Fines)	3	60	0.20	0.42	0.20	1.33
5B (Coarse)	3	70	0.15	0.42	0.15	1.00
6	30	60	2.83	9.77	2.83	18.85
TOTAL			36.76	126.63	36.76	236.44

1.5.3 Design Requirements

1. Design requirements for the polymer encapsulation process are defined by the FDC per reference to "an immobilization" system. These are listed as follows:

   a. Capability to make-up a days requirement of immobilization agents and mix the agents with conditioned waste in a controlled manner. The system must be capable of controlling and easily changing the immobilization formulations.

   b. Packaging of waste into new 55-gallon drums.

   c. Two days lag storage and visual inspection of curing treated waste. The capability to extract liquid, or an infrequent basis, from the top of a curing drum shall also be provided.

   d. Capability to extract samples to support process operation, and samples for verification of successful treatment.

2. Design goals for the polymer encapsulation process include the following:

   a. Proof of the process technology for immobilization shall be accomplished by actual production experience or by laboratory/prototype demonstration supplemented with full scale simulation and engineering analysis.

   b. The system shall be designed to insure that polymer operations are carried out in suitable high integrity enclosures.

   c. The system shall be designed to minimize generation of secondary waste and radiation exposure to personnel per ALARA principles.

   d. The system shall be designed to maximize location of components outside of confinement without compromising confinement criteria or process efficiency.

   e. Design life of 30 years on a single shift basis, five days per week, and a 70 percent facility availability.

   f. The system shall utilize an integrated design approach to ensure a compatible interface with other WRAP 2A processes.

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1.5.4 Process Selection

1.5.4.1 Industry Experience

1. The selection of polymer encapsulation for immobilization of the waste feedstream identified earlier is based upon current vendor information which provides experience with similar waste forms. Also, communications with industry have confirmed that these same waste forms have not been successfully immobilized in grout in many cases. Early indications from the Treatability Screening Tests have given optimistic results for three surrogate wastes simulating feedstream 1B, 1C, and 2A, Basin 183 H crystalline solids, basin sludge, and LETF crystalline solids respectively. These feedstreams are specific problem feeds for grouting because of high nitrate, sulfate, or ammonia concentrations. High soluble nitrate and sulfate concentrations inhibit or prevent grout setup as well as degrade overall durability of the grout. Ammonia present in the LETF wastes will be released in a standard grout matrix during the mixing and curing of the mixture due to inherent high pH.

2. The remaining feedstreams which have been selected for immobilization in polymer also pose potential problems in a grout matrix. Feedstream 1A, Basin 183 H solidified liquids, is a basin liquid high in sodium nitrate salts. This waste stream was pretreated at Hanford by attempting to incorporate the waste in a Sorbond LPC II matrix which is comparable to a grout formulation. In many cases, the matrix did not setup properly and must be retreated for proper immobilization. The proposed CDR concept is to add absorbent to the waste, if required, size reduce, and incorporate into a polymer matrix that easily tolerates high soluble nitrate concentrations.

3. Toxic or reactive metals, feedstreams 5A, 5B, and 5C, have been identified for incorporation into polymer due to potential leaching problems or reactions in a grout matrix. The polymer matrix will totally physically encapsulate the waste form in a closed cell structure to prevent water or air external to the matrix from reaching the waste form. Thus, the leaching of heavy metals from the matrix will be inhibited and the reaction of oxygen with any unreacted zirconium or beryllium fines will be minimized. Specific vendor experience with encapsulation of zirconium fines in VES resin has produced a treated waste monolith that will not sustain combustion in the presence of an open flame. The open cell structure of a grout matrix may not prevent these occurrences.

4. The final feedstream proposed for incorporation into polymer, feedstream 2B ion exchange resins, has been proven on a commercial basis. Nitrated, unstable, ion exchange resins have been successfully encapsulated in VES resin polymer by both stirred and vacuum dewatering techniques. The advantage of using the vacuum dewatering technique is an essentially 100 percent waste loading in polymer, on a volume basis. This is due to the displacement of water occupying the interstitial spaces in the resin with polymer. As a result, there is no appreciable increase in volume for the treated waste form. Vacuum dewatering of ion exchange resins has been commonly done commercially in sizes ranging from 55-gallon drums to 200 ft^3 liners. The processing operation and certified testing of the treated resins are well documented and meet all NRC testing guidelines.

5. Incorporation of ion exchange resins in a grout matrix is possible at significantly lower waste loadings than experienced for the polymer process. However at higher waste loadings, the resins tend to cause cracking and deformation of the final monolith due to swelling of the beads in a caustic grout mix environment. This does not occur in a polymer matrix since there is little, if any, chemical interaction.

1.5.4.2 Developmental Program Requirements

1. Due to the lack of extensive commercial experience for treatment of waste with VES resin, a developmental program is ongoing as described in **Appendix F** (Volume I). This program will address some of the specific problem waste forms identified for encapsulation in polymer and scale-up data required for commercial plant design.

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2. One of the primary process parameters studied in this program will be in-drum mixing of waste. This philosophy is similar to that for the grouting operation where stirred or vibrated mixing will be used to mix waste and binder in repacked 55-gallon drums. However, the concept of preloading waste into the drum first followed by addition of polymer and additives with subsequent mixing is a concept that has not been proven on a pilot or commercial basis.

3. Previous vendor experience has been limited to preloading 55-gallon drums with the polymer resin and additives. After mixing the resin and additives, the waste (normally a dry particulate) is slowly metered into the drum during mixing. This technique assures even distribution of waste into the polymer and minimizes mixer torque requirements. All developmental test work to date has been directed at this sequencing and mixing technique.

4. The Phase III testing operation of the waste form qualification program must demonstrate that preloaded waste in 55-gallon drums can be homogeneously mixed in a polymer matrix. The ultimate proof of this technique will not be forthcoming until samples from the full scale demonstration meet all applicable Washington Administrative Code, Hanford Site Waste Acceptance Criteria, and RCRA Land Disposal Restrictions.

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1.5.4.3 Safety Review Requirements

1. The polymer encapsulation process uses chemical additives and polymer resins that are volatile, flammable, and potentially explosive. A thorough safety review will be necessary prior to certification of the process to demonstrate that operation and maintenance of the facility is within all safety guidelines. Review of safety measures from previous commercial or pilot operations of similar facilities handling flammable materials is paramount.

1.5.5 Process Description

1. The polymer encapsulation system includes the polymer resin and chemical storage, polymer mixing, and polymer encapsulation areas. Polymer resin and chemical storage are shown on PFD H-2-140620 and MFD H-2-140622. Polymer mixing and encapsulation are shown on PFD H-2-140621 and MFD H-2-140623.

1.5.5.1 Polymer Resin and Chemical Storage

1. Vinyl Ester Styrene (VES) resin is received from tank trucks approximately once per week into one of two VES resin Storage Tanks (T-05-305 A,B). Each tank, located under a sun shielded roof outdoors, is sized at 5,900 gallons which is sufficient to receive a full tank truck load. Receipt will be alternated between each tank to minimize the inventory time period.

2. Extender, catalyst, and promoter will be received from 55-gallon drums via drum pumps into Extender Storage Tank T-05-302, Catalyst Storage Tank T-05-303, and Promoter Storage Tank T-05-304, respectively. The 750-gallon extender storage tank, 140-gallon promoter, and catalyst tanks are located outdoors under a sun shielding roof.

3. Solvent will be received and stored in an underground vault to minimize liquid surface area exposure in the event of a tank rupture. This will also allow a more evenly controlled temperature environment to minimize excessive vaporization. Solvent will be received by tank truck into two solvent storage tanks (T-05-301 A,B). The entire solvent storage volume will be contained in the vault except during flushing of miscellaneous storage tanks when up to 200 gallons may be contained above ground. Spent solvent will be collected in the hydrocarbon waste tank (T-05-402) also located in the underground vault. Spent solvent and/or waste hydrocarbon will be transferred from the waste tank to tank trucks or drums via hydrocarbon waste transfer pump (P-05-404) for disposal as hazardous waste.

4. The underground storage vault for solvent and hydrocarbon waste will be mechancially ventilated on a continuous basis to prevent build up of explosive and flammable vapor. Ventilation air will be swept through the vault at a design rate of 700 cfm per fire code guidelines. Exhaust air will flow through carbon adsorber prefilters (F-05-301 A or B) and into vault exhaust carbon absorbers (V-05-301 A,B or C) for removal of hydrocarbon vapors.

Normally one prefilter and two carbon adsorbers will be in service at a time. Air will then pass through one of the two vault exhaust filters (F-05-302 A or B) for carbon particulate removal prior to discharge through vault exhaust blowers (C-05-301 A or B) to atmosphere. One blower will normally operate with the second on standby in the event of failure.

5. All tanks are nitrogen blanketed and vented to atmosphere through pressure safety valves. The VES resin storage tanks and solvent storage tanks can also be vented to the tank delivery trucks through flame arrestors during bulk filling. Those tanks containing hydrocarbons will have capability for pump out to the Hydrocarbon Waste Tank, T-05-402. Solvent can be pumped via Solvent Transfer Pumps, P-05-301 A,B, to all tanks for flushing purposes, except for the catalyst storage tank which will be flushed with water. The bulk storage tanks located outdoors will have a curbed area draining to a sump serviced by Bulk Storage Sump Pump, P-05-306 which discharges to the hydrocarbon waste tank. The catalyst storage tank will be in a curbed area which drains to a sump serviced by the Catalyst Sump Pump, P-05-307. This pump is capable of pumping aqueous waste to the nonactive waste water collection system. The promoter storage tank is in a curbed area which also services the Polymer Mix Tank, T-05-401.

6. Tanks containing styrene or vinyl ester styrene will have the capability to be cooled with chilled water during high outside ambient temperatures. Liquid contents will be maintained at 70°F or less by circulating extender or VES resin through Extender Cooler, E-05-301 or VES Resin Coolers, E-05-305 A,B, respectively. Each tank will be insulated to minimize heat gain.

7. VES resin will be transferred to the polymer mixing tank via VES resin Transfer Pumps, P-05-305A,B once per day at 30 gpm. Promoter and extender (if required) will be transferred once per day via Metering Pumps P-05-304 and P-05-302, respectively, to the polymer mixing tank. Catalyst will be transferred continuously to the polymer encapsulation process and combined with the resin premix via in-line static mixers. Catalyst will be forwarded to the mixers by Catalyst Metering Pumps P-05-303 A or B. Any excess catalyst not required, on demand will be returned to the Catalyst Storage Tank, T-05-303.

1.5.5.2 Polymer Mixing

1. Vinyl Ester Styrene (VES) resin, promoter, and extender are premixed in the Polymer Mixing Tank, T-05-401. This tank is of sufficient capacity, 1,100 gallon, to allow mixing once per day. The tank will be monitored remotely for liquid level. However, prior to preparation of a batch each day, the tank will be visually inspected by use of a sight glass to ensure it is empty and that any resin inventory has not solidified. The VES resin is then transferred to the mixing tank and metered via a flow totalizer. Promoter and extender, if required, are then metered into the tank by manual activation of the metering pumps which are automatically shut-down subsequently by respective flow totalizers.

2. Promoter is an organic compound such as dimethylanaline or cobalt naphthenate which accelerates the setting of the polymer. Extender and styrene is added as a viscosity control agent to minimize segregation of the mixed waste and resin and to control mixing energy input requirements. The catalyst is an organic (based benzoyl peroxide) or water-based (hydrogen peroxide) compound which is added during the final in-drum mixing operation. The catalyst is the last ingredient to allow the cross-linking of the thermoset polymer.

3. The contents of the mixing tank are blended by Polymer Mixing Agitator, M-05-401 and by recirculation of the tank contents via Mixed Polymer Pumps, P-05-401 A or B. The Mixed Polymer Cooler, E-05-401, located in the recirculation loop allows cooling of the polymer mix with chilled water during high ambient temperatures. The polymer mixing tank is located in a shed adjacent to the process building. The area containing the mixing tank and promoter storage tank is curbed and drains to a sump serviced by Day Tank Sump Pump, P-05-405. This pump discharges to the hydrocarbon waste tank. During cleanout of the mixing tank with solvent, the contents can be transferred to the waste tank, as well, via the mixed polymer pumps.

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1.5.5.3 Polymer Encapsulation

1. Redrummed waste enters the polymer encapsulation area repacked in new drums in premeasured quantities that will allow direct, in-drum, encapsulation with polymer. Repacked drums are delivered via AGV to one of 4 polymer fill stations in Polymer Encapsulation Enclosure, GB-05-401. All 4 stations have the capability for stirred or vibrated in-drum mixing. One of the 4 stations is also capable of vacuum dewatering for encapsulation of ion exchange resins.

a. Stirred Mixing

1) Waste which is a dry or wet small particulate such as crystals or sludge is mixed with polymer via the stirred technique. The drums containing premeasured waste and an agitator shaft with prop are delivered to Lift Tables, LT-05-401, 402, 403, or 404. The lift table positions the drum under the port and hydraulically raises the drum into position. A simple double lid is opened hydraulically and the agitator shaft is coupled to the motor drive for In-Drum Mixers, M-05-402, 408, 409, or 410. Premixed polymer is then injected into the drum and filling is monitored by television cameras and ultrasonic level detectors in the enclosure. Polymer is automatically metered into the drums based upon predetermined waste loadings and controlled by load cells on the lift tables.

2) The mixed polymer is pumped to the encapsulation enclosure via Mixed Polymer Pumps, P-05-401 A or B. Catalyst is mixed with the polymer resin in In-Line Mixers, M-05-404, 405, 406, or 407. The flow of catalyst is controlled proportional to that of resin by proportional flow controllers. Preset catalyst and polymer quantities are metered upstream of the in-line mixer. After each batch, compressed air is used to clear the in-line mixers and any piping where catalyst and resin have been premixed. Periodically, the mixers and piping will be disassembled, removed from the process building, and cleaned in solvent.

3) During injection of the premixed polymer into the drums, the waste and polymer are mixed via the in-drum mixers. After polymer injection, the mixing will continue until a homogeneous mix is obtained as determined by mixer amperage and visual observation.

4) After mixing, the agitator prop is detached and the mixed polymer and waste is allowed to sit until a gel is formed. Verification of gel formation can be confirmed by visual inspection using television cameras mounted in the enclosure. This may be aided by using the vibratory mixers to produce standing waves apparent on the surface prior to polymer setup. The simple double lid is then closed and the drum is lowered. An AGV then retrieves the capped drum and transports it to the polymer curing and storage area. One percent of the cured product will be transported to the sample management area for core sampling.

b. Vibrated Mixing

1) Waste forms which are large, irregular, or non-mixable by stirred techniques are mixed by vibrated techniques. This process uses Vibratory Mixer, M-05-403, 411, 412, or 413 which are positioned on the lift tables. The vibratory mixers provide mixing during and after introduction of polymer into the drum. The action of the vibratory mixers is to remove air pockets for macro-encapsulated waste such as lead bricks or mix shredded or irregular waste. All other operations are identical to the stirred mixing process.

1.5.5.4 Vacuum Dewatering

1. Ion exchange resins which have significant amounts of interstitial water are simultaneously dewatered and encapsulated in polymer at one of the fill stations. Premeasured ion exchange resins, preloaded in 55-gallon drums with a dipleg pipe spool, are loaded on the enclosure station capable of vacuum dewatering. After connection of the spool to the vacuum source, polymer injection into the drum is initiated. A vacuum is drawn on the Liquid Catch Drum, V-05-401 by use of the Vacuum Dewater Pump, P-05-403. As water is drawn from the 55-gallon drum,

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polymer flows downward through the ion exchange resin, filling the interstitial spaces. Visual observation of the liquid flowing to the catch drum using a sight-glass, will indicate by a "foamy" appearance when the polymer break-through has occurred.

2. After breakthrough, the vacuum pump is shutdown. The polymer is then allowed to gel and the remaining waste drum transfer sequence is identical to that previously described for polymer encapsulation. Waste water collected in the liquid catch drum is transferred to the active waste water collection system using Waste Water Transfer Pump, P-05-402.

3. The vacuum dewatering system is also capable of removing free water which may form in curing drums resulting from waste encapsulated by stirred or vibrated mixing techniques. CCTV in the polymer encapsulation enclosure will allow visual inspection of drum contents during the initial curing phase. If free water generation is evident, the drum will be retained at the enclosure and free water removed via vacuum dewatering. This operation is expected to occur very infrequently, if ever, assuming proper control of all polymer mixing and encapsulation parameters.

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1.5.5.5 Cure Storage

1. After completion of the polymer encapsulation treatment process, drums of treated waste will be transferred to a polymer cure storage area for final curing. This transfer will be done after the polymer has gelled to form a stable mass that will not shift or spill during transit. The drums will be relocated to the polymer cure storage area prior to initiation of the temperature exotherm. Each drum will be retained in this area for a full 48 hours (per FDC requirements) to allow heat removal during curing. This will necessitate a polymer cure storage capacity of 74 drums, equivalent to two days of polymer treated waste production. An air ventilation system will maintain the room air temperature at 95°F or less. Room air will be exhausted through the active HVAC system HEPA filters and stack. Drum temperature will be monitored by use of infrared pyrometers throughout the exotherm and cooling period.

2. The polymer cure storage area is currently planned to be located on the main floor directly under the process off-gas system equipment. Drawing H-2-140601 shows the equipment general arrangement of the vessel and process off-gas system as originally planned. However, this equipment is planned to be moved upward one floor to provide room for the polymer cure storage area. This will allow a better usage of the vertical building space in this area of the facility. The ventilation system equipment for the polymer cure storage area will also be located on an upper floor in this area. The precise location of process off-gas system and polymer cure storage area ventilation equipment will be defined in future design. The estimated cost impact of the aforementioned design change concept, however, has been included in the TEC.

3. If required, cured drums of polymer treated waste can be returned to the polymer encapsulation enclosure for visual inspection. Any free water discovered may be removed via the vacuum dewatering system. It is anticipated that the frequency of this inspection operation will be quite low and limited to waste treated during suspect processing upsets. However, this assumption cannot be confirmed until the waste form qualification testing for polymer treatability is completed.

1.5.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.1, 2.2.3, 2.2.5, 3.8, 5.0, 7.0.

2. DOE 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement
   0110-13, Physical Protection
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities
   1300, Special Facilities, General Requirements
   1324, Radioactive Solid Waste Facilities

DOE Order 5400.5, Radiological Protection of the Public and the Environment.
DOE Order 5820.2A, Radioactive Waste Management.
DOE Order 5400.3, Hazardous and Mixed Waste Program

3. Hanford Plant Standards Design Criteria:

   WHC-CM-6-9, Radiological Design Criteria.
   WHC-CM-4-10, "Radiation Protection".
   WHC-CM-4-11, "ALARA Protection Program".
   WHC-EP-0063, "Hanford Solid Waste Acceptance Criteria".

4. Treatability test program results of polymer with various waste simulates.

1.5.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140619	Block Flow Diagram - Polymer Facility
H-2-140620	Process Flow Diagram - Polymer Resin and Chemical Storage
H-2-140621	Process Flow Diagram - Polymer Encapsulation
H-2-140622	Mechanical Flow Diagram - Polymer Resin and Chemical Bulk Storage
H-2-140623	Mechanical Flow Diagram - Polymer Mixing and Encapsulation
H-2-140626	Polymer Encapsulation - Plan
H-2-140627	Polymer Encapsulation - Section
H-2-140601	Vessel and Process Off-Gas - Equipment General Arrangement

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1.6 Special Waste Treatment

1.6.1 Introduction

1. The special waste treatment system is designed to pretreat waste forms containing toxic or reactive metals. This waste will require physical inspection to determine if sorting of elemental lead or mercury from bulk contaminated solids is justified. Elemental lead or mercury will be treated per BDAT which requires macroencapsulation and amalgamation, respectively. Bulk contaminated solids will be shredded and residual mercury metal removed as required per BDAT. All waste pretreated in the special waste processing area will be redrummed and routed to the polymer encapsulation area for final immobilization as a monolith for disposal.

1.6.2 Feeds and Throughput

1. Waste feedstreams pretreated in the special processing area include the following:

   Feedstream 5A: Mercury/Mercury Contaminated Solids
   Feedstream 5B: Reactive Metals
   Feedstream 5C: Lead/Lead Contaminated Solids

2. These waste feedstreams are described in detail in the Task V Follow-on Activities Report (Reference 1). Feedstream 5A, Mercury/Mercury Contaminated Solids, are assumed to contain elemental mercury that has been collected and prepacked in containers. These can physically be separated from the bulk contaminated solids which are wastes such as fluorescent light bulbs, laboratory thermometers and manometers, and mercury absorbants. It is assumed that easily separable elemental mercury in flasks represents 1 volume percent of the total waste stream.

3. Feedstream 5B represents reactive metals such as zirconium and beryllium. These metals can be easily ignited or oxidized in air if the particle size is fine enough and an ignition source is available. Per NFPA 482, zirconium particles finer than 48 mesh (300 micron) can be easily ignited in air. It is assumed that 50 wt% of the total incoming feedstream is smaller than 48 mesh and must be deactivated by pretreatment. The remaining 50 wt% is considered stable in

the dry state and is not pretreated prior to encapsulation. No distinction is made between zirconium or beryllium metals for treatment requirements. It is assumed that no other reactive metals such as sodium, potassium, or calcium are present in this feedstream. These reactive metals would require entirely different treatment techniques due to their reactive properties.

4. Feedstream 5C consists of lead and lead contaminated bulk solids. This waste stream consists of elemental lead shielding bricks which have been packed in 55-gallon drums. Other elemental lead shielding materials such as lead sheets may also be in this feedstream packed in large waste boxes. However, this waste form volume is considered to be very minimal and will be pretreated outside the special waste enclosure. Lead contaminated solids are anticipated to consist of lead lined gloves, aprons, blankets, and other shreddable items. It is assumed that the lead shielding bricks compose 95 wt% and bulk contaminated lead forms compose 5 wt% of the total incoming waste feedstream.

5. The following is a summary of input waste feedstream quantities and treated waste quantities for each feedstream as developed for the special waste area material balance. As noted previously, lead contained in boxes will not enter the special waste process enclosure.

FEEDSTREAM	CAMPAIGN LIFE (YEARS)	INPUT DRUMS/ DAY	INPUT FT3/ DAY	OUTPUT DRUMS/ DAY	OUTPUT FT-3/ DAY
5A (elemental)	3		0.25	1.41	1.79
5A (bulk)	3	3.33 TOTAL	24.33	2.51	13.20
5B (fines)	3			0.20	0.42
5B (coarse)	3	0.17 TOTAL	0.84 TOTAL	0.15	0.42
5C (elemental)	14		4.85	4.91	4.85
5C (bulk)	14	3.48 TOTAL	0.25	0.25	0.50

1.6.3 Design Requirements

1. Design requirements for the special processing area are defined by the FDC for the special enclosure and overall facility. These are as follows:

a. Lag storage space for at least 20 drums.

b. Remote operation of the enclosure shall be provided but due to the uncertain nature of the processes that may be employed a minimal amount of routine contact operations shall be permitted in the design.

c. Decontamination of the enclosure with liquid wastes reporting to the Liquid Waste Handling area.

d. Capability to directly transport materials and containers between the immobilization process and specialty enclosures.

e. Capability to easily enter and remove large pieces of equipment during construction downtimes.

f. Capability to easily add and delete services to and from the enclosure.

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g. A process to amalgamate elemental mercury and mercury contaminated waste as per the Best Demonstrated and Available Technology specified per RCRA (EPA Current version) with the following features: campaign life of three years, design entering container volume throughput of 4,300 CF per year.

h. Reagent services with controlled addition capability from the AMU tanks identified in section 2.2.8.

2. Design goals for the special waste processing area are as follows:

a. Pretreat reactive metals, lead, and mercury wastes by BDAT techniques to allow compatibility with final encapsulation process.

b. Minimize generation of secondary waste and lifetime occupational radiation exposure.

c. Contact handling operations will be limited to the minimum possible.

d. Incorporate human factors and ALARA principals in the design process.

e. Provide the flexibility to modify processes and replace equipment as waste stream campaigns are completed through the specialty enclosure, i.e., use a modular approach with skid mounted equipment for quick and easy removal from the cell.

f. System shall be designed to maximize location of components outside of confinement without compromising confinement criteria or process efficiency.

g. Design life of 30 years on a single shift basis, 5 days per week, and a 70 percent facility availability.

h. System shall utilize an integrated design approach to ensure a compatible interface with other WRAP 2A processes.

1.6.4 Process Selection

1.6.4.1 Existing BDAT Guidelines

1. Land disposal restrictions, as taken from 40 CFR part 268 for 1992 RCRA regulations, list technology based standards for treating specific radioactive hazardous mixed wastes. For elemental lead forms such as shielding the BDAT is "macroencapsulation with surface coating materials such as polymer organics (resins or plastics) or with a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media". VES resin should qualify for use in direct encapsulation of this waste form without pretreatment.

2. BDAT, as listed for elemental mercury contaminated with radioactive materials, is "amalgamation utilizing inorganic agents such as copper, zinc, nickel, gold, and sulfur that result in a nonliquid, semi-solid amalgam and thereby reducing potential emissions of elemental mercury to the air". Any free elemental mercury which is separated by sorting or evaporation in the process will be amalgamated with a suitable amalgamating agent.

3. Bulk contaminated solids containing mercury in excess of 260 mg/kg must undergo "retorting or roasting in a thermal processing unit capable of volatilizing mercury and subsequently condensing the volatilized mercury for recovery." It is assumed that all bulk contaminated solids potentially containing mercury will be in excess of the 260 mg/kg concentration and require mercury recovery. This will be done by heating the bulk waste batchwise in a mercury evaporator to volatilize, recover, and subsequently amalgamate any elemental mercury. All amalgamated mercury, as well as the retreated solids, will be directed to the polymer encapsulation for final immobilization.

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4. RCRA regulations also list BDAT for beryllium dust in nonwaste waters as metal recovery using direct physical/removal technologies of thermal recovery techniques. However ,the physical recovery techniques listed include ion exchange, adsorption, reverse osmosis, precipitation and other process operations normally associated with waste water treatment.

5. Thermal recovery options for beryllium dust listed under industrial furnaces in 40 CFR 260.10 include kilns; blast furnaces; smelting, melting and refining furnaces or other combustion devices. However, all thermal processing operations to recover or oxidize beryllium dust will most certainly exceed the 500°F temperature limit imposed on WRAP 2A processing operations.

1.6.4.2 Waste Acceptance Criteria

1. Hanford Site Solid Waste Acceptance Criteria or Washington Administrative Code treatment requirements state any LLW pyrophoric material "shall be rendered safe through mixture with chemically stable materials or through processing to remove the hazardous properties". One method by which hazardous properties of reactive metals can be removed is to oxidize the metals in a controlled manner. This can be done by reacting the metals with air in a humidified atmosphere. This technique is proposed for the reactive metal fines which may be unstable in the normal handling required to repack the metals for ultimate encapsulation in polymer. Reactive metal fines are defined as those less than 48 mesh (300 micron) which may freely ignite in air per NFPA 482.

2. Hanford Site Disposal WAC also makes reference to treatment of contaminated mercury or lead. Per Hanford criteria, mercury shall be solidified by amalgamation with zinc powder (or sponges containing an amalgamating powder) to prevent migration from the package in event of a leak. Lead that is contaminated with a hazardous waste will be treated per 40 CFR 268 methods and treatment standards before burial in the Hanford Site 200.

1.6.4.3 Campaigning Philosophy

1. For optimization of process enclosure space and to conform to the FDC, the feedstreams processed in the special waste area will be campaigned. Only one of the three wastes will be processed at a given time after sufficient quantities of a particular waste lot have been accumulated. The anticipated total calculated life for each waste is as follows:

Feedstream 5A (elemental/bulk mercury)	: 3 years
Feedstream 5B (reactive metals)	: 3 years
Feedstream 5C (elemental/bulk lead)	: 14 years

2. These campaign lives are total durations for processing each waste representing stored and future anticipated generation rates. Since each waste form will be generated in some amount throughout the 30 year plant life, several campaigns will be required for each allowing accumulation between each "mini-campaign".

3. A detailed engineering study will be required to evaluate the optimum campaigning schedule as well as the optimum equipment configuration to minimize equipment changeout between campaigns. Equipment changeout between campaigns will require a significant downtime for decontamination and changeout. Accessing the special waste enclosures will cause exposure to personnel in the enclosure as well as adjacent processes which may have to be shutdown during this procedure. These hazards, as well as the potential significant operative costs, must be weighed against the savings allowed by reduction of process enclosure size.

1.6.4.4 Safety Limitations

1. Processing of the toxic and reactive metal wastes have adhered to BDAT guidelines in all cases where applicable. The use of an elevated temperature process is required in the mercury evaporator to allow reasonable volatization rates. This maximum allowable operating temperature must be evaluated based upon potential volatization of several radionuclides. WHC (3/4/92 memo from J. Joyce to B. Olson) has reviewed this concern and recommended a

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maximum temperature limit of 260°C (500°F) assuming the presence of non-gaseous radionuclides. The isotope with the lowest boiling point expected to be present in the waste is cesium with a boiling point of 669°C (1236°F). Evaporation of mercury will proceed fairly rapidly at temperatures of 500°F or less since its vapor pressure is high at this temperature (approximately 1.325 psia @ 477°F).

2. Mercury vapor from the evaporator will be normally collected by cooling and condensation. However, if cooling water supply is lost to the condenser, the mercury vapors will be discharged to the evaporator enclosure. This enclosure is ventilated to the chemical scrubber for removal of residual mercury vapor. As an additional precaution, the scrubber exhaust is further treated by activated carbon filtration in the off-gas treatment area.

3. Mercury evaporator temperatures should be minimized to prevent volatization and pyrolysis of organic compounds which might be present in the bulk wastes. Also, there is potential for combustion in the evaporator if nitrogen purge gas is lost. A safety analysis of the safety backup systems, including nitrogen purge gas, must be carried out as design proceeds.

4. Deactivation of reactive metals in a humidification chamber also must be addressed from a safety standpoint. Nitrogen purge gas is relied upon for the drum tipping and metals screening area to prevent premature ignition. Also, a water spray heat removal system is planned for the humidifier in case of an uncontrolled reaction of metal fines with humidified air. This is a process controlled safety system and is not considered part of the plant fire protection system. These safety systems and any other required backups must be addressed in a safety analysis.

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1.6.5 Process Description

1.6.5.1 Special Waste Processing System

1. The special waste processing system includes those facilities required to pretreat and redrum waste that has been identified as containing mercury, lead or reactive metals. This waste will be treated in campaigns within the special waste enclosure prior to final encapsulation in polymer for disposal. Sorting and size reduction operations for lead and mercury contaminated waste are shown on PFD H-2-140649. Mercury waste pretreatment consisting of mercury evaporation and amalgamation is shown on PFD H-2-140650. Reactive metals pretreatment, which consists of screening and deactivation by humidification, is given on PFD H-2-140651.

2. Lead treatment in the special waste enclosure will be limited to sorting of lead bricks from bulk lead contaminated waste and redrumming of the lead bricks and shredded bulk lead waste. Since 95 wt% of the total incoming lead waste is assumed to be lead bricks and the remaining 5 wt% to be bulk lead, only a small portion will require size reduction by shredding. These pretreatment operations will be carried out in a fourteen year campaign schedule in the special waste enclosure using the identical equipment required for mercury (bulk mercury processing). Since the mercury waste campaign is anticipated to last only three years, the equipment will be used more effectively if both bulk lead and bulk mercury are shredded in this enclosure. Also, there will be less potential for lead and mercury cross contamination to other waste forms if all sorting and shredding is accomplished in the special waste enclosure.

3. Lead waste from boxes (such as oversize lead sheets) will never enter the special waste enclosure. This lead will be size reduced and repacked in the Box Breakdown area.

4. Mercury/mercury contaminated waste and reactive metals will each be campaigned for three (3) years. Lead/lead contamination waste will be campaigned for fourteen (14) years total operation. For the worst case material balance scenario for sizing the polymer encapsulation process, it is assumed that all special wastes can be campaigned simultaneously. However, the facility will require equipment changeout to allow reactive metal processing.

1.6.5.2 Special Waste - Sorting and Size Reduction

1. Lead contaminated waste and mercury contaminated waste are transported from interim storage in 55-gallon drums by transfer car to the Shredder Enclosure (GB-06-101). The drums are loaded onto the Lift Table - Drum Entry (LT-06-101). The drum is lifted through a simple double lid into the enclosure by use of the lift table and Transfer Crane (CR-06-101). The crane transfers the drum from the double lid entry port to the Sliding Hatch (DO-06-103) where it is lowered through the hatch from the entry box onto the Drum Pusher (CY-06-101) conveyor. The drum is transferred along the conveyor by the pusher to the Drum Handler/Tipper (DH-06-102). The contents of each drum is then tipped onto Sorting/Tipping Table (ST-06-101) for inspection and removal of items incompatible for shredding. An overhead Manipulator Assembly (EM-06-101) is used to pick out lead bricks and place them in Lead Brick Transfer Basket (X-06-101). The lead bricks in baskets are placed in new 55-gallon drums using Basket Transfer Crane (CR-06-103). The new drums are located on Lift Table - Drum Exit (LT-06-102) and are external to the enclosure. The repacked lead in drums is then transferred to the polymer encapsulation area. Mercury flasks picked out by the manipulator are transferred out of the shredder enclosure by gloveports through the Mercury Bottle Bagless Transfer (DO-06-104).

2. After removal of lead bricks or mercury flasks, the bulk contaminated waste is fed to the Shredder (SH-06-101) by tipping the sorting table. Bulk lead contaminated solids are shredded and discharged into one of the Shredder Discharge Bins (T-06-101A or B). The shredded material is then sampled and a determination is made whether the material size distribution is proper for direct loadout to a 55-gallon drum on the drum exit lift table. If the material requires further shredding, the shredder discharge bin is transferred to the shredder inlet by Bin Hoist (CR-06-102).

3. Mercury contaminated bulk solids are shredded in a manner similar to the lead bulk solids. These shredded solids are transferred to the mercury evaporator area in a discharge bin via the bin hoist.

1.6.5.3 Mercury Pretreatment

1. Shredded mercury contaminated bulk solids are transferred to the Mercury Evaporator (H-06-201) once per day using the shredder discharge bin. The mercury evaporator is located within Evaporator Enclosure (GB-06-202) and is loaded through a charge door in the top of the vessel. The evaporator is heated via electric immersion heaters to 500°F or less while purged with inert nitrogen gas. Evaporated mercury is condensed in Evaporator Condenser (E-06-201) and is collected in flasks. The condenser is cooled with chilled water at a supply temperature of 42°F. Chilled water flow rates are controlled based upon condenser noncondensable discharge temperature. Noncondensables, such as nitrogen purge gas, are collected in the retort enclosure and routed to the chemical scrubber.

2. Condensed mercury, collected in recycled flasks, is transferred from the retort enclosure through the Mercury Bottle Bagless Transfer (DO-06-204). The flasks enter the Amalgamation Enclosure (GB-06-201) through Mercury Bottle Bagless Transfer (DO-06-203). Flasks containing mercury from the mercury sorting area also enter through the same bagless transfer. New one-liter bottles containing premeasured amalgamating chemical also enter the amalgamation enclosure through this transfer system. Mercury is weighed into the bottles in the proper proportion and each bottle is capped and placed on the Jar Mill (X-06-201A or B). Each jar mill is capable of mixing 2 one-liter bottles at a time. Approximately 55 to 60 bottles of amalgamated mercury will be handled each day on both jar mills assuming a mix time of about 20 minutes each.

3. The treated mercury in bottles will exit the amalgamation enclosure through the bagless transfer system. The bottles will then be manually transferred to the shredder enclosure through a bagless transfer system. These bottles will then be loaded into the Mercury Transfer Basket (XX-06-102) using the manipulator assembly. The baskets containing mercury bottles will then be transferred by basket transfer crane to new 55-gallon drums for loadout. Repacked amalgamated mercury is forwarded to the polymer encapsulation area for final treatment.

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4. Treated bulk solids from the mercury evaporator will be discharged into 55-gallon drums after being allowed to cool overnight. The new drums will be loaded onto Lift Table - Drum Exit (LT-06-201) external to the shredder enclosure. The treated solids in drums will be conveyed to the Evaporator Discharge Conveyor (CV-06-201) to allow transfer to the polymer encapsulation area via AGV.

5. Proprietary amalgamating compounds may include chemical compounds, such as, sulfamic acid to accelerate the reaction at room temperature. Because of potential generation of noxious off-gases, such as SO_2, SO_3 or NH_3, during amalgamation, the amalgamation enclosure will be vented to the chemical scrubber. The ventilation rate corresponds to approximately 15 air changes per hour.

1.6.5.4 Reactive Metals Pretreatment

1. The reactive metals processing equipment will allow deactivation of zirconium and beryllium metals if this feedstream is identified as stored or newly generated waste by WHC. The equipment will not initially be installed in the facility until this waste stream is confirmed. If identified, the reactive metals will be campaigned in equipment installed in the Shredder Enclosure (GB-06-101) by changeout or removal of equipment used to process lead or mercury waste.

2. Reactive metals are received by transfer car in 55-gallon drums and transferred into the shredder enclosure using the same drum entry and loading equipment as described for lead and Mercury Waste (1.6.5.2.1).

3. The processing equipment for deactivating reactive metals consists of a Vibrating Screen (S-06-301) and Humidifier Discharge Vibratory Conveyor (CV-06-301). Reactive metals are segregated using a 48 mesh (300 micron) screen into a coarse and fines stream. It is assumed that approximately 50 percent of the total reactive metals stream is less than 48 mesh particle size which is considered to be unstable for handling of zirconium fines per NFPA 482. These fines are allowed to react with humidified air to oxidize the fines and render them nonactive. The metal fines are discharged onto a conveyor belt which forms a thin layer of metal fines due to vibration. Approximately 1/2 ft^3/day of fines are allowed to react with humid air for a full 24-hour period. The fines are then conveyed out of the chamber, via the vibratory conveyor, into Discharge Bin (T-06-301). Coarse metal larger than 48 mesh does not require any residence time in the humidification chamber area and is immediately conveyed to the discharge bin using an upper parallel section of the vibratory conveyor. Load out of the metals into new 55-gallon drums at a total average rate of .35 drum/day is done using the same lift table as used for shredded lead and amalgamated mercury waste loadout. These drums are transported to polymer encapsulation by AGV. Used empty drums from the drum tipper are transported to the open/sort size reduction area via Transfer Tunnel Airlock (AL-06-101).

4. Nitrogen purge gas from the inert gas generation system is supplied to the screening area of the chamber. Humidified air is supplied to the enclosed humidifier vibratory conveyor from the chemical scrubbing package. In case of a fire or other abnormal process condition, water is supplied to the humidifier/screening chamber via a spray header system. Screening/humidifier off-gas containing nitrogen purge gas and humidified air is discharged to the process off-gas treating system. The off-gas is heated to 20-30°F above dewpoint by Scrubber Off-gas Reheater(H-06-301) to prevent condensation in the HVAC System.

5. Off-gas from mercury evaporation and amalgamation is routed to the packed bed Chemical Scrubber (V-06-301) to remove and neutralize chemical contaminants. Off-gas is contracted with liquid supplied by the Scrubber Circulation Pump (P-06-301). The circulating liquid can be cooled by indirect exchange with chilled water at 42°F using Scrubber Circulation Cooler (E-06-301). Process water makeup to the scrubber is accomplished via level control while pH is controlled by separate caustic makeup from the AMU. Blowdown from the scrubber is a manual operated purge from the circulating liquid loop and is directed to the active waste water collection and treatment system.

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6. Treated off-gas from the scrubber, which is saturated air at approximately 50°F, is forwarded via flow control through the Scrubber Off-gas Blower (C-06-301) a single stage centrifugal fan. This water saturated off-gas will normally be fed to the humidification chamber. During humidifier downtime the off-gas will be bypassed directly to off-gas treating after reheat.

1.6.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.3, 2.2.3.3,3.8, 5.0, 7.0

2. DOE 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement.
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
   1161, Enclosures.
   1300, Special Facilities.
   1324, Radioactive Solid Waste Facilities.

   DOE 5820.2A, Radioactive Waste Management.
   DOE 5400.3, Hazardous and Mixed Waste Program.

1.6.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140648	Block Flow Diagram - Special Waste Treatment
H-2-140649	Process Flow Diagram - Special Waste Size Reduction
H-2-140650	Process Flow Diagram - Mercury Pretreatment
H-2-140651	Process Flow Diagram - Reactive Metals Pretreatment
H-2-140652	Equipment GA - Plan
H-2-140653	Equipment GA - Sections

1.7 Decontamination

1.7.1 Introduction

1. The process scheme for WRAP 2A decontamination is shown on the Decontamination System Flow Diagram (H-2-140602). Decontamination capability is provided for all process enclosures and equipment within by employing a specific technique or a combination of techniques as appropriate. Process waste material will not be decontaminated. The system also makes provision for monitoring treated waste drums and decontaminating them if necessary.

1.7.2 Feeds and Throughput

1. Feeds and throughputs are not strictly applicable to the decontamination system which provides a secondary process function for the WRAP 2A facility.

2. It is more appropriate to consider the 20 gallons/day average process water throughput required for decontaminating enclosures, equipment and treated waste product drums. The throughput estimate is broadly based on periodic decontamination being undertaken every two years (i.e., 350 facility operating days).

1.7.3 Design Requirements

1. The decontamination system will provide the following capabilities:

   a. Minimization of secondary waste generation and aid to decommissioning.

   b. Maximization of dry decontamination.

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c. Intermittent washdown of process enclosures or decontamination of waste drum exteriors prior to removal from confinement.

d. Location of equipment outside confinement without compromising the confinement criteria.

e. Incorporation of human factor principles and ALARA into the design.

1.7.4 Process Selection

1. Manual decontamination techniques have been selected for decontaminating small enclosures and waste product drum surfaces using wiping. This method minimizes secondary waste and follows the preferred option for decontaminating WRAP 1 enclosures.

2. Pressurized water spray technique (with the capability of adding detergent) has been widely selected to decontaminate enclosures, equipment within enclosures and grouted waste product drum surfaces. This technique has been selected because it is a proven method, material compatibility is generally considered safe, the technique is easily adapted for remote operations and is sufficiently flexible to decontaminate large, fixed, geometrically complex plant items (Reference 6).

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1.7.5 Process Description

1.7.5.1 Decontamination Water Supply System

1. All process areas of the WRAP 2A facility will be supplied with a water header for decontamination of equipment and enclosures except for the Box Breakdown area and the sample management enclosures. Process water will be supplied from the process water distribution system as shown on H-2-140690. Water supply pressure will range from between 40 and 60 psi. The decontamination system can use water at this pressure by-passing the decon booster pump P-04-201. However, for most applications supply water pressure will be boosted to approximately 150 psi to provide a more physically aggressive spray to remove loosely held contamination. Water decontamination effectiveness can be further improved by detergent dosing as follows. The proportional flow control instrument on the discharge side of P-04-201 is activated and sends a signal to the decontamination solution metering pump (P-12-107, H-2-140687) situated in the AMU area. The metering pump is triggered to pump detergent at a controlled rate to the mixing tee downstream of P-04-201 to yield a detergent dosed water solution.

1.7.5.2 Box Breakdown Area

1. The Box Breakdown area is part of the overall open, sort, size reduce and repack process flow diagram. The area will have remotely operated heavy equipment to repackage waste received in large boxes, into drums.

2. Strippable coating has been selected to decontaminate general building areas and equipment in the box breakdown on an infrequent periodic basis. The method will involve remotely spraying a protective strippable coating film on areas and items to be decontaminated. Following contamination, a second spraying will be carried out to trap the active material. Manual access to the Box Breakdown area will then be permitted for the removal of strippable coating with sandwiched radioactive waste.

3. The Box Breakdown area is designated as the maintenance area in WRAP 2A for occasional ad hoc decontamination and maintenance of large reusable items (i.e., manipulators).

1.7.5.3 Size Reduce and Repackage Enclosures

1. The two size reduce and repackage enclosures receive, physically condition and weigh out drummed waste for either polymer or grout encapsulation processes.

2. The larger enclosure contains the following major solid waste processing equipment: a drum elevator/tipper, two sort tables, two manipulators, a shredder unit, a vibrating table and a weigh hopper these items will become contaminated and will require periodic decontamination. The decontamination proposal is to use strategically positioned hydrolasers (X-04-210A, B, C and D) located close to equipment. Hydrolasers will have a selection of nozzles and extensions available for fitting within the enclosure. These auxiliary features enhance the versatility of the gloveported hydrolaser decontamination operation. Liquid effluent resulting from decontamination will be drained to the enclosure sump. The sump will be emptied by the sump pump (P-04-210A) which operates on level control to discharge effluent into the active drain for subsequent collection in the secondary waste treatment area. Hydrolasers will operate at the higher water pressure of approximately 150 psi, detergent may also be added to increase decontamination factors.

3. The smaller enclosure is similar to the larger enclosure and contains a drum tipper/elevator, a sort table, a manipulator, a pug mill and a weigh hopper for solid waste processing. The decontamination proposal is to use strategically placed hydrolasers (X-04-210 E&F) in the same manner as described above for the larger enclosure. Liquid effluent will drain to the enclosure sump and be pumped into the active drain by Sump Pump (P-04-210B).

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1.7.5.4 Sample Management Enclosure

1. The sample management enclosures consist of an enclosure containing remotely operated equipment for lot verification and core sampling, and a series of fume hoods for rudimentary chemical tests to support plant operations.

2. The lot verification sampling enclosure will be decontaminated by manual techniques through gloveports. Manual decontamination will involve the used of brushes and wipes. Small amounts of water and/or hand cleaners may also be used to facilitate contamination removal.

3. Fume hood enclosures (GB-05-601A,B,C&D) will be decontaminated by manual means through the aperture located at the front of each fume hood. The method will involve gloved operators wiping down the fume hood internals through the access aperture.

1.7.5.5 Specialty Waste Process Enclosures

1. The special waste process enclosure comprises a main enclosure and a sub-enclosure for pretreating and redrumming lead, mercury and reactive metals during phased campaigns. Initially lead and mercury will be campaigned followed by enclosure equipment change out to campaign reactive metals. The initial major equipment will comprise: a drum handler/elevator, a manipulator, a sort table, a shredder and other equipment similar to the size reduce and repackage enclosures. Consequently the decontamination method selected will be to use strategically positioned hydrolasers (X-05-231A,B&C) in close proximity to equipment needing decontamination. Hydrolasers will operate at the higher available water pressure of approximately 150 psi, detergent may also be added to increase decontamination factors. Liquid effluent resulting from the decontamination process will drain to the enclosure sump. Pump (P-04-230) operates on sump level control to automatically discharge effluent from the enclosure sump. The enclosure is also fitted with a fixed spray ring (X-04-230) for decontaminating walls and general areas.

2. The sub-enclosure is used for mercury amalgamation and will be conveniently decontaminated by manual wiping techniques through gloveports.

1.7.5.6 Polymer Encapsulation Enclosure

1. The polymer encapsulation enclosure has four polymer drum filling ports situated at the base of the enclosure. Polymer is added through these ports to immobilize drums of waste material. The drum lid enters containment during the operation while a loose seal is achieved between the drum rim and the enclosure port using the simple double lid arrangement. The outside of the drum remains in a clean environment and external drum surface contamination is not anticipated.

2. Normal enclosure decontamination will be completed by manually wiping the inside of the enclosure through gloveports with swabs wetted by organic solvent. After the solvent cleaning a water based swab will be admitted into the enclosure to remove solvent residue. Additional decontamination is provided in the form of spray ring X-04-240 which sprays the enclosure walls.

3. Liquid waste will be pumped from the enclosure sump to the active drain using P-04-240. This system will definitely be used prior to enclosure decommissioning and periodically as required.

4. Product drums from the polymer facility will be swabbed and the swab monitored for contamination, if in the unlikely event, the drums is found to be contaminated. Decontamination will be carried out by manually wiping the outside of the drum with organic solvent applied to swabs. The drum will be re-monitored for activity to ensure that it is acceptable to be sentenced for storage.

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1.7.5.7 Grout Area

1. Grout waste product drums will be produced in the grout area. There is a potential for drums to become contaminated during grout encapsulation which is undertaken inside containment. A gloveported swab wipe monitoring technique will be used at the drum monitoring station. At the station, the operator swabs the drum and deposits the swab in a shielded gamma monitor within the enclosure. The gamma monitor count will determine the degree of external drum contamination.

2. If monitoring indicates that decontamination is required then the first decontamination choice will be manual wiping through gloveports at the monitoring station. The monitoring procedure is repeated to determine if the drum is suitable for export or if further decontamination is required.

3. In the extremely unlikely event that a drum does need decontaminating then the drum will be sent to the drum decontamination booth for a high pressure spray at 1500 psi using drum spray (X-04-252) and positive displacement pump P-04-250. Spraying works on a recirculation system to minimize water consumption. The system operates in the following manner as follows. Pump P-04-250 draws water through a filter from the sump and delivers through spray nozzles situated adjacent to the slowly rotating drum. Spent water is drained to the sump for re-use. Sump level controls ensure that suitable operating levels are maintained. The sump water is monitored remotely for gamma activity. If high activity is detected a signal is sent to switch off P-04-250, the active water discharged via sump pump P-04-251, the sump is refilled with process water to permit the drum decontamination cycle to continue. Drum re-monitoring will occur (as previously described) before the drum can be released for storage.

2. Decontamination in and around the drum decontamination area can be augmented by using strategically placed hydrolaser X-04-251 through gloveports.

3. Fixed spray rings X-04-250 A and B are provided to decontaminate walls and general areas. Liquid effluent from water spray operation will drain to the enclosure sump for discharge to the active drain via sump pump (P-04-251).

1.7.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.3.1, 3.6, 3.8, 5.0, and 7.0.

2. DOE Order 6430.1A, "General Design Criteria", Sections: 0110-99, Special Facilities, Nonreactor Nuclear Facilities.

1161, Enclosures
1300-11, Decontamination and Decommissioning
1300-12, Human Factors Engineering
1324, Radioactive Solid Waste Facilities

3. WHC-CM-4-11, "ALARA Protection Program".

4. WHC-CM-4-29, "Nuclear Criticality Safety Manual".

1.7.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140602	Process Flow Diagram - Decontamination System
H-2-140687	Process Flow Diagram - AMU
H-2-140690	Process Flow Diagram - Process Water and Chilled Water
H-2-140688	AMU Area Equipment - GA

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1.8 Seconary Waste Treatment

1.8.1 Introduction

1. Radioactive and non-radioactive liquid wastes will be generated at WRAP 2A during normal operations such as decontamination, aqueous solution make-up, building HVAC condensate, and other miscellaneous sources. Sanitary wastes are segregated from the radioactive and non radioactive wastes streams to prevent cross contamination. The sanitary wastes are collected, treated, and disposed of in a separate treatment system. Radioactive and non-radioactive liquid waste treatment systems are provided to collect, sample, treat, and recycle the water within the WRAP 2A facility. The treatment for non-radioactive waste is limited to pH adjustment while the treatment for the radioactive waste consists of pH adjustment, filtration, and carbon adsorption. A backup capability to dispose of radioactive liquid waste to the C018 LETF is provided. In addition, capability of drumming non-radioactive hazardous waste and shipping it to an approved hazardous waste treatment, storage and disposal facility is also provided.

1.8.2 Feeds and Throughput

1. The secondary waste treatment systems are not used to directly treat any of the incoming waste streams. Rather, they are used to collect, sample and treat all liquid wastes which are generated in the WRAP 2A facility during the processing of the incoming waste streams.

2. The radioactive liquid waste system is designed to handle an average of 160 gallons per day while the non-radioactive waste system is expected to handle an average of five gallons per day. The secondary waste treatment systems will be utilized throughout the entire life of the WRAP 2A facility.

1.8.3 Design Requirements

1. No liquid effluent will be discharged to the environment.

2. Provide segregated systems for radioactive and non-radioactive liquid waste.

3. Minimize generation of secondary waste.

4. Incorporate the principals of human factors and ALARA into the process design.

5. All necessary tanks, piping, pumps, monitoring and control instrumentation and chemical injection shall be provided.

6. All liquid waste handling systems have adequate spill prevention, secondary containment and leak detection.

7. All system components in contact with waste designed and constructed to be resistant to any expected or known corrosive environments.

8. Capabilities for extracting samples required to support characterization, processing and process verification of the waste.

9. All system operable locally and from the control area.

10. All tanks provided with process water service.

11. The capability to package hazardous liquid waste for transport and disposal in 55-gallon drums as per WHC-EP-0063 and environmental regulations.

12. A radioactive liquid waste collection system consisting of one tank sized to provide two months storage plus a 50 percent safety factor and a 25 percent "heel".

13. A system to receive and treat radioactive liquid waste from the collection tank shall be provided. Treatment shall condition the waste as needed to permit use as make-up water for immobilization agents or, in situations when this is not possible, make compatible for treatment in the C-018H facility.

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1.8.4 Process Selection

1. The radioactive and non-radioactive waste collection systems are dictated by the FDC.

2. The treatment provided for the radioactive liquid waste treats the waste to make it suitable for reuse as make-up water in the agitated grout system. The agitated grout process requires water with a neutral to slightly alkaline pH and is free of organic material. Therefore, pH adjustment and carbon absorption were selected as part of the treatment process. Filtration of the liquid waste is also provided to prevent residual solids from settling out or fouling piping or equipment downstream of the active waste treatment system.

3. The treatment provided for the nonactive liquid waste treats the waste to make it suitable for reuse as make-up water in the vibro grout system. The vibro grout requires water with a neutral to slightly alkaline pH and is non-hazardous; pH adjustment is the only treatment provided for the nonactive liquid waste. If the waste is determined to be hazardous for reasons other than pH, the waste will be drummed and sent to an approved hazardous waste treatment, storage and disposal facility.

1.8.5 Process Description

1. The process scheme for Secondary Waste Treatment is shown on the attached Process Flow Diagrams H-2-140658 and H-2-140659.

1.8.5.1 Nonactive Waste Treatment

1. Nonactive liquid wastes are collected at an average rate of five gallons per day in the nonactive waste drain header and conveyed to one of the 500 gallon Nonactive Waste Collection Tanks (T-07-101 A,B). The waste is collected in one tank at a time. High level indication in one tank automatically diverts the waste to the empty tank. The waste is then sampled and analyzed for hazardous constituents. Based on the results of the analysis, the waste is disposed of in one of two disposal methods. First, if the waste is identified as being a hazardous waste, the waste is pumped utilizing the Nonactive Waste Pumps (P-07-101 A,B) to a drum fill station. The waste is loaded into drums and shipped to an approved hazardous waste treatment, storage and disposal facility. If the waste is characterized as being both non-active and non-hazardous, then the waste is pumped utilizing the Nonactive Waste Pumps (P-07-101 A,B) to the vibro grout system where it is used for grout makeup water. The treatment of nonactive waste is limited to pH adjustment. The waste is neutralized to a pH of 7 prior to reuse or drumming. The pH adjustment is accomplished utilizing dilute sulfuric acid and dilute sodium hydroxide supplied

from the aqueous solution makeup area. A pH controller located in each tank controls the acid and caustic addition by adjusting the feed rate of the acid and caustic metering pumps. The Nonactive Waste Tank Mixers (M-07-101 A,B) provide the blending for the pH adjustment. The nonactive waste collection tanks are ventilated to the Off-gas Treatment System. The nonactive waste collection tanks are located in an area which provides secondary confinement in the event of spills. A sump is provided within the confinement to collect any spills or leaks. Water collected in the sump is pumped back to one of the nonactive waste collection tanks by the Nonactive Waste Sump Pump (P-07-102). A process water connection is provided on each of the nonactive waste collection tanks to periodically flush the tanks between fill cycles.

1.8.5.2 Active Waste Treatment System

1. Active liquid wastes are collected at an average rate of 160 gallons per day in the active waste drain header and conveyed to the 10,000-gallon Active Waste Collection Tank (T-07-201). If the collected wastes have a high solids content, the solids are slurried and pumped to a drum fill station where the solids are drummed. When the solids loading is low, the waste is periodically pumped utilizing the Active Waste Pump (P-07-201) through the Active Waste Filter (F-07-201) and the Active Waste Carbon Filter (F-07-202) to the 3,000-gallon Treated Active Waste Tank (T-07-202). The active waste filter removes particles larger than 25 microns from the waste while the carbon filter removes trace organics and mercury from the waste. The waste is neutralized to a pH of 7 in the treated active waste tank. The pH adjustment is accomplished utilizing dilute sulfuric acid and dilute sodium hydroxide from the Aqueous Makeup area. The acid and caustic addition is controlled by a pH controller located in treated active waste tank. The treated Active Waste Tank Mixer (M-07-201) provides the blending for the pH adjustment. The waste is then sampled and characterized to verify that the waste is acceptable for reuse in the agitated grout system. The waste is then pumped via the Treated Active Waste Pump (P-07-203) to the agitated grout system for reuse within the process. In an event where excessive water is generated, such as fire conditions, the option exists to pump the liquid waste to a truck fill station. The liquid waste would be loaded into tanker trucks for transfer to the CO18 Liquid Effluent Treatment Facility for final disposal. The active waste collection tank and the treated active waste tank are ventilated to the off-gas treatment system. The active waste collection tank, the active waste filter, the active waste carbon filter and the treated active waste tank are located in an area which provides secondary confinement in the event of spills. A sump is provided within the confinement to collect any spills or leaks. Water collected in the sump is pumped back to either the active waste collection tank or the treated active waste tank by the Active Waste Sump Pump (P-07-202). A process water connection is provided on the active waste collection tank and the treated active waste tank to periodically flush the tanks between fill cycles.

1.8.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.2.8, 2.2.9, 3.8, 5.0, 7.0.

2. DOE 6430.1A General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement.
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
   1161, Enclosures.
   1300, Special Facilities.
   1324, Radioactive Solid Waste Facilities.

   DOE Order 5400.3, Hazardous and Mixed Waste Program.
   DOE Order 5820.2A, Radioactive Waste Management.

3. WHC-CM-4-10, Radiation Protection.

   WHC-CM-4-11, ALARA Protection Program.
   WHC-CM-4-29, Nuclear Criticality Safety Manual.

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1.8.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140660	Secondary Waste Collection Equipment General Arrangement - Plan
H-2-140661	Secondary Waste Collection Equipment General Arrangement - Section
H-2-140651	BFD - Overall Plant Water Balance
H-2-140658	PFD - Active and Nonactive Plant Drains
H-2-140659	PFD - Active and Nonactive Liquid Waste Systems

1.9 Off-Gas Treatment System

1.9.1 Introduction

1. The off-gas treatment system included in WRAP 2A is designed to prevent the spread of airborne contamination from indoor process enclosures, vessels and tanks to the general process area or to the atmosphere. The off-gas system is a closed system which controls process enclosures, vessels and tanks under a negative pressure and collects and treats off-gas from these confined areas before discharge to the Zone I HVAC exhaust system. The off-gas treatment system is designed to perform the following functions:

a. Filter indoor air drawn into confinement systems held at negative pressure by HVAC exhaust fans. The HEPA filters are needed to protect the general indoor process area from contamination in case of airflow reversal due to positive pressure inside the confinement zones caused by abnormal operating conditions.

b. Collect, heat and filter off-gas from indoor storage tanks. Nonactive and active tank off-gas is filtered separately, with each containing a prefilter and two stages of HEPA filtration.

c. Collect and filter (prefilter plus two HEPA filters) off-gas from indoor grout silo dust collectors. This nonactive off-gas comes partially from pneumatic conveying of grout powders into their respective silos and partially from each silo to maintain a negative pressure in each silo.

d. Collect fugitive dust laden off-gas from size reduction activities such as shredding, pug mill operation, sorting, and repacking into drums and remove the bulk of the dust in a bag filter. Combine the bag filter off-gas with off-gas from the waste box breakdown cell and pass the off-gas through a final filtration-step (one prefilter and two HEPA filters).

e. Collect off-gas from the special waste shredder enclosure and the humidifier chamber and treat the gas with a combination filter having (in order) a prefilter, HEPA filter, two carbon filters and HEPA filter. The carbon filters remove trace amounts of mercury or hydrocarbons which may be present in the off-gas while HEPA filters remove particulates.

f. Collect off-gas from the polymer encapsulation enclosure and remove organic hydrocarbons by a combination of condensation (using chilled water) and carbon adsorption. Particulates are removed with a prefilter and two stages of HEPA filtration.

g. Filter off-gas from the grout stabilization enclosure through a prefilter and two HEPA filters.

h. Filter off-gas from the sample management hoods and drum sampling enclosure through a prefilter, two carbon filters and two HEPA filters. The carbon filters remove mercury and hydrocarbon vapors and the HEPA filters remove particulates.

1.9.2 Feeds and Throughput

1. This system collects and treats off-gas from a variety of enclosures that process a range of waste streams and throughputs. The off-gas flow rates, however, are not determined by the waste feed flow rates, but are based on the volume of the tanks and enclosures. Tanks are

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vented at a rate of four air changes per hour, based on empty tanks. Enclosures are vented at a rate of 15 air changes per hour, or the same ventilation rate used for the gloveboxes in the WRAP 1 design. The off-gas flow rates for specific tanks and enclosures are given in Section 1.9.5, Process Description. The total off-gas flow rate is 11,540 ACFM to the HVAC exhaust fans.

2. The operating life of the off-gas treatment system will be approximately 30 years, or the same as the useful operating life of the facility. The off-gas treatment system will operate continuously (24 hours per day, 7 days per week) to maintain negative pressures in indoor tanks and enclosures at all times.

1.9.3 Design Requirements

1. All make-up, feed and bulk storage tanks and process enclosures within the building shall operate under negative pressure relative to ambient room pressure.

2. The off-gas treatment system in conjunction with the HVAC system shall ensure safe operation and maintain airflow from non-contaminated areas to areas of progressively higher potential contamination.

3. Provide one stage of HEPA filtration on inlet air ducts to indoor tanks and enclosures vented to the off-gas treatment system.

4. Transfer system for all dry materials shall be enclosed and have adequate provisions for the collection of dust and particulate materials.

5. A special exhaust ventilation system shall be provided to remove radioactive and non-radioactive contaminants from gases and vapors created during processing. The system shall be comprised of inlet air ducts and HEPA filters to tanks and enclosures and exhaust ducts with off-gas treatment equipment and control dampers. Treated off-gas will be discharged to the Zone I HVAC exhaust system.

6. Minimize generation of secondary waste, design for ease of decommissioning and provide economic system design from the standpoint of capital cost and operation/maintenance.

7. Components not exposed to contamination that can be located outside of confinement without compromising the confinement criteria (Section 1324-6 of DOE 6430.1A) shall be so located. This applies especially to piping, tanks, rotating equipment, and instruments.

8. Incorporate principals of human factors engineering, ALARA, decontamination and decommissioning in the design process.

9. The off-gas systems, as a minimum, will be operating prior to and during processing waste in any particular submodule throughout the life of the facility.

10. Ducts shall be sized for the transport velocities needed to convey, without settling, all particulate contaminants.

11. Provide representative effluent record sampling and continuous on-line monitoring of exhaust stack (after exhaust fan).

12. Permit in-place testing of HEPA filter installations.

13. Provide parallel HEPA filter systems so that one may be changed out while the other is operating.

14. Utilize welded joints ground smooth (or equivalent) on ductwork carrying potentially contaminated materials.

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15. Minimize the ability of and provide means to detect buildup of radioactive materials in the ductwork.

16. Provide changeable prefilters upstream of first HEPA filters on exhaust ducts.

17. Use bagout or self-contained filters and other features for changing contaminated components wherever possible.

18. The off-gas and HVAC systems shall be controlled by a central process control system.

19. Provide moisture separators or heaters to minimize moisture loading on filters.

20. Remove flammable vapors from off-gas streams.

1.9.4 Process Selection

1.9.4.1 Based on Design Requirements

1. The process selection for the off-gas treatment system was based on the design requirements given above and on industry experience. The following off-treatment equipment was selected based on design requirements:

a. Inlet air HEPA filters.

b. Heaters on aqueous solution tank vents to minimize moisture loading on filters.

c. Prefilters upstream of exhaust HEPA filters.

d. Two stage, testable, bag-in, bag-out, spared exhaust HEPA filters.

e. Removal of flammable vapors from polymer encapsulation via chilled water condensation and carbon adsorption.

f. Individual HEPA filters located as near as possible to the source of contamination.

g. Pressure control dampers to maintain negative pressures in enclosures and indoor tanks.

1.9.4.2 Based on Industry Experience

1. The following equipment was selected based on industry experience:

a. Dust collectors (baghouses) were selected to remove the bulk of the fugitive dust generated by size reduction shredders, pug mill, and opening, sorting and repacking activities. These dust collectors minimize waste production by collecting and thus generating a concentrated waste stream which otherwise would have to be removed by prefilters resulting in a larger volume of waste.

b. Carbon filters, installed as part of a HEPA filter train, were selected to remove residual amounts of mercury (as well as organic hydrocarbons) from the off-gas from the special waste processing enclosure, sample management hoods and the drum sampling enclosure. These carbon filters will require a special pretreatment to filter out mercury.

c. Fire screens were selected for installation upstream of all prefilters where the potential for sparks or burning embers is present.

1.9.4.3 Waste Acceptance Criteria

1. The off-gas treatment system will generate the following wastes: size reduction baghouse dust, polymer encapsulation condensed hydrocarbon liquids, polymer encapsulation adsorber

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spent carbon, special waste filter spent carbon, sample management filter spent carbon, dirty prefilters and dirty HEPA filters from nine different process and tank areas.

2. The disposition of off-gas treatment wastes will be as follows:

Waste	Disposition
Size reduction baghouse dust	Polymer encapsulation
Polymer encapsulation condensed hydrocarbon liquids	Mix with solid organic absorbent and send to thermal treatment facility
Polymer encapsulation absorber spent carbon	Send to thermal treatment facility
Special waste filter spent carbon	Polymer encapsulation
Sample management filter spent carbon	Polymer encapsulation
F-04-101 A,B (PF, HEPA's)	Size reduction, grout stabilization
F-04-102 A,B (PF, HEPA's)	Size reduction, grout stabilization
F-04-103 A,B (PF, HEPA's)	Size reduction, grout stabilization
F-04-104 A,B (HEPA)	Size reduction, grout stabilization
F-04-105 A,B (PF, HEPA's)	Size reduction, grout stabilization
F-04-106 (PF, HEPA's)	Size reduction, grout stabilization
F-04-107 A,B (PF, HEPA's)	Size reduction, grout stabilization
F-04-108 (PF, HEPA's)	Size reduction, grout stabilization
F-04-109 A,B (PF, HEPA's)	Size reduction, grout stabilization

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1.9.4.4 WRAP 1 Lessons Learned

1. The air flow rate criteria of 15 air changes per hour through enclosures was taken from the WRAP 1 criteria for air flow rate through the gloveboxes.

2. The negative pressure range for indoor tanks and enclosures of -0.7 to -1.0 inches of water was taken from the WRAP 1 design pressure for gloveboxes.

1.9.5 Process Description

1. The off-gas treatment system includes: 1) the inlet air filters for fresh indoor air supplied to AMU tanks, waste collection tanks and process enclosures and, 2) off-gas treatment equipment (reheaters, condensers, dust collectors, filters and carbon adsorbers) to treat exhaust gases (primarily air) from the above mentioned tanks and enclosures. The tank/enclosure inlet air filters are shown on PFD H-2-140600 (Sheet 1) and the off-gas treatment system is shown on PFD H-2-140600 (Sheet 2). The off-gas treatment system is designed to operate on a continuous basis.

2. The inlet air filters are not spared since they can be changed out without affecting safe operations of the tanks or enclosures. In general, all off-gas treatment equipment is spared. Two exhaust filters (F-04-106 and F-04-108) are not spared but off-gas flow to these filters can be diverted to other similar filters which have spares. Inlet air filters are not testable. All off-gas filters are designed to be testable, i.e., samples can be taken to check filter or equipment performance.

1.9.5.1 Tank/Enclosure Inlet Air Filters

1. Inlet air is drawn from Zone 2 room air in the process area through the inlet air filters to tanks and enclosures controlled at a negative pressure of -0.7 to -1.0 inches of water. Inlet air filters are necessary to protect the process area from contamination in case the tanks or enclosures develop a positive pressure. Tanks are vented at a flow rate criteria of four air changes per hour, assuming the tanks are empty. Enclosures are vented at a flow rate criteria of 15 air changes per hour. Manual dampers are located upstream of the inlet air filters to adjust the negative pressure inside the tanks or enclosures.

2. The inlet air filters for the tanks are listed below, along with the nominal air flow rate and tank volumes:

Tank Description	Tank Volume, Gallon	Inlet Air Filter		Nominal Air Flow, ACFM
		Tank Tag No.	Tag No.	
Acid Feed Tank	75	T-12-101	F-04-121	1
Caustic Feed Tank	75	T-12-102	F-04-122	1
Decon Solution Feed Tank	150	T-12-103	F-04-123	3
Nonactive Waste Collection Tanks	500 ea.	T-07-101A,B	F-04-124A,B	5 ea.
Active Waste Collection Tank	10,000	T-07-201	F-04-125	140
Treated Active Waste Tank	3,000	T-07-202	F-04-126	30

3. These filters will be small, circular nontestable HEPA filters designed to be installed in the inlet air piping near the tanks.

4. Filter F-04-127 will filter inlet air to four enclosures with similar or compatible processes: the Size Reduction Shredders Enclosure (GB-05-521), the Pug Mill Enclosure (GB-05-541), the box breakdown cell and the Grout Stabilization Enclosure (GB-05-201). This large filter (8500 ACFM) system will have a prefilter and nontestable HEPA filter on each of the nine filter trains.

5. Filter F-04-128 will filter inlet air (200 ACFM) to the Polymer Encapsulation Enclosure (GB-05-401). This filter will be a small, circular nontestable HEPA installed in the inlet air line to the enclosure.

6. Filter F-04-129 will filter inlet air (1,600 ACFM) to the Special Waste Shredder Enclosure (GB-06-101) and the Drum Sampling Enclosure (GB-05-600). This filter train will include a prefilter and nontestable HEPA filter.

1.9.5.2 Vessel and Process Off-Gas Treatment

1. Exhaust gases from all tanks and enclosures located inside the process building are treated by various methods before being exhausted through redundant fans to the exhaust stack. Both active and nonactive off-gas are treated in the same system since the volume of nonactive gases is less than two percent of the total off-gas volume and the use of double HEPA filtration on all streams prevents contamination by active off-gases to nonactive areas in case of positive system pressures.

1.9.5.2.1 Nonactive Tanks Off-Gas

1. Off-gas from three Aqueous Make-Up (AMU) tanks (Acid Feed Tank [T-12-101], Caustic Feed Tank [T-12-102] and Decon Solution Tank [T-12-103]) and two Nonactive Waste Collection Tanks (T-07-101A,B) is combined and heated from 60°F to 100°F in the Nonactive Tanks Off-Gas Reheater (H-04-101) to prevent moisture condensation before passing through the Nonactive Tanks Off-Gas Filter (F-04-109A,B). This 20 ACFM filter contains a prefilter and two stages of HEPA filtration, primarily for protection in case of flow reversal due to positive pressure in the exhaust system. A pressure controller maintains the required negative pressure in the tanks by controlling a modulating damper downstream of the redundant filters.

1.9.5.2.2 Active Tanks Off-Gas

1. Off-gas from the Active Waste Collection Tank (T-07-201) and the Treated Active Waste Tank (T-07-202) are combined and heated from 60°F to 100°F in the Active Waste Tanks Off-Gas Reheater (H-04-102) to prevent moisture condensation before passing through the Active Waste Tanks Off-Gas Filter (F-04-101A,B). This 200 ACFM filter contains a prefilter and two stages of HEPA filtration. A pressure controller maintains the required negative pressure in the tanks by controlling a damper downstream of the filter.

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1.9.5.2.3 Size Reduction Off-Gas

1. Off-gas from the Size Reduction Shredders Enclosure (GB-05-521), and Pug Mill Enclosure (GB-05-541) is combined (1,500 ACFM) and passes through the Size Reduction Off-Gas Dust Collector (S-04-101A,B). This is a reverse pulse jet baghouse designed to remove the majority of the fugitive dust generated in these enclosures. Compressed air is supplied to the dust collector to reverse the air flow through the filter bags, shaking loose the dust collected on the bags. Dust is collected in a sloped hopper and discharged through a rotary valve to a drum with a dust seal. Off-gas from the baghouse is combined with off-gas from the box breakdown cell and passes through the Size Reduction Off-Gas Filter (F-04-102A,B). This 6,000 ACFM filter contains six trains, each with a firescreen, prefilter and two HEPA filters. A pressure controller maintains a negative pressure upstream of F-04-102A,B. In addition, pressure controllers are located at each enclosure to maintain a negative pressure of -0.7 to -1.0 inches of water. Each pressure controller controls a damper located on the off-gas piping from that enclosure.

1.9.5.2.4 Polymer Encapsulation Off-Gas

1. Off-gas (200 ACFM) from the Polymer Encapsulation Enclosure (GB-05-401) is cooled to 45°F with chilled water in the Polymer Encapsulation Vapor Condenser (E-04-101) to condense as much organic hydrocarbon vapor as possible. This condenser is a fintube heat exchanger with about 160 square feet of extended surface area. Condensed hydrocarbons are collected in a trap and flow by gravity to a sealed drum containing an organic absorbent. The drum will be blanketed with nitrogen.

2. Noncondensed gas from the condenser is filtered in the Polymer Encapsulation Off-Gas Prefilter (F-04-103A,B) which consists of a firescreen, prefilter and HEPA filter. Any residual organics are then removed in Polymer Encapsulation Off-Gas Carbon Adsorber (V-04-101A,B). Each vessel contains about 950 pounds of pelletized activated carbon which can typically retain about 10 pounds of organics per 100 pounds of carbon. Flow will be diverted from one carbon adsorber to the other when "breakthrough" of organic hydrocarbons is detected downstream of the adsorbers. The "spent" carbon will be drained into 55-gallon drums for disposal and fresh carbon added to the absorber. The gas then passes through the Polymer Encapsulation Off-Gas Final Filter (F-04-104A,B) which consists of a single HEPA filter. A pressure controller maintains the required negative pressure in the enclosure by controlling a damper downstream of F-04-104A,B.

1.9.5.2.5 Grout Silo Dust Collectors Off-Gas

1. Off-gas from pneumatic conveying of grouting powders from the bulk powder storage silos located outside to the three Vibro Grout Silos (T-05-201, 203 and 210) located inside, and the three Agitated Grout Silos (T-05-205, 206, and 209) also located inside is combined into one pipe after passing through dust collectors on the top of each silo. Powder is transferred from one Bulk Silo to one of the six indoor silos at a time by Dense Phase Pump (P-05-102) using 100 SCFM of compressed air. A continuous off-gas flow of 100 ACFM will also be drawn from the six grout silos and weigh hoppers to maintain negative pressure in these tanks. The 200 ACFM of total off-gas from the dust collectors is filtered in the Grout Powder Tanks Off-Gas Filter (F-04-105A,B). This filter has a firescreen, prefilter and two HEPA filters. A pressure controller maintains the required negative pressure upstream of (F-04-105A,B) by controlling a damper downstream of the filter.

1.9.5.2.6 Grout Stabilization Off-Gas

1. Off-gas from the Grout Stabilization Enclosure (GB-05-201) is filtered through the Grout Enclosure Off-Gas Filter (F-04-106). This 2,500 ACFM filter consists of a firescreen, prefilter and two HEPA filters. A pressure controller maintains the required negative pressure in the enclosure by controlling a damper downstream of the filter. This filter is not spared, but during a filter changeout, the off-gas flow will be directed to either F-04-102A or 102B, whichever is not in use at the time of the filter changeout.

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1.9.5.2.7 Special Waste Enclosures Off-Gas

1. Off-gas (1,200 ACFM) from the Special Waste Shredder Enclosure (GB-06-101) is joined with 20 ACFM of off-gas from the Special Waste Humidifier Chamber (GB-06-301) (heated to prevent moisture condensation) and flows to the Special Waste Enclosures Off-Gas Filter (F-04-107A,B). This filter consists (in order of flow) of a firescreen, prefilter, HEPA filter, two carbon filters and a HEPA filter. The carbon filters consist of packed beds of sulfur impregnated granular activated carbon capable of removing elemental and organic mercury which may be present in the special waste enclosures. The carbon filters can also remove trace amounts of organic hydrocarbons which may be present in the off-gas. A pressure controller maintains the required negative pressure between the dust collector and off-gas filter by controlling a damper located downstream of the filter. Pressure controllers are also needed at the Shredder Enclosure and the Humidifier Chamber to maintain the necessary negative pressure at these enclosures by controlling dampers in the off-gas lines from these enclosures.

1.9.5.2.8 Sample Management Off-Gas

1. Four Sample Management hoods are designed to draw air in at 100 feet per minute through hood openings. While not all hoods will likely be used at the same time, the off-gas ducts are designed for all hoods in operation. Off-gas from the hoods is combined with off-gas from the Drum Sampling Enclosure (GB-05-600) and flows to the Sample Management Off-Gas Filter (F-04-108). This filter is basically a small version of the Special Waste Off-Gas Filter (F-04-107A,B), i.e., firescreen, prefilter, HEPA filter, two carbon filters and a HEPA filter since the off-gas could contain dust, mercury vapors and organic hydrocarbon vapors. This filter is not spared, but when a filter change out is necessary, the off-gas will be diverted to F-04-107A or 107B, whichever filter is not in use. A pressure controller maintains the correct negative pressure upstream of the filter by controlling a damper downstream of the filter.

1.9.5.3 Equipment Layout

1. Large off-gas treatment equipment layout (baghouse, carbon adsorbers, larger filters) is shown on drawing H-2-140601 "Vessel and Process Off - Gas General Arrangement". Small equipment such as canister filters for inlet air and tank vents, tank vent reheaters, and polymer vapor condenser are located in ducts near the source of contamination.

1.9.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.1.3, 2.1.5, 2.2.3, 2.2.5, 2.2.8, 2.2.9, 3.2, 3.6, 3.7, 3.8, 5.0, 7.0.

2. DOE Order 6430.1A, "General Design Criteria", Sections:

0110-7	Architectural and Special Design Requirements; Environmental Protection and Pollution Control.
0110-99.0	Special Facilities; Nonreactor Nuclear Facilities - General.
1161	Enclosures.
1300-7	Special Facilities - General Requirements; Confinement Systems.
1300-12	Special Facilities - General Requirements; Human Factors Engineering.
1323	Radioactive Liquid Waste Facilities.
1324	Radioactive Solid Waste Facilities
1325	Laboratory Facilities (Including Hot Laboratories).
1550	Heating, Ventilating and Air-Conditioning Systems:
1550-1.5	General Sizing and Design Criteria; Ventilation - Exhaust Systems design Requirements.
1550-99.0	Special Facilities; Nonreactor Nuclear Facilities - General.
1589	Air Pollution Control.
1596-6	Controls; Control of Air Handling Systems.

3. DOE Order 5400.1

1106: SPECIAL WASTE	1	2	3	4	5	6	7	8	9
EQUIPMENT:	H-06-201	X-06-201	55 GAL DRUMS	T-06-101 A/B	55 GAL. DRUMS	CV-06-301	55 GAL DRUMS	V-06-301	V-06-301
DETERMINANT:	RESIDUAL Hg	RESIDUAL Hg	WASTE CHARACTER	SIZE DISTRIBUTION	WASTE CHARACTER	OXIDIZING POTENTIAL	WASTE CHARACTER	TRACE Hg	CHEMICAL COMP.
FLUID:	PRETREATED WASTE	PRETREATED WASTE	REPACK/AMALGAM RETRACTED WASTE	BULK Hg OR Pb	REPACKED SHREDDED LEAD	DEACTIVATED REACTIVE METALS	REPACKED DEACTIVATED REACTIVE METALS	SCRUBBER OFF-GAS	SCRUBBER BLOWDOWN
TURN-ROUND TIME.	2 WEEKS	2 WEEKS	2 WEEKS	< 1 HR	2 WEEKS	1 DAY	2 WEEKS	< 1 HR	< 1 HR
FREQUENCY:	1 / DAY	1 / DAY	1 / DRUM	1 / DAY	1 / DRUM	1 / DAY	1 / DAY	1 / DAY	1 / DAY
CATEGORY:	A	A	A	C	A	B	A	C	C

1106: SAMPLING MANAGEMENT	1
EQUIPMENT:	WASTE DRUM
DETERMINANT:	LOT VERIF.
FLUID:	ALL WASTE
TURN-ROUND TIME:	2 WEEKS
FREQUENCY:	DAILY
CATEGORY:	A

1105: POLYMER	1	2	3	4	5	6	7	8
EQUIPMENT:	T-05-401	T-05-402	M-07-404 THRU 407	V-05-401	55 GAL. DRUMS	T-05-304	T-05-303	T-05-305 A/B
DETERMINANT:	CHEMICAL COMP.	CHEMICAL COMP.	CHEMICAL COMP	ACTIVITY & CHEM. COMP.	CERTIFY	Q.C. / PREMATURE POLYMERIZATION	Q.C. / PREMATURE POLYMERIZATION	Q.C. / PREMATURE POLYMERIZATION
FLUID:	MIXED POLYMER	WASTE	MIXED POLY. & CATALYST	WASTE WATER	TREATED WASTE	PROMOTER	CATALYST	VES RESIN
TURN-ROUND TIME:	< 1 HR	< 1 DAY	< 1 HR	1 DAY	2 WEEKS	< 1 DAY	< 1 DAY	< 1 DAY
FREQUENCY:	1 / DAY	1 / WEEK	1 / DAY	1 / DAY	1 / DRUM	1 / WEEK	1 / WEEK	1 / WEEK
CATEGORY:	C	C	C	B	A	C	C	C

1105: BOX BREAKDOWN CELL	1	2
EQUIPMENT:	CELL	BOX
DETERMINANT:	WASTE CHARACTER	LOT VERIFICATION
FLUID:	FEEDSTREAMS - 5C, 1D & HEPA FILTERS.	FEEDSTREAMS - 5C, 1D & HEPA FILTERS.
TURN-ROUND TIME:	1 WEEK	2 WEEKS
FREQUENCY:	1 / MONTH	1 / MONTH
CATEGORY:	A	A

1105: GROUT	1	2	3	4	5	6	7
EQUIPMENT:	T-05-101 THRU 104	DRUM OF POLY. ADDITIVE	T-05-201 THRU 211	T-05-212	DRUM OF WASTE (VIBRO)	DRUM OF WASTE (AGIT)	P-05-203
DETERMINANT:	Q.C. BULK POWDER	Q.C. ADDITIVE	Q.C. BULK POWDER	WET GROUT MIX	RADIONUCLIDE INVENTORY	RADIONUCLIDE INVENTORY	RADIONUCLIDE INVENTORY
FLUID:	OPS, BFS, PFA & GYPSUM	POLYESTER	OPS, BFS, PFA & BLENDS	MIXTURE OF OPC, BFS & PFA	CERTIFY	CERTIFY	WATER
TURN-ROUND TIME:	2 DAYS	2 DAYS	2 HOURS	1 HOUR	2 WEEKS	2 WEEKS	1 DAY
FREQUENCY:	1 / MONTH	1 / MONTH	DAILY / 10 DAY	10 / DAY	1 / LOT	1 / LOT	1 / MONTH
CATEGORY:	C	C	C	C	A	A	B

SAMPLE MANAGEMENT

1105: SIZE RED. & REPACK	1	2	3
EQUIPMENT:	GB-05-521 (SHREDDER)	GB-05-541 (PUG MILL)	GB-05-521 (REPACK)
DETERMINANT:	WASTE CHARACTER	WASTE CHARACTER	WASTE CHARACTER
FLUID:	FEEDSTREAMS - 1A, 1D, 2D, 3, 4 & 5D	FEEDSTREAMS - 1B, 1C & 6	FEEDSTREAMS - 2A, 2B, 2C, 5C, 7 & 8
TURN-ROUND TIME:	1 WEEK	1 WEEK	1 WEEK
FREQUENCY:	1 / MONTH	1 / MONTH	1 / MONTH
CATEGORY:	A	A	A

1107: SECONDARY WASTE	1	2	3
EQUIPMENT:	T-07-101 A/B NON-ACTIVE TANKS	T-07-201 ACTIVE TANK	T-07-202 TREATED ACTIVE TANK
DETERMINANT:	CHEMICAL CHARACTERIZATION	RADIOACTIVE CHARACTERIZATION	RADIOACTIVE CHARACTERIZATION
FLUID:	NON-ACTIVE LIQUID WASTE	ACTIVE LIQUID WASTE	TREATED ACTIVE LIQUID WASTE
TURN-ROUND TIME:	2 WEEKS	2 WEEKS	2 WEEKS
FREQUENCY:	1/2 MONTH	1/2 MONTH	1/2 MONTH
CATEGORY:	C	B	B

1112: AQUEOUS MAKE-UP	1	2	3
EQUIPMENT:	T-12-101 ACID FEED	T-12-102 CAUSTIC FEED	T-12-103 DECON SOLUTION
DETERMINANT:	VERIFY STRENGTH	VERIFY STRENGTH	VERIFY STRENGTH
FLUID:	DILUTE ACID (1-5%)	DILUTE CAUSTIC (1-5%)	DECON CHEMICAL
TURN-ROUND TIME:	1 DAY	1 DAY	1 DAY
FREQUENCY:	1/2 MONTH	1/2 MONTH	1/2 MONTH
CATEGORY:	C	C	C

1114: HVAC	1
EQUIPMENT:	EXHAUST STACK
DETERMINANT:	TEST FOR PARTICULATES
FLUID:	SOLIDS ON FILTER PAPER
TURN-ROUND TIME:	3-5 DAYS
FREQUENCY:	1/2 WEEK
CATEGORY:	B

1104: OFF-GAS	1	2	3	4	5	6	7	8	9
EQUIPMENT:	F-04-101 A/B	F-04-102 A/B	F-04-103 A/B	V-04-101 A/B	F-04-105 A/B	F-04-106	F-04-107 A/B	F-04-108	F-04-109 A/B
DETERMINANT:	DOP TEST FOR LEAKS	DOP TEST FOR LEAKS	DOP TEST FOR LEAKS	CHECK FOR HYDROCARBON	DOP TEST FOR LEAKS	DOP TEST FOR LEAKS	CHECK FOR HYDROCARBON	CHECK FOR HYDROCARBON	DOP TEST FOR LEAKS
FLUID:	VENT FROM ACTIVE TANKS	OFF-GAS FROM SIZE REDUCTION	OFF-GAS FROM POLYMER ENCAP.	OFF-GAS FROM POLYMER ENCAP.	OFF-GAS FROM INDOOR GROUT SILO'S	OFF-GAS FROM GROUT STABILIZATION	OFF-GAS FROM SPECIAL WASTE	OFF-GAS FROM SAMPLE MANI. HOODS	OFF-GAS FROM NON-ACTIVE TANKS
TURN-ROUND TIME:	DOP TEST IMMEDIATE	DOP TEST IMMEDIATE	DOP TEST IMMEDIATE	1-2 DAYS	DOP TEST IMMEDIATE	DOP TEST IMMEDIATE	DOP TEST IMMEDIATE (B) 1-2 DAYS	DOP TEST IMMEDIATE (B) 1-2 DAYS	DOP TEST IMMEDIATE
FREQUENCY:	AFTER FILTER INSTALL.	AFTER FILTER INSTALL.	AFTER FILTER INSTALL.	AFTER FILTER INSTALL. ONCE PER WEEK	AFTER FILTER INSTALL.	AFTER FILTER INSTALL.	AFTER FILTER INSTALL. (B) CARBON 2 WEEKS	AFTER FILTER INSTALL. (B) CARBON 2 WEEKS	AFTER FILTER INSTALL.
CATEGORY:	C	C	C	C	C	C	C	C	C

NOTES:

CATEGORY A = OFF-SITE ANALYSIS.
CATEGORY B = SMA ANALYSIS.
CATEGORY C = SOURCE ANALYSIS.

United Engineers & Constructors
A Raytheon Company
Western Operations

TRANSMITTAL # SD-W100-CDR-001

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
WESTINGHOUSE HANFORD COMPANY

	BY	DATE
DESIGNED	S MACKAY	05-11-92
DRAWN	C MOORE	05-12-92
CHECKED		
APPROVED		
Q.A.		
OTHER		
OTHER		
OTHER		

APPROVED FOR DETAILED DESIGN
BY
FOR
DATE

WRAP 2A CONCEPTUAL DESIGN
SAMPLE MANAGEMENT SHEDULE

SIZE	BLDG NO.	INDEX NO.	DRAWING NUMBER	REV
D	2337-W		Figure 1.10-1	A

SCALE: NONE | DISCIPLINE NO: 01- | SHEET 1 OF 1

REV NO	DESCRIPTION	REV BY/DATE	CHK BY/DATE	APPROVALS/DATE
A	PRELIMINARY			

REFERENCE DRAWINGS
REVISIONS
DRAWING TRACEABILITY LIST
NEXT USED ON:
CADFILE: WR2FIG11
CADCODE: 2C:IBM:ACD2:11:NN

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4. DOE Order 5440.1C

5. DOE Order 5480.1 and 5480.4

6. WHC-CM-4-9, "Radiological Design"

7. WHC-CM-4-10, "Radiation Protection"

8. WHC-CM-4-11, "ALARA Program Manual"

9. WHC-CM-7-5, "Environmental Compliance Manual"

1.9.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140600 (Sht. 1 and 2)	PFD - Vessel and Process Off-Gas System
H-2-140601	Vessel and Process Off-Gas - Equipment GA

1.10 Sample Management

1.10.1 Introduction

1. An environmentally controlled Sample Management Area (SMA) is provided in which a variety of operations will be undertaken involving the physical handling and tracking of radioactive, hazardous and MW samples.

2. Samples taken will permit five main criteria to be met:

a. Lot Verification: Radioactive solid wastes entering the facility will be sampled in order to verify chemical and radiological components. The analysis of these samples will be undertaken by existing Hanford Site laboratories external to WRAP 2A.

b. Recharacterization: Nonroutine samples taken for external analysis in the event of failure of lot verification.

c. Process Control: Samples will be taken routinely throughout the facility in order to ensure process control. These samples will also be used to accomplish the tracking of waste lots throughout the facility.

d. Certification: The treated waste will be sampled representatively to permit certification. This sample along with NDA results will confirm the suitability of the wastes for disposal.

e. Destructive Examination: A sample will be taken in order to undergo destructive examination to establish the integrity of the final wasteform.

f. Archive: A1 liter (min) sample of each treated waste form will be abstracted and retained from each lot. Retention will be for the life of the facility.

1.10.2 Throughput

1. In the sample management area the term 'throughput' is used to signify the flow of samples through the facility. A schedule of samples has been produced and is represented in schematic form by **Figure 1.10-1**.

2. The schedule contains the first level of data for all the main samples identified as arising from each of the process areas. Information gathered from this analysis will give a preliminary indication of:

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a. The total number of samples taken in each process.

b. The turn-round time for each sample.

c. The frequency of sample taking.

3. This preliminary analysis provides sufficient information to construct a logic by which the sample traffic through the SMA can be predicted. Three categories of sample are proposed. The following table explains the categories and gives the total of samples in each category.

	Category A	Category B	Category C
	Samples for transfer to external analytical facility	Samples for analysis within SMA	Samples for analysis local to process
No. off per day	14	6	26

4. The provisions for sample handling in the SMA are based on the above data.

1.10.3 Design Requirements

1. The SMA will not provide a complete laboratory service to support the process. All samples taken from the facility will be physically handled and administratively controlled through the SMA but only a limited capability to analyses samples will be provided within the SMA.

2. The majority of active samples taken from the facility will be transported from the SMA to Hanford Analytic Laboratories for analysis of radioactive and hazardous components. The scope of the analytical requirements being provided in the SMA is based on supporting those process samples which demand a quick turn round and may not be tested at source. Typically these will include simple analyses which may not easily be performed at source.

3. The Sample Management Area will be provided with the following capability:

a. Handling of all radiologically contaminated and non-contaminated samples required to support the WRAP 2A operation.

b. Administrative control of all analytical data to achieve process control, archiving and tracking requirements.

c. Limited local analytical capability to support those process samples requiring a short turn-round duration.

d. Repackaging and shipping of samples as required by transport needs to other testing facilities.

e. Archive storage of samples from each lot of final waste form for the facility life.

f. Bar code labelling of all samples.

4. The FDC for WRAP 2A (WHC-SD-N100-PDC-001) calls for 48 hours lag storage for verification sampling. However, in view of the proposed strategy for verification sampling and the real need to reduce costs where possible, it was considered prudent to minimize lag storage in this area. The current strategy for drum handling to and from the sampling area is to utilize W-112 to provide the lag storage and so avoid the need for the store in WRAP 2A.

1.10.4 Process Selection

1. The operational philosophy for the SMA is based on the requirements of the FDC, expanded by the specific needs of the WRAP 2A facility.

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2. A review of the sampling needs of the entire facility (**Figure 1.10-1**) revealed that the majority of samples will be inactive and will be required for quality or process control. Where possible, it is proposed that these samples are analyzed at source and only the results transmitted to the SMA.

3. All other samples will be active or hazardous and the majority of these will only enter the SMA in transit for external analysis. Four fume hoods are provided within the SMA: Two for the handling of active samples in transit, one for the handling of inactive samples in transit and one for the small scale analysis to be performed within the SMA. Additionally, a glovebox enclosure is provided for collecting samples from waste drums.

1.10.5 Process Description

1. Non-radioactive samples will be transported to the sample management area in standard sample containers. In some cases it may be possible to perform limited testing local to the sample source. This requirement will be determined by a need for quick turn-round time.

2. Radioactive samples taken out of Zone 1 areas will be transported to the SMA in shielded sample pigs. These will be collected in racks and be delivered by manual powered handcart or by AGV. Sample pigs received into the SMA will be marshalled according to their designation. The majority of radioactive samples will require full radionuclide inventories as well as detailed chemical analysis for hazardous components. These will be logged and bar-coded by the SMA before despatching to external laboratories.

3. It is anticipated that most samples received into the SMA which are in transit for external analysis will not require repackaging. After bar-coding they will leave the SMA without being removed from their container. When it becomes necessary to remove, sort and repackage samples for transit, this operation will take place in one of the four fume hood enclosures provided within the SMA. Repackaging of active waste for transit will be kept to a minimum. The bar code for all samples will be affixed in the SMA. Samples generated outside the SMA will be routed to the SMA for bar coding.

4. The main usage of the four sample fume hoods will be for simple analysis of active and nonactive samples (Category B). At present, one enclosure will be dedicated to 'in-house' analysis and three will be dedicated to 'in-transit' samples.

5. Samples taken from drums within the facility will invariably require sophisticated analysis off-site. The method of sample taking in each case may differ according to requirement but the following description is offered as typical of drum sampling.

6. Drum Sampling: Drum sampling involves either lot verification or core sampling and is shown on PFD H-2-140633, the former is described below.

a. A 55-gallon drum in W-112 is selected for lot verification and transferred through Shipping and Receiving using a FLT as described in Shipping and Receiving process description. The drum is moved through a series of conveyors and an air lock before being transferred onto Sampling Management Conveyor (CV-05-632). Further transfer is completed by an AGV, Conveyor (CV-05-630), and Lift Table (LT-05-640) to position the drum below the 55-gallon drum entry port on the Sample enclosure (GB-05-600).

b. The simple double lid port (DO-05-623) above the drum is opened and the drum raised partly into the enclosure using LT-05-640. Drum Hoist (CR-05-601) picks up the drum and deposits it on the drum band removal, de-lidding and sample extract station. Simple Double Lid (DO-05-623) is closed. Drum Clamp Band Saw (RT-05-611) cuts clamp band. Lid Lifter (RT-05-610) removes lid from drum to expose untreated waste material.

c. Sphincter Port (DO-05-620) is opened to allow porting in of a 1 liter bar coded sample container and then closed. A gloveported operation is used to de-lid the sample container and position it on the sample load station. Manipulator Assembly (EM-05-602) picks out

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material samples from the open drum and deposits them into the sample container until a volume of 1 liter is collected. The sample container is now re-lidded and the bar code label read through a window using the scanner located outside of containment. An empty bagless transfer container is fitted to the Bagless Transfer Port (DO-05-621) and port opened up for the filled sample container to be posted into the bagless transfer container. The port door is shut and the loaded bagless transfer container removed for transfer to the Hanford Site Laboratories.

d. An empty 83-gallon labeled overpack drum, previously used for the transfer of 55-gallon drums between the Box Breakdown area and the size reduction enclosure, is delivered by the AGV and transferred to the Simple Double Lid Port (DO-05-622) on Conveyors (CV-05-632) and (CV-05-631) and Lift Table (LT-05-641). The sampled drum is relidded within the enclosure using (RT-05-610) and the simple double lid is operated to delid the 83-gallon drum. Drum Hoist (CR-05-601) is used to load the 55-gallon drum into the 83-gallon overpack and the simple double lid is operated to replace the overpack lid. The overpacked 55-gallon drum is returned to W-112 to rejoin its lot, pending sample analysis results to confirm process selection.

7. Voids created in core sampled drums will be filled using an inert filler after the core has been removed.

8. A small area within the SMA is provided to store archive samples from all exiting lots.

1.10.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.0, 2.2.5.

2. DOE Order 6430.1A, "General Design Criteria", sections:

   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
   1161, Enclosures.
   1300-12, Human Factors Engineering.
   1324, Radioactive Solid Waste Facilities.

3. WHC-CM-4-11, "ALARA Protection Program".

4. WHC-CM-4-29, "Nuclear Criticality Safety Manual".

1.10.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140633	Drum Sampling PFD

1.11 NON-DESTRUCTIVE ASSAY

1.11.1 Introduction

1. The function of the Drum Non-Destructive Assay System (NDA) is to provide assay measurements of the drums in WRAP Module 2A facility in order to assign the correct low-level waste category and assist with certification. The principal document that dictates these requirements is WHC-EP-0063. The main impact of these requirements on WRAP Module 2A is the determination and certification of the LLW waste category (Category 1, 3 or > 3). In order to provide the required accuracy, the drums are assayed at a point as far downstream in the process as possible but prior to immobilization. The NDA capability will use information from the waste generator and/or laboratory results.

1.11.2 Feeds and Throughput

1. All waste being treated in the WRAP 2A facility will pass through NDA before being immobilized. The total daily capacity is 55 drums. Assuming 7 hours per day of effective operational time, this results in a rate of one every 7.6 minutes. Assuming a measurement time

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of 10 minutes for each PAN and GEA unit, a need for two trains of PAN and GEA equipment is determined.

1.11.3 Design Requirements

1. The NDA facility will provide the following capabilities:

   a. To determine the radionuclide inventory and assign the low-level waste category for all drums.

   b. To measure the key gamma and neutron emitters and calculate the total radionuclide inventory to assist with certification of existing waste drums.

   c. To interact with analytical data for any excess water removed or added to waste drums in order to adjust final waste category, if necessary.

   d. To assay 55-gallon drums weighing up to 1,000 lbs.

   e. Drums arriving at the NDA facility will all be pre-weighed.

1.11.4 Process Selection

1. The category of process selection does not apply to the NDA facility. Instead, aspects of its design criteria are presented.

1.11.4.1 Waste Form Criteria

1. The drum weight will be up to 1,000 lbs

2. The TRU content will be up to 100 nCi/g

3. The drum exposure will be up to 200 mR/hr

4. The containment will be new 55-gallon drums in accordance with ANSI DOT 17H.

1.11.4.2 Accuracy Requirements

1. The total measurement uncertainty for fissile content shall be that which can guarantee the drum category classification. In the case of LLW categorization, this figure is 10 nCi/g. Therefore, in order not to over classify too many drums into the wrong category, the maximum total uncertainty shall be limited to: +/- 3 nCi/g at 10 nCi/g concentrations with a corresponding limit of detection of 1 nCi/g.

2. The limit of detection target for key gamma emitter measurement (of nuclides such as Cs-137 and Co-60) needs to be sufficient to enable LLW categorization to be carried out based on the most pessimistic characterization isotopic ratio.

3. The requirement for accuracy dictates that the NDA of immobilized drums will not be acceptable. For this reason NDA is now provided for drums awaiting immobilization.

1.11.4.3 Operator Interface

1. The objective of the plant is to minimize direct interfaces between the operator and NDA equipment for normal measurement and verification requirements. For example, inputs required by the NDA equipment such as drum type, drum contents and characterization data will be entered by a data link interface. Outputs from the NDA equipment shall be transferred by data link to the Plant Management System. Abnormal activities, such as diagnostic searches, system reconfiguration and general maintenance, will be carried out using a local console supplied as part of the NDA system.

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1.11.5 Process Description

1.11.5.1 Summary of Process Operations

1. Drums arising in the lag storage area from the process area will be registered in the PMS as "Drums Requiring Assay".

2. A control room operator will select a pick list of drums which require assaying. This information will then be entered into the PMS which will establish the "next drum to be sent to NDA". The PMS will then determine PAN availability and direct the AGV to the transfer conveyor of the appropriate PAN unit (ND-09-201,202).

3. Once this drum is in position on the transfer conveyor, the Plant Control System (PCS) will interface with the PAN unit as necessary to get the drum in position inside the PAN unit. If the PAN or GEA system requires more information prior to commencement of data acquisition (counting) or data processing, the control room operator will be prompted for this information, otherwise PAN operations will start.

4. On completion of PAN operations the drum will be automatically transferred to the next available GEA station (ND-09-203,204).

5. On completion of GEA operations, the data gathered from both the PAN and the GEA systems will be combined with characterization information transmitted from the Data Management System (DMS), to obtain full certification data. This operation will take place in the NDA System Integration Equipment (ND-09-205).

6. On completion of nuclide concentration evaluation, the NDA System Integration Equipment will provide this information to the DMS which will then convert the data into the appropriate format for reports and will determine the drum LLW category.

7. The drums will then be sent to lag store, grout or polymer treatment as appropriate by the AGV.

1.11.5.2 Summary of operation of PAN units ND-09-201,202

1. The PAN units combine active and passive neutron counting techniques to measure induced and spontaneously fissile nuclide concentrations respectively. The active portion of the device utilizes a neutron generator to provide short bursts of thermal neutrons to interrogate the waste. The passive portion of the system uses neutron detectors in combination with coincidence counters to calculate the quantity of spontaneously fissioning nuclides such as Pu-240. Whereas the active portion can determine total fissile content, the passive portion will produce a "Pu-240 equivalent" value which can then be combined with the Pu isotopic ratio given by the GEA to give a total Pu content.

1.11.5.3 Summary of Operation of GEA Units ND-09-203,204

1. The Gamma Energy Assay system will be used to obtain isotopic information about the drums. The GEA system can be used to determine absolute concentrations of strong radionuclide gamma emitters, such as Cs-137 and Co-60, and can determine radionuclide concentration ratios of weaker gamma emitters, such as Pu-239, Pu-241, Am-241 and other fission and activation products. Assays are performed in segments along a waste container's vertical axis. By using a transmission source, density corrections can be made.

1.11.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Section 2.2.

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2. DOE Order 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement
   0110-13, Physical Protection
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities
   1300, Special Facilities, General Requirements
   1324, Radioactive Solid Waste Facilities
   1400, Conveying Systems

   DOE Order 5400.3, Hazardous and Mixed Waste Program
   DOE Order 5820.2A, Radioactive Waste Management

1.11.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140673	PFD Non-Destructive Assay

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1.12 MATERIAL HANDLING

1.12.1 Introduction

1. The material handling system services the drum size reduction area, special waste processing area, grout area, polymer area, NDA, drum sampling area, the airlock between the shipping and receiving area and the lag storage area. The automated system is controlled by a central computer. Two Automatic Guided Vehicles (AGVs) are provided for these areas. Each AGV has a dual rollerdeck that can accept up to two waste drums at a time for transfer purposes. An automated storage/retrieval system is utilized in the lag storage area to minimize space requirements and improve the transfer efficiency.

1.12.2 Feeds and Throughput

1. The material handling system transfers 9,515 new drums annually to the size reduction area and special waste area for waste load out which are then transferred to lag storage. The NDA area receives 9,515 drums annually from lag storage which is then transferred to either the polymer or grout area. The number of drums transferred annually to the polymer area and grout area is 6,429 and 3,086 respectively. The shipping and receiving area receives 9,515 drums annually through the airlock from the processing area for shipment preparation.

1.12.3 Design Requirements

1. The material handling equipment must be able to manage the material flow without creating a bottleneck between the process areas. The estimated material throughput of the facility is 5,259 waste drums received and 9,515 waste drums processed annually. The system must handle 9,515 new 55-gallon drums annually.

2. The material handling system is to incorporate an automated design for transferring drums from one area to another in order to comply with ALARA requirements and achieve the facility throughput requirements.

3. The material handling equipment shall ensure the safe transportation of waste drums in the process areas.

4. The equipment must be selected to be able to handle the weight requirements of 3,000 pounds for drums.

5. Lag storage is to be provided within the process area to accumulate drums for treating and to allow for temporary disruptions in the material flow.

1.12.4 Process Selection

1. The equipment and process selected for the material handling area were based on the design and engineering studies from WRAP Module 1.

1.12.5 Process Description

1.12.5.1 Drum Size Reduction and Special Waste Areas

1. The material handling system for this area consists of one AGV (GV-08-101), new Drum Transfer Conveyors (CV-08-501 and CV-08-502) and lift tables from the size reduction and special waste areas. The material handling system for drums is automated and the AGV and the conveyors are controlled by a central computer.

2. The Automatic Guided Vehicle (AGV) brings a new drum from the shipping and receiving airlock to the size reduction area. As waste is processed through the size reduction area into the weigh hoppers, the AGV is requested by the central computer to pick up a new drum from the Airlock Conveyor (CV-08-502). The AGV transfers the new drum to either the repack and shred Lift Table (LT-05-523) or the pug mill Lift Table (LT-05-543) for waste load out. Once the drum is filled with waste, the lift table transfers the drum back to the AGV which takes the drum to the lag storage area.

3. The material handling of the special waste area is similar to the size reduction area. As the special waste processing approaches completion, the AGV (GV-08-101) brings a new drum from the shipping and receiving airlock to the special Waste Exit Conveyor (CV-06-302) or the Lift Table (LT-06-302) for the reactive metals enclosure. Once the new drum is filled with waste at the special waste or reactive metal enclosure, the conveyor or lift table transfers the drum to the AGV which takes the drum to the lag storage area.

1.12.5.2 Lag Storage Area

1. The storage/retrieval system includes a AS/RS stacker crane, storage racks, inventory control system and transfer conveyors. The storage racks are configured in two rows with 13 bays stacked 7 high for a storage capacity of 182 drums. The storage/retrieval system records drum information and tracks the location of each drum by utilizing its inventory control system.

2. Drums from the size reduction and special waste areas are transferred by the AGV (GV-08-101) to the Drum AS/RS Infeed Conveyor (CV-08-301). The drum is conveyed to the discharge end and pushed onto a slave pallet positioned on the storage/retrieval conveyor by a drum pusher. At this point, the bar code label on the drum is read and entered into the DMS. The conveyor transfers the drum to the Drum Storage/Retrieval System (CR-08-101) which picks up the drum and places into one of the 182 individual drum slots.

3. When drums are requested for treatment by the central computer, the AS/RS stacker crane retrieves the preselected drum and places the drum on its storage/retrieval discharge conveyor. The drum is transferred to its discharge end and pushed off the slave pallet by a drum pusher onto the Drum AS/RS Discharge Conveyor (CV-08-302). The drum is transferred to the discharge end and when the presence of the AGV (GV-08-102) is noted, a handshake will occur and the drum will be conveyed onto the AGV.

4. The drum storage/retrieval system utilizes slave pallets for the stacking of drums in the storage racks. The slave pallets remain within the lag storage area. At stated previously, a drum is pushed onto the pallet by a drum pusher before it is stored and the drum is pushed off the pallet before it is transferred to the discharge conveyor for AGV pickup. The slave pallets are transferred from the discharge conveyor to the infeed conveyor by a Slave Pallet Transfer Conveyor (CV-08-303) which includes two chain transfer devices for the transfer between the conveyors.

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5. The lag storage area will provide segregated area to allow lots to be stored separately and facilitate the compaigning of wastes to be treated and also treated wastes to be shipped back to W-112.

1.12.5.3 NDA

1. The material handling system for drums in this area consists of one AGV (GV-08-102) and transfer conveyors at each NDA station (CV-08-101, CV-08-102, CV-08-103, and CV-08-104). The AGV brings a drum from the lag storage area to the first available PAN station. At the station the AGV stops at the transfer conveyor and AGV signals the transfer conveyor of its presence. Once the interface is established, if a drum is finished in the station, the transfer conveyor transfers the drum to the AGV. The AGV moves one position so that it can begin transferring the first drum to the transfer conveyor which transfers the drum into the station. The AGV takes the newly loaded drum to the GEA station.

2. After the drums have been assayed by PAN and GEA, the AGV will transfer the drums either to the grout enclosure or polymer encapsulation enclosure. If the treating enclosures can not accept a drum the AGV will transfer the drum back to the lag storage area.

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1.12.5.4 Agitated and Vibro Grout Enclosure

1. The material handling system for drums in this area consists of one AGV (GV-08-102). Waste drums to be grouted are picked up by the treatment area AGV (GV-08-102) at a GEA Transfer Conveyor (CV-08-103 or CV-08-104) and delivers the drum to the Agitated or Vibro Grout Infeed Conveyor (CV-05-212B or CV-05-212A). The AGV transfers the drum to the appropriate conveyor and proceeds onto its next requested destination.

2. After the completion of the grouting process, the Grout Discharge Conveyor (CV-05-227) transfers the drum to the AGV. The AGV transports the waste to the shipping and receiving Airlock Transfer Conveyors (CV-08-503 and CV-08-504), which convey the waste drum through the airlock into the shipping and receiving area.

1.12.5.5 Polymer Encapsulation Enclosure

1. The material handling system for drums in this area consists of one AGV (GV-08-102). Waste drums requiring polymer encapsulation are picked up by the treatment area AGV (GV-08-102) at a GEA Transfer Conveyor (CV-08-103 or CV-08-104) and delivers the drum to polymer enclosure. The AGV transfers the drum onto one of the four Filling Station Lift Tables (LT-05-401, LT-05-402, LT-05-403 or LT-05-404). The AGV transfers the drum to the appropriate lift table and proceeds onto its next requested destination.

2. After the completion of the polymer process, the lift table transfers the drum to the AGV. The AGV transports the waste to the shipping and receiving Airlock Transfer Conveyors (CV-08-503 and CV-08-504), which convey the waste drum through the airlock into the polymer cure storage area.

1.12.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.0, 3.8, 5.0, 7.0

DOE Orders

2. DOE Order 6430.1A, General Design Criteria, sections:

   0110-9, Operation, Maintenance, Repair, and Replacement
   0110-13, Physical Protection
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities

1300, Special Facilities, General Requirements
1324, Radioactive Solid Waste Facilities
1400, Conveying Systems

DOE Order 5400.3, Hazardous and Mixed Waste Program
DOE Order 5820.2A, Radioactive Waste Management

WHC Manuals

3. Hanford Plant Standards Design Criteria:

WHC-CM-6-4 Housing and Rigging Manual
WHC-CM-4-10 Radiation Protection

1.12.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140665	Material Handling Block Flow Diagram
H-2-140666	Material Handling Equipment General Arrangement
H-2-140667	Automated Storage Retrieval Equipment General Arrangement

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1.13 Aqueous Solution Make-Up/Bulk Chemical Make-Up

1.13.1 Introduction

1. The aqueous solution make-up area is utilized for receipt, storage, mixing and delivery of aqueous reagents used for pH adjustment and decontamination. Segregated storage space with leak detection and spill collection capabilities are provided for incompatible chemicals. Concentrated reagents are diluted in a chemical feed tank and pumped to users on demand.

1.13.2 Feeds and Throughput

1. The aqueous solution make-up area, being an utility area, does not directly process any of the incoming wastes.

2. The aqueous solution make-up systems will be utilized throughout the entire life of the WRAP 2A facility.

1.13.3 Design Requirements

1. Storage in bulk, drums, and pallets of raw chemicals will be provided for two weeks of operation.

2. Bulk storage tanks shall be ventilated to operate under vacuum relative to ambient room pressure.

3. Segregated storage space shall be provided for incompatible solid and liquid reagents (e.g., acid and alkaline chemicals).

4. Floor space and services to permit the installation of one additional make-up/feed train shall be provided.

5. The make-up/feed systems shall be targeted to be sized to require chemical make-up once per week, however several times per week is acceptable if economically justified.

6. Instrumentation for local and remote detection and alarms for liquid level, leaks, temperature and pressure shall be provided as required.

7. Appropriate sample ports shall be provided on the make-up/feed systems.

8. The make-up/feed systems shall be ventilated to operate under a vacuum relative to ambient room pressure.

9. Mixing capability shall be provided on all make-up/feed systems tanks.

10. Spill collection shall be provided for all reagents.

1.13.4 Process Selection

1. Aqueous solution make-up systems are provided in accordance with the FDC and the process requirements of the secondary waste treatment area, the decontamination area, and the special waste area.

1.13.5 Process Description

1. The process scheme for the Aqueous Solution Makeup area is shown on the attached Process Flow Diagram H-2-140687.

1.13.5.1 Acid Feed System

1. Dilute sulfuric acid is prepared in the Aqueous Solution Makeup area for use in the Secondary Waste Treatment area. Sulfuric acid is made up in 1 percent to 5 percent solutions by weight by filling the Acid Feed Tank (T-12-101) with process water to a predetermined level. A level controller automatically shuts off the process water supply to the acid feed tank upon high level indication to prevent overfilling the tank. Then the appropriate amount of concentrated sulfuric acid (93 percent acid by weight) is pumped from a 55-gallon drum using the Acid Drum Pump (P-12-101) to the Acid Feed Pot (T-12-104). The concentrated sulfuric acid is then slowly drained into the acid feed tank while the Acid Tank Mixer (M-12-101) blends the two miscible liquids into a homogenous mixture. The dilute sulfuric acid is pumped on demand to the Secondary Waste Treatment area by the Acid Metering Pump (P-12-102). The flow rate of the pump is controlled from a pH control signal received from the Secondary Waste Treatment area. A sample connection is provided on the acid feed tank to draw a sample of dilute acid for verification of acid strength. Off-gas from the acid feed tank is directed to the Off-gas Treatment system. The acid feed tank may periodically be flushed between make-up cycles with all generated wastes being directed to the Nonactive Waste Drain Header. The acid feed tank has a 75 gallon capacity. In the event that dilute acid can be directly purchased from a chemical supplier, the acid feed tank has the capacity to hold the entire contents of a 55-gallon drum.

1.13.5.2 Caustic Feed System

1. Dilute sodium hydroxide is prepared in the Aqueous Solution Make-up area for use in the Secondary Waste Treatment area and the Special Waste Treatment area. Sodium hydroxide is made up in 1 percent to 5 percent solutions by weight by filling the Caustic Feed Tank (T-12-102) with process water to a predetermined level. A level controller automatically shuts off the process water supply to the caustic feed tank upon a high level indication to prevent overfilling of the tank. Then the appropriate amount of concentrated sodium hydroxide (50 percent by weight) is pumped from a 55-gallon drum using the Caustic Drum Pump (P-12-103) to the Caustic Feed Pot (T-12-105). The concentrated sodium hydroxide is then slowly drained into the caustic feed tank while the Caustic Tank Mixer (M-12-102) blends the two miscible liquids into a homogenous mixture. The dilute sodium hydroxide is pumped on demand to the Secondary Waste Treatment area by the Secondary Waste Treatment Caustic Pump (P-12-104). The flow rate of the pump is controlled from a pH control signal received from the Secondary Waste Treatment area. Likewise, dilute sodium hydroxide is also pumped on demand to the chemical scrubber located in the Special Waste Treatment area by the Chemical Scrubber Feed Pump (P-12-105). The flow rate of the pump is controlled from a pH control signal received from the chemical scrubber. A sample connection is provided on the caustic feed tank to draw a sample of dilute caustic for verification of caustic strength. Off-gas from the caustic feed tank is directed to the off-gas treatment system. The caustic feed tank may periodically be flushed

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between make-up cycles with all generated wastes being directed to the nonactive waste drain header. The caustic feed Tank has a 75 gallon capacity. In the event that dilute caustic can be directly purchased from a chemical supplier, the acid feed tank has the capacity to hold the entire contents of a 55-gallon drum.

1.13.5.3 Decontamination Solution System

1. A generic chemical feed system is provided for make-up of decontamination solutions to allow flexibility in feeding a variety of chemicals. Under normal operating conditions, concentrated decontamination solutions, such as surfactants, are received in 55-gallon drums from the chemical supplier. The decontamination solution is pumped from a 55-gallon drum using the Decon Solution Drum Pump (P-12-106) to the Decon Solution Feed Tank (T-12-103). The decontamination solution is pumped by the Decon Solution Metering Pump (P-12-107) on demand to an inline mixing tee located downstream of the discharge of the deconwater booster pump. The flow rate of the pump is controlled in proportion to the decontamination fluid flow rate from a flow control signal received from the decontamination area. In addition, the capability of using dilute decontamination solutions is provided. To make-up a dilute decontamination solution, the Decon Solution Feed Tank (T-12-103) is filled with process water to a predetermined level. A level controller automatically shuts off the process water supply to the Decon Feed Tank upon high level indication to prevent overfilling the tank. Then the appropriate amount of concentrated decontamination solution is pumped from a 55-gallon drum using the Decon Solution Drum Pump (P-12-106) to the Decon Solution Feed Pot (T-12-106). The concentrated decontamination solution is then slowly drained into the Decon Solution Feed Tank while the Decon Solution Tank Mixer (M-12-103) blends the two miscible liquids into a homogenous mixture. A sample connection is provided to draw a sample of decontamination solution. Off-gas from the Decon Solution Feed Tank is directed to the Off-gas Treatment system. The decon solution feed tank may periodically be flushed between make-up cycles with all generated wastes being directed to the nonactive waste drain header. The Decon Solution Feed Tank has a 150 gallon capacity to hold the entire contents of two 55-gallon drums. This tank is for concentrated decon solution and will be mixed with water to provide the required decon volume.

1.13.5.4 Chemical Bulk Storage

1. Segregated bulk storage areas are provided for acids, caustics, oxidizers and organics. Each storage area is sized to accommodate storage of two weeks of required chemicals.

1.13.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Section 2.2.

2. DOE Order 6430.1A, "General Design Criteria".

   0110-9, Operation, Maintenance, Repair, and Replacement.
   0110-99.0, Special Facilities, Nonreactor Nuclear Facilities.
   1660, Special Systems.

1.13.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140688	Aqueous Make-Up Area Equipment General Arrangement.
H-2-140687	PFD - Aqueous Solution Make-Up.

1.14 References

1. Task V Follow-On Activities Report (UDL0012.004) Issued to WHC 7 February 1992.

2. UE&C Trip Report TR92001.006, March 4, 1992. Saginaw Valley College, "Treatability Screening Tests for WRAP 2A problem wastes".

3. WHC Trip Report, March 4, 1992. Diversified Technologies, Saginaw, MI.

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4. Functional Design Criteria for WRAP 2A, Project W-100 WHC-SD-W100-FDC-001 Rev. 1 January 1992.

5. Conference Notes from "Over-the-Shoulder" Review CN92006.006, 15/16 April 1992.

6. Electrical Power Research Institute (EPRI). "Plant Decontamination Methods Review" NP-1168, TPS 78-816, Final Report May 1981.

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2.0 UTILITY SYSTEMS DESCRIPTION

2.1 Electrical

2.1.1 Introduction

1. The electrical system for WRAP 2A will be integrated into the Hanford system. High voltage at 13.8 KV is brought onto the WRAP 2A site by overhead distribution system by WHC Facilities. WRAP 2A interface starts at disconnects located on the overhead system. High voltage cable is then brought underground to three 3,000 KVA transformers. Secondary power distribution from these transformers shall provide voltages at levels to support HVAC, process function and emergency equipment.

2.1.2 Feeds and Throughput

1. Not used.

2.1.3 Design Requirements

1. The electrical system for the WRAP 2A Facility shall be designed in accordance with the Functional Design Criteria, Revision 1 and the Supplemental Design Basis Document.

2. The major equipment loads for the facility that form the basis for the electrical power requirements are listed in 2.1.6.

3. Electrical design will be based on a nonhazardous National Electrical Code (NEC) classification. Electrical equipment located in the process area will be NEMA 4.

4. All electrical equipment will be rated for operation at an elevation of 715 feet above sea level. Seismic disturbances will be provided for in the design of all electrical equipment (seismic Zone 2B) and its installation to ensure safety during seismic (earthquake) disturbances. Electrical equipment will not contain Polychlorinated Biphenyl (PCB). Special considerations will be applied to electrical devices and wiring subjected to radiation environments.

5. The estimated maximum electrical demand for the facility is 6,150 KVA. The load factor with three 3,000 KVA transformers is approximately 68 percent.

2.1.3.1 Primary Service

1. Three-phase primary service will be brought to the site from an existing 13.8KV overhead line installed in the WRAP Module project by WHC Facilities group. A new overhead line will be added west approximately 300 feet (2 spans) to two terminal poles on the north side of 23rd Street.

2. One 13.8 KV service will be extended under 23rd Street to three 3,000 KVA oil-filled transformers on the north-east corner of the building. All transformers are to be loop fed from the one service.

3. Three transformers and services were chosen for the following reasons:

   a. Reduce the size of the service and accompanying fault current that would result from a single service.

   b. Provide a measure of redundancy for the HVAC system, and other loads. The HVAC system for Module 2A is considerably larger than Module 1 due to the increase in building volume and a requirement for six air changes per hour.

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4. It should be noted that this is not a fully redundant system. That is, the transformers are not sized so that one transformer alone can supply the entire building.

2.1.3.2 Building Service

1. The primary power is transformed to three-phase 480/277 volt solidly grounded wye at each transformer and enters the building via three overhead, 4,000 amp bus ducts. The bus ducts terminate at a line up of low voltage switchgear in the electrical room.

2. The low voltage switchgear is arranged in a split bus configuration with a nonautomatic tie breakers. This allows paralleling the loads in the event a transformer or preceding feeder is lost, but prevents automatic paralleling of loads without first shedding loads to prevent overloading a transformer.

3. Metering will be provided on each incoming feeder, and will include three-phase volts, amps and watthours. In addition, each feeder will send a loss of power signal to the control room for power loss/recovery procedures.

4. No spare breakers will be provided.

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2.1.3.3 Alternate Power

1. Alternate power in the form of emergency or standby engine generators will not be provided. However, see Portable Power Connection, Paragraph 2.1.3.6, this section.

2.1.3.4 Distribution

1. Utilization Voltages: Two voltage systems will be established in the plant. They include a 480Y/277 Volt, three phase; and 208Y/120 Volt, three phase, and 120 single phase.

2. Electrical loads will be assigned as follows:

- Motors and loads larger than 1/2 HP-480V, three phase
- Motors 1/2 HP and less-120V, single phase
- Lighting-277V, single phase

3. 480V Motor Control Centers are provided on the following basis:

   a. Power will be distributed throughout the plant by eight Motor Control Centers (MCC).

   b. Nonmotor 480V loads will be served by 480V panelboards located near the loads they serve.

4. Lighting: All lighting will be served by a 480Y/277V panelboard in the electrical room.

5. Miscellaneous Power: Power for miscellaneous loads and receptacles will be derived from 480-208Y/120V dry type transformers and panelboards located in the Electrical Room, or near the load they serve.

6. Conductors and Raceways:

   a. All conductors will be copper.

   b. Power, controls and instrumentation will be distributed via conduit in the administrative utility and nonprocess areas, and wireways with conduit dropouts in the process areas.

c. The process areas will use two separate wireway systems, one for power, and one for instrumentation and control.

d. Intermediate Metal Conduit (IMC) will be used in lieu of rigid metal conduit; electrical metal tubing will be used indoors where not subject to damage; and concrete encased heavy duty PVC will be used for outdoor underground ducts.

2.1.3.5 Uninterruptible Power Supply (UPS)

1. A solid state UPS with static transfer switch and 55-minute gel cell sealed batteries will be provided. Batteries shall be located in a cabinet attached to the UPS electronics and provided as a single shipping unit.

2. The UPS will support the following loads:

- Data Management System
- Operator Consoles (3)
- Distributed Control Cabinets
- Criticality Alarms
- Radiation Monitors
- Stack Monitor Systems
- Emergency Evacuation Systems
- Closed Circuit Television (CCTV) System

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2.1.3.6 Portable Power Connection

1. Portable engine generators up to 45 KW are available at Hanford, usually within one hour. In order to take advantage of this, a plug-in receptacle will be provided. The receptacle will be located outside, on the northeast wall near the electrical room.

2. It will be connected by manual transfer switch to panelboard TBD. It will provide power for the UPS system, control and computer room lights and egress lighting.

2.1.3.7 Lighting

1. Lighting levels will be per Hanford Standard SDC 7.5 as follows:

- Work Stations 50 footcandles
- Work Areas 30 footcandles
- Nonwork Areas 10 footcandles

2. Interior Lighting: In low ceiling areas, fixtures will be recessed or pendant, 277V fluorescent with local switching. In high bay areas, such as Shipping and Receiving, NDA, and Process, fixtures will be 277V high pressure sodium with local switching.

3. Exterior Lighting: The exterior of the building will be illuminated by a 175 watt, 277V low pressure sodium wallpack over each door. Area lighting will be provided for the parking lot and truck driveway/loading area.

4. Emergency and Exit Lighting: Emergency egress and exit lighting will be provided per the NFPA 101 Life Safety Code. Selected fluorescent fixtures will contain battery type ballasts. Nonfluorescent areas will have battery operated, recharging wall pack units. Exit lights will be electric with battery backup and automatic recharge.

5. Glovebox Lighting: Glovebox Lighting will be located primarily on the outside roof of the glovebox. The glovebox will have windows that the light fixtures will sit on. The type of fixtures will be determined during detail design.

2.1.3.8 Grounding

1. A grounding grid will be established for the building per NFPA 70 and IEEE 142. A separate ground wire will be provided for each power raceway. Raceways will not be used as ground paths. A single point ground system will be provided for instrument and control signal grounds. The overall grounding scheme is shown in **Figure 1**.

2.1.3.9 Lightning Protection

1. Lightning protection will be provided for the building. Protection will be designed per NFPA 78. Downcomers will be protected and will connect to the main ground grid.

2.1.3.10 Cathodic Protection

1. The need for cathodic protection of underground water piping will be studied during title design. Due to the high soil resistivity, the anticipated corrosion activity is mild, and an impressed current system will provide the best protection if required based on study.

2.1.3.11 Communications

1. Communications will be provided based on criteria indicated in the FDC. Capabilities and interface requirements for systems specified are indicated as "TBD". Additional information is needed for specifics of title design to complete project requirements.

2. The local operating telephone contractor will install their facilities to a demarcation point within the facility's main telecommunications terminal room. The WRAP Module 2A project will provide for all telecommunications facilities from this demarcation line.

3. The implementation of an integrated Voice and Data Telecommunications System (IVDTS) will transfer control of the telephone terminations to the Hanford site. Auxiliary telephone terminals will be provided by private automatic exchanges and private branch exchanges. All alarm systems in building will integrate into this system.

4. Telephone System: Conduit, cable, junction boxes, wiring for TBD telephone outlets, type RJ-11 or RJ-45 and TBD LAN outlets will be provided. No end instruments are required.

5. PA System: Approximately seven speakers for low noise areas, nine for high noise areas, and PA system electronics. Conduit, wire, and junction boxes are included. Separate conduit system for 70V power and audio signals will be provided.

6. Emergency Evacuation System: Conduit, cable, junction boxes for sixteen speakers will be provided. A sound generator amplifier is provided. Interface requirements to site system are TBD and will be addressed in the title design. Telephone and LAN interfaces for work stations or office areas will be via power poles with appropriate telephone/LAN jacks as required. Interfaces with the CASS system and Hanford Fire Department need further definition and will be included as title design proceeds.

2.1.3.12 Spares

1. Transformers, motor control centers and panelboards will have 25 percent spare capacity.

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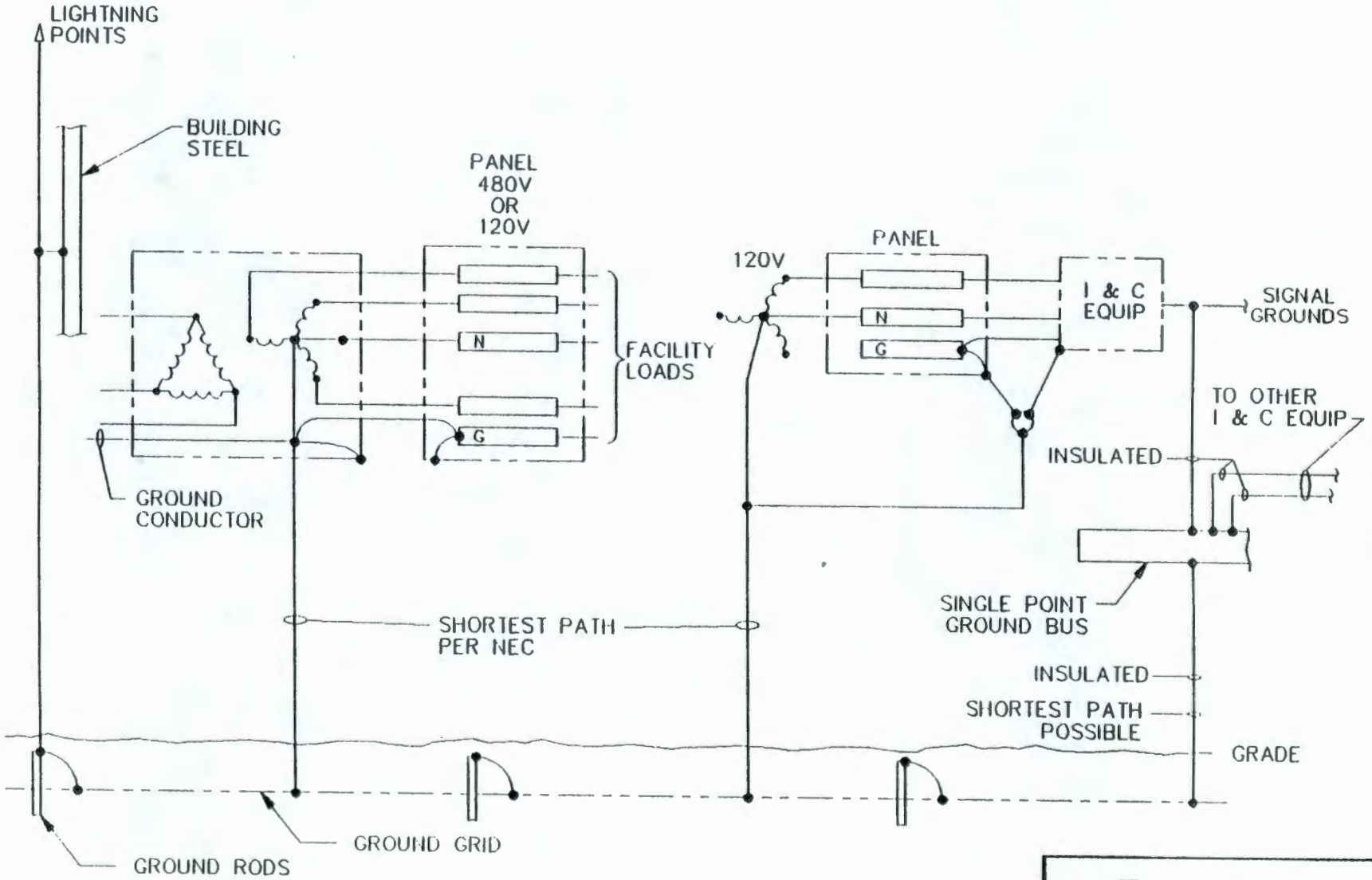

FIGURE 1
WRAP 2A GROUNDING

2. Motor control centers and panelboards will have a minimum of 10 percent spare compartments and breaker positions (spare only).

3. In addition, space is provided at each end of the main low voltage switchgear, and at least one end of each motor control center for the addition of future sections.

4. Underground concrete encased duct banks will be provided with one spare conduit. Per the NEC, all conduit fill will be sized to 40 percent of the conduit cross section. Trays and wire ways will be sized for 100 percent spare capacity.

2.1.3.13 Major Electrical Equipment

1. The major electrical equipment for the facility consists of three 3,000 KVA transformers, ten motor control centers, and a single non-redundant 50 KVA UPS system.

2.1.4 Key DOE/WHC Criteria

- DOE Order 6430.1A General Design Criteria
- Hanford Plant Standard Design Criteria, 5/10/82
- American National Standards Institute (ANS)
- Factory Mutual (FM) Approval Guide
- Institute of Electrical and Electronic Engineers (EEE)
- Illuminating Engineering Society (IES) Handbook
- National Association of Corrosion Engineers (NACE) RP-01-69
- National Fire Protection Association (NFPA) RP-01-69
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code, ANSI C2
- Underwriters Laboratories (UL)

2.1.5 Reference Drawings

Drawing Number	Drawing Title
H-2-140698	MASTER ONE-LINE DIAGRAM
H-2-140699	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREA 04 and 05
H-2-140700	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREAS 06, 07, 08 and 09
H-2-140701	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREAS 13 and 14
H-2-140702	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREA 14
H-2-140703	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREA 14
H-2-140704	MOTOR CONTROL CENTER ONE-LINE DIAGRAM AREA 05

2.1.6 Electrical Load List

1. The WRAP 2A load is 7,397 amperes or 6,150 KVA. Transformer size should be a minimum of 25 percent oversized for future growth or 6,150 x 1.25% = 7,687 KVA. Utilizing three 3,000 KVA transformers there will be 15 percent reserve capacity. Following is a detailed electrical load listing for the WRAP 2A facility.

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
MCC-14-101						
Supply Fan SF-14-101 A	50 HP		65 A	65 A		HVAC Load
Air Handling Unit AH-14-101A	310 KW 170 KW 200 KW		373A 205A 241A	373A 205A 241A		HVAC Load
Chiller CH-14-101A	175 HP 3 KW		240A 4A		240A 4A	HVAC Load
Chiller CH-14-101B	175 HP 3 KW		240A 4A		240A 4A	HVAC Load
MCC Total				884A	488A	
MCC-14-102						
Supply Fan SF-14-101B	50 HP		65A	65A		HVAC Load
Air Handling Unit AH-14-101B	310 KW 170 KW 200 KW		373A 205A 241A	373A 205A 241A		HVAC Load
Glycol Pump P-14-101A	50 HP		65A	65A		HVAC Load
Glycol Pump P-14-101B		50 HP	65A			HVAC Load
Glycol Pump P-14-102A	15 HP		21A	21A		HVAC Load
Glycol Pump P-14-102B		15 HP	21A			HVAC Load
MCC Total				970A		
MCC-14-103						
Supply Fan SF-14-101C	50 HP		65A	65A		HVAC Load
Air Handling Unit AH-14-101C	310 KW 170 KW 200 KW		373A 205A 241A	373A 205A 241A		HVAC Load
MCC Total				884A		
MCC-14-104						
Air Handling Unit AH-14-401	200 KW 66 KW 30 HP 5 HP		241A 79.4A 40A 7.6A	241A 79.4A 40A 7.6A		HVAC Load
Air Handling Unit AH-14-601	160 KW 30 HP		193A 27A	193A 27A		HVAC Load
Exhaust Fan EF-14-601A	2 HP		3.4A	3.4A		HVAC Load
Exhaust Fan EF-14-601B	2 HP		3.4A	3.4A		HVAC Load
AC-14-501A	15 KW 5 KW 5 HP		18A 6A 7.6A	18A 6A 7.6A		HVAC Load
AC-14-501B		15 KW 5 KW 5 HP	18A 6A 7.6A			HVAC Load
Air Handling Unit AH-14-201	150 KW 7 1/2 HP 5 HP 1 HP		180.6A 11A 7.6A 1.8A	180.6A 11A 7.6A 1.8A		HVAC Load
Air Handling Unit AH-14-301	100 KW 20 KW 20 HP		120.4A 24A 27A	120.4A 24A 27A		HVAC Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Return Fan RF-14-301	3 HP		4.8A	4.8A		HVAC Load
MCC Total				1003A		
MCC-14-105						
SF-14-101D	50 HP		65A	65A		HVAC Load
AH-14-101D	310 KW 170 KW 200 KW		373A 205A 241A	373A 205A 241A		HVAC Load
MCC Total				884A		
MCC-14-106						
Exhaust Fan EF-14-101A	75 HP		96A	96A		HVAC Load
Exhaust Fan EF-14-101B	75 HP		96A	96A		HVAC Load
Exhaust Fan EF-14-101C	75 HP		96A	96A		HVAC Load
Exhaust Fan EF-14-101D	75 HP		96A	96A		HVAC Load
Power Panel PP-14-101	112 KVA		135	101		HVAC Load
Exhaust Fan EF-14-104A	50 HP		65A	65A		HVAC Load
Exhaust Fan EF-14-104B		50 HP	65A			HVAC Load
Lighting Panel LP-14-101	225 KVA		217A	162A		
Exhaust Fan EF-14-103A	30 HP		40A	40A		HVAC Load
Exhaust Fan EF-14-103B		30 HP	40A			HVAC Load
Cooling Tower CT-14-101	25 HP 15 KW 25 HP		34A 18A 34A	34A 18A 21A		HVAC Load HVAC Load
Glycol Pump P-14-104A	15 HP			21A		HVAC Load
MCC Total				859A		
MCC-13-101						
Domestic Water Heater H-12-201	60 KW		72A	72A		HVAC Load
Compressor C-12-301A	50 HP		65A	65A		HVAC Load
Compressor C-12-301B		50 HP	65A			HVAC Load
Pump P-12-601A	1 1/2 HP		2.6A	2.6A		HVAC Load
Chiller CH-12-501A	1 Hp		1.8A	1.8A		HVAC Load
Chiller CH-12-501B	1 HP		1.8A	1.8A		HVAC Load
Facility Interior & Exterior Lighting Panel LP-14-101	225 KVA		180A	180A		
Power Panel PP-13-101	45KVA		54A	27A		
UPS-13-101 Egress Lighting, Control Room Lighting	50 KVA 10 KVA 5 KVA		76A 12A 6A	76A 12A 6A		Supports process & critical loads
MCC Total				444A		
MCC-09-101						
Transfer Crane CR-06-101	2 HP		3.4A			Process Load
Repacked Shredded Lead Conveyor CV-06-101	3/4 HP		1.4A			Process Load
Lead Brick Basket Hoist CR-06-103	2 HP		3.4A			Process Load
Shredder Sh-06-101	150HP		180A			Process Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Lift Table Drum Entry LT-06-101	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Bin Hoist CR-06-102	3 HP		4.8A			Process Load
Airlock Transfer Tunnel AL-06-101	3 HP		4.8A			Process Load
Evaporator Disch. Conveyor OV-06-201	3/4 HP		1.4A			Process Load
Mercury Evaporator H-06-201	20 KW		24A			Process Load
Lift Table Drum Exit LT-06-201	1 1/2 HP		2.6A			Process Load
Scrubber Off-gas Blower C-06-301	3 HP		4.8A			Process Load
Humidifier Discharge Vibratory CV-06-301	3 HP		4.8A			Process Load
Scrubber Off-Gas Reheater	5 KW		6A			Process Load
Vibrating Screen S-06-301	3 HP		4.8A			Process Load
Non-Radioactive Waste Pump P-07-102A,B	1 1/2 HP	1 1/2 HP	2.6A			Process Load
Radioactive Waste Pump P-07-203	1 1/2 HP		4A			Process Load
Radioactive Sump Pump P-07-202	1 1/2 HP		2.6A			
Humidifier Cond. Pump P-06-302	1 1/2 HP		2.6A			Process Load
Non-Radioactive Sump Pump P-07-102	1 1/2 Hp		2.6A			Process Load
Radioactive Waste Pump P-07-201	3 HP		4.8A			Process Load
Treated Radioactive Waste Tank Mixer M-07-201	1 HP		1.8A			Process Load
Slave Pallet Transfer Conveyor CV-08-303	3/4 HP		1.4A			Process Load
Drum Storage/Retrieval CR-08-101	3 HP 10 HP		4.8A 14A			Process Load
NDA Drum Transfer Conveyor CV-08-101	3/4 HP		1.4A			Process Load
NDA Drum Transfer Conveyor CV-08-102	3/4 HP		1.4A			Process Load
NDA Drum Transfer Conveyor CV-08-103	3/4 HP		1.4A			Process Load
NDA Drum Transfer Conveyor CV-08-104	3/4 HP		1.4A			Process Load
Drum AS/RS Transfer Conveyor CV-08-301	3/4 HP		1.4A			Process Load
Drum AS/RS Transfer Conveyor CV-08-302	3/4 HP		1.4A			Process Load
Drum Rec./Ship Transfer Conveyor CV-08-501	3/4 HP		1.4A			Process Load
Drum Rec./Ship Transfer Conveyor CV-08-502	3/4 HP		1.4A			Process Load
Drum Rec./Ship Transfer Conveyor CV-08-503	3/4 HP		1.4A			Process Load
Drum Rec./Ship Transfer Conveyor CV-08-504	3/4 HP		1.4A			Process Load
Jib Crane CR-09-101	1 HP 2 HP 1/4 HP		1.8A 3.4A 0.5A			Process Load
Jib Crane CR-09-102	1 HP 2 HP 1/4 HP		1.8A 3.4A 0.5A			Process Load
Feed Conveyor CV-09-102	3/4 HP		1.4A			Process Load
Feed Conveyor CV-09-103	3/4 HP 1 1/2 HP		1.4A 2.6A			Process Load
Discharge Conveyor CV-09-104	1 1/2 HP		2.6A			Process Load
Scale Conveyor CV-09-105	3/4 HP		1.4A			Process Load
Drum Conveyor CV-09-106	3/4 HP		1.4A			Process Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Fork Truck Charger	10 KVA		12A			Process Load
Automated Guided Vehicle Charger	3.4 KVA		4A			Process Load
Power Panel PP-09-101	30 KVA		36			Process Load
Airlock AL-09-101	10 HP		14A			Process Load
Drum Pan Unit ND-09-201	9 KVA		10.8A			Process Load
Drum Pan Unit ND-09-202	9 KVA		10.8A			Process Load
Drum GEA Equipment ND-09-203	16 KVA		19.3A			Process Load
Drum GEA Equipment ND-09-204	16 KVA		19.3A			Process Load
Manipulator EM-06-101	5 H\HP		7.6A			Process Load
Drum Lifter/Tripper DH-06-102	7 1/2 HP 3 HP		11A 4.8A			Process Load
Lift Table Drum Exit LT-06-102	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
MCC Total	480.4A x 0.8 Demand Factor = 384A					
MCC-04-101						
Decon Water Booster Pump P-04-201	1 1/2 HP		2.6A			Process Load
Sump Pump P-04-210A,B	1 1/2 HP	1 1/2 HP	2.6A			Process Load
Special Waste Process Sump Pump P-04-230	1 1/2 HP		2.6A			Process Load
Polymer Encapsulation Enclosure Sump Pump P-04-240	1 1/2 HP		2.6A			Process Load
High Pressure Recirculation Pump P-04-250	10 HP		14A			Process Load
Grout Area Sump Pump	1 1/2 HP		2.6A			Process Load
Nonactive Tanks Off-Gas Reheater	5 KW		6A			Process Load
Polymer Mixing Agiator M-05-401	2 HP		3.4A			Process Load
Extender Metering Pump P-05-302	3/4 HP		1.4A			Process Load
Hydrocarbon Waste Transfer Pump P-05-404	1 1/2 HP		2.6 A			Process Load
Power Panel PP-04-101	15 KVA		18A			Process Load
Lift Table LT-05-401	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Lift Table LT-05-402	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Lift Table LT-05-403	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Lift Table LT-05-404	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Ves Resin Transfer Pump P-05-305A	1 1/2 HP		2.6A			Process Load
Vibrated Grout Curing Roller Conveyor CV-05-221	3/4 HP 3/4 HP		1.4A 1.4A			Process Load
Transfer Roller Conveyor CV-05-224	3/4 HP		1.4A			Process Load
Turn Table Roller Conveyor CV-05-225	3/4 HP 3/4 HP		1.4A 1.4A			Process Load
Powder Blender M-05-202	1 HP		1.8A			Process Load
Grout/Waste Drum Mixer M-05-203	1 HP		1.8A			Process Load
BFS Hopper Rotary Fdr T-05-205	3/4 HP		1.4A			Process Load
PFA Hopper Rotary Fdr Y-05-206	3/4 HP		1.4A			Process Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Blended Powder Rotary Fdr Y-05-207	3/4 HP		1.4A			Process Load
Polymer Pump P-05-101	3/4 HP		1.4A			Process Load
OPC Rotary Fdr Y-05-209	3/4 HP		1.4A			Process Load
OPC Silo Dust Collector Fan C-05-105	5 HP		7.6 A			Process Load
Ves Resin Transfer Pump P-05-305B	1 1/2 HP		2.6A			Process Load
Additive Silo Dust Collector Fan C-05-102	5 HP		7.6A			Process Load
Vibro Grout Mixer Pump P-05-201	3/4 HP		1.4A			Process Load
Entry Air Lock AL-05-201	5 HP 5 HP		7.6A 7.6A			Process Load
Exit Air Lock AL-05-202	5 HP 5 HP		7.6A 7.6A			Process Load
Air Lock Conveyor CV-05-226	3/4 HP		1.4A			Process Load
Output Conveyor to AGV CV-05-227	3/4 HP		1.4A			Process Load
Transfer Conveyor CV-05-228	3/4 HP		1.4A			Process Load
PFA Silo Dust Collector Fan C-05-103	5 HP		7.6A			Process Load
BFS Silo Dust Collector Fan C-05-104	5 HP		7.6A			Process Load
Input Conveyor to AGV CV-05-212A,B	3/4 HP	3/4 HP	1.4A			Process Load
Airlock Conveyor CV-05-213A,B	3/4 HP	3/4 HP	1.4A			Process Load
Airlock to Lift Table Roller Conveyor CV-05-215	3/4 HP		1.4A			Process Load
Airlock to Lift Table Conveyor CV-05-216	3/4 HP		1.4A			Process Load
Drum Transfer Roller Conveyor CV-05-217	3/4 HP		1.4A			Process Load
Agitated Grout Curing Roller Conveyor CV-05-218	3/4 HP 3/4 HP		1.4A 1.4A			Process Load
Drum Transfer Conveyor CV-05-220	3/4 HP		1.4A			Process Load
Air Compressor Package C-05-101	200 HP		240A			Process Load
Fork Truck Charger	10 KVA		12A			
Automated Guided Vehicle Charger	3.4 KVA		4A			
MCC Total	429A x 0.8 Demand Factor = 343A					
MCC-05-101						
Lift Table LT-05-201	1 1/2 HP		2.6A			Process Load
Entry Air Lock AL-05-203	5 HP 5 HP		7.6A 7.6A			Process Load
Lift Table LT-05-202	1 1/2 HP		2.6A			Process Load
Lift Table LT-05-203	1 1/2 HP		2.6A			Process Load
Overhead Crane CR-05-501	10 HP 1 HP 2 HP		14A 1.8A 3.4A			Process Load
Inlet Conveyor CV-05-501	3/4 HP 3/4 HP		1.4A 1.4A			Process Load
Conveyor Feed Transfer Car CV-05-502	3/4 HP		1.4A			Process Load
Drum Airlock from Receipt AL-05-501	5 HP 5 HP		7.6A 7.6A			Process Load
Drum Pallet Truck FT-05-501	1 HP		1.8A			Process Load
Lift Table Drum Entry LT-05-521	1 1/2 HP 1/3 HP		2.6A 1A			Process Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Drum Hoist CR-05-521	2 HP		3.4A			Process Load
Drum Handler Tripper DH-05-522	7 1/2 HP 3 HP		11A 4.8A			Process Load
Hoist Non-Shred Items CR-05-522	1 HP		1.8A			Process Load
Absorbent Discharge Hopper T-05-522	2 HP 1 1/2 HP		3.4A 2.6A			Process Load
Manipulator Assembly EM-05-521	5 HP 5 HP		7.6A 7.6A			Process Load
Lift Table LT-05-522	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Transfer Car TC-05-501	10 HP		14A			Process Load
Coarse Shredder SH-05-521	300 HP		325A			Process Load
Fine Shredder SH-05-522	150 HP		180A			Process Load
Vibrating Conveyor CV-05-521	2 HP		3.4A			Process Load
Diverter Tray X-05-522	3 HP		4.8A			Process Load
Weigh Hopper T-05-521A,B	1 1/2 HP 1 1/2 HP 2 HP 2 HP	1 1/2 HP 1 1/2 HP 2 HP 2 HP	2.6A 2.6A 3.4A 3.4A			Process Load
Lift Table LT-05-523A,B	1 1/2 HP 1 1/2 HP 1/3 HP 1/3 HP	1 1/2 HP 1 1/2 HP 1/3 HP 1/3 HP	2.6A 2.6A 1A 1A			Process Load
Maintenance Hoist CR-05-523	1 HP		1.8A			Process Load
Transfer Car TC-05-521	10 HP		14A			Process Load
Lift Table Drum Entry LT-05-541	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Drum Hoist CR-05-541	2HP		3.4A			Process Load
Drum Handler/Tripper DH-05-542	7 1/2 HP 3 HP		11A 4.8A			Process Load
Airlock Pug Mill to Transfer Tunnel AL-05-541	3 HP		4.8A			Process Load
Airlock Shred to Transfer AL-05-521	3 HP		4.8A			Process Load
Manipulator Assembly EM-05-541	5 HP		7.6A			Process Load
Hoist CR-05-542	1 HP		1.8A			Process Load
Maintenance Hoist CR-05-543	1 HP		1.8A			Process Load
Lift Table LT-05-542	3/4 HP		1.4A			Process Load
Pug Mill SH-05-541	20 HP		27A			Process Load
Weigh Hopper T-05-541	2 HP 1 1/2 HP		3.4A 2.6A			Process Load
Lift Table Drum Exit LT-05-543	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Box Entry Airlock AL-05-561	7 1/2 HP 7 1/2 HP 7 1/2 HP		11A 11A 11A			Process Load
Box Inlet Conveyor CV-05-561A, B, C	1 1/2 HP 1 1/2 HP	1 1/2 HP	2.6A 2.6A			Process Load
Overhead Crane CR-05-561	10 HP 2 HP 1 HP		14A 3.4A 1.8A			Process Load

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Load Description	Connected Load		Full Load Amperes	Demand Load (AMPS)		Remarks
	Operating	Stand By		Heating	Cooling	
Power Manipulator Assembly EM-05-561	3 HP 1/2 HP 1 1/2 HP 2 HP 7 1/2 HP		4.8A 1A 2.6A 3.4A 11A			Process Load
Filter Compactor CM-05-561	5 HP		7.6A			Process Load
Lift Table Drum Exit	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Mechanical Saw RT-05-561	5 HP		7.6A			Process Load
Drum Hoist CR-05-601	2 HP		3.4A			Process Load
Manipulator Assembly EM-05-603	5 HP		7.6A			Process Load
Conveyor CV-05-632	3/4 HP		1.4A			Process Load
Lift Table LT-05-640	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Lift Table LT-05-641	1 1/2 HP 1/3 HP		2.6A 1A			Process Load
Core Drill RT-05-612	3 HP		4.8A			Process Load
Power Panel PP-05-101	45 KVA		54A			Process Load
MCC Total	927A x .8 Demand Factor = 742A					

2.2 Fire Protection

2.2.1 Introduction

1. Fire protection at the WRAP 2A facility will be provided by a combination of automatic wet pipe sprinkler systems, automatic dry pipe sprinkler systems (for exterior and building exposure protection), hose connections (standpipes), manual dry chemical extinguishers, smoke and heat detectors and an alarm system.

2.2.2 Design Requirements

1. Provide safe and reliable fire protection, alarm and detection systems that are adequately sized for the WRAP 2A facility.

2. Provide interlocks and alarms on the fire protection system to alert operators to unsafe system conditions.

2.2.3 Process Selection

1. The fire protection, alarm and detection systems selected will incorporate best available technology which has been proven in similar services, e.g., in other DOE facilities or in the commercial nuclear industry.

2. Requirements of DOE orders, WHC criteria and WAC criteria (pertaining to ignitive and reactive wastes) will be followed. Requirements include a fire hazard analysis per DOE 5480.7 and 6430.1A. This fire hazard analysis will be performed early in Title I design to confirm the selection of fire protection systems and the extent of protection required.

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3. Experience from WRAP 1 Title I design efforts have been incorporated in the conceptual design of WRAP 2A. Specific areas include: glovebox fire protection and detection system requirements, use of Class ABC dry chemical extinguishers only, i.e., no CO_2 extinguishers, and use of automatic sprinkler systems in electrical equipment and control rooms, i.e., no CO_2 or halon systems.

2.2.4 Maximum Possible Fire Loss

1. If the contents of the drums are required to be included in the combustibles, the maximum possible fire loss would exceed $75 M. However, this design assumes that the drum contents do not become part of the combustibles. This is the assumption being made on WRAP 1, and it appears that some tests will need to be performed to confirm this conclusion. This topic should be further addressed during title design.

2.2.5 Process Description

2.2.5.1 Water Supply and Distribution System

1. The water supply for the fire protection system will be taken from an existing 12 inch potable water main. Two separate reliable sources of water are required by DOE Order 6430.1A, Section 1530-99.0. Currently, the 200 areas, and therefore WRAP 2A, are not supplied with a secondary water source. However, multiple projects (e.g., Project B-604) are being planned to provide a second source. If the second source will not be available at WRAP 2A start-up, a criteria deviation request will need to be made. This design provides for two supplies from the 12" main and the estimated water supply requirement at the base of any one riser is 1,000 gpm at 80 psi.

2. The fire protection system will consist of two looped sprinkler systems. Each system will be supplied via two separate and independent risers. Sectional valves, complete with valve tamper devices, will be provided to allow isolation of portions of the sprinkler system, i.e., zones, and prevent a single active component failure from disabling the complete fire protection system (DOE 6430.1A, Section 1530-99.0). See Drawings H-2-140695, 140696, and 140697 for further information and the conceptual fire and zone configuration.

2.2.5.2 Fire Areas and Zones

1. The entire facility is provided with automatic wet or dry pipe sprinkler protection. The facility is divided into two fire areas, i.e., areas separated by at least 2 hour fire rated barriers (see drawings H-2-140696 and H-2-140697). Fire Area 1 covers all process support areas, i.e., the non-SWP sections of the building. Fire Area 2 is the process area and glovebox enclosures (the SWP portions of the building). Each fire area will be further subdivided into fire zones. A fire zone is an area in which fire detection or suppression systems provide alarm information indicating the location of a fire at the Fire Alarm Control Panel (FACP) (Ref: NFPA 801 - 1991). Fire zones have been selected based on building layout and physical proximity of the rooms or spaces within the fire areas.

2. The building has been divided into two fire areas separated by a 2 hour fire wall for the following reasons:

a. UBC requires a minimum of a 1 hour separation between B-2 (the "noncontrolled" areas) and H-7 (the "controlled" areas) occupancies.

b. The minimum separation for fire areas recognized by DOE orders is 2 hours.

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c. The total floor area of the building exceeds that allowed by NFPA 13 for a single sprinkler system. Dividing the building into two fire areas separates the two sprinkler systems and allows independent fire suppression in the H-7 and B-2 occupancies.

d. In order to not exceed the allowable UBC floor area, an area separation wall of 2 hours is required.

3. Selected fire zones for Fire Area 1 are: a) office and conference room area, b) lunch room, locker rooms, laundry rooms, mechanical room and electrical room, c) transfer corridor, d) non-SWP HVAC room, and e) polymer storage area. The inactive liquid waste room and the grout mix room are conceptually part of the transfer corridor zone (see also drawing H-2-140695).

4. Selected fire zones for Fire Area 2 are: a) polymer encapsulation and NDA area, b) grout stabilization area and glovebox, c) drum storage area, d) process off-gas room, e) active liquid waste room, f) special waste treatment area, g) four individual glovebox enclosure zones in the special waste treatment area, and h) box breakdown room (see also drawing UT-6).

5. All fire zones will be adjusted and finalized during Title I design.

2.2.5.3 Fire Protection - General

1. Two looped sprinkler systems, corresponding to the fire areas already discussed, will be provided to protect the entire facility (see drawings H-2-140696 and H-2-140697). Each system will be complete with redundant risers and alarm check valves.

2. Each system will be further subdivided into zones, with each zone being separated from the loop header by isolation valves equipped with valve tamper switches (see Drawing UT-6). In this fashion, any zone could be temporarily taken out of service, e.g., for repair, without compromising the operation of the remainder of the system. Zones out of service for any reason will transmit an alarm to the FACP, via valve tamper switches, to notify both the operators and the Hanford Fire Department (HFD) that the zone is unprotected. Individual zone water flow switches will provide alarm and location information at the FACP in the event of a fire.

3. Designing the systems as "loops" allows each zone on a system to be fed from two directions, thus maintaining redundant feeds not only to the building and fire areas, but also to the individual zones. No single active component failure can disable the fire protection systems for the building.

4. In addition to the sprinkler systems, the WRAP Module 2A will also be equipped with wet standpipe and hose stations (Class III), and with hand held dry chemical extinguishers. Hose stations will be located in all airlocks, and elsewhere in the building as required by NFPA 14 - 1990, "Installation of Standpipe and Hose Systems". Portable extinguishers will be provided in accordance with NFPA 10 - 1990, "Portable Fire Extinguishers", and WHC-CM-4-3 Standard (and Guide) FP-2.

2.2.5.4 Fire Protection - Fire Area 1

1. Except for the polymer storage area this sprinkler system will be designed to NFPA 13 Ordinary Hazard, Group 1 criteria. The system will be hydraulically designed with a design density of 0.15 gpm per sq. ft. over 1,500 sq. ft. design area.

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2. The polymer storage area, a higher hazard area, will be designed to NFPA 13 Ordinary Hazard, Group 2 criteria of 0.20 gpm per sq. ft. over a design area of 1,500 sq. ft. This zone is protected by automatic dry pipe type sprinklers fed from the Fire Area 1 loop header.

3. Ordinary temperature rated sprinkler heads will be used for all portions of the system. Sprinkler heads listed and approved for outside service will used in the polymer storage/exposure protection zone. The system will be a looped system with multiple zones. Five fire zones are currently anticipated (see Fire Areas and Zones above).

4. The computer rooms and electrical equipment rooms will be provided with automatic sprinkler protection. Protection, detection and construction (i.e., fire barriers) at the control and computer rooms (located on the second floor) will comply with the requirements of DOE/EP-0108, January 1984 and the requirements of NFPA 75, 19D. This standard applies to "all essential electronic computer data processing equipment" as defined in DOE/EP-0108. "Essential" equipment includes that which is vital to the DOE mission, is required for security and has a monetary value in excess of $1,000,000. Installations which are not "essential" are expected to comply with DOE/EP-0108 "to the extent that is practicable". The use of flow control, e.g., "on-off", heads (as allowed by DOE 6430.1A, Section 1530-4.2.5), or a preaction type sprinkler system, will be considered during Title I design. These designs would reduce the chance of accidental water discharge, and may reduce the amount of water discharged in the event of a fire, and consequently the amount of water damage to sensitive and costly computer and electrical equipment.

5. Exposure protection for the main WRAP 2A building from a fire in the polymer storage area will be provided by automatic dry pipe exposure protection sprinklers. The systems will be designed and installed in accordance with NFPA 13 - 1991 "Installation of Sprinkler Systems" and NFPA 80A - 1987 "Exterior Fire Exposures". Exposure protection will be provided for all exposed building surface from grade to the roof along column lines 3 and 4. An alternate to the dry pipe exposure sprinkler protection just described is spatial separation (25 feet) between the main building and the polymer storage area. A study will be done during Title I design to determine the most cost effective approach.

6. In addition to the sprinkler system, Fire Area 1 will be equipped throughout with dry chemical extinguishers and standpipe systems. Class ABC dry chemical extinguishers will be located and sized in accordance with NFPA 10 - 1990, and WHC-CM-4-3 Standard (and Guide) FP-2. Class III fire hose stations, or connections, will be installed where required by NFPA 14 - 1990.

2.2.5.5 Fire Protection - Fire Area 2

1. This sprinkler system will be designed to NFPA 13 Ordinary Hazard, Group 2 criteria. The system will be hydraulically designed with a design density of 0.20 gpm per sq. ft. over 1,500 sq. ft. design area. Intermediate temperature rated sprinkler heads will be used throughout. The system will be a looped system with multiple zones. Eleven fire zones are currently anticipated (see Fire Areas and Zones above).

2. The process enclosures (gloveboxes) are provided with automatic sprinkler systems of the supervised preaction type to minimize the possibility of accidental discharge of water. In addition to this, the preaction systems may be equipped with flow control type sprinkler heads to limit the amount of water that would be discharged in the event of a fire, and thus reduce the amount of liquid radioactive waste generated. The use of "on-off" heads is allowed by DOE 6430.1A, Section 1530-4.2.5. In addition to the automatic suppression system, each glovebox will be provided with manual dry chemical extinguishing equipment. Hand held portable extinguishers equipped with either bayonet or quick-disconnect type nozzles will be located near operator stations and available for use in manual fire fighting efforts. The design will comply

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with the draft version of "Glovebox Fire Protection Criteria, August 1991" prepared for the U.S. Department of Energy by Westinghouse Hanford Company. The requirements of WHC-CM-4-3 Standard (and Guide) FP-5 will also be met in the design of the glovebox fire protection system.

3. Glovebox exhaust openings will be provided with fire screens and prefilters. Fire screens will meet WHC criteria. Glovebox lines will also be provided with fire dampers in accordance with WHC criteria (Glovebox Fire Protection Criteria, August 1991, and WHC-CM-4-3 Standard (and Guide) FP-5). The requirements of DOE 6430.1A, Section 1530-99.0, which states that closure of fire dampers shall not compromise functioning of the confinement system where loss of confinement poses a greater threat than the spread of fire, shall be followed.

4. The drum storage area consists of two rows of drum racks, each 13 bays long and 7 tiers high. Overall height is approximately 22 feet. The protection requirements for this storage configuration are covered by NFPA 231C - 1991, "Rack Storage of Materials". In-rack sprinklers will be installed in accordance with the requirements of Chapter 6 of NFPA 231C. The commodity class of the waste filled drums will be determined during Title I design.

5. Fire Area 2 will be equipped throughout with dry chemical extinguishers in accordance with NFPA 10 - 1990 and WHC-CM-4-3 Standard (and Guide) FP-2. Class III fire hose stations, or connections, will also be installed where required by NFPA 14 - 1990. All airlocks will be equipped with hose connections fed from the Fire Area 2 loop.

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2.2.5.6 Fire Alarm and Detection - General

1. A fire alarm and detection system, as required by DOE 6430.1A and 5480.7, will be installed in the WRAP Module 2A facility. All alarm conditions will annunciate locally (chimes and lights) at the FACP and at the Hanford Fire Department (HFD) via Radio Fire Alarm Reporters (RFAR's). The alarm and detection system will comply with DOE 6430.1A, Sections 1530-8, 1670-2 and 1671-2.

2. All alarm initiating devices and alarm indicating appliances will be installed in accordance with NFPA 72 - 1990, "Installation, Maintenance and Use of Protective Signalling Systems" and NFPA 72E - 1990, "Automatic Fire Detectors". All alarm initiating and indicating circuits will be supervised; "Trouble" signals will annunciate at the FACP located in the facility and at the HFD.

3. Automatic detection systems in the "high bay" areas, e.g., the special processing area and rack drum storage, of the facility will be studied during Title I design to determine the optimal detection system to be installed. "Standard" smoke and heat detection devices and systems are unlikely to be adequate due to the height of the areas. Therefore, optical detectors, "air sampling detectors", e.g., VESDA, and reduced detector spacing will all be considered.

4. Smoke detectors will be provided in ventilation ducts as required by NFPA 90A - 1989, "Installation of Ventilating and Air Conditioning Systems" and NFPA 92A - 1988, "Smoke Control Systems". In-duct smoke detectors and installation shall will comply with the requirements of NFPA 72E - 1990. In-duct smoke detector alarm signals will also initiate closure of associated duct smoke and fire dampers.

5. The alarm system will include all water flow devices (alarm check valves and water flow switches) and valve tamper switches associated with the sprinkler systems.

6. All alarm and trouble conditions will be indicated by zone at the FACP and at the HFD. A permanently installed zone map will be provided to aid the fire department in establishing the location of alarm signals.

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2.2.5.7 Fire Alarm and Detection - Fire Area 1

1. Fire Area 1 will be furnished with both automatic smoke detection and manual fire alarm systems. Smoke detectors will be installed per NFPA 72E - 1990. The alarm and signalling systems will be installed per NFPA 72 - 1990. A proprietary protective signalling system automatically reporting to the Hanford Fire Department will be installed.

2. Local alarms (chimes, lights, bells) will be located throughout Area 1. Alarm signals will be transmitted to the HFD via RFAR (Radio Fire Alarm Reporter) upon receipt at the FACP.

3. Manual fire alarm stations, i.e., manual pull stations, will be located throughout Fire Area 1 as required by NFPA 101 - 1991, Chapter 26, "Business Occupancies". As a minimum, manual fire alarm stations will be provided along all required egress paths and at all exit doors.

2.2.5.8 Fire Alarm and Detection - Fire Area 2

1. Fire Area 2 will be furnished with a complete alarm and detection system, including automatic smoke and heat detectors, and manual fire alarm stations. Smoke and heat detectors will be installed per NFPA 72E - 1990, the alarm and signalling systems will be installed per NFPA 72 - 1990. A proprietary protective signalling system automatically reporting to the Hanford Fire Department will be installed.

2. Local alarms (chimes, lights, bells) will be located throughout Area 2. Alarm signals will be transmitted to the HFD via RFAR upon receipt at the FACP.

3. Manual fire alarm stations (i.e., manual pull stations) will be located throughout Fire Area 2 as required by NFPA 101 - 1991, Chapter 28, "Industrial Occupancies". As a minimum, manual fire alarm stations will be provided along all required egress paths and at all exit doors. Additional alarm stations will be provided in areas where indicated by difficulty of egress, congestion of equipment, etc. Such areas may include around the glovebox enclosures, the rack drum storage area and the NDA area.

4. Each glovebox enclosure will be equipped with thermal detectors. Self-restoring line type thermal detectors, as well as spot type thermal detectors, will be considered during Title I design. Detection systems will comply with WHC Glovebox Fire Protection Criteria dated August 1991, WHC-CM-4-3 Standard (and Guide) FP-5, NFPA 801 - 1991, "Recommended Fire Protection Practice for Facilities Handling Radioactive Materials" and with NFPA 72 and 72E.

2.2.6 Key DOE/WHC Criteria

1. DOE Orders

DOE 5480.7	Fire Protection
RLIP 5480.7	Fire Protection
DOE 6430.1A	General Design Criteria
DOE/EP-0108	Standard for Protection of DOE Electronic Computer/Data Processing Systems
DOE	Fire Protection Resource Manual

2. WHC Orders

(no number)	Glovebox Fire Protection Criteria, August 1991
WHC-CM-4-3	Standard FP-2 Portable Fire Extinguishers
WHC-CM-4-3	Guide FP-2 Portable Fire Extinguishers
WHC-CM-4-3	Standard FP-5 Glovebox Fire Protection
WHC-CM-4-3	Guide FP-5 Glovebox Fire Protection

WHC-CM-4-3	Standard FP-8 Fire Barriers
WHC-CM-4-3	Standard FP-11 Building Emergency Exits

2.2.7 Reference Drawings

Drawing Number	Title
H-2-140696	Fire Protection Zone Plan Ground and Lower Level
H-2-140695	Fire Protection Mechanical Flow Diagram
H-2-140697	Fire Protection Zone Plan Upper Level

2.3 Potable Water/Sanitary Waste

2.3.1 Introduction

1. This section has been formatted to include sanitary sewer, storm drainage and potable water and plumbing fixtures which have been grouped under utilities as plumbing systems.

2.3.2 Design Requirements

1. The plumbing systems shall be designed and installed in compliance with the uniform plumbing code, 1991 edition.

2.3.3 Process Description

2.3.3.1 Sanitary Sewer System

1. The sanitary Sewer system serving the toilet rooms, showers, mechanical room floor drains and janitor's sink, kitchen unit sink and drinking fountains shall flow by gravity to a new 4,000-gallon septic tank and leaching field. The sewer piping shall be pitched in the direction of flow as required to maintain a minimum velocity of 2 feet per second. Contaminated or potentially contaminated waste shall not enter the sanitary system. All fixtures shall be trapped and vented as required by the uniform plumbing code. Cleanouts shall be provided at changes of direction and at 50 foot intervals for interior piping.

2.3.3.2 Storm Drainage System

1. The building storm drainage system shall consist of exterior gutters and downspouts. The downspouts shall discharge to concrete splashblocks at grade.

2.3.3.3 Potable Water System

1. Potable water shall be supplied to the building by a separate 3 inch service line fed from an existing 12 inch, 120 psig water main. A water pressure regulating station at the service entry will reduce the maximum system pressure to 75 psig. The system shall be sized to supply the maximum peak GPM requirement with a minimum of 30 psig residual pressure.

2. Reduced pressure backflow preventers shall be provided where required to protect the potable water system from cross connection and contamination. All nonpotable systems shall be isolated from the potable supply.

3. Shut-off valves shall be provided on branch lines and for groups of fixtures. Shock absorbers consisting of factory sealed pressurized compression chambers and stainless steel expansion bellows shall be provided at quick closing valves. Stop valves shall be provided at all fixtures.

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4. Domestic hot water shall be generated by an electric storage type water heater, 700-gallon storage capacity, 60 kw input. Hot water will be stored at 140°F. Showers shall have individual thermostatic mixing valves. Hot water to hand washing lavatories shall be supplied at 110°F. A hot water circulating pump shall be used to provide continuous hot water to the most remote fixtures and equipment.

2.3.3.4 Plumbing Fixtures

1. Plumbing fixtures shall be white vitreous china. Waterclosets and urinals shall be wall mounted, and flush valve operated. Lavatories shall have cold and hot water mixing faucets. Refrigerated drinking water coolers shall be provided. Showers shall be provided with 3 GPM shower heads. Combination emergency shower and eye wash units shall be provided where needed. A personnel decontamination shower which drains to the active waste collection tank shall be provided.

2.3.4 Key DOE/WHC Criteria

1. Potable water systems shall be provided with positive backflow prevention to assure isolation from process systems. Sanitary waste effluent shall be monitored and if required analyzed (e.g., alpha activity).

2.3.5 Reference Drawings

Drawing Number	Drawing Title
H-2-140694	Sanitary Waste and Vent Flow Diagram
H-2-140693	Potable Water Utility Flow Diagram

2.4 Compressed Air/Inert Gas/Breathing Air

2.4.1 Introduction

1. The compressed air system included in the WRAP 2A is designed to supply compressed air for instrumentation, plant air and feed air for the nitrogen generation unit. Indoor air is pre-filtered, compressed to 125 psig, cooled, dried, final filtered and accumulated in an air receiver and distributed to users. Instrument air is reduced to 90 psig before distribution to instrument air users throughout the WRAP 2A facility. Plant air is reduced to 80 psig before distribution to plant air users and utility hose drops. Feed air to the nitrogen generation package is reduced to 100 psig before passing through the membranes, producing 98 percent purity nitrogen for use as inert gas in the WRAP 2A facility. Nitrogen is used to blanket polymer chemical and storage tanks, polymer mix tank and hydrocarbon waste tanks, and to provide an inert gas atmosphere for (1) the mercury evaporator operating at temperatures approaching 500°F, (2) the reactive metals screening/humidification chamber, and (3) the polymer encapsulation condensed hydrocarbon drum.

2. Breathing air is supplied through ten portable bottle racks for use throughout the WRAP 2A facility. Each bottle rack contains two high pressure breathing air cylinders manifolded together with piping, valves, regulators and 100 feet of hose leading to a breathing air mask. These ten units will be located at key process areas in the WRAP 2A building, but are completely portable to all sections of the plant as breathing air is required.

2.4.2 Feeds and Throughput

1. The flow rates for compressed air and nitrogen were not based on waste feed throughput but rather on the number and type of users for each utility.

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2. The flow rate of 200 scfm of compressed air was determined from the number of instrument air users throughout the WRAP 2A facility process and HVAC, the specific air usage for each instrument, an estimate of plant air usage and an estimate of air consumption for the nitrogen generation unit. An overall contingency of 20 percent was added to account for the lack of precise design information.

3. The flow rate of 4 scfm of nitrogen was estimated from the number and type of nitrogen users: seven tanks associated with polymer encapsulation, the mercury evaporator, the reactive metals screening/humidification chamber and the polymer encapsulation condensed hydrocarbon drum.

4. The number of portable breathing air units was determined by the criteria to locate these units near key process entrance and exit points. These are described in Section 2.4.5.3.

5. The operating life of these utility systems will be approximately 30 years, or the same as the useful operating life of the facility. The compressed air and nitrogen systems will operate continuously (24 hours per day, 7 days per week) since compressed air is needed for control of the off-gas and HVAC systems, which also operate continuously, and since nitrogen blanket gas is needed on a continuous basis for the polymer chemical storage tanks and the reactive metals screening/humidification chamber (only during the three year reactive metals campaign). Breathing air will also be available at all times, although it will normally be used only during periods when operating personnel are present.

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2.4.3 Design Requirements

1. Provide safe and reliable utility systems that are adequately sized to handle the anticipated range of process and facility conditions for the WRAP 2A facility.

2. The WRAP 2A design shall ensure that all electrical, mechanical and instrument systems shall fail to the safest mode. Interlocks and alarms shall be provided on all systems or components to prevent operation in a manner which may affect safety, product quality, or be detrimental to the equipment.

3. Incorporate human factors and ALARA principals in the design process.

4. Compressed air for use throughout the facility will be provided by packaged air compressors consisting of one on-line unit and a common spare.

5. Compressors will discharge air into an air receiving tank with dryers as necessary.

6. All electric motors and heaters $\leq$ 1/2 horsepower (hp) shall be single phase 120V, and all electric motors and heaters > 1/2 hp shall be 3 phase, 480V.

7. Use commercially available equipment.

8. Utility stations shall be provided in process areas. Plant air and water will be provided as a minimum. Hose runs will not exceed 50 feet. Utility stations will be designed for easy access.

9. All piping connections from non-radioactive services to process vessels shall be equipped with a seal (seal pot or isolation valve) to prevent syphon or other interchange between hot and cold systems.

10. Valves shall be designed to fail in a safe mode with respect to the process served.

11. Flanges should be used at equipment nozzles only when necessary for servicing.

12. Provisions should be made for completely draining all vessels. The drains should be hard-piped to an appropriate waste treatment system.

13. Tanks and vessels shall be designed in accordance with WHC-CM-7-5.

14. When the process uses or produces combustible gases or vapors, the design shall include features such as inert gas purging to provide the dilution required to maintain the concentration of gases or vapors below the lower limit for flammability.

15. Entry of air into furnaces operating with reducing gas shall be precluded by the use of inert-gas purge locks or other suitable means at the furnace entry and exit. (This criteria was assumed to apply to the mercury evaporator).

16. The use of an inert gas atmosphere within the primary confinement shall be considered when handling pyrophoric material or tritium. (This criteria was assumed to apply to reactive metals).

17. Fresh breathing air will be provided at all major process area entries and exits.

18. Breathing air will be supplied by portable bottle racks.

19. Bottle racks will be equipped with two high-pressure air bottles manifolded together with valves, regulators and alarms.

20. Breathing air bottle racks shall be designed in accordance with WHC-CM-4-3.

2.4.4 Process Selection

1. The selection of oil-flooded rotary screw compressors for the air compressors was based on extensive favorable industrial experience with this type of compressor. They are quieter running and have greater reliability than reciprocating compressors. In some industry applications,rotary screw compressors have been designed to operate continuously compared to the generally accepted on-off mode of operation based on demand.

2. The heaterless air dryer was selected because it is a simpler design with more reliability than the typical heated dryers since no electric heating coils are used.

3. An air receiver designed to hold three minutes of instrument air (150 scfm) at 90 psig was selected. Both instrumentation and utility air will be dried before flowing to the receiver. Since the system operates using dry (-40°F dew point) air, the receiver and all downstream users (including utility air users which often use wet air) will have longer operating lives since moisture-related corrosion and rusting will be eliminated.

4. A wall-mounted nitrogen generating system using semi-permeable membranes was selected since it is very reliable (no moving parts) and produces 98 percent purity nitrogen which is adequate for an inert gas system. Compressed air at 100 psig is the feed gas. Nitrogen is produced at a cheaper cost than higher purity nitrogen from high-pressure cylinders or liquid nitrogen systems. Other inert gas systems such as carbon dioxide cylinders or inert gas generation systems using combustion of natural gas (or other clean fuels) were rejected due to higher cost or more complex operation. It should be noted, however, that a back-up system consisting of nitrogen cylinders will be installed in case the nitrogen generation unit fails.

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2.4.5 Process Description

1. The compressed air system includes the instrument air compressors, air dryer, air receiver and air distribution system. The inert gas system includes the nitrogen generation unit, nitrogen receiver and nitrogen distribution system. The breathing air system consists of ten portable breathing air units. These systems are shown on PFD H-2-140691.

2.4.5.1. Compressed Air System

1. The compressed air system supplies dry, filtered air at 125 psig for instrument air, plant air and feed air for the nitrogen generation unit. Two oil-flooded rotary screw compressors rated for 200 scfm at 125 psig supply the air. One compressor is designed to run in an automatic on-off mode with the other on standby. In the event of an unusually high demand, both compressors would run simultaneously. Each compressor is run by a 50 horsepower motor and starter with hand-off-automatic operation for dual control of both compressors. Each compressor package includes an inlet air filter, air cooled oil cooler and air aftercooler, multi-stage air-oil separation and automatic condensate trap.

2. Wet compressed air containing oil droplets is filtered through a coalescing filter assembly. Oil-water condensate is released through an automatic drain valve. Condensate from the oil-water separator and the coalescing filter flows by gravity to the Nonactive Waste Collection Tanks T-07-101A,B. Filtered wet air flows to the instrument air dryer package where two heaterless regenerative towers containing silica gel alternately dry the air to a -40°F dew point in one tower while the other tower is being regenerated. The dry air flows through an after filter to remove desiccant dust before entering the 1,500-gallon instrument air receiver.
3. From the receiver, instrument air is regulated to 90 psig before going to instrument air users. Plant air is reduced to 80 psig before distribution to utility air users. Compressed air is also sent to the nitrogen generation unit for production of nitrogen.

2.4.5.2 Inert Gas System

1. Nitrogen is generated in a wall-mounted unit using hollow fiber membranes to separate oxygen and any residual water vapor from nitrogen. About 13 scfm of compressed air is filtered and reduced to 100 psig pressure and passed through multiple beds containing the membranes. Oxygen and water vapor pass through the membranes and are vented to the HVAC exhaust system at very low pressures. About 4 scfm of 98 percent nitrogen inert gas is produced with very low pressure drop. Nitrogen flows to a 180-gallon receiver and is then reduced to about 70 psig before distribution. Nitrogen is used as a blanket gas for the Polymer Resin and Chemical Storage Tanks (T-05-301, 302, 303, 304 and 305A,B) and for the Polymer Mixing Tank (T-05-401) and Hydrocarbon Waste Tank (T-05-402). Nitrogen purge is also required for the Mercury Evaporator (H-06-201) and the Reactive Metals Screening/Humidifier Chamber (GB-06-301) to prevent thermal oxidation of reactive metals in these areas. Nitrogen is also used as a blanket gas for the drum where condensed hydrocarbons from the polymer encapsulation enclosure are collected.

2.4.5.3. Breathing Air

1. Ten portable breathing air units are also shown on PFD H-2-140691, although not part of the compressed air or inert gas systems. These units each consist of two bottles of compressed breathing air manifolded together with several stages of pressure regulation. These units are fully portable around the WRAP 2A process area. The units will be located at entrance/exit points of the following enclosures or plant locations:

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- NDA
- Grout Stabilization
- Polymer Encapsulation
- Hazardous (Nonactive) and Active Waste Tanks
- Size Reduction Shredder
- Pug Mill
- Box Breakdown
- Special Waste
- Sample Management
- Process HVAC

2.4.5.4 Equipment Logout

1. The instrument air compressors, air dryer, air receiver, nitrogen generation unit and nitrogen receiver are located in the Utilities' Compressor Room shown on H-2-140692 Chilled Water, Compressed Air and Nitrogen - Equipment General Arrangement. The distribution systems for compressed air and nitrogen, as well as the portable breathing air units, are located throughout the WRAP 2A building and are not shown on any specific general arrangement drawing. Due to the noise produced by the air compressors, this equipment is generally isolated from the general process area by locating the equipment in a separate room or building.

2. The instrument air compressors are oil-flooded rotary screw compressors which are quieter running than reciprocating air compressors. Special coalescing type prefilters are used to remove tiny oil droplets which may escape the air-oil-water separators on each air compressor skid.

3. The instrument air dryer package is a heaterless type that uses the heat generated by moisture absorption on the silica gel to drive off moisture during the regeneration step. Drying systems often use electric heating during the regeneration cycle.

4. The nitrogen generation system is a wall-mounted unit that uses semi-permeable membrane to separate "fast" gases like oxygen and water vapor from "slow" gases like nitrogen. This unit has no moving parts and produces 98 percent purity nitrogen which is adequate for use as inert gas and much cheaper than liquid nitrogen and more convenient than bottled nitrogen cylinders.

2.4.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.1, 2.2, 3.2, 3.5, 3.6, 3.8, 5.2, 7.0

2. DOE Order 6430.1A, General Design Criteria:

0110-99.0	Special Facilities; Nonreactor Nuclear Facilities - General
0203	Utilities Within Easements or Corridors
0260	Piped Utility Materials
0950	Acoustical Treatment
1300-3	Safety Class Criteria
1300-6.9	Radiation Protection; Breathing Air System
1300-12	Human Factors Engineering
1324	Radioactive Solid Waste Facilities
1325-4	Confinement Systems
1530-99	Special Facilities
1595	Controls

3. DOE Order 5480.1

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4. WHC-CM-4-3, "Industrial Safety Standards"

5. WHC-CM-7-5, "Environmental Compliance Manual"

2.4.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140691	PFD - Compressed Air and Nitrogen
H-2-140692	Chilled Water, Compressed Air and Nitrogen - Equipment GA

2.5 Process Water/Process Chilled Water Systems

2.5.1 Introduction

1. The process water system is a piping network to distribute water taken from the sanitary water system to the process water users throughout the WRAP 2A Facility. The process water system is separated from the sanitary water system by backflow preventers. The process water system will operate at the same pressure as the sanitary water system, which has three pressure-reducing valves set at 65, 70 and 75 psig, respectively. At low flow rates, the system will operate at 75 psig, but as flow rates increase the system pressure will decrease to a minimum of 65 psig. Since sanitary water requirements exceed process water needs, the sanitary water demands will probably determine the system operating pressure.

2. The chilled water system consists of two Process Chillers CH-12-501A,B, each rated at five tons of refrigeration capacity, and two chilled water systems. Both the Active and Nonactive Process Chilled Water Systems are designed to circulate 4.5 gpm of 42°F chilled water each using Active Chilled Water Pumps P-12-501A,B and Nonactive Chilled Water Pumps P-12-502A,B. Each chiller has two separate evaporators designed to cool both chilled water streams from 57°F to 42°F. The Active Chilled Water System cools the Polymer Encapsulation Vapor Condenser, the Mercury Evaporator Condenser and Scrubber Circulation Cooler. The Nonactive Chilled Water System cools the VES Resin Cooler, the Extender Cooler and the Mixed Polymer Cooler to keep these chemicals below 70°F to minimize product degradation.

2.5.2 Feeds and Throughput

1. The process water flow rates to the decontamination system, the chemical scrubber, the aqueous make-up tanks and the sample management area were based on rough estimates of process water required for decontamination of drums and process enclosures, for chemical scrubber make-up or for sample management uses rather than on the waste feed throughput of the WRAP 2A Facility. The process water required by the vibro grout area is proportional to the waste throughput of this grouting procedure.

2. The chilled water flow rates to active process users are based on estimates of process flows that require cooling. The Polymer Encapsulation Vapor condenser cooling duty is based primarily on polymer encapsulation off-gas flow rate, which is a function of the polymer enclosure volume rather than waste feed throughput. The Mercury Evaporator Condenser and Scrubber Circulation Cooler cooling duties are somewhat proportional to the waste feed throughput in these particular areas. The Scrubber Circulation Cooler duty is only required if the off-gas temperature from the mercury evaporator is very high. The total cooling duty for the Active Chilled Water System of 2.5 refrigeration tons is considerably in excess of estimated cooling duties.

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3. The chilled water flow to nonactive process users are not based on waste feed throughput but are based on heat absorbed by the VES Resin, Extender and Mixed Polymer Tanks (located outdoors) during the warmer months of the year. During the colder months, no chilled water cooling will be needed for these tanks.

4. The operating life of the process water and chilled water systems will be approximately 30 years, or the same as the useful operating life of the facility. The process water system can operate continuously, although most process water will be delivered during day time operations. The Active Chilled Water System is designed to operate continuously although the cooling loads will peak during day time operations. The Nonactive Chilled Water System is also designed to operate continuously and will likely do so during the hottest part of the year. During more temperate periods in the spring and fall, the system may operate only during the warmest part of the day. During the colder days of the year, the system will not be operated at all. This means that the hours of operation for the chillers will vary significantly depending on process operations, time of day or time of year.

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2.5.3 Design Requirements

1. Provide safe and reliable utility systems that are adequately sized to handle the anticipated range of process and facility conditions for the WRAP 2A Facility.

2. The WRAP 2A design shall ensure that all electrical, mechanical and instrument systems shall fail to the safest mode. Interlocks and alarms shall be provided on all systems or components to prevent operation in a manner which may affect safety, product quality, or be detrimental to the equipment.

3. Incorporate human factors and ALARA principles in the design process.

4. All electric motors and heaters ≤ ½ horsepower (hp) shall be single phase 120 V, all electric motors and heaters > ½ hp shall be 3-phase, 480 V.

5. Use commercially available equipment.

6. Utility stations shall be provided in process areas. Plant air and water will be provided as a minimum. Hose runs will not exceed 50 feet. Utility stations will be designed for easy access.

7. All piping connections from non-radioactive services to process vessels shall be equipped with a seal (seal pot or isolation valve) to prevent syphon or other interchange between hot and cold systems.

8. Valves shall be designed to fail in a safe mode with respect to the process served.

9. Flanges should be used at equipment nozzles only when necessary for servicing.

10. Domestic water supply be fed from the existing distribution header and branch feed all fixtures and equipment requiring potable water and process water.

11. The maximum system pressure shall be limited to 80 psi by a pressure control valve.

12. Reduced pressure backflow preventers shall be used where required to protect the potable water system from cross connection and contamination by the process water system.

13. Isolation shutoff valves shall be provided on branch lines and groups of fixtures.

14. Water hammer arresters shall be provided at quick closing valves and shall consist of factory sealed pressurized compression chambers and stainless steel expansion bellows.

15. Non-potable water lines shall be clearly marked to indicate that the water is not safe for drinking, washing or cooking.

16. Water distribution systems subject to freezing temperatures shall employ dry standpipe features as required.

17. Process water addition is required to make-up and feed tanks.

18. All active and nonactive waste collection tanks are provided with process water service.

19. Maximize equipment interchangability.

20. Select pumps to operate in the middle of their flow and head range.

21. New mechanical refrigeration equipment: Use CFC-22 (i.e. R-22) as the refrigerant where feasible (i.e, equipment in size ranges commercially available by a minimum of two suppliers with adequate operational experience). All available equipment types (reciprocating, helical screw, and centrifugal) shall be considered before determining feasibility.

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2.5.4 Process Selection

1. No process selection was required for the process water system since no equipment is required and the system uses the pressure of the sanitary water system.

2. The Process Chillers were selected based on a minimum commercial size of five refrigeration tons and a refrigerant requirement of R-22. Each chiller contains two evaporators to allow complete separation of the Active Chilled Water System from the Nonactive Chilled Water System. Chilled water composition of 45 percent propylene glycol/55 percent water (by weight) and the use of centrifugal chilled water pumps was based on the WRAP 1 design.

2.5.5 Process Description

1. The process water system is simply a distribution system that takes water from the potable water system and, after going through backflow preventers, distributes process water to various users. The chilled water system includes a 5-ton Process Chiller and spare (CH-12-501 A,B) to chill two separate chilled water distribution systems. An active Process Chilled Water System cools two process condensers and the chemical scrubber circulation cooler via two Active Chilled Water Pumps P-12-501A,B(one operating, one spare). A Nonactive Process Chilled Water System cools two polymer tank coolers and a mixed polymer tank cooler via two Nonactive Chilled Water Pumps P-12-501A,B (one operating, one spare).

2.5.5.1 Process Water System

1. Process water is taken from the sanitary water system at a pressure of 65 to 75 psig and is passed through two backflow preventers to isolate the process water from sanitary water. The process water is then distributed to users using available line pressure.

2. About 20 gpd of process water is used for decontamination or washdown of open/sort/repack equipment, sample cabinets, special waste enclosure and equipment, and polymer and grout enclosures and associated equipment.

3. About 100.2 gpd of process water is used to make grout in the vibro grout area. Normally process water is not used to make grout in the agitated grout area except during startup or when insufficient recycled waste water is available.

4. Process water is available to flush the polymer catalyst storage tank (hydrogen peroxide solution) as needed (normally no flow).

5. About 50 gpd of process water is used for makeup for the chemical scrubber. Process water is available as needed for emergency deluge of the reactive metals humidifier.

6. Process water is also available to flush the Active and Nonactive Waste Collection Tanks and for dilution (about 2 gpd) in the Aqueous Solution Makeup Tanks. About 25 gpd of process water will be used in the sample management area. Process water will also be piped to six utility hose drops.

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2.5.5.2 Chilled Water System(s)

1. Two chilled water systems use a common Process Chiller (CH-12-501A,B) designed to cool chilled water from 57°F to 42°F. The process chiller and spare each have five tons of refrigeration capacity having a reciprocating compressor using R-22 refrigerant. Each chiller has two evaporators where cold liquid refrigerant is evaporated while cooling two chilled water streams, one an "active" system cooling radioactive process streams and a "nonactive" system cooling three polymer chemical and mixing tanks. Each evaporator can cool 4.5 gpm of a 45 percent propylene glycol/55 percent water (by weight) solution. The evaporators and pumps for each chilled water system are oversized to accommodate future expansion of chilled water needs.

2.5.5.2.1 Active Process Chilled Water System

1. The Active Process Chilled Water System is designed to provide 4.5 gpm of chilled water at 42°F to "active" process users. Two Active Chilled Water Pumps P-12-501A,B (one operating and one spare) circulate warm (57°F) return chilled water through a process chiller evaporator to cool the chilled water to 42°F which then flows to the Polymer Encapsulation Vapor Condenser, the Mercury Evaporator Condenser and the Special Waste Chemical Scrubber Circulation Cooler. These condensers and cooler handle radioactively "active" streams.

2. In case of leakage in Evaporator 1, nonradioactive R-22 refrigerant will flow at a higher pressure into the active chilled water system. In case of leakage in the two process condensers or process cooler, nonradioactive chilled water will flow at a high pressure into the radioactive process streams. In this way, nonradioactive fluids will always flow into radioactive areas, thus preventing the spread of contamination outside of the process streams.

2.5.5.2.2 Nonactive Process Chilled Water System

1. To prevent the possibility of cross contamination of active process equipment to nonactive process equipment, a separate Nonactive Process Chilled Water System is also used. Like the active system, the Nonactive Process Chilled Water System is designed to provide 4.5 gpm of chilled water at 42°F to "nonactive" process users. Two Nonactive Chilled Water Pumps (P-12-502A,B) (one operating and one spare) circulate warm (57°F) return chilled water through a process chiller evaporator to cool the chilled water to 42°F which then flows to the VES Resin Tank Cooler, the Extender Tank Cooler and the Mixed Polymer Tank Cooler. These cooling requirements are necessary only during the warmer months to keep these insulated polymer tanks (located outdoors) below 70°F.

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2.5.5.3 Equipment Layout

1. The process water system is a piping distribution system with no major equipment and as such is not shown on any general arrangement drawing but is physically located throughout the WRAP 2A process area.

2. The Process Chillers and Active and Nonactive Process Chilled Water Pumps are located in the Utilities Compressor Room shown on H-2-140692 Chilled Water, Compressed Air and Nitrogen - Equipment General Arrangement. The noise generated by the chillers and their process function dictated their location in the Utilities Compressor Room. The piping distribution systems for both active and nonactive users are located in several locations in the WRAP 2A building and are not shown on any specific general arrangement drawing.

3. The Process Chillers are package units restricted to using R-22 refrigerant (to prevent ozone degeneration in case of leakage to the atmosphere). Each chiller contains two evaporators to allow complete separation of the active chilled water circulation to radioactive process coolers from the nonactive chilled water circulation. Since the R-22 refrigerant is at a higher pressure than either chilled water system, evaporator leaks will always flow from the refrigerant side to the chilled water side.

2.5.6 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.1, 2.2, 3.2, 3.5, 3.6, 3.8, 5.2, 7.0

2. DOE Order 6430.1A, General Design Criteria:

0110-99.0	Special Facilities; Nonreactor Nuclear Facilities - General
0203	Utilities within Easements or Corridors
0260	Piped Utility Materials
0266	Water Distribution Systems
1300-3	Safety Class Criteria
1300-12	Human Factors Engineering
1324	Radioactive Solid Waste Facilities
1525	Mechanical Insulation
1530-9	Water Storage and Distribution
1540	Plumbing/Service Piping
1550-2	Heating, Ventilating and Air-Conditioning Systems - Selection
1550-3	Heating, Ventilating and Air Conditioning Systems - Testing, Adjusting and Balancing
1565	Refrigeration
1595	Controls

3. WHC-CM-4-3, "Industrial Safety Standards"

4. WHC-CM-7-5, "Environmental Compliance Manual"

2.5.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140690	PFD - Process Water and Chilled Water
H-2-140692	Chilled Water, Compressed Air and Nitrogen - Equipment GA

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3.0 HVAC SYSTEM DESCRIPTION

3.1 Function

1. The HVAC system will provide the following functions.

   a. The facility will be designed to meet various plant operating requirements during the normal mode of operation and during a postulated design basis accident (DBA).

   b. In process areas, the design philosophy of the system will be to protect the outdoors from airborne contamination particulates generated by the waste treatment processes and also provide for a safe and comfortable working indoor environment within the as low as reasonably (ALARA) guidelines. The process areas will be kept at a negative pressure with respect to the outdoors.

   c. Provide proper environmental conditions for the health, safety and comfort of personnel.

3.2 Design Requirements

3.2.1 Physical Design Conditions

1. The following outdoor design conditions were used for design calculations and equipment sizing:

AMBIENT AIR CONDITIONS	TEMPERATURE (°F DB)	TEMPERATURE (°F WB)
WINTER		
Zone I and II Areas	9	--
All other Areas	12	--
SUMMER		
Zone I and II Areas	101	68
All Other Areas	98	66
Cooling Tower	101	68
Mean Daily Temperature Range	30°F	

2. For heating design in conjunction with the above design temperatures, the wind velocity shall be 15 MPH from the WNW (Winter). For cooling design the wind shall be 7 MPH from the WSW (Summer). The design ground temperature ten feet below grade shall be 55°F. The site latitude is 46°0′ longitude 119°30′ and the elevation is 700 feet above sea level.

3. The following indoor parameters were used for equipment sizing:

	CONDITIONED SPACE TEMP WINTER	CONDITIONED SPACE TEMP SUMMER
■ ZONE 1 AREAS (Zone I air will not be separately conditioned since it will be drawn from Zone II process area.)		
■ ZONE II AREAS		
Temperature °F (DB)	75	75
Relative Humidity Percent Minimum	30	30

	CONDITIONED SPACE TEMP WINTER	SUMMER
■ (Computer and Control Rooms)		
Temperature °F (DB)	72	72
Relative Humidity Percent Minimum/Maximum	30/50	30/50
■ (Administrative and Support Areas)		
Temperature °F (DB)	72	78
Relative Humidity Percent Minimum	30	30

3.2.2 Functional Requirements

1. The HVAC system will be designed to comply with DOE Order 6430.1A and ASHRAE 62-89. The system will be designed to be energy efficient in accordance with DOE 6430.1A. The system shall be functionally designed as follows:

a. Air quantities supplied to the spaces will be based on the dilution requirements of hazardous materials, heat gains in space via equipment and calculated heat loads.

b. The supply air will be distributed to provide uniform distribution. The air flow patterns will be downward, and designed to minimize eddies and areas of stagnation, and restrict the spread of contamination.

c. Ventilation system will establish and maintain a negative pressure gradient to provide airflow from uncontaminated areas to the areas of higher potential for contamination.

d. The ventilation system will be provided with detectors and will be alarmed to report and record its status.

3.3 System Description

3.3.1 Confinement Zone Description

1. The Waste Receiving and Processing (WRAP) Facility 2A will provide the capability to examine, treat, and certify contact-handled (CH) transuranic waste, mixed waste, and CH low level waste. To ensure the safe processing of the waste materials, process operations will be accomplished in containment systems (e.g., gloveboxes with the associated confinement ventilation systems).

2. In accordance with DOE 6430.1A, Section 1324, the WRAP 2A facility is classified as a Radioactive Solid Waste Facility and as such is required to have primary and secondary confinement systems. The WRAP 2A primary confinement system, with respect to the waste process area, are the enclosures and the Zone I ventilation system. The secondary confinement system is the building structures and the Zone II ventilation system.

3. The confinement system meets the various plant operating requirements during the normal mode of operation and during postulated Design Basis Accidents (DBA). The facility is defined as a "low hazard" facility.

4. The following paragraphs summarize the confinement system features of the HVAC system.

a. The WRAP 2A HVAC system will have multiple services. Primarily it serves as a confinement system. A zoned approach is used based upon a "cascade" pressure differential principle, i.e., the air flows from areas with lesser contamination potential to areas with a

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higher potential for contamination. The differential flow conditions are achieved by establishing boundaries within the facility that allows for maintenance of pressure zones that become progressively more negative from the outside environment to the interior of the waste process gloveboxes where the contamination source is greatest.

b. The primary confinement for the LLW, TRU and restricted waste operations consists of enclosures and process cells. It includes one stage non testable HEPA filters located at the inlet of the enclosures and off-gas tanks. It also includes an exhaust ventilation system which consists of one stage non testable HEPA and two stage testable HEPA filters, and an exhaust fan.

c. The primary confinement system equipment (exhaust duct, fans and filters) will be designed to maintain its structural integrity during and after operational and natural phenomena Design Basis Accident as prescribed in WHC 4.1 for a "low hazard" classification Radioactive Solid Waste facility. However, in the event of an electrical power failure, the primary exhaust fans will shut down and the system will go to a static (safe shut down) condition. This credible event will be evaluated in the PSAR, that demonstrates the radioactive whole body dose is within the allowable limits of less than 5 REM on-site and less than 0.5 REM off-site.

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d. The primary confinement system materials of construction will be all welded stainless steel for the process enclosures, exhaust ductwork and ventilation equipment. Each enclosure supply air inlet will be equipped with a HEPA filter to prevent backflow or migration of contamination in the event of an air pressure excursion or electrical power failure.

e. The Secondary confinement system consist of the building structures surrounding the waste process area and the Zone I HVAC exhaust system equipment. It is ventilated and HEPA filtered by the Zone II HVAC system. This system provides the operating and maintenance areas surrounding the primary confinement system with air quantities in accordance with the prescribed levels specified in ERDA 76-21 for potential airborne contamination. Some air provided to the Zone II area becomes supply air to the process enclosures. The remaining supply air is exhausted through the process room exhaust filter train at a controlled rate to maintain the proper room negative pressure.

f. Design room pressures in various zones are tabulated as follows:

Zone Description	Differential Pressure with respect to atmosphere
Zone I Process Enclosures	-1.15" W.G.
Zone II Process Area	-0.15" W.G.
Zone III Shipping and Receiving, Administration Area	+0.05" W.G.
Airlocks	-0.05" W.G.

g. Other system features are:

- Will not utilize safety class 1 or 2 systems. (Designated WHC safety Class 3).
- Will not be housed in a Category I structure.
- Only the exhaust enclosures, exhaust ductwork, ductwork supports, stack, off-gas system and HEPA filter housings will be designed to withstand safety Class 3 DBE.

- The exhaust fans will not operate after the DBE.
- Redundant exhaust HEPA filters and fans will be provided for maintenance purposes.
- Exhaust fans will not be on standby power.
- System will not include tornado missile or falling aircraft protection.
- Fire screens and fire dampers will be provided in the exhaust ductwork.
- System will not be required to meet single failure criteria.
- Entry into Zone II will be through airlocks.
- System will be designed for a safe shutdown with automatic isolation of confinement Zone I.
- System will not maintain negative pressure during DBE.
- Stack monitoring will be done during normal operation. Emergency power will be utilized during a power failure.

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3.3.2 Ventilation System

3.3.2.1 Zone Description

1. Zone I which comprises of interior of the primary confinement is purged with conditioned air at the rate of 15 air changes per hour. Air is supplied to the Zone I enclosures from Zone II process area.

2. Zone II comprises of the process area surrounding the primary confinement, and the process equipment room which houses the HEPA filter units.

3. Area next to the process area which is designated as access corridor and Shipping and Receiving area is classified as non-contaminated Zone III. Also Zone III includes administration and support areas as well as HVAC equipment room located at the upper level. Zone III will be maintained at a positive pressure of 0.05" W.G to ensure that no contamination from Zone II area can infiltrate into Zone III.

3.3.2.2 Zone I Supply and Exhaust

1. Assumption was made to purge the Zone I space with 15 air changes, per hour, in order to remove contaminated vapors and prevent any accumulation of radioactive materials with the Zone I boundary. The air change, per hour figure used is of the conservative value and further evaluation will be made in advanced conceptual phase of the design.

2. Zone I confinement boundary also consists of off-gas treatment system. Air quantities for exhaust from various enclosures (Grout, Polymer Shredder) are tabulated on drawing GP-8. Air is drawn into the off-gas system from the Zone II process area via non-testable inlet HEPA filters located at various enclosures.

3. Typically air is supplied to the process cells/gloveboxes from the space air surrounding the cell. Inlet air to zone I enclosures or off-gas tanks will be prefiltered and then HEPA filter prior to entry. Zone I Negative pressure will be kept constant inside each Zone I enclosure.

4. Each Zone I enclosure or off-gas tank is equipped with an exhaust filter bank consisting of 2-stage HEPA filter and prefilter assembly. All exhaust streams from Zone I confinement are collected and directed to the stack via the exhaust fan. 100 percent redundant exhaust fans will be provided for Zone II exhaust.

5. Zone I filtration unit will be designed to meet the requirements of ERDA 76-21 ANSI N509/510 and DOE Order 6430.1A.

6. Exhaust fans will be controlled from air flow measuring devices located in the exhaust ductwork. Variable flow fans will be utilized in order to maintain flow requirements.

7. Supply air to the Zone I confinement is utilized from Zone II supply air system. Make-up air handling units provide conditioned air to Zone II. The purpose of the make-up air units will be to deliver air quantities to Zone I as well as Zone II space. Required air handling unit supply fans will be controlled to deliver the exact air CFM required to maintain room pressure differentials. This will be accomplished by controlling the fan airflow utilizing variable inlet vane dampers.

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3.3.2.3 Zone II Supply and Exhaust

1. Zone II supply air distribution system consists of four air handling units (one of which will be a standby unit) supplying conditioned air to Zone II and Zone I confinement.

2. Supply air handling units will consist of prefilters, glycol heat recovery coil, chilled water, cooling coil, electric heating coil humidifier and supply blower. Units will be 100 percent air once-through type.

3. Air from Zone II process area will be exhausted once through, to the stack via 2-stage HEPA filters.

4. Four (4) HEPA filter units trains are proposed for Zone II exhaust system (one of which is a standby).

5. The room pressure control system for Zone II areas will be based upon an airflow balance utilizing airflow monitors. Exhaust air for Zone II will be kept at a constant volume and the supply air will be modulated in order to maintain Zone II room differential pressure.

6. Exhaust fans located at the HEPA filter trains will be controlled by utilizing variable inlet vanes in order to achieve constant air flow.

7. The filtration system will conform to the requirements of DOE 6431.1A, ANSI 509/510 and ERDA 76-21. The exhaust stack will be 1.3 times the building height (from the highest point).

8. Ductwork will be round, welded 304L stainless steel.

9. A local ventilation system is planned to be provided to ventilate and cool the polymer drums during storage for curing. The equipment will include fan, chiller, filters, ductwork and controls. This local ventilation system is not currently shown in the drawings, but the system cost estimate has been included in the project TEC.

3.3.2.4 Zone III Supply and Exhaust

1. Zone III is designated as a non-contaminated area. This zone consists of administration and support area, Transfer Corridor, Shipping and Receiving, Computer and Control Rooms and HVAC Equipment Room.

a. Administration and support areas will be served by a separate air handling unit consisting of filters, chilled water cooling coil, electric heating coil and supply blower. No redundant unit is required. The HVAC system will be a variable volume type utilizing variable volume boxes in the supply distribution system and variable frequency drive control for supply fan. Air will be returned back to the unit via return air fan. Rooms will be kept at +0.05" W.G. pressure by air balancing methods. Economizer control will be provided to insure most efficient use of outside and return air.

2. Locker Rooms

a. The locker rooms area will be served by a packaged 100 percent outside air make-up unit with heat recovery. Exhaust air from locker rooms will exchange heat with the incoming 100 percent outside air in an air-to-air rotating wheel type heat exchanger. The supply air will be electrically heated or cooled (chilled water) as required to maintain locker room conditions. Final filtration shall be 80 percent bags with 2" throwaway 30 percent prefilters. Ductwork shall be commercial grade galvanized except for the exhaust branches from the shower areas, through the heat exchanger, which shall be commercial grade 304L stainless steel.

b. Electric heating coils will be utilized for heating 100 percent outside air. A constant speed supply fan with constant temperature discharge shall be utilized to control the room temperature.

3. Shipping and Receiving Area

a. Area will be served by a packaged air handling unit, and return air fan. Room will be maintained at +0.05" W.G. by air balancing methods.

b. Air distribution ductwork will be of round or rectangular, galvanized steel materials.

c. Economizer controls will be provided to insure most efficient use of outside and return air. System does not require redundant unit.

4. Mechanical Equipment Room

a. Packaged make-up air unit with variable airflow fan will serve mechanical room with 100 percent outside air for summer cooling. Minimum outside air will be used during winter.

b. Heating will be accomplished, using electric heating coils. No redundancy is required.

5. Computer Room/Control Room

a. Packaged air handling units consisting of chilled water cooling coil, electric heating coil, filters humidifier, and supply fan will serve the room.

b. 100 percent redundant unit will be provided room temperature and humidity will be controlled as required per criteria.

3.3.3 Chilled Water System

1. The chilled water system consist of two centrifugal water cooled chillers, closed circuit cooling tower, primary and secondary pumps. No redundancy is provided for chillers and cooling tower at peak load conditions. Pumps will have 100 percent redundancy.

2. Primary - secondary pumping system will be utilized for chilled water distribution.

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3. Chillers will be located inside the HVAC equipment room at lower level. Cooling Tower will be located exterior to the building.

3.4 Safety Features

1. Safety features of the WRAP Module 2A facility include the following:

   a. The Process Zone I enclosures will be confined by both supply and exhaust HEPA filters mounted on the gloveboxes in order to confine contamination during a total loss of power. Likewise Process Zone II rooms will be confined by two stages of HEPA exhaust filters and a low leakage isolation damper located in the supply duct.

   b. The HVAC control systems will fail in the safe position. That is, the dampers and controls in Zone I and Zone II areas will fail in the position that will allow airflows and negative pressure to be maintained. In the case of a DBA accident the dampers will fail closed to isolate the Zone II spaces from the environment, and the exhaust dampers on the supply air will fail open. Control systems will also be maintained by a hierarchy of control such that one single failure of the Central Control System will not disable all of the HVAC systems. This will be accomplished by allowing HVAC systems to revert to local individual control if the PCS system fails. Local control panels will allow manual adjustment of setpoints.

   c. The process HVAC systems are equipped with isolation dampers on the inlet and discharge of both the make-up air handlers and exhaust filter trains.

   d. HVAC HEPA (high efficiency particulate air) filters in the process exhaust filter plenums will be testable in place to verify efficiency of filters as a contamination barrier. Enclosure inlet and exhaust HEPA filters will be non-testable. Continuous air monitoring will be provided downstream of non-testable HEPA's, in the exhaust ductwork.

   e. In the event the process air exhaust fan(s) shutdown, experienced belt failure or other abnormal conditions, the supply air fans will be interlocked to automatically shutdown. This precludes pressurization and expulsion of possible contamination from the process area to the environment.

2. Sufficient redundancy has been provided in the equipment and control components to ensure a reliable and maintainable system.

3.5 Interfaces

1. The WRAP 2A HVAC system will require interface with the following mechanical utility systems.

   a. Instrument air system

   b. Chilled water supply

   c. Chilled water return

   d. Sanitary sewer

   e. Domestic cold water

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2. The HVAC system will require interface with the following electrical system.

   a. Standby power system

   b. Normal power system

3. The HVAC system will require interface with plant control system.

3.6 Key DOE/WHC Criteria

KEY DOE/WHC CRITERIA:

1. WRAP 2A FDC Sections 2.1, 3.8, 3.9, 5.0, 7.0.

2. DOE ERDA 76-21 (ORNL-NSIC-65-1) Nuclear Air Cleaning Handbook: The Design, Construction and Testing of High Efficiency Air Cleaning Systems.

3. DOE 5400.1 General Environmental Protection Program Requirements Chapter IV Environmental Monitoring Requirements.

4. DOE 5480.11 Radiation Protection for Occupational Workers.

5. DOE ORDER 6430.1A General Design Criteria:

0110-9	Operation, Maintenance, Repair, and Replacement
0110-12	Energy Conservation
0110-99.0	Special Facilities, Nonreactor Nuclear Facilities--General
1161	Enclosures
1300-1	Coverage and Objectives
1300-6	Radiation Protection
1300-7	Confinement Systems
1300-8	Waste Management
1300-9	Effluent Control and Monitoring
1300-11	Decontamination and Decommissioning
1300-12	Human Factors Engineering
1324	Radioactive Solid Waste Facilities
1324-6	Confinement Systems
1324-7	Effluent Control and Monitoring
1525	Mechanical Insulation
1530-99.0	Nonreactor Nuclear Facilities--General
1550	Heating, Ventilating and Air-Conditioning Systems
1550-1	General Sizing and Design Criteria
1550-2	Heating, Ventilating, and Air-Conditioning Systems
1550-3	Testing, Adjusting, and Balancing
1550-99.0	Nonreactor Nuclear Facilities - General
1565-1	Refrigeration, CFC Limitations as a Refrigerant
1589-1	Air Pollution Control, General
1589-2	Improved Risk Concept
1589-99.0	Special Facilities, Nonreactor Nuclear Facilities--General
1595	Controls (All Sections)
1694	Energy Conservation

Westinghouse Hanford Company Manuals

6. Hanford Plant Standards Design Criteria, SDC-5.1, Standard Design Criteria for Heating, Ventilating and Air Conditioning, Rev. 6.

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7. Hanford Plant Standards, HPS-157-M to HPS-163-M. Standard Specifications for HEPA Filters.

8. WHC-CM-4-9, Radiological Design Criteria, Section 4, Ventilation (To be provided by WHC).

9. WHC-CM-4-3, Industrial Safety Manual

10. WHC-CM-4-11, ALARA Program Manual

CODES AND STANDARDS:

1. Associated Air Balance Council:

   AABC Volume A-82, National Standards for Total System Balance Air Distribution. Hydronic Systems-Sound-Vibration-Field Surveys for Energy Audits.

2. American Conference of Governmental Industrial Hygienists

   ACGIH Industrial Ventilation Manual of Recommended Practice.

3. Air Movement and Control Association:

   AMCA Publication 99, Standards Handbook.
   AMCA Publication 201, Fans and Systems.
   AMCA Publication 210, Laboratory Methods for Testing Fans for Ratings.
   AMCA Publication 261, Directory of Products Licensed to Bear the AMCA Certified Rating Seal.

4. American National Standards Institute:

   ANSI N13.1 Guide to Sampling Airborne radioactive Materials in Nuclear Facilities.

5. Air Conditioning and Refrigeration Institute:

ARI	410	Forced Circulation Air Cooling and Air Heating Coils.
ARI	430	Central Station Air Handling Units.
ARI	450	Water-Cooled Refrigerant Condensers, Remote Type.
ARI	460	Remote Mechanical-Draft Air-Cooled Refrigerant Compressors.
ARI	520	Positive Displacement Refrigerant Compressors and Condensing Units.
ARI	550	Centrifugal Water Chilling Packages.
ARI	590	Reciprocating Water Chilling Packages.
ARI	850	Commercial and Industrial Air Filter Equipment.

6. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

   ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.
   ASHRAE Standard 20, Methods of Testing for Rating Remote Mechanical Draft Air Cooled Refrigerant Condenser.
   ASHRAE Standard 24, Methods of Testing for Rating Liquid Coolers.
   ASHRAE Standard 51, Methods of Testing Fans for Rating.
   ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy.
   ASHRAE Standard 62, Ventilation for Acceptable Indoor Air Quality.
   ASHRAE Standard 90, Energy Conservation in New Building Design.
   ASHRAE, Applications Handbook.
   ASHRAE, Equipment Handbook.
   ASHRAE, Fundamentals Handbook.

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ASHRAE, Refrigeration Handbook.
ASHRAE, Systems Handbook.
ASHRAE, Manual, Design of Smoke Control Systems for Buildings.
ASHRAE, Publication GRP 158 Cooling and Heating Load Calculation Manual.

7. American Society of Mechanical Engineers:

ASME B16 Series, Fittings, Flanges, and Valves.
ASME B31.1, Power Piping.
ASME N509, Nuclear Power Plant Air Cleaning Units and Components.
ASME N510, Testing of Nuclear Air Cleaning Systems.
ASME, Boiler and Pressure Vessel Code, Section VIII.

8. American Society for Testing and Materials:

ASTM G46, Recommended Practice for Examination and Evaluation of Pitting Corrosion.

9. Building Officials and Code Administrators International, Inc.:

BOCA, Basic/National Mechanical Code.

10. Cooling Tower Institute:

CTI Bulletin ATC-105, Test for Water Cooling Towers.

11. National Electrical Manufacturers Association:

NEMA MG-1, Motors and Generators.

12. National Fire Protection Association:

NFPA 45, Fire Protection for Laboratories Using Chemicals.
NFPA 72E, Standard on Automatic Fire Detectors.
NFPA 90A, Air Conditioning and Ventilation Systems.
NFPA 91, Blower and Exhaust Systems.
NFPA 96, Cooking Equipment, Vapor Removal.
NFPA 101, Life Safety Code.
NFPA 255, Test and Surface Burning Characteristics of Building Materials.

13. U.S. Nuclear Regulatory Commission:

NRC NUREG 0700, Guidelines for Control Room Design Reviews.

14. Sheet Metal and Air Conditioning Contractors National Association:

SMACNA, HVAC Air Duct Leakage Test Manual.
SMACNA, HVAC Duct Construction Standards--Metal and Flexible.
SMACNA, Fibrous Glass Duct Construction Standards.
SMACNA, Round Industrial Duct Construction Standards.
SMACNA, HVAC Duct Design Manual.
SMACNA, Energy Recovery Equipment and Systems Manual.

15. Thermal Insulation Manufacturers Association:

TIMA, Economic Thickness Manual.

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16. Underwriters Laboratories:

UL 207, Refregerant-Containing Components and Accessories, Nonelectrical.
UL 586, High Efficiency Particulate, Air Filter Units.
UL 723, Test for Surface Burning Characteristics of Building Materials.
UL 900, Test Performance of Air Filter Units.
UL 984, Hermetic Refrigerant Motor--Compressors.

3.7 Reference Drawings

Drawing Number	Drawing Title
H-2-140726	HVAC Notes and Abbreviations
H-2-140727	Process Area - Master HVAC Airflow Diagram
H-2-140728	Process Supply - HVAC Airflow Diagram
H-2-140729	Process Exhaust - HVAC Airflow Diagram
H-2-140730	Administration and Locker Room - HVAC Airflow Diagram
H-2-140731	Shipping/Receiving, Computer, Control and Mechanical Rooms HVAC Airflow Diagram
H-2-140732	HVAC Chilled Water - Piping Flow Diagram
H-2-140733	HVAC Zone Plan - Lower and Ground Level
H-2-140734	HVAC Zone Plan - Upper Level
H-2-140735	HVAC General Arrangement - Lower Level Plan
H-2-140736	HVAC General Arrangement - Upper Level Plan
H-2-140737	HVAC General Arrangement - Building Sections

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4.0 PLANT MANAGEMENT SYSTEM DESCRIPTION

4.1 Introduction

1. The design scope for the process control systems at WRAP 2A encompasses a micro-processor based Plant Management System (PMS) consisting of two sub-systems; 1) the Data Management System (DMS) and 2) the Plant Control System (PCS).

2. As part of the Plant Management System, the central micro-processor based Data Management System shall accurately collect, analyze, store and report waste container data and inventories. This will provide a facility material balance of waste and enable the fissile contents within processing areas to be estimated. Additionally, a distributed architecture Plant Control System shall orchestrate the movement of waste containers among the various operating stations and monitor and control process operations and facility HVAC and utility systems.

3. Operator consoles with graphic displays that mimic the process shall be used in a centrally located control room and at local work stations. These consoles and work stations shall provide process and alarm status, and allow operators to control the process. The Control Room and local operator consoles and workstations shall have the capability for surveillance of plant status by means of CCTV monitors. Data entry and retrieval to/from the Data Management System shall be provided at the operator consoles and work stations.

4.2 Plant Control System

1. The PCS is based on a Distributed Control System (DCS) architecture with programmable logic controller (PLC) providing the sequencing logic for process and facility control and monitoring. The PCS has local control units housed in eight enclosures located on the plant floor to service the process and facilities areas as follows:

Controller	Areas Served
CNR-11-201	Shipping and Receiving HVAC Utilities Stack Sampling System
CNR-11-202	Size Reductions and Repack
CNR-11-203	Pug Mill
CNR-11-204	Box Open, Sort and Repack Health Physics Monitors
CNR-11-205	Special Waste Size Reduction Mercury Pretreatment
CNR-11-206	Polymer/Resin Chemical Storage Polymer Encapsulation
CNR-11-207	Bulk Powder Storage Vibro Grout Agitated Grout NDA
CNR-11-208	Off-Gas Treatment Decontamination System Aqueous Solution Make-up Active/Nonactive Liquid Waste Health Physics Monitors

2. Control of the Internal Transport System is distributed among the various area control units. This facilitates the interface between the transport system and the various enclosure. Radiation and Health Physics monitors are also distributed among the control units so that the shortest run of signal wiring from monitor to control unit will be achieved.

3. Free standing cabinets are provided to house all electronic equipment such as controllers, communication network interface modules, multiplexers, power supplies, I/O modules and terminals. Racks and cabinets shall meet or exceed NEMA 4 requirements.

4. Local control units provide continuous control and monitoring, independent of control room operator interfaces or communication network, by use of regulatory and sequential controllers. The local control units may consist of one or a combination of multi-loop regulatory and sequential controllers.

5. The system is designed so that control functions are distributed on a modular basis to distribute risk. Control functioning shall not depend on a centrally based device or communication system.

6. The sequential controller is capable of implementing sequential control logic, interlock logic and discrete control functions without higher level support. The configuration of the system will allow either fully automatic operation or remote manual as controlled by operators located in the control room.

7. Power supplies (24 to 28 volt dc) for field transmitters and digital inputs shall have current output sufficient to power 4-20 milliamperes analog inputs and digital inputs as contained in the I/O list. Failed power supplies will have automatic switch over to a backup unit. Power supply failure contacts will be provided to indicate failure of either the primary or backup unit.

8. The Plant Control System will be capable of handling the following input/output signals:

- 4-20 milliamperes Input
- 1-5 volts DC Input
- Field Contact State Input
- 3-Wire PNP Source/Sinking Transistor Input
- Digital Pulse Input
- Grounded/Ungrounded Thermocouple Input
- R.T.D Input
- Contact Output
- 120 VAC Output
- 4-20 milliamperes Output
- RS-232C Serial Link

9. All Digital I/O modules will contain optical isolating devices providing 1200 volts DC or more isolation from user wiring or other I/O modules.

10. Elements of the PCS are connected on a redundant, separately routed data highway compatible with linking to the Data Management System for a fully integrated Plant Management System.

4.3 Data Management System

1. A separate networked computer system is provided to perform the function of the Data Management System. The system consists of industrial personal computer (PC) data terminals through out the facility for data entry and a desk top workstation in the control room as system manager and for central processing.

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2. The central processing unit in the control room is a high performance workstation equivalent in capability to Sun Micro Systems Inc. SPARC station 2 including monitor, memory, hard and floppy disk drives printer and ethernet interface capabilities. The central processor runs on a UNIX operating system.

3. Each data entry terminals consists of:

- A 80386 central processing unit (33 MHz)
- 4 megabyte of random access memory (RAM)
- 80 Megabyte hard drive
- 600 x 800 fixed resolution video graphics array (VGA) graphics card
- 14 inch VGA display monitor
- Standard english keyboard
- Bar code reader wand (sample management area only)

4. The data entry terminals are provided in the following locations.

Location	Function
Pb and Hg Special Waste Glovebox	Input Container Content Data
Shred and Repack Glovebox	Input Container Content Data
Pug Mill Glovebox	Input Container Content Data
Box Breakdown Area	Input Container Content Data
Sample Management Area	Prepare and Retrieve Sample Data
Computer Room	Waste Record Preparation for Solid Waste Information Tracking System (SWITS)

5. The data entry station in the Sample Management area is provided with the following peripherals.

a. Bar code label printer to generate labels to tag each sample.

b. Bar code reader wand to identify labeled samples.

c. Printer to generate necessary documentations.

6. Also connected on the DMS communication network are four (4) NDA stations and an NDA system integrator. The NDA equipment provides the isotopic data needed to complete the waste documentation.

7. Communication with DMS system components is by means of ethernet baseband coax cable as a backbone. The system conforms to IEEE 802.3 protocol.

8. Interface to system and database outside of WRAP 2A, e.g., other WRAP and solid waste project systems, is provided by an ethernet concentrator. The ethernet concentrator is equivalent in capabilities to an Ungermann-Bass Access/One ethernet on Fiber Option System. The ethernet concentrator connects to the Hanford Local Area Network (HLAN) by means of a fiber optic adapter. The ethernet concentrator also serves as a hub for the office personal computer network, giving maximum flexibility for data access.

4.4 Control Room Arrangement

1. The control room contains four consoles with both graphics screens and closed circuit television (CCTV) monitors for supervisory and control purposes. The number of graphics screens and CCTV monitors at each console is determined by the processes being

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monitored/controlled. The division of responsibilities for the operators of these consoles is as follows.

a. CNS-11-201 This is the Lead Operations Console. The operator at this station will be responsible for directing the flow of material throughout the plant. This includes all drums and boxes received at and shipped from WRAP 2. All facility monitoring of the plant via CCTV cameras other than those in the grout and Polymer Encapsulation areas is done at this console.

b. CNS-11-202 This is a Process Control Console for the grout area. That includes the Bulk Powder Storage, Vibro Grout System, and the Agitated Grout System. The operator here shall be responsible for all processes in these areas as well as monitoring some of the general process areas such as Off-Gas, Decon, Aqueous Makeup, and Act/Non-Act. Liq. Waste.

c. CNS-11-203 This is the Process Control Console for the Polymer Encapsulation area and some of the general process areas. The operator here controls the flow of drums, lift tables, vacuum dewatering enclosures, in-drum mixers, and the waste water transfer pump in the Poly. Encapsulation area. Secondary duties are monitoring and providing control for such areas as Off-Gas, Decon, Aqueous Makeup, and Act/Non-Act. Liq. Waste.

d. CNS-11-204 A Process Control Console for the Drum NDA area. Most of operator's time will be spent sending and receiving info. to and from the NDA area. This will include entering isotopic data received from the NDA equipment into the records database.

2. The control room consoles are configured as follows:

a. 1 section containing CCTV monitor w/control panel

b. 1 section containing Color Graphic terminal w/keyboard and trackball

3. Each console will be free standing and will be totally enclosed (except for required ventilation) with access doors at rear. The console will provide the cabinetry and table surfaces as required to mount the equipment specified.

4. Operator consoles will be designed in accordance with human factors guidelines given in Military Specification (MS) MIL-STD-1472D.

5. Operator interfaces with graphic displays that mimic the process are used to operate and control the plant. Data entry and retrieval to/from the Data Management System will be provided at the NDA operator console. Operator interfaces consist of a CRT monitor and keyboard assemblies complete with associate electronics package including micro-processor and memory, a power distribution assembly, and floppy/hard disk drives. A track-ball assembly will be provided for cursor control.

6. Consoles are located in the control room such that the operators will have visual access to the Process area.

7. An alarm and event printer is included in the design to provide hard copy reports on a demand basis.

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4.5 Control Philosophy

1. Receiving and Shipping

a. Each container will be visually and radiologically inspected, and its accompanying documentation inspected by an operator. Documentation will also be received electronically via the HLAN and available through the DMS. Each drum and box will have bar code identifiers on the sides and top. The radiological survey will be done manually.

b. All receiving operations will be done manually by an operator with the aid of a hand held bar code reader and a local work station with access to the Plant Management System. Information obtained from visual and radiological inspection will be input by the operator using the local work station.

c. Each box and drum will be identified via bar code reader, weighed, and the weight entered automatically into the Data Management System. Weigh information will be stored in pounds and kilograms.

d. Processed drums coming back from the process area will be manually loaded onto pallets in the shipping area. Each drum will be identified by the operator using a hand held bar code reader. Weight of the drum will be taken in the conveyor and automatically entered into the DMS.

2. Process Gloveboxes

a. Operations within the process gloveboxes will be controlled locally by means of operator interface unit communicating with the Plant Control System. The following gloveboxes are provided with local interface units:

- Size Reduce and Repack
- Pug Mill
- Lead and Mercury Pretreatment

b. The processes within these gloveboxes will be a combination of semi-auto with manual override. All operation will be controlled through the logic and I/O contained in the Plant Control System. The operator has the choice of either stepping through a series of operations to process a drum or take control of each individual device.

c. Alarms, interlocks and system shutdown will be active through the PCS whether the system is in semi-auto or manual mode.

d. A data entry terminal will be provided at each glovebox. This terminal will enable the operator, by mean of visual observation to update a "process file" of the container. The process file will contain information about container contents and other necessary information.

3. Non-Destructive Assay (NDA) Station

a. The NDA equipment will include passive-active neutron (PAN) systems, and Gamma Energy Assay (GEA) systems. Each NDA system will utilize weight, density, and radionuclide distribution data from the Data Management System and established algorithms to calculate

necessary radionuclide information. Drums containing known waste matrices and radionuclide content will be used as standards for periodic recalibration of all NDA equipment.

b. An operator in the control room will be able to remotely move the containers into each of the NDA units, and the units will automatically identify the container as tracked by the software. The assays will be preformed automatically with necessary container movement control and computational algorithms provided by the control system. The operator will then enter the necessary certification information into the Data Management System and initiate routing of the container to the next station.

4. Box Open/Repack Station

a. The operations at the Box Open/Repack station will be a combination of local hard wired control and manual control through the PCS. Conveyor and airlock doors will be controlled manually by an operator from a local interface unit through the input/output of the PCS. The unpacking will be done with a locally hard wired manipulator.

b. A data input terminal will be provided to input information about drum content into the DMS as they are being packed.

5. Immobilization Processes

a. Both the grouting and resin encapsulator processes will be controlled from the control room. The operator will be aided by input from PCS sensors as well as from visual input from the CCTV system.

b. Bulk loading of grouting materials will be done locally by means of hard wired local control and push buttons.

c. The polymer/resin chemical storage area will be controlled locally. The operator will set local totalizers for the desired amount of chemical to be added to a tank. The local totalizes will control the addition and shut off the pump when complete.

d. The polymer mixing tank will be filled and mixed locally. Local instrumentation will aid the local operator. Monitoring of tank levels and alarms will be provided in the control room.

e. The actual immobilization operation will be controlled from the control room from either the Grout Operator's console or the Encapsulation Operator's console. Input/output devices will be controlled through the PCS. Mimic screen on a graphics terminal will aid the control room operator as well as CCTV visual input.

6. Sample Management Area

a. Samples will be taken in the Sample Management Area from drums placed in a glovebox through an airlock. A terminal and printer directly connected to the DMS will be available in the Sample Management Area to record information about the sample. The samples will then be sent to a laboratory for analysis.

b. Once the laboratory analysis is complete, the information will be retrieved through the Sample Management Area terminal via the HLAN. The sample information will be used to input information to the DMS about how to process (i.e., treat, ship, or store) the waste from which the sample was taken. This information will be stored in the DMS.

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7. Internal Transport System

a. Control of the Internal Transport System will be by means of a vendor supplied automated guided vehicle (AGV) control system interfaced to the PCS. The vendor supplied control system will supply the path information to an on-board processor which keeps the AGV on track. The task request will be made by the PCS through a network link to the AGV controller. Task requests include information which directs the AGV to proceed to a location, retrieve a load and take it to another location.

b. Task requests will be defined by the software code in the PCS. The software will control container movement automatically. In the case where the automatic sequence must be altered, the operator in the control room may take remote manual control of task requests and direct the AGV to complete the necessary load movement. In manual override mode, AGV, and consequently drum movement, shall be tracked and recorded by the PCS.

8. HVAC System

a. The HVAC system will be monitored by the Plant Control System. Graphic displays mimicking the HVAC system will be available in the central Control Room for operator monitoring and for remote manual override control. The Control Room operator will have the capability to start and stop the HVAC system and to change setpoints. Alarms and out-of-tolerance conditions will be annunciated in the Control Room. Loop control will be provided by the HVAC system by means of local loop controllers.

9. Utility Systems

a. The Electrical system will not be under Plant Control System control. Power loss alarms and/or indications will be routed to the Plant Control System.

b. The Fire Detection System will be a stand alone system. Alarms and indications will be routed to the Plant Control System for monitoring by the Control Room operator. The fire control panel will be located in the main lobby. The fire alarm system will be tied into Hanford Fire Department via a RFAR box.

c. Air Systems will be operated locally through hard wired control panels. Alarms and indications will be routed to the Plant Control System for monitoring by the Control Room operator.

4.6 Health Physics System Description

1. Health Physics Systems include all equipment necessary to monitor and control beta and gamma radiation for the WRAP Module 2A facility, external of the waste handling and processing operations. In this section, CDR design objectives for each Health Physics System is described. Requirements for uninterruptible power supply (UPS) support is also discussed.

2. The majority of Health Physics Systems for WRAP Module 2A will be to Westinghouse Hanford Company (WHC) site standards or those already typically in use at WHC. For the purposes of this report, vendor names and models have been specified for each system, however, for applications where WHC site standards do not exist, the vendors and models listed only serve as a representative example for CDR design.

3. Air Monitor Systems include those which detect the presence of radioactive particles (beta) in the air. Existence of these particles will be monitored in the stack, glovebox ventilation ducts, all rooms containing waste drums, and the Process HVAC room. These systems can measure

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contamination real-time, or collect a sample for analysis at a later date. Alpha will not be monitored since no transuranics are being processed at WRAP 2A.

4. Isokinetic Exhaust Stack Monitoring System is provided at the ventilation exhaust stack to monitor plant emissions. Features of this system include:

a. A dual exhaust stack sampling system, consisting of an isokinetically controlled record sampler and an isokinetically controlled sampling system, is a regulatory requirement (40 CFR 60 and 61).

b. The term "isokinetic" implies that representative stack air velocity be used to measure total air volume passing through the stack. This information is used to accurately calculate the concentration of contaminated particles being exhausted through the stack. This requires use of a "rake" type probe (multiple flow sensors) inserted into the stack.

c. The record sampler is a system which collects representative stack exhaust particulates on a paper filter. This filter is periodically removed, with the collected particulates measured for concentration of various contaminants using isokinetic air volume measurements in the calculation. This requires an independent "rake" type sampling probe inserted into the stack. This is not a real-time system.

d. The sampling system provides a real-time indication of radiation particle concentration using isokinetic air volume measurements and in situ radiation detectors. This requires an independent "rake" type sampling probe be inserted into the stack for each type of radiation to be monitored. Beta particulates will be monitored independently for WRAP Module 2A.

e. The independent beta monitoring system is required due to the potential release of beta particles during handling and processing of waste containing mixed fission products.

f. The WRAP Module 2A CDR Isokinetic Exhaust Stack Monitoring System consists of:

1) A Kurz Instruments exhaust sampling assembly and triple automatic isokinetic sample probes, Model Kurz-EVA 4200D;

2) A Kurz enclosure mounted exhaust isokinetic airflow controller, Model 4200;

3) A Kurz record filter assembly;

4) Three Kurz flow controllers, Model 710;

5) Three Kurz control valves, Model 730;

6) Three Kurz sampler pumps, Model 251;

7) An Eberline beta continuous air monitor (CAM), Model AMS-3A;

8) All mounted in a generic monitoring exhaust cabinet.

g. It is a regulatory requirement that the stack exhaust monitoring system remain functional during loss of building power. As a result, the stack monitoring system is supported by the Uninterruptable Power Supply (UPS) system for the building.

5. Glovebox Ventilation Duct Continuous Air Monitoring (CAM) System: The non-isokinetic, Glovebox Ventilation Duct CAM system will measure the concentration beta particulates leaving each Process glovebox HEPA filter. This will aid building operators and Health Physics personnel

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in isolating and quantifying amounts of radioactive particulates bypassing glovebox filtering systems in the event of an operation problem. There are no requirements for emergency power to the ventilation monitoring systems. Each CAM system will consist of:

a. An Eberline beta air monitor, Model AMS-3A;

b. An Eberline regulated air pump, Model RAP-1;

c. A sample probe.

6. Room Continuous Air Monitoring (CAM) Systems: The Room CAM systems will measure the concentration of beta particulates in all rooms containing drums, the Process HVAC room, and around Process gloveboxes. Room CAMs will be strategically (near room exhaust walls) placed in each room containing waste drums and in the Process HVAC room, to allow representative sampling of room air for beta concentrations. The beta CAMs are required due to the potential release of beta particles during handling and processing of waste containing mixed fission products and a potential leak in the filter trains in the process HVAC room. Room CAMs must remain functional during loss of building power. As a result, these systems must be supported by the UPS system for the building. The WRAP Module 1 Title I design consists of:

a. Eberline beta CAMs, Model AMS-3A;

b. Eberline regulated air pumps, Model RAP-1.

7. Operator Breathing Air Samplers: Operator Breathing Air Samplers will be strategically placed near process gloveboxes to sample air near frequently employed operator work stations. Filters collected from these samplers are periodically removed, with collected particulates analyzed for various contaminants. The design includes fixed air samplers consisting of an Eberline regulated air sampler, Model RAS-1. The Operator Breathing Air Sampling Systems must be supported by the UPS system.

8. Radiation Monitoring Systems are those which detect the presence of abnormal radiation levels in air. This includes systems to measure gamma rays. These systems include both stationary and portable detectors.

9. Area Radiation Monitoring (ARM) System: Design includes ARMs throughout the Process area and ARMs in the Shipping and Receiving room each strategically located near routinely occupied work stations. The ARMs must remain functional during loss of building power. As a result, this system must be supported by the UPS system for the building. Each system includes:

a. An Eberline panel mount display, Model EC-8;

b. An Eberline gamma detector, Model DA1-6.

10. Portable Gamma Monitors are necessary for monitoring gamma radiation levels during maintenance activities, during routine surveys, and prior to shipment and receipt of waste containers. The WRAP Module 2A CDR design will not include Portable Gamma Monitors. It is expected that Portable Gamma Monitors will be supplied by the Westinghouse Hanford Corporation (WHC) as required.

11. Contamination Control Monitoring Systems aid in restricting the spread of contamination both inside, and outside the facility. These monitors identify surface contamination and alert the operator or Health Physics technician as to the location and intensity of such contamination.

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They are typically used as part of the routine egress procedure from gloveboxes gloves and the Process and Shipping and Receiving rooms, and before entering and exiting the locker rooms.

12. Fixed Friskers - Surface Contamination Monitors: Fixed Friskers or poppies consist of a fixed electronic counting device and a hand held "wand". They are used by operators and Health Physics personnel to detect contamination on the surfaces of skin, clothing, drums and equipment. The WRAP 2A CDR design identified 16 locations where the use of Fixed Friskers would be beneficial. There are no requirements for emergency power to the friskers. These areas include:

a. 2 at each of the 3 process gloveboxes for monitoring hands and clothing immediately after hand removal from gloves;

b. 2 at the exit of the Process area for monitoring the entire body for contamination before leaving the process area;

c. 2 at the exit of the coveralls removal area, before entering the locker rooms;

d. 1 at the Grout area decontamination stations;

e. 1 at the exit of the Shipping and Receiving room;

f. 1 in the Sample Management area;

Each system includes:

a. An Eberline radiation monitor, Model RM-20;

b. An Eberline (hold) probe, (hold).

14. Portable Friskers: Portable Friskers are necessary for monitoring surface contamination levels during maintenance activities, during routine surveys, and prior to shipment and receipt of waste containers. Portable Friskers are identical to Fixed Friskers except that they are not secured and utilized in one particular area. The WRAP 2A CDR design will not include Portable Friskers. It is expected that Portable Friskers will be supplied by the Westinghouse Hanford Corporation (WHC) as required.

15. Hand and Foot Monitors: WRAP 2A CDR design identified 2 locations where the use of Hand and Foot Monitors would be beneficial. These areas are the exits of the men's and women's locker rooms. These monitors detect surface contamination (both alpha and beta/gamma) on the hands and feet of personnel. An Eberline Hand and Foot Monitor, Model HFM-6 would be used for WRAP 2A design. There are no requirements for emergency power to the Hand and Foot Monitors.

16. Smear Counters: Smear Counters are desk top instruments used to detect radiation contamination (both alpha and beta/gamma) emitting from paper samples or paper filters. A sliding tray with a dish type depression allows entry of the paper sample or filter into the detector. Variable count times can be selected to measure contamination levels. Multiple tray units are available. WRAP 2A CDR design has identified the decontamination room of the Process area and RPT office as the most appropriate locations for Smear Counters. The Smear Counter identified for CDR design is the Eberline Model (hold) counter. There are no requirements for emergency power to the Smear Counters.

17. Alarms/Annunciators: Alarms, with appropriate annunciators, will be strategically placed throughout WRAP 2A to aid in the suspected hazard indication.

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4.7 CCTV System Description

1. The Closed Circuit Television (CCTV) system for WRAP 2A has been designed for process monitoring and control. The major components of the CCTV systems are as follows:

2. Video Cameras: Solid state monochrome (black and white) cameras with 6:1 zoom lenses provide good resolution and sensitivity for viewing process. The cameras are sealed in pressurized housing to protect camera from possibility of contamination. There are twenty seven (27) video cameras in the plant. Their locations are as follows:

a. 2ea. in the NDA area to view the movement of the Automated Guided Vehicle (AGV) in the area from the Control Room.

b. 2ea. in the Drum Size Reduce and Repack Area to view the various functions not visible from the outside.

c. 2ea. in the Pug Mill to view the various functions not visible from the outside.

d. 4ea. in the Special Processes Area to view the various functions not visible from outside.

e. 2ea. in the Polymer Encapsulation Area to view the movement of the AGV in the area from the Control Room.

f. 4ea. in the Polymer Encapsulation Enclosures to monitor filling of the drums from the Control Room.

g. 4ea. in the Grout Area to monitor the process from the Control Room.

h. 1ea. in the Auto Drum Stacker/Retriever Area to view the movement of the AGV and the auto-stacker from the Control Room.

i. 2ea. in the Box Size Reduce and Repack to view the process from outside the room.

j. 2ea. in the Shipping and Receiving Area to monitor activities from the Control Room.

3. Video Monitors: There are nine (9) 14-inch monochrome (black and white) video monitors to view various plant process's. Four (4) of the monitors are in the Control Room in the Operator Consoles. And, one monitor is at each of the three Process area operator stations and two are in the box breakdown workstation.

4. Video Matrix Switcher: This is a microprocessor based unit capable of accepting 40 video inputs and switching them to any of the 20 video outputs. The video inputs come from the following sources:

a. 25ea. Video Cameras

b. 2ea. Video Cassette Recorders

5. Video Outputs are configured as follows:

a. 9ea. Monochrome video monitors

b. 2ea. Video Cassette recorders

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6. Camera Control System: This is a microprocessor based system to switch camera control. With the Video Matrix Switcher, this allows the operator to select video input and outputs and control pan, tilt, zoom, focus, and iris functions of the selected camera. There is one operator control panel associated with each of the nine (9) monitors.

7. Video Cassette Recorders: There are two (2) Video Cassette Recorders (VCR) provided in the design to record or playback process operations for future reference, training or record purposes.

8. Drawing H-2-140683 is a location plan that provides a graphic representation of the CCTV system component locations.

4.8 Equipment Listings

1. **Table 4.1** list an instrument count as taken from the various process and material flow diagrams. The list was used to obtain a cost estimate for capital purchase of instrumentation. Some of the instrumentation which appear on the list was taken directly from instrument "bubbles" which appear on the MFD. Other instruments do not show up on PFD's but were assumed as being likely to appear on a detailed design. Due to the evolution of the design and budget and schedule constraints, a one-for-one correlation between **Table 4.1** and the final MFD's may not exist. However, the differences are not sufficient to change the instrumentation cost estimate by an appreciable amount. A detailed instrument index will be developed during Title I and II design.

2. **Table 4.2** is a listing of input/output points for the distributed control system. The Table was used to estimate the size of the Plant Control Systems for purposes of establishing an architecture and to estimate system cost. The list makes distinction among digital input (DI), digital outputs (DO), analog inputs (AI), analog outputs (AO) and loop input/output (LI and LO). The same limitations, as to level of detail, apply to **Table 4.2** as applied to **Table 4.1**.

3. **Table 4.3** is a listing of bar code equipment as taken from process and mechanical flow diagrams. The list was used to estimate the cost of the bar code reader system. Drawing H-2-140683 provides the locations of bar code equipment.

4. **Table 4.4** gives a listing of Health Physics Instrumentation for WRAP Module 2A. This list was used to produce the cost estimate. Drawing H-2-140681 provides the location of Health Physics monitor at WRAP Module 2A.

5. **Table 4.5** gives a listing of Closed Circuit Television equipment at WRAP 2A. The list was used to provide the cost estimate for the CCTV system. Drawing H-2-140683 give locations of CCTV system components.

6. **Table 4.6** give a listing of the basis for the cost estimate.

4.9 Key DOE/WHC Criteria

1. WRAP 2A FDC Sections 2.1, 2.2.6, 2.2.7, 3.7, 3.8, 5.0, 7.0.

2. DOE 1360.1A Acquisition and Management of Computing Resources.

3. DOE 1360.2A Unclassified Computer Security Program.

4. DOE 1350.3B Automatic Data Processing Standards.

5. DOE 1360.6 Automatic Data Processing Equipment/Data Systems.

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6. The major applicable DOE Order 6430.1A sections are as follows:

0110-9	Operation, Maintenance, Repair, and Replacement
0110-13.5	Physical Protection; communications Equipment
0110-99.0	Special Facilities, Nonreactor Nuclear Facilities
0110-99.8	Telecommunications, Alarm and ADP Centers and Radio Repeater Stations
0278	Power and Lighting
0279	Exterior Communications and Alarms Systems
1161	Enclosures, Hoods, and Gloveboxes
1300-3	Safety Class Criteria
1300-6.9	Radiation Protection; Breathing Air System
1300-7	Confinement Systems
1300-8	Waste Management
1300-9	Effluent Control and Monitoring
1300-10.2	Physical Protection
1300-11	Decontamination and Decommissioning
1300-12	Human Factors Engineering
1324	Radioactive Solid Waste Facilities
1550-2.5	Air Handling and Air Distribution Systems
1595	Controls
1600	Electrical; General Requirements
1605	Basic Electrical Materials and Methods
1639	Grounding
1640	Interior Electrical Systems
1660	Special Systems
1670	Exterior Communications and Alarm Systems
1671	Interior Communications and Alarm Systems

7. DOE 5400.5, Radiation Protection of the Public and the Environment.

8. DOE 5400.3, Hazardous and Mixed Waste Program.

9. Westinghouse Hanford Company Standards

   a. Hanford Plant Standard Design Criteria.

   b. Hanford Plant Standards; Instrumentation, HPS-400 to 499-I.

      - WHC-CM-2.6, Sec. 3.4, Bar Code Identifier Standards

10. Manual WHC-CM-1-3: Acquisition of Automatic Data Processing System, Equipment and Related Resources.

11. Codes and Standards

   a. ANSI American National Standards Institute.

      - N Designation (Nuclear Related Standards)

   b. ASME American Society of Mechanical Engineers.

   c. ANS American Nuclear Society.

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d. EPRI Electric Power Research Institute.

- NP-3659 chp. 4 Recommended Panel Design Features

e. IEEE Institute of Electrical and Electronic Engineers.

f. ISA Instrument Society of America.

- ISA-RP60.8 Electrical Guide for Control Centers
- ISA-S5.1 Instrumentation Symbols and Identification
- ISA-S5.3 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems
- ISA-S5.4 Instrument Loop Diagrams
- ISA-S5.5 Graphic Symbols for Process Displays
- ISA-S18.1 Annunciator Sequences and Specifications
- ISA-S51.1 Standard Process Instrumentation Terminology
- ISA-S75.01 Standard Control Valve Sizing Equations

g. MIL-STD Military Standard.

- MIL-STD-1472D Human Engineering Design Criteria for Military Systems, Equipment and Facilities

h. NEMA National Electric Manufacturers Association.

- ICS 6-1983 Enclosures for Industrial Controls and Systems

i. NFPA National Fire Protection Association.

- 70-90 National Electric Code

j. NUREG U.S. Nuclear Regulatory Commission.

- 0700 Guidelines for Control Room Design Reviews

4.10 Reference Drawings

Drawing Number	Drawing Title
H-2-140678	PCS BLOCK DIAGRAM
H-2-140679	DMS BLOCK DIAGRAM
H-2-140680	DMS BLOCK FLOW DIAGRAM (SHT. 1 OF 3)
H-2-140680	DMS BLOCK FLOW DIAGRAM (SHT. 2 OF 3)
H-2-140680	DMS BLOCK FLOW DIAGRAM (SHT. 3 OF 3)
H-2-140681	HSE LOCATION PLAN
H-2-140682	CONTROL ROOM AND COMPUTER ROOM LAYOUTS
H-2-140683	CCTV AND BAR CODE READER LOCATION PLAN

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
T-07-201A	ANALOG INDICATOR	1	L	LEVEL	ACTIVE/NONACTIVE LIQUID WASTE
T-07-101B	ANALOG INDICATOR	1	L	LEVEL	ACTIVE/NONACTIVE LIQUID WASTE
T-07-201B	ANALOG INDICATOR	1	L	LEVEL	ACTIVE/NONACTIVE LIQUID WASTE
T-07-101A	ANALOG INDICATOR	1	L	LEVEL	ACTIVE/NONACTIVE LIQUID WASTE
T-07-101B	LEVEL SW. - FLOAT	2	R	LO-LO, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
T-07-101A	LEVEL SW. - FLOAT	2	R	LO-LO, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
T-07-201B	LEVEL SW. - FLOAT	2	R	LO-LO, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
P-07-202	LEVEL SW. - FLOAT	3	R	LOW, HIGH, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
P-07-102	LEVEL SW. - FLOAT	3	R	LOW, HIGH, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
T-07-201A	LEVEL SW. - FLOAT	2	R	LO-LO, HI-HI	ACTIVE/NONACTIVE LIQUID WASTE
T-07-201A	LEVEL TRANSMITTER	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-101A	LEVEL TRANSMITTER	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-101B	LEVEL TRANSMITTER	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-201B	LEVEL TRANSMITTER	1	R		ACTIVE/NONACTIVE LIQUID WASTE
F-07-201	PRESS. DIFF. SW.	1	R	HIGH	ACTIVE/NONACTIVE LIQUID WASTE
F-07-202	PRESS. DIFF. SW.	1	R	HIGH	ACTIVE/NONACTIVE LIQUID WASTE
P-07-101ABC	PRESS. SW.	1	R	LEAD/LAG/STANDBY CONTROL	ACTIVE/NONACTIVE LIQUID WASTE
P-07-201ABC	PRESS. SW.	1	R	LEAD/LAG/STANDBY CONTROL	ACTIVE/NONACTIVE LIQUID WASTE
T-07-101A	SOL. VALVE - 3 WAY	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-201B	SOL. VALVE - 3 WAY	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-101B	SOL. VALVE - 3 WAY	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-201A	SOL. VALVE - 3 WAY	1	R		ACTIVE/NONACTIVE LIQUID WASTE
T-07-101B	VALVE - BALL	1	L		ACTIVE/NONACTIVE LIQUID WASTE
T-07-201A	VALVE - BALL	1	L		ACTIVE/NONACTIVE LIQUID WASTE
T-07-201B	VALVE - BALL	1	L		ACTIVE/NONACTIVE LIQUID WASTE
T-07-101A	VALVE - BALL	1	L		ACTIVE/NONACTIVE LIQUID WASTE
CV-05-204	CURRENT CONTACT	1	R		AGITATED GROUTING SYSTEM
CV-05-202	CURRENT CONTACT	1	R		AGITATED GROUTING SYSTEM
T-05-208	FLOW ELEMENT	2	L		AGITATED GROUTING SYSTEM
T-05-208	FLOW TRANSMITTER	2	R		AGITATED GROUTING SYSTEM
T-05-205	LEVEL SW. - CAP	3	R		AGITATED GROUTING SYSTEM
T-05-206	LEVEL SW. - CAP	1	R		AGITATED GROUTING SYSTEM
T-05-207	LEVEL SW. - CAP	1	R		AGITATED GROUTING SYSTEM
T-05-209	LEVEL SW. - CAP	3	R		AGITATED GROUTING SYSTEM
Y-05-208	LEVEL SW. - ULTRASOUND	1	R		AGITATED GROUTING SYSTEM
T-05-205	LOAD CELLS	4	L		AGITATED GROUTING SYSTEM
T-05-206	LOAD CELLS	4	L		AGITATED GROUTING SYSTEM
T-05-208	LOAD CELLS	4	L		AGITATED GROUTING SYSTEM
T-05-209	LOAD CELLS	4	L		AGITATED GROUTING SYSTEM
T-05-207	LOAD CELLS	4	L		AGITATED GROUTING SYSTEM
LT-05-202	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-213	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
LT-05-203	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-213	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-212	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-213B	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-212B	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
CV-05-214	PHOTOEYE	2	R		AGITATED GROUTING SYSTEM
LT-05-203	PROX. SW.	2	R		AGITATED GROUTING SYSTEM
AL-05-201	PROX. SW.	4	R	(OPEN, CLOSE) X 2	AGITATED GROUTING SYSTEM
LT-05-202	PROX. SW.	2	R		AGITATED GROUTING SYSTEM
AL-05-202	PROX. SW.	4	R	(OPEN, CLOSE) X 2	AGITATED GROUTING SYSTEM
DO-05-303	PROX. SW.	2	R		AGITATED GROUTING SYSTEM
DO-05-202	PROX. SW.	2	R		AGITATED GROUTING SYSTEM
T-05-210	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
Y-05-205	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
CV-05-205	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
Y-05-207	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
Y-05-208	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
Y-05-209	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
P-05-203	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
CV-05-208	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
Y-05-206	PUSHBUTTON STATION	1	L	START, STOP	AGITATED GROUTING SYSTEM
CV-05-213B	ROPE SW.	2	L		AGITATED GROUTING SYSTEM
CV-05-212	ROPE SW.	2	L		AGITATED GROUTING SYSTEM
CV-05-212B	ROPE SW.	2	L		AGITATED GROUTING SYSTEM
CV-05-214	ROPE SW.	2	L		AGITATED GROUTING SYSTEM
CV-05-205	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
P-05-203	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
T-05-210	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
Y-05-207	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
CV-05-208	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
Y-05-209	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
Y-05-206	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
Y-05-208	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
Y-05-205	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	AGITATED GROUTING SYSTEM
T-05-205	SOL. VALVE - 2 WAY	1	R		AGITATED GROUTING SYSTEM
T-05-206	SOL. VALVE - 2 WAY	1	R		AGITATED GROUTING SYSTEM
T-05-209	SOL. VALVE - 2 WAY	1	R		AGITATED GROUTING SYSTEM
T-05-206	SOL. VALVE - 3 WAY	2	R		AGITATED GROUTING SYSTEM
T-05-209	SOL. VALVE - 3 WAY	2	R		AGITATED GROUTING SYSTEM
T-05-205	SOL. VALVE - 3 WAY	1	R		AGITATED GROUTING SYSTEM
DO-05-202	SOL. VALVE - 4 WAY	1	R		AGITATED GROUTING SYSTEM
LT-05-202	SOL. VALVE - 4 WAY	1	R		AGITATED GROUTING SYSTEM

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
LT-05-203	SOL. VALVE - 4 WAY	1	R		AGITATED GROUTING SYSTEM
DO-05-203	SOL. VALVE - 4 WAY	1	R		AGITATED GROUTING SYSTEM
LT-05-203	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
CV-05-212	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
CV-05-212B	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
LT-05-202	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
CV-05-213	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
CV-05-214	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
CV-05-213B	SPEED SW.	1	R		AGITATED GROUTING SYSTEM
P-05-203	VALVE - 1 INCH	1	L		AGITATED GROUTING SYSTEM
T-05-205	WEIGHT TRANSMITTER	1	R		AGITATED GROUTING SYSTEM
T-05-206	WEIGHT TRANSMITTER	1	R		AGITATED GROUTING SYSTEM
T-05-207	WEIGHT TRANSMITTER	1	R		AGITATED GROUTING SYSTEM
T-05-208	WEIGHT TRANSMITTER	1	R		AGITATED GROUTING SYSTEM
T-05-209	WEIGHT TRANSMITTER	1	R		AGITATED GROUTING SYSTEM
P-12-103	CONTROLLER - FLOW	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-102	LEVEL SW. - CAP.	2	R	LOW, HIGH	AQUEOUS SOLUTION MAKE-UP
T-12-101	LEVEL SW. - CAP.	2	R	LOW, HIGH	AQUEOUS SOLUTION MAKE-UP
T-12-103	LEVEL SW. - CAP.	2	R	LOW, HIGH	AQUEOUS SOLUTION MAKE-UP
P-12-103	PRESS. SW.	1	R	HIGH	AQUEOUS SOLUTION MAKE-UP
P-12-105	PRESS. SW.	2	R	LOW, HIGH	AQUEOUS SOLUTION MAKE-UP
P-12-104	PRESS. SW.	2	R	LOW ,HIGH	AQUEOUS SOLUTION MAKE-UP
P-12-102	PRESS. SW.	1	R	HIGH	AQUEOUS SOLUTION MAKE-UP
T-12-106	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-105	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-104	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-102	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-101	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
T-12-103	SOL. VALVE - 2 WAY	1	L		AQUEOUS SOLUTION MAKE-UP
CV-05-561B	PHOTOEYE	2	R		BOX BREAKDOWN
LT-05-561	PHOTOEYE	2	R		BOX BREAKDOWN
CV-05-561A	PHOTOEYE	2	R		BOX BREAKDOWN
AL-05-561	PHOTOEYE	3	R		BOX BREAKDOWN
CV-05-561C	PHOTOEYE	2	R		BOX BREAKDOWN
LT-05-561	PROX. SW.	2	R	UP, DOWN	BOX BREAKDOWN
DO-05-562	PROX. SW.	2	R	OPEN, CLOSE	BOX BREAKDOWN
AL-05-561	PROX. SW.	6	R	OPEN, CLOSE	BOX BREAKDOWN
CV-05-561A	PUSHBUTTON	1	R	START, STOP	BOX BREAKDOWN
CV-05-561B	PUSHBUTTON	1	R	START, STOP	BOX BREAKDOWN
DO-05-562	PUSHBUTTON	1	R	OPRN, CLOSE	BOX BREAKDOWN
AL-05-561	PUSHBUTTON	2	L	(OPEN, CLOSE) X 2	BOX BREAKDOWN
LT-05-561	PUSHBUTTON	1	L	UP, DOWN	BOX BREAKDOWN

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
CV-05-561C	ROPE SW.	2	L		BOX BREAKDOWN
LT-05-561	ROPE SW.	1	L		BOX BREAKDOWN
CV-05-561B	SELECTOR SW. - 3 POS	3	R	H-O-A SW.	BOX BREAKDOWN
CV-05-561A	SELECTOR SW. - 3 POS	3	R	H-O-A SW.	BOX BREAKDOWN
AL-05-561	SELECTOR SW. - 3 POS	3	R	H-O-A SW.	BOX BREAKDOWN
CV-05-561C	SELECTOR SW. - 3 POS	3	R	H-O-A SW.	BOX BREAKDOWN
LT-05-561	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	BOX BREAKDOWN
DO-05-562	SOL. VALVE - 4 WAY	1	L		BOX BREAKDOWN
LT-05-561	SOL. VALVE - 4 WAY	1	L		BOX BREAKDOWN
LT-05-561	SPEED SW.	1	R		BOX BREAKDOWN
CV-05-561A	SPEED SW.	1	R		BOX BREAKDOWN
CV-05-561B	SPEED SW.	1	R		BOX BREAKDOWN
CV-05-561C	SPEED SW.	1	R		BOX BREAKDOWN
P-05-101	CURRENT TRANSMITTER	1	R		BULK POWDER STORAGE
P-05-102	CURRENT TRANSMITTER	1	R		BULK POWDER STORAGE
P-05-102	FLOW ELEMENT - MASS FLOW	1	L		BULK POWDER STORAGE
P-05-102	FLOW TRANSMITTER	1	R		BULK POWDER STORAGE
T-05-10X	HORN	1	R	HIGH LEVEL WARNING	BULK POWDER STORAGE
T-05-103	LEVEL GAUGE	1	L		BULK POWDER STORAGE
T-05-102	LEVEL GAUGE	1	L		BULK POWDER STORAGE
T-05-104	LEVEL GAUGE	1	L		BULK POWDER STORAGE
T-05-101	LEVEL GAUGE	1	L		BULK POWDER STORAGE
T-05-101	LEVEL SW. - CAP.	3	R	LOW, HIGH, HI-HI	BULK POWDER STORAGE
T-05-104	LEVEL SW. - CAP.	3	R	LOW, HIGH, HI-HI	BULK POWDER STORAGE
T-05-102	LEVEL SW. - CAP.	3	R	LOW, HIGH, HI-HI	BULK POWDER STORAGE
T-05-103	LEVEL SW. - CAP.	3	R	LOW, HIGH, HI-HI	BULK POWDER STORAGE
C-05-XXX	PRESS. SW.	3	R	LOW, HIGH, HI-HI	BULK POWDER STORAGE
C-05-XXX	PUSHBUTTON	2	L	START/STOP	BULK POWDER STORAGE
T-05-104	SELECTOR SW. - 2 POS.	1	L	OPEN, CLOSE	BULK POWDER STORAGE
T-05-103	SELECTOR SW. - 2 POS.	1	L	OPEN, CLOSE	BULK POWDER STORAGE
T-05-101	SELECTOR SW. - 2 POS.	1	L	OPEN, CLOSE	BULK POWDER STORAGE
T-05-102	SELECTOR SW. - 2 POS.	1	L	OPEN, CLOSE	BULK POWDER STORAGE
T-05-104	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	BULK POWDER STORAGE
T-05-103	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	BULK POWDER STORAGE
T-05-102	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	BULK POWDER STORAGE
T-05-104	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	BULK POWDER STORAGE
T-05-103	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (FEEDER)	BULK POWDER STORAGE
T-05-102	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	BULK POWDER STORAGE
T-05-101	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	BULK POWDER STORAGE
T-05-101	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	BULK POWDER STORAGE
Y-05-101	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
CV-05-102	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
CV-05-104	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
T-05-101	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
CV-05-103	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
Y-05-104	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
S-05-104	SOL. VALVE - 2 WAY	1	R		BULK POWDER STORAGE
S-05-102	SOL. VALVE - 2 WAY	1	R		BULK POWDER STORAGE
S-05-101	SOL. VALVE - 2 WAY	1	R		BULK POWDER STORAGE
T-05-103	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
T-05-104	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
S-05-103	SOL. VALVE - 2 WAY	1	R		BULK POWDER STORAGE
Y-05-102	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
CV-05-101	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
Y-05-103	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
T-05-102	SOL. VALVE - 2 WAY	2	R		BULK POWDER STORAGE
T-05-103	SOL. VALVE - 3 WAY	1	R		BULK POWDER STORAGE
T-05-102	SOL. VALVE - 3 WAY	1	R		BULK POWDER STORAGE
T-05-104	SOL. VALVE - 3 WAY	1	R		BULK POWDER STORAGE
T-05-101	SOL. VALVE - 3 WAY	1	R		BULK POWDER STORAGE
T-05-103	VALVE - GATE	1	L		BULK POWDER STORAGE
T-05-101	VALVE - GATE	1	L		BULK POWDER STORAGE
T-05-102	VALVE - GATE	1	L		BULK POWDER STORAGE
T-05-104	VALVE - GATE	1	L		BULK POWDER STORAGE
P-04-201	FLOW TRANSMITTER	1	L		DECON SYSTEM PFD
P-04-242	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-210	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-220	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-250	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-240	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-241	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-230	LEVEL SW. - FLOAT	3	L	LOW, HIGH, HI-HI	DECON SYSTEM PFD
P-04-250	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-210	PILOT LIGHT	1	L		DECON SYSTEM PFD
P-04-230	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-220	PILOT LIGHT	1	L		DECON SYSTEM PFD
P-04-240	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-201	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-242	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-241	PILOT LIGHT	1	L	"RUN"	DECON SYSTEM PFD
P-04-250	PRESS. SW.	1	L	HIGH	DECON SYSTEM PFD
P-04-201	PRESS. SW.	2	R	HIGH, LOW	DECON SYSTEM PFD
P-04-250	SELECTOR SW. - 2 POS.	1	L	"DRUM SPRAY"/"DRAIN"	DECON SYSTEM PFD

TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
P-04-250	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DECON SYSTEM PFD
P-04-250	SOL. VALVE - 3 WAY	1	L		DECON SYSTEM PFD
P-04-250	VALVE - BALL	2	L		DECON SYSTEM PFD
CV-09-202A	AGV INTERLOCK	2	R		DRUM NDA
CV-09-202B	AGV INTERLOCK	2	R		DRUM NDA
WT. CON. A	AGV INTERLOCK	1	R		DRUM NDA
WT. CON. B	AGV INTERLOCK	1	R		DRUM NDA
CV-09-202A	BAR CODE TERMINAL	1	R		DRUM NDA
WT. CON. A	BAR CODE TERMINAL	1	R		DRUM NDA
CV-09-202B	BAR CODE TERMINAL	1	R		DRUM NDA
WT. CON. B	BAR CODE TERMINAL	1	R		DRUM NDA
WT. CON. A	LOAD CELL	4	L		DRUM NDA
WT. CON. B	LOAD CELL	4	L		DRUM NDA
WT. CON. B	PHOTOEYE	1	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
CV-09-201A	PHOTOEYE	1	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
WT. CON. A	PHOTOEYE	1	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
CV-09-202A	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
CV-09-202B	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
CV-09-201B	PHOTOEYE	1	R	TRANSMITTER/RECEIVER PAIR	DRUM NDA
WT. CON. B	PUSHBUTTON	3	L	FORWARD, STOP, REVERSE	DRUM NDA
CV-09-201B	PUSHBUTTON	3	L		DRUM NDA
CV-09-201A	PUSHBUTTON	3	L		DRUM NDA
WT. CON. A	PUSHBUTTON	3	L	FORWARD, STOP, REVERSE	DRUM NDA
WT. CON. A	ROPE SW.	2	L		DRUM NDA
WT. CON. B	ROPE SW.	2	L		DRUM NDA
CV-09-202A	ROPE SW.	2	L		DRUM NDA
CV-09-202B	ROPE SW.	2	L		DRUM NDA
CV-09-201A	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
WT. CON. A	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
CV-09-202A	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
WT. CON. B	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
CV-09-202B	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
CV-09-201B	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	DRUM NDA
WT. CON. B	WEIGHT TRANSMITTER	1	R		DRUM NDA
WT. CON. A	WEIGHT TRANSMITTER	1	R		DRUM NDA
SF-14-102A	ANNUBAR	1	L		HVAC
EF-14-101A	ANNUBAR	1	L		HVAC
EF-14-101B	ANNUBAR	1	L		HVAC
SF-14-101B	ANNUBAR	1	L		HVAC
SF-14-102B	ANNUBAR	1	L		HVAC
SF-14-101A	ANNUBAR	1	L		HVAC
SF-14-101C	ANNUBAR	1	L		HVAC

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
SF-14-101A	CONTROLLER - FLOW	1	R		HVAC
SF-14-101C	CONTROLLER - FLOW	1	R		HVAC
SF-14-102A	CONTROLLER - FLOW	1	R		HVAC
EF-14-101A	CONTROLLER - FLOW	1	R		HVAC
SF-14-101B	CONTROLLER - FLOW	1	R		HVAC
SF-14-102B	CONTROLLER - FLOW	1	R		HVAC
EF-14-101B	CONTROLLER - FLOW	1	R		HVAC
EF-14-103	CONTROLLER - PRESS.	1	R		HVAC
EF-14-104A	CONTROLLER - PRESS.	1	R		HVAC
EF-14-104B	CONTROLLER - PRESS.	1	R		HVAC
EF-14-101B	FLOW TRANSMITTER	1	L		HVAC
SF-14-101C	FLOW TRANSMITTER	1	L		HVAC
SF-14-102B	FLOW TRANSMITTER	1	L		HVAC
SF-14-102A	FLOW TRANSMITTER	1	L		HVAC
EF-14-101A	FLOW TRANSMITTER	1	L		HVAC
SF-14-101B	FLOW TRANSMITTER	1	L		HVAC
SF-14-101A	FLOW TRANSMITTER	1	L		HVAC
SF-14-101C	I/P CONVERTER	1	L		HVAC
SF-14-102A	I/P CONVERTER	1	L		HVAC
EF-14-104A	I/P CONVERTER	1	L		HVAC
SF-14-101B	I/P CONVERTER	1	L		HVAC
EF-14-104B	I/P CONVERTER	1	L		HVAC
SF-14-101A	I/P CONVERTER	1	L		HVAC
SF-14-102B	I/P CONVERTER	1	L		HVAC
EF-14-101A	I/P CONVERTER	1	L		HVAC
EF-14-101B	I/P CONVERTER	1	L		HVAC
EF-14-103	I/P CONVERTER	1	L		HVAC
AH-14-101C	PRESS. DIFF. SW.	1	R		HVAC
EF-14-104A	PRESS. DIFF. SW.	1	R		HVAC
EF-14-101A	PRESS. DIFF. SW.	1	R		HVAC
EF-14-104B	PRESS. DIFF. SW.	1	R		HVAC
SF-14-101C	PRESS. DIFF. SW.	1	R		HVAC
BUILDING	PRESS. DIFF. SW.	10	R		HVAC
FT-14-101A	PRESS. DIFF. SW.	3	R		HVAC
AH-14-101A	PRESS. DIFF. SW.	1	R		HVAC
F-14-102A	PRESS. DIFF. SW.	2	R		HVAC
SF-14-102A	PRESS. DIFF. SW.	1	R		HVAC
FT-14-101B	PRESS. DIFF. SW.	3	R		HVAC
EF-14-101B	PRESS. DIFF. SW.	1	R		HVAC
AH-14-101B	PRESS. DIFF. SW.	1	R		HVAC
F-14-102B	PRESS. DIFF. SW.	2	R		HVAC
SF-14-102B	PRESS. DIFF. SW.	1	R		HVAC

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
SF-14-101B	PRESS. DIFF. SW.	1	R		HVAC
EF-14-103	PRESS. DIFF. SW.	1	R		HVAC
SF-14-101A	PRESS. DIFF. SW.	1	R		HVAC
BUILDING	PRESS. DIFF. TRANSMITTER	10	R		HVAC
EF-14-104A	PRESS. TRANSMITTER	1	L		HVAC
EF-14-104B	PRESS. TRANSMITTER	1	L		HVAC
EF-14-103	PRESS. TRANSMITTER	1	L		HVAC
AH-14-101C	SOL. VALVE - 3 WAY	2	L		HVAC
AH-14-101A	SOL. VALVE - 3 WAY	2	L		HVAC
EF-14-104A	SOL. VALVE - 3 WAY	1	L		HVAC
AH-14-101B	SOL. VALVE - 3 WAY	2	L		HVAC
EF-14-101B	SOL. VALVE - 3 WAY	1	R		HVAC
FT-14-101A	SOL. VALVE - 3 WAY	1	R		HVAC
FT-14-101B	SOL. VALVE - 3 WAY	1	R		HVAC
FT-14-101	SOL. VALVE - 3 WAY	1	R		HVAC
SF-14-102	SOL. VALVE - 3 WAY	1	R		HVAC
EF-14-104B	SOL. VALVE - 3 WAY	1	L		HVAC
SF-14-101	SOL. VALVE - 3 WAY	1	R		HVAC
EF-14-101A	SOL. VALVE - 3 WAY	1	R		HVAC
F-14-102B	SOL. VALVE - 3 WAY	1	L		HVAC
F-14-102A	SOL. VALVE - 3 WAY	1	L		HVAC
E-06-201	CONTROLLER - TEMP	1	L		MERCURY PRETREATMENT
X-06-201B	CURRENT RELAY	1	L		MERCURY PRETREATMENT
X-06-201A	CURRENT RELAY	1	L		MERCURY PRETREATMENT
X-06-201A	CURRENT TRANSMITTER	1	L		MERCURY PRETREATMENT
X-06-201B	CURRENT TRANSMITTER	1	L		MERCURY PRETREATMENT
E-06-201	FLOW SW.	1	R		MERCURY PRETREATMENT
GB-06-202	FLOW SW.	1	L		MERCURY PRETREATMENT
GB-06-201	FLOW SW.	1	R		MERCURY PRETREATMENT
GB-06-202	HORN	1	L		MERCURY PRETREATMENT
GB-06-201	HORN	1	L		MERCURY PRETREATMENT
E-06-201	I/P CONVERTER	1	L		MERCURY PRETREATMENT
AL-06-105	PHOTOEYE	3	L		MERCURY PRETREATMENT
CV-06-202	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	MERCURY PRETREATMENT
CV-06-201	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	MERCURY PRETREATMENT
E-06-201	PILOT LIGHT	1	R	COOL WATER LOW FLOW	MERCURY PRETREATMENT
X-06-201B	PILOT LIGHT	2	L	RUNNING, JAM	MERCURY PRETREATMENT
X-06-201A	PILOT LIGHT	2	L	RUNNING, JAM	MERCURY PRETREATMENT
GB-06-202	PILOT LIGHT	2	L	HOOD RUNNING, HOOD FAILED	MERCURY PRETREATMENT
GB-06-201	PILOT LIGHT	2	L	HOOD RUNNING, HOOD FAILED	MERCURY PRETREATMENT
AL-06-105	PROX. SW.	4	R		MERCURY PRETREATMENT
CV-06-202	PUSHBUTTON	2	R	START, STOP	MERCURY PRETREATMENT

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
CV-06-201	PUSHBUTTON	2	R	START, STOP	MERCURY PRETREATMENT
AL-06-105	PUSHBUTTON	4	L	(UP,DOWN) X 2	MERCURY PRETREATMENT
CV-06-201	ROPE SW.	2	L		MERCURY PRETREATMENT
CV-06-202	ROPE SW.	2	L		MERCURY PRETREATMENT
AL-06-105	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	MERCURY PRETREATMENT
E-06-201	TEMP. ELEMENT	1	L		MERCURY PRETREATMENT
E-06-201	TEMP. TRANSMITTER	1	L		MERCURY PRETREATMENT
E-06-201	VALVE	1	L		MERCURY PRETREATMENT
H-04-102	HYDROCARBON LEL DETECTOR	1	R	4 DO, 1 AO	OFF-GAS TREATMENT
H-04-101	HYDROCARBON LEL DETECTOR	1	R	4 DO, 1 AO	OFF-GAS TREATMENT
V-04-101AB	HYDROCARBON LEL DETECTOR	1	R	4 DO, 1 AO	OFF GAS TREATMENT
F-04-102AB	I/P CONVERTER	1	L		OFF-GAS TREATMENT
F-04-108	I/P CONVERTER	1	L		OFF-GAS TREATMENT
S-04-102AB	I/P CONVERTER	3	L		OFF-GAS TREATMENT
F-04-104AB	I/P CONVERTER	1	L		OFF-GAS TREATMENT
F-04-106AB	I/P CONVERTER	1	L		OFF-GAS TREATMENT
H-04-101	I/P CONVERTER	1	L		OFF-GAS TREATMENT
F-04-101AB	I/P CONVERTER	1	L		OFF-GAS TREATMENT
F-04-105AB	I/P CONVERTER	1	L		OFF-GAS TREATMENT
F-04-106AB	PARTICLE DETECTOR	1	R	2 DO, 1AO	OFF-GAS TREATMENT
S-04-101A	PARTICLE DETECTOR	1	R	BAG BREAK - 2 DO, 1AO	OFF-GAS TREATMENT
S-04-101B	PARTICLE DETECTOR	1	R	BAG BREAK - 2 DO, 1AO	OFF-GAS TREATMENT
S-04-102A	PARTICLE DETECTOR	1	R	BAG BREAK - 2 DO, 1AO	OFF-GAS TREATMENT
S-04-102B	PARTICLE DETECTOR	1	R	BAG BREAK - 2 DO, 1AO	OFF-GAS TREATMENT
F-04-105AB	PARTICLE DETECTOR	1	R	2 DO, 1AO	OFF-GAS TREATMENT
F-04-109B	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
V-04-101B	PRESS. DIFF. SW.	1	R		OFF-GAS TREATMENT
F-04-107A	PRESS. DIFF. SW.	5	R		OFF-GAS TREATMENT
F-04-108	PRESS. DIFF. SW.	5	R		OFF-GAS TREATMENT
F-04-109A	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
V-04-101A	PRESS. DIFF. SW.	1	R		OFF-GAS TREATMENT
F-04-107B	PRESS. DIFF. SW.	5	R		OFF-GAS TREATMENT
F-04-103A	PRESS. DIFF. SW.	2	R		OFF-GAS TREATMENT
F-04-101A	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-104B	PRESS. DIFF. SW.	2	R		OFF-GAS TREATMENT
F-04-105A	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-103B	PRESS. DIFF. SW.	2	R		OFF-GAS TREATMENT
F-04-104A	PRESS. DIFF. SW.	2	R		OFF-GAS TREATMENT
F-04-102A	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
F-04-101B	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-106B	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-102B	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-106A	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
F-04-105B	PRESS. DIFF. SW.	3	R		OFF-GAS TREATMENT
S-04-101B	PRESS. DIFF. TRANSMITTER	1	R	BAG FILL	OFF-GAS TREATMENT
S-04-101A	PRESS. DIFF. TRANSMITTER	1	R	BAG FILL	OFF-GAS TREATMENT
S-04-102B	PRESS. DIFF. TRANSMITTER	1	R	BAG FILL	OFF-GAS TREATMENT
S-04-102A	PRESS. DIFF. TRANSMITTER	1	R	BAG FILL	OFF-GAS TREATMENT
F-04-105AB	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
F-04-101AB	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
F-04-106AB	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
F-04-104AB	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
F-04-102AB	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
S-04-102AB	PRESS. TRANSMITTER	3	L		OFF-GAS TREATMENT
H-04-101	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
F-04-108	PRESS. TRANSMITTER	1	L		OFF-GAS TREATMENT
S-04-101A	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
V-04-101B	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
S-04-101B	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
S-04-102A	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
V-04-101A	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
S-04-102B	SOL. VALVE - 2 WAY	2	R		OFF-GAS TREATMENT
F-04-104AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
V-04-101AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-109AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
S-04-101AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-101AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
S-04-102AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-107AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-102AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-103AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-105AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-106AB	SOL. VALVE - 3 WAY	4	R		OFF-GAS TREATMENT
F-04-108	TEMP. SW.	1	R	FIRE DETECTION	OFF-GAS TREATMENT
F-04-105AB	TEMP. SW.	1	R	FIRE DETECTION	OFF-GAS TREATMENT
H-04-102	TEMP. SW.	1	R		OFF-GAS TREATMENT
F-04-106AB	TEMP. SW.	1	R	FIRE DETECTION	OFF-GAS TREATMENT
H-04-101	TEMP. SW.	1	R		OFF-GAS TREATMENT
H-04-102	TEMP. TRANSMITTER	1	R		OFF-GAS TREATMENT
H-04-101	TEMP. TRANSMITTER	1	R		OFF-GAS TREATMENT
M-05-401	CURRENT TRANSMITTER	1	R		POLMER MIXING & ENCAPSULATION

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
M-05-410	CURRENT TRANSMITTER	1	R		POLYMER MIXING & ENCAPSULATION
M-05-402	CURRENT TRANSMITTER	1	R		POLYMER MIXING & ENCAPSULATION
M-05-408	CURRENT TRANSMITTER	1	R		POLYMER MIXING & ENCAPSULATION
M-05-409	CURRENT TRANSMITTER	1	R		POLYMER MIXING & ENCAPSULATION
T-05-401	FLOW ELEMENT	4	L		POLYMER MIXING & ENCAPSULATION
P-05-401B	FLOW ELEMENT	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303AB	FLOW ELEMENT	1	L		POLYMER MIXING & ENCAPSULATION
T-05-401	FLOW TOTALIZER	3	R		POLYMER MIXING & ENCAPSULATION
P-05-401B	FLOW TRANSMITTER	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303AB	FLOW TRANSMITTER	1	L		POLYMER MIXING & ENCAPSULATION
T-05-401	FLOW TRANSMITTER	4	L		POLYMER MIXING & ENCAPSULATION
E-05-401	I/P CONVERTER	1	L		POLYMER MIXING & ENCAPSULATION
P-05-401AB	I/P CONVERTER	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303	I/P CONVERTER	1	L		POLYMER MIXING & ENCAPSULATION
T-05-401	LEVEL SWITCH - CAP	2	R		POLYMER MIXING & ENCAPSULATION
V-05-401	LEVEL SW.	2	R	LOW, HIGH	POLYMER MIXING & ENCAPSULATION
T-05-303	LEVEL SW. - CAP	2	R		POLYMER MIXING & ENCAPSULATION
T-05-304	LEVEL SW. - CAP	2	R		POLYMER MIXING & ENCAPSULATION
P-05-405	LEVEL SW. - FLOAT	3	R		POLYMER MIXING & ENCAPSULATION
P-05-307	LEVEL SW. - FLOAT	3	R		POLYMER MIXING & ENCAPSULATION
M-05-405	LEVEL SW. - ULTRASOUND	1	R		POLYMER MIXING & ENCAPSULATION
M-05-406	LEVEL SW. - ULTRASOUND	1	R		POLYMER MIXING & ENCAPSULATION
M-05-404	LEVEL SW. - ULTRASOUND	1	R		POLYMER MIXING & ENCAPSULATION
M-05-407	LEVEL SW. - ULTRASOUND	1	R		POLYMER MIXING & ENCAPSULATION
T-05-401	LEVEL TRANSMITTER	1	R		POLYMER MIXING & ENCAPSULATION
LT-05-401	PHOTOEYE	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-403	PHOTOEYE	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-402	PHOTOEYE	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-404	PHOTOEYE	2	R		POLYMER MIXING & ENCAPSULATION
P-05-303	PRESS. SW.	1	R		POLYMER MIXING & ENCAPSULATION
P-05-304	PRESS. SW.	1	R		POLYMER MIXING & ENCAPSULATION
P-05-401AB	PRESS. SW.	1	R	LOW	POLYMER MIXING & ENCAPSULATION
T-05-303	PRESS/VAC. RELIEF VALVE	1	L		POLYMER MIXING & ENCAPSULATION
T-05-304	PRESS/VAC. RELIEF VALVE	1	L		POLYMER MIXING & ENCAPSULATION
T-05-401	PRESS/VAC. RELIEF VALVE	1	L		POLYMER MIXING & ENCAPSULATION
LT-05-403	PROX. SW.	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-401	PROX. SW.	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-402	PROX. SW.	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-404	PROX. SW.	2	R		POLYMER MIXING & ENCAPSULATION
LT-05-404	ROPE SW.	2	L		POLYMER MIXING & ENCAPSULATION
LT-05-403	ROPE SW.	2	L		POLYMER MIXING & ENCAPSULATION
LT-05-401	ROPE SW.	2	L		POLYMER MIXING & ENCAPSULATION

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
LT-05-402	ROPE SW.	2	L		POLYMER MIXING & ENCAPSULATION
LT-05-402	SELECTOR SW. - 3 POS.	2	R	H-O-A SW.	POLYMER MIXING & ENCAPSULATION
LT-05-404	SELECTOR SW. - 3 POS.	2	R	H-O-A SW.	POLYMER MIXING & ENCAPSULATION
LT-05-403	SELECTOR SW. - 3 POS.	2	R	H-O-A SW.	POLYMER MIXING & ENCAPSULATION
LT-05-401	SELECTOR SW. - 3 POS.	2	R	H-O-A SW.	POLYMER MIXING & ENCAPSULATION
M-05-406	SOL. VALVE - 2 WAY	1	L		POLYMER MIXING & ENCAPSULATION
M-05-405	SOL. VALVE - 2 WAY	1	L		POLYMER MIXING & ENCAPSULATION
M-05-407	SOL. VALVE - 2 WAY	1	L		POLYMER MIXING & ENCAPSULATION
M-05-404	SOL. VALVE - 2 WAY	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303	SOL. VALVE - 3 WAY	1	L		POLYMER MIXING & ENCAPSULATION
M-05-407	SOL. VALVE - 3 WAY	2	L		POLYMER MIXING & ENCAPSULATION
P-05-401AB	SOL. VALVE - 3 WAY	1	L		POLYMER MIXING & ENCAPSULATION
M-05-406	SOL. VALVE - 3 WAY	2	L		POLYMER MIXING & ENCAPSULATION
M-05-405	SOL. VALVE - 3 WAY	2	L		POLYMER MIXING & ENCAPSULATION
M-05-404	SOL. VALVE - 3 WAY	2	L		POLYMER MIXING & ENCAPSULATION
LT-05-401	SOL. VALVE - 4 WAY	1	L		POLYMER MIXING & ENCAPSULATION
LT-05-403	SOL. VALVE - 4 WAY	1	L		POLYMER MIXING & ENCAPSULATION
LT-05-402	SOL. VALVE - 4 WAY	1	L		POLYMER MIXING & ENCAPSULATION
LT-05-404	SOL. VALVE - 4 WAY	1	L		POLYMER MIXING & ENCAPSULATION
T-05-401	SOL. VALVE 3-WAY	3	L		POLYMER MIXING & ENCAPSULATION
LT-05-404	SPEED SW.	1	R		POLYMER MIXING & ENCAPSULATION
LT-05-401	SPEED SW.	1	R		POLYMER MIXING & ENCAPSULATION
LT-05-402	SPEED SW.	1	R		POLYMER MIXING & ENCAPSULATION
LT-05-403	SPEED SW.	1	R		POLYMER MIXING & ENCAPSULATION
E-05-401	TEMP. ELEMENT	1	L		POLYMER MIXING & ENCAPSULATION
E-05-401	TEMP. TRANSMITTER	1	L		POLYMER MIXING & ENCAPSULATION
P-05-401AB	VALVE	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303	VALVE	1	L		POLYMER MIXING & ENCAPSULATION
P-05-303	VALVE - 3 WAY BALL	1	L		POLYMER MIXING & ENCAPSULATION
P-05-401AB	VALVE - 3 WAY BALL	1	L		POLYMER MIXING & ENCAPSULATION
M-05-407	VALVE - BALL	2	L		POLYMER MIXING & ENCAPSULATION
M-05-405	VALVE - BALL	2	L		POLYMER MIXING & ENCAPSULATION
M-05-406	VALVE - BALL	2	L		POLYMER MIXING & ENCAPSULATION
T-05-401	VALVE - BALL	3	L		POLYMER MIXING & ENCAPSULATION
M-05-404	VALVE - BALL	2	L		POLYMER MIXING & ENCAPSULATION
T-05-302	LEVEL SW. - CAP.	2	R		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	LEVEL SW. - CAP.	2	R		POLYMR RESIN & CHEM. BULK STRG
T-05-402	LEVEL SW. - CAP.	2	R		POLYMR RESIN & CHEM. BULK STRG
T-05-301	LEVEL SW. - CAP.	2	R		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	LEVEL SW. - CAP.	2	R		POLYMR RESIN & CHEM. BULK STRG
P-05-306	LEVEL SW. - FLOAT	3	R		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	LEVEL TRANSMITTER	1	R		POLYMR RESIN & CHEM. BULK STRG

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
T-05-402	LEVEL TRANSMITTER	1	R		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	LEVEL TRANSMITTER	1	R		POLYMR RESIN & CHEM. BULK STRG
T-05-301	LEVEL TRANSMITTER	1	R		POLYMR RESIN & CHEM. BULK STRG
T-05-302	LEVEL TRANSMITTER	1	R		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	PRESS./VAC. RELIEF VALVE	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-402	PRESS./VAC. RELIEF VALVE	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	PRESS./VAC. RELIEF VALVE	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-301	PRESS./VAC. RELIEF VALVE	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-302	PRESS./VAC. RELIEF VALVE	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	SELECTOR SW. - 2 POS.	1	L	OPEN/CLOSE	POLYMR RESIN & CHEM. BULK STRG
T-05-305A	SELECTOR SW. - 2 POS.	1	L	OPEN/CLOSE	POLYMR RESIN & CHEM. BULK STRG
T-05-305B	SELECTOR SW. - 3 POS.	1	R	H-O-A SW.	POLYMR RESIN & CHEM. BULK STRG
T-05-305A	SELECTOR SW. - 3 POS.	1	R	H-O-A SW.	POLYMR RESIN & CHEM. BULK STRG
T-05-305B	SOL. VALVE - 2 WAY	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	SOL. VALVE - 2 WAY	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-402	SOL. VALVE - 3 WAY	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	SOL. VALVE - 3 WAY	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	SOL. VALVE - 3 WAY	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-402	VALVE - BALL	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305B	VALVE - BALL	1	L		POLYMR RESIN & CHEM. BULK STRG
T-05-305A	VALVE - BALL	1	L		POLYMR RESIN & CHEM. BULK STRG
LT-06-301	AGV INTERLOCK	2	R		REACTIVE METAL PRETREATMENT
C-06-301	CONTROLLER - FLOW	1	L		REACTIVE METAL PRETREATMENT
V-06-301	CONTROLLER - LEVEL	1	L		REACTIVE METAL PRETREATMENT
H-06-301	CONTROLLER - TEMP.	1	L		REACTIVE METAL PRETREATMENT
P-06-301	CONTROLLER - TEMP.	1	L		REACTIVE METAL PRETREATMENT
C-06-301	FLOW ELEMENT	1	L		REACTIVE METAL PRETREATMENT
P-06-301	FLOW SW.	1	R		REACTIVE METAL PRETREATMENT
HD-06-301	FLOW SW.	1	L		REACTIVE METAL PRETREATMENT
C-06-301	FLOW TRANSMITTER	1	L		REACTIVE METAL PRETREATMENT
HD-06-301	HORN	1	L		REACTIVE METAL PRETREATMENT
P-06-301	I/P CONVERTER	1	L		REACTIVE METAL PRETREATMENT
V-06-301	I/P CONVERTER	1	L		REACTIVE METAL PRETREATMENT
C-06-301	I/P CONVERTER	1	L		REACTIVE METAL PRETREATMENT
V-06-301	LEVEL SW. - CAP.	1	R	HI-HI (ABOVE VENTURI)	REACTIVE METAL PRETREATMENT
V-06-301	LEVEL SW. - CAP.	2	R	LOW, HIGH	REACTIVE METAL PRETREATMENT
V-06-301	LEVEL TRANSMITTER	1	L		REACTIVE METAL PRETREATMENT
LT-06-301	LIMIT SW.	2	R		REACTIVE METAL PRETREATMENT
CV-06-301	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	REACTIVE METAL PRETREATMENT
LT-06-301	PHOTOEYE	2	R		REACTIVE METAL PRETREATMENT
CV-06-302	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	REACTIVE METAL PRETREATMENT
LT-06-301	PILOT LIGHT	1	L	HYD. POWER UNIT WARNING	REACTIVE METAL PRETREATMENT

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
HD-06-301	PILOT LIGHT	2	L	HOOD RUNNING, HOOD FAILED	REACTIVE METAL PRETREATMENT
C-06-301	PRESS. DIFF. SW.	1	R		REACTIVE METAL PRETREATMENT
LT-06-301	PRESS. SW.	2	R	HPU - LOW, HIGH	REACTIVE METAL PRETREATMENT
P-06-301	PRESS. SW.	1	R		REACTIVE METAL PRETREATMENT
LT-06-301	PUSHBUTTON	2	L	UP/DOWN	REACTIVE METAL PRETREATMENT
LT-06-301	ROPE SW.	2	L		REACTIVE METAL PRETREATMENT
CV-06-301	ROPE SW.	2	L		REACTIVE METAL PRETREATMENT
CV-06-302	ROPE SW.	2	L		REACTIVE METAL PRETREATMENT
S-06-301	SELECTOR SW. - 2 POS.	1	L	ON/OFF	REACTIVE METAL PRETREATMENT
HD-06-301	SELECTOR SW. - 2 POS.	1	L	ON/OFF	REACTIVE METAL PRETREATMENT
CV-06-301	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	REACTIVE METAL PRETREATMENT
C-06-301	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	REACTIVE METAL PRETREATMENT
LT-06-301	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	REACTIVE METAL PRETREATMENT
CV-06-302	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	REACTIVE METAL PRETREATMENT
C-06-301	SOL. VALVE - 2 WAY	2	R		REACTIVE METAL PRETREATMENT
P-06-301	SOL. VALVE - 2 WAY	2	R		REACTIVE METAL PRETREATMENT
LT-06-301	SOL. VALVE - 4 WAY	1	R		REACTIVE METAL PRETREATMENT
LT-06-301	SPEED SW.	1	R		REACTIVE METAL PRETREATMENT
CV-06-302	SPEED SW.	1	R		REACTIVE METAL PRETREATMENT
CV-06-301	SPEED SW.	1	R		REACTIVE METAL PRETREATMENT
H-06-301	TEMP. ELEMENT	1	L		REACTIVE METAL PRETREATMENT
P-06-301	TEMP. ELEMENT	1	L		REACTIVE METAL PRETREATMENT
H-06-301	TEMP. SW.	1	R		REACTIVE METAL PRETREATMENT
H-06-301	TEMP. TRANSMITTER	1	L		REACTIVE METAL PRETREATMENT
P-06-301	TEMP. TRANSMITTER	1	L		REACTIVE METAL PRETREATMENT
P-06-301	VALVE	1	L		REACTIVE METAL PRETREATMENT
V-06-301	VALVE	1	L		REACTIVE METAL PRETREATMENT
P-06-301	VALVE - BALL	2	L		REACTIVE METAL PRETREATMENT
C-06-301	VALVE - BUTTERFLY	2	R		REACTIVE METAL PRETREATMENT
CV-09-101	BAR CODE TERMINAL	2	R		SHIPPING/RECEIVING AREA
CV-09-103	PHOTOEYE	1	L	TRANSMITTER/RECEIVER PAIR	SHIPPING/RECEIVING AREA
CV-09-101	PHOTOEYE	1	L	TRANSMITTER/RECEIVER PAIR	SHIPPING/RECEIVING AREA
CV-09-104	PHOTOEYE	1	L	TRANSMITTER/RECEIVER PAIR	SHIPPING/RECEIVING AREA
CV-09-105	PHOTOEYE	1	L	TRANSMITTER/RECEIVER PAIR	SHIPPING/RECEIVING AREA
CV-09-103	ROPE SW.	2	L		SHIPPING/RECEIVING AREA
CV-09-101	ROPE SW.	2	L		SHIPPING/RECEIVING AREA
CV-09-104	ROPE SW.	2	L		SHIPPING/RECEIVING AREA
CV-09-105	ROPE SW.	2	L		SHIPPING/RECEIVING AREA
CV-09-104	SELECTOR SW. - 3 POS	1	L	H-O-A SW.	SHIPPING/RECEIVING AREA
CV-09-103	SELECTOR SW. - 3 POS	1	L	H-O-A SW.	SHIPPING/RECEIVING AREA
CV-09-101	SELECTOR SW. - 3 POS	1	L	H-O-A SW.	SHIPPING/RECEIVING AREA
CV-09-105	SELECTOR SW. - 3 POS	1	L	H-O-A SW.	SHIPPING/RECEIVING AREA

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
SH-05-521	CURRENT CONTACT	1	R		SIZE REDUCTION & REPACK
SH-05-522	CURRENT CONTACT	1	R		SIZE REDUCTION & REPACK
GB-05-521	FLOW SW.	1	R		SIZE REDUCTION & REPACK
GB-05-521	HORN	1	L		SIZE REDUCTION & REPACK
T-05-521	LOAD CELL	4	L		SIZE REDUCTION & REPACK
LT-05-521	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
TC-05-501	PHOTOEYE	1	R		SIZE REDUCTION & REPACK
CV-05-501B	PHOTOEYE	1	R		SIZE REDUCTION & REPACK
CV-05-501A	PHOTOEYE	1	R		SIZE REDUCTION & REPACK
AL-05-501	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
LT-05-522	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
LT-05-561	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
LT-05-523	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
CV-05-521	PHOTOEYE	1	R		SIZE REDUCTION & REPACK
AL-05-501	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
CV-05-561	PHOTOEYE	2	R		SIZE REDUCTION & REPACK
GB-05-521	PILOT LIGHT	2	L	HOOD RUNNING, HOOD FAILED	SIZE REDUCTION & REPACK
TC-05-501	PROX. SW.	6	R		SIZE REDUCTION & REPACK
DO-05-522	PROX. SW.	2	R		SIZE REDUCTION & REPACK
AL-05-501	PROX. SW.	4	R	(OPEN, CLOSE) X 2	SIZE REDUCTION & REPACK
T-05-521	PROX. SW.	1	R		SIZE REDUCTION & REPACK
LT-05-523	PROX. SW.	2	R		SIZE REDUCTION & REPACK
LT-05-521	PROX. SW.	2	R		SIZE REDUCTION & REPACK
ST-05-521A	PROX. SW.	4	R		SIZE REDUCTION & REPACK
DO-05-521	PROX. SW.	2	R		SIZE REDUCTION & REPACK
DH-05-522	PROX. SW.	4	R		SIZE REDUCTION & REPACK
LT-05-561	PROX. SW.	2	R	UP, DOWN	SIZE REDUCTION & REPACK
AL-05-501	PROX. SW.	4	R		SIZE REDUCTION & REPACK
DO-05-523	PROX. SW.	2	R		SIZE REDUCTION & REPACK
LT-05-522	PROX. SW.	2	R		SIZE REDUCTION & REPACK
CY-05-521	PROX. SW.	2	R		SIZE REDUCTION & REPACK
ST-05-521B	PROX. SW.	4	R		SIZE REDUCTION & REPACK
CY-05-521	PUSHBUTTON	2	L	EXTEND, RETRACT	SIZE REDUCTION & REPACK
LT-05-522	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
ST-05-521B	PUSHBUTTON	2	L	UP, DOWN, EXTEND, RETRACT	SIZE REDUCTION & REPACK
DO-05-522	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
DO-05-523	PUSHBUTTON	2	L	OPEN, CLOSE	SIZE REDUCTION & REPACK
TC-05-501	PUSHBUTTON	4	L	CONV, FWD, RVS, E-STOP	SIZE REDUCTION & REPACK
DO-05-521	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
LT-05-521	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
DH-05-522	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
CV-05-521	PUSHBUTTON	2	L	START, STOP	SIZE REDUCTION & REPACK

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
ST-05-521A	PUSHBUTTON	2	L	UP, DOWN, EXTEND, RETRACT	SIZE REDUCTION & REPACK
DH-05-522	PUSHBUTTON	2	L	CLAMP, UNCLAMP	SIZE REDUCTION & REPACK
AL-05-501	PUSHBUTTON	4	L	(OPEN, CLOSE) X 2	SIZE REDUCTION & REPACK
DH-05-522	PUSHBUTTON	3	L	TILT FWD, TILT RVS, STOP	SIZE REDUCTION & REPACK
LT-05-561	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
AL-05-501	PUSHBUTTON	4	L	(UP,DOWN) X 2	SIZE REDUCTION & REPACK
LT-05-523	PUSHBUTTON	2	L	UP, DOWN	SIZE REDUCTION & REPACK
CV-05-561A	ROPE SW.	2	L		SIZE REDUCTION & REPACK
LT-05-521	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK
TC-05-501	ROPE SW.	2	L		SIZE REDUCTION & REPACK
LT-05-523	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK
LT-05-522	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK
CV-05-521	ROPE SW.	2	L		SIZE REDUCTION & REPACK
LT-05-561	ROPE SW.	2	L		SIZE REDUCTION & REPACK
CV-05-501B	ROPE SW.	2	L		SIZE REDUCTION & REPACK
CV-05-561	ROPE SW.	2	L		SIZE REDUCTION & REPACK
CV-05-561	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
CY-05-521	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
CV-05-521	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
AL-05-501	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
DO-05-523	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
ST-05-521B	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
DH-05-522	SELECTOR SW. - 3 POS	3	R	H-O-A SW.	SIZE REDUCTION & REPACK
LT-05-561	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
DO-05-521	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
AL-05-501	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
CV-05-501B	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
LT-05-523	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
TC-05-501	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
LT-05-521	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
LT-05-522	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
ST-05-521A	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK
DO-05-522	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK
ST-05-521A	SOL. VALVE - 4 WAY	2	R		SIZE REDUCTION & REPACK
LT-05-522	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
LT-05-561	SOL. VALVE - 4 WAY	1	L		SIZE REDUCTION & REPACK
T-05-521	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
CY-05-521	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
LT-05-523	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
DO-05-521	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
DO-05-522	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
DO-05-523	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
LT-05-521	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK
ST-05-521B	SOL. VALVE - 4 WAY	2	R		SIZE REDUCTION & REPACK
CV-05-501A	SPEED SW.	1	R		SIZE REDUCTION & REPACK
LT-05-561	SPEED SW.	1	R		SIZE REDUCTION & REPACK
CV-05-561	SPEED SW.	1	R		SIZE REDUCTION & REPACK
LT-05-521	SPEED SW.	2	R		SIZE REDUCTION & REPACK
CV-05-501B	SPEED SW.	1	R		SIZE REDUCTION & REPACK
LT-05-523	SPEED SW.	1	R		SIZE REDUCTION & REPACK
LT-05-522	SPEED SW.	1	R		SIZE REDUCTION & REPACK
TC-05-501	SPEED SW.	2	R		SIZE REDUCTION & REPACK
T-05-521	WEIGHT TRANSMITTER	1	R		SIZE REDUCTION & REPACK
SH-05-541	CURRENT CONTACT	1	R		SIZE REDUCTION & REPACK (PUG MILL)
T-05-541	LOAD CELL	4	L		SIZE REDUCTION & REPACK (PUG MILL)
SH-05-541	PHOTOEYE	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	PHOTOEYE	2	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	PHOTOEYE	2	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-541	PHOTOEYE	2	R		SIZE REDUCTION & REPACK (PUG MILL)
DH-05-542	PROX. SW.	4	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-541	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-541	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-542	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-544	PROX. SW.	2	R		SIZE REDUCTION & REPACK (PUG MILL)
T-05-541	PROX. SW.	1	R		SIZE REDUCTION & REPACK (PUG MILL)
ST-05-542	PROX. SW.	4	R		SIZE REDUCTION & REPACK (PUG MILL)
DH-05-542	PUSHBUTTON	2	L	TIP, RETURM	SIZE REDUCTION & REPACK (PUG MILL)
CV-05-541	PUSHBUTTON	1	L	UP, DOWN	SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK (PUG MILL)
LT-05-541	ROPE SW.	2	L	UP, DOWN	SIZE REDUCTION & REPACK (PUG MILL)
CV-05-541	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SIZE REDUCTION & REPACK (PUG MILL)
DH-05-542	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SIZE REDUCTION & REPACK (PUG MILL)
ST-05-542	SOL. VALVE - 4 WAY	2	R		SIZE REDUCTION & REPACK (PUG MILL)
T-05-541	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-541	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-541	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-542	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
DO-05-544	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	SOL. VALVE - 4 WAY	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-543	SPEED SW.	1	R		SIZE REDUCTION & REPACK (PUG MILL)

TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
LT-05-543	SPEED SW.	1	R		SIZE REDUCTION & REPACK (PUG MILL)
LT-05-541	SPEED SW.	1	R		SIZE REDUCTION & REPACK (PUG MILL)
T-05-541	WEIGHT TRANSMITTER	1	R		SIZE REDUCTION & REPACK (PUG MILL)
SH-06-101	CURRENT RELAY	1	L		SPECIAL WASTE SIZE REDUCTION
SH-06-101	CURRENT TRANSMITTER	1	L		SPECIAL WASTE SIZE REDUCTION
HD-06-101	FLOW SW.	1	L		SPECIAL WASTE SIZE REDUCTION
HD-06-101	HORN	1	L		SPECIAL WASTE SIZE REDUCTION
CV-06-102	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
CV-06-101	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
CV-06-105	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
CV-06-103	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
CV-06-106	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
CV-06-104	PHOTOEYE	3	R	TRANSMITTER/RECEIVER PAIR	SPECIAL WASTE SIZE REDUCTION
HD-06-101	PILOT LIGHT	2	L	HOOD RUNNING, HOOD FAILED	SPECIAL WASTE SIZE REDUCTION
SH-06-101	PILOT LIGHT	2	L	RUNNING, JAM	SPECIAL WASTE SIZE REDUCTION
CV-06-102	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-101	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-103	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-105	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-104	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-106	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
HD-06-101	SELECTOR SW. - 2 POS.	1	L	ON/OFF	SPECIAL WASTE SIZE REDUCTION
SH-06-101	SELECTOR SW. - 2 POS.	1	L	ON/OFF	SPECIAL WASTE SIZE REDUCTION
CV-06-103	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-106	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-105	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-101	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-104	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-102	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
GB-06-101	CURRENT TRANSMITTER	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-103	PHOTOEYE	1	R		SPECIAL WASTE SIZE REDUCTION
AL-06-101	PHOTOEYE	3	L		SPECIAL WASTE SIZE REDUCTION
AL-06-102	PHOTOEYE	3	L		SPECIAL WASTE SIZE REDUCTION
CV-06-104	PHOTOEYE	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
AL-06-104	PHOTOEYE	3	L		SPECIAL WASTE SIZE REDUCTION
CV-06-102	PHOTOEYE	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-105	PHOTOEYE	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-101	PHOTOEYE	1	R		SPECIAL WASTE SIZE REDUCTION
AL-06-103	PHOTOEYE	3	L		SPECIAL WASTE SIZE REDUCTION
CV-06-106	PHOTOEYE	3	R		SPECIAL WASTE SIZE REDUCTION
AL-06-102	PROX. SW.	4	R		SPECIAL WASTE SIZE REDUCTION
AL-06-104	PROX. SW.	4	R		SPECIAL WASTE SIZE REDUCTION

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
AL-06-101	PROX. SW.	4	R		SPECIAL WASTE SIZE REDUCTION
AL-06-103	PROX. SW.	4	R		SPECIAL WASTE SIZE REDUCTION
AL-06-102	PUSHBUTTON	4	L	(UP,DOWN) X 2	SPECIAL WASTE SIZE REDUCTION
AL-06-104	PUSHBUTTON	4	L	(UP,DOWN) X 2	SPECIAL WASTE SIZE REDUCTION
AL-06-103	PUSHBUTTON	4	L	(UP,DOWN) X 2	SPECIAL WASTE SIZE REDUCTION
AL-06-101	PUSHBUTTON	4	L	(UP,DOWN) X 2	SPECIAL WASTE SIZE REDUCTION
CV-06-105	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-103	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-106	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-104	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-101	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
CV-06-102	ROPE SW.	2	L		SPECIAL WASTE SIZE REDUCTION
AL-06-104	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-103	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-101	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-104	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-106	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
AL-06-103	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
AL-06-101	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-105	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
AL-06-102	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-102	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	SPECIAL WASTE SIZE REDUCTION
CV-06-102	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-101	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-104	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-105	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-103	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
CV-06-106	SPEED SW.	1	R		SPECIAL WASTE SIZE REDUCTION
T-05-212	CONTROLLER - FLOW	2	R		VIBRO GROUTING SYSTEM
CV-05-204	CURRENT CONTACT	1	R		VIBRO GROUTING SYSTEM
CV-05-202	CURRENT CONTACT	1	R		VIBRO GROUTING SYSTEM
T-05-212	FLOW ELEMENT	2	L		VIBRO GROUTING SYSTEM
T-05-212	FLOW TRANSMITTER	2	R		VIBRO GROUTING SYSTEM
T-05-211	LEVEL SW. - CAP	1	R		VIBRO GROUTING SYSTEM
T-05-212	LEVEL SW. - CAP	1	R		VIBRO GROUTING SYSTEM
T-05-204	LEVEL SW. - CAP	1	R		VIBRO GROUTING SYSTEM
T-05-201	LEVEL SW. - CAP	3	R		VIBRO GROUTING SYSTEM
T-05-203	LEVEL SW. - CAP	3	R		VIBRO GROUTING SYSTEM
T-05-210	LEVEL SW. - CAP	3	R		VIBRO GROUTING SYSTEM
T-05-202	LEVEL SW. - CAP	1	R		VIBRO GROUTING SYSTEM
P-05-201	LEVEL SW. - ULTRASOUND	1	R		VIBRO GROUTING SYSTEM
T-05-202	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
T-05-212	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
T-05-211	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
T-05-204	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
T-05-203	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
T-05-210	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
T-05-201	LOAD CELLS	4	L		VIBRO GROUTING SYSTEM
CV-05-202	PHOTOEYE	1	R		VIBRO GROUTING SYSTEM
CV-05-204	PHOTOEYE	1	R		VIBRO GROUTING SYSTEM
LT-05-201	PHOTOEYE	2	R		VIBRO GROUTING SYSTEM
CV-05-214	PHOTOEYE	3	R		VIBRO GROUTING SYSTEM
CV-05-213A	PHOTOEYE	1	R		VIBRO GROUTING SYSTEM
CV-05-212A	PHOTOEYE	1	R		VIBRO GROUTING SYSTEM
AL-05-203	PHOTOEYE	2	R		VIBRO GROUTING SYSTEM
AL-05-203	PROX. SW.	4	R	(OPEN, CLOSE) X 2	VIBRO GROUTING SYSTEM
LT-05-201	PROX. SW.	2	R		VIBRO GROUTING SYSTEM
DO-05-201	PROX. SW.	2	R		VIBRO GROUTING SYSTEM
DO-05-201	PUSHBUTTON	2	L	OPEN, CLOSE	VIBRO GROUTING SYSTEM
T-05-203	PUSHBUTTON	2	L	OPEN, CLOSE	VIBRO GROUTING SYSTEM
LT-05-201	PUSHBUTTON	2	L	UP, DOWN	VIBRO GROUTING SYSTEM
T-05-201	PUSHBUTTON	6	L	(OPEN, CLOSE) X 3	VIBRO GROUTING SYSTEM
AL-05-203	PUSHBUTTON	4	L	(OPEN, CLOSE) X 2	VIBRO GROUTING SYSTEM
T-05-210	PUSHBUTTON	4	L	(OPEN, CLOSE) X 2	VIBRO GROUTING SYSTEM
CV-05-214	ROPE SW.	2	L		VIBRO GROUTING SYSTEM
LT-05-201	ROPE SW.	2	L	UP, DOWN	VIBRO GROUTING SYSTEM
CV-05-212A	ROPE SW.	2	L		VIBRO GROUTING SYSTEM
T-05-201	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (DUST COLLECTOR)	VIBRO GROUTING SYSTEM
CV-05-212A	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	VIBRO GROUTING SYSTEM
T-05-210	SELECTOR SW. - 3 POS	2	R	H-O-A SW. (VALVES)	VIBRO GROUTING SYSTEM
LT-05-201	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	VIBRO GROUTING SYSTEM
T-05-201	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (FEED MOTOR)	VIBRO GROUTING SYSTEM
T-05-201	SELECTOR SW. - 3 POS	3	R	H-O-A SW. (VALVES)	VIBRO GROUTING SYSTEM
T-05-203	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (DUST COLLECTOR)	VIBRO GROUTING SYSTEM
CV-05-214	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	VIBRO GROUTING SYSTEM
T-05-203	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (VALVES)	VIBRO GROUTING SYSTEM
DO-05-201	SELECTOR SW. - 3 POS	1	R	H-O-A SW.	VIBRO GROUTING SYSTEM
T-05-210	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (FEED MOTOR)	VIBRO GROUTING SYSTEM
T-05-203	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (FEED MOTOR)	VIBRO GROUTING SYSTEM
AL-05-203	SELECTOR SW. - 3 POS	2	R	H-O-A SW.	VIBRO GROUTING SYSTEM
T-05-210	SELECTOR SW. - 3 POS	1	R	H-O-A SW. (DUST COLLECTOR)	VIBRO GROUTING SYSTEM
T-05-203	SOL. VALVE - 2 WAY	2	R		VIBRO GROUTING SYSTEM
T-05-201	SOL. VALVE - 2 WAY	2	R		VIBRO GROUTING SYSTEM
T-05-210	SOL. VALVE - 2 WAY	2	R		VIBRO GROUTING SYSTEM

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TABLE 4.1
Instrument Count

Equipment	Instrument	QTY	L/R	Comments	PFD
P-05-201	SOL. VALVE - 3 WAY	1	R		VIBRO GROUTING SYSTEM
T-05-203	SOL. VALVE - 3 WAY	1	R		VIBRO GROUTING SYSTEM
T-05-210	SOL. VALVE - 3 WAY	2	R		VIBRO GROUTING SYSTEM
T-05-201	SOL. VALVE - 3 WAY	4	R		VIBRO GROUTING SYSTEM
DO-05-201	SOL. VALVE - 4 WAY	1	R		VIBRO GROUTING SYSTEM
LT-05-201	SOL. VALVE - 4 WAY	1	R		VIBRO GROUTING SYSTEM
CV-05-213A	SPEED SW.	1	R		VIBRO GROUTING SYSTEM
LT-05-201	SPEED SW.	1	R		VIBRO GROUTING SYSTEM
CV-05-214	SPEED SW.	1	R		VIBRO GROUTING SYSTEM
CV-05-212A	SPEED SW.	1	R		VIBRO GROUTING SYSTEM
P-05-201	VALVE - 3 WAY	1	L		VIBRO GROUTING SYSTEM
T-05-201	VALVE - GATE	3	L		VIBRO GROUTING SYSTEM
T-05-210	VALVE - GATE	2	L		VIBRO GROUTING SYSTEM
T-05-203	VALVE - GATE	1	L		VIBRO GROUTING SYSTEM
T-05-212	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-211	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-210	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-201	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-203	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-202	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM
T-05-204	WEIGHT TRANSMITTER	1	R		VIBRO GROUTING SYSTEM

This table was devloped at an early stage of the conceptual design based on estimated quantities. Due to design evaluation, one-for-one correlation between **Table 4.1** and the PFDs may not exist. **Table 4.6.4** represents instrument count take-off from the final PFDs and the cost estimate is based on the **Table 4.6.4** quantities. Since a detailed index will be developed during Title Design, it was decided not to update **Table 4.1** at the conceptual stage.

TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
LI1	DP-04-101	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI2	DP-04-102	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI3	DP-04-103	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI4	DP-04-104	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI5	DP-04-105	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI6	DP-04-106	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI7	DP-04-107	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI8	DP-04-108	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI9	DP-04-109	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI10	C-04-101A	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LI11	C-04-101B	Loop Input	PIT		PRESSURE CONTROL	OFF-GAS TREATMENT
LO1	DP-04-101	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO2	DP-04-102	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO3	DP-04-103	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO4	DP-04-104	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO5	DP-04-105	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO6	DP-04-106	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO7	DP-04-107	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO8	DP-04-108	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO9	DP-04-109	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO10	C-04-101A	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
LO11	C-04-101B	Loop Output	PY		PRESSURE CONTROL	OFF-GAS TREATMENT
DI	H-04-101	Temperature Switch	TSH		HIGH TEMPERATURE	OFF-GAS TREATMENT
DI	H-04-102	Temperature Switch	TSH		HIGH TEMPERATURE	OFF-GAS TREATMENT
DI	F-04-101	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-101	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-102	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-102	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-103	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-104	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-104	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-105	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-105	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-106	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-106	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-107	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-107	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-108	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-108	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-109	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-109	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-110	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-110	Press. Diff. SW	PDSH		HEPA Filt. Hi DP	OFF-GAS TREATMENT
DI	F-04-111A	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-111A	Press. Diff. SW	PDSH		HEPA Filt. #1 Hi DP	OFF-GAS TREATMENT
DI	F-04-111A	Press. Diff. SW	PDSH		HEPA Filt. #2 Hi DP	OFF-GAS TREATMENT
DI	F-04-111B	Press. Diff. SW	PDSH		PREFILT. HI DP	OFF-GAS TREATMENT
DI	F-04-111B	Press. Diff. SW	PDSH		HEPA Filt. #1 Hi DP	OFF-GAS TREATMENT
DI	F-04-111B	Press. Diff. SW	PDSH		HEPA Filt. #2 Hi DP	OFF-GAS TREATMENT
DI	U-04-101	Trouble Alarm	XS		CONDENSER TROUBLE	OFF-GAS TREATMENT

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	C-04-111A	START	ST		START	OFF-GAS TREATMENT
DO	C-04-111A	STOP	SP		STOP	OFF-GAS TREATMENT
DI	C-04-111A	STATUS	S		RUNNING	OFF-GAS TREATMENT
DI	C-04-111A	L-O-R SW	LOR		LOCAL/REMOTE	OFF-GAS TREATMENT
DO	C-04-111B	START	ST		START	OFF-GAS TREATMENT
DO	C-04-111B	STOP	SP		STOP	OFF-GAS TREATMENT
DI	C-04-111B	STATUS	S		RUNNING	OFF-GAS TREATMENT
DI	C-04-111B	L-O-R SW	LOR		LOCAL/REMOTE	OFF-GAS TREATMENT
DO	P-04-201	START	ST		START	DECON SYSTEM PFD
DO	P-04-201	STOP	SP		STOP	DECON SYSTEM PFD
DI	P-04-201	STATUS	S		RUNNING	DECON SYSTEM PFD
DI	P-04-201	L-O-R SW	LOR		LOCAL/REMOTE	DECON SYSTEM PFD
AI	P-04-201	FLOW INPUT	FIT		RATIO FLOW CONTROL	DECON SYSTEM PFD
LI12	P-04-201	LOOP INPUT	FIT		RATIO FLOW CONTROL	DECON SYSTEM PFD
LO12	P-04-201	LOOP OUTPUT	FY		RATIO FLOW CONTROL	DECON SYSTEM PFD
DO	P-04-210	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-210	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-210	STATUS	S		RUNNING	DECON SYSTEM PFD
DO	P-04-230	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-230	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-230	STATUS	S		RUNNING	DECON SYSTEM PFD
DO	P-04-240	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-240	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-240	STATUS	S		RUNNING	DECON SYSTEM PFD
DO	P-04-241	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-241	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-241	STATUS	S		RUNNING	DECON SYSTEM PFD
DO	P-04-242	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-242	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-242	STATUS	S		RUNNING	DECON SYSTEM PFD
DO	P-04-251	PERMISSIVE	LY		OK TO RUN	DECON SYSTEM PFD
DI	P-04-251	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	DECON SYSTEM PFD
DI	P-04-251	STATUS	S		RUNNING	DECON SYSTEM PFD
AI	P-04-251	RADIATION INPUT	RIT		GAMMA RADIATION	DECON SYSTEM PFD
AI	X-04-252	RADIATION INPUT	RIT		GAMMA RADIATION	DECON SYSTEM PFD
DO	CV-05-501	START	ST		START	DECON SYSTEM PFD
DI	CV-05-501	STATUS	S		RUNNING	DECON SYSTEM PFD
DI	CV-05-501	L-O-R SW	LOR		LOCAL/REMOTE	DECON SYSTEM PFD
LI	P-04-251	LEVEL INPUT	LIT		LEVEL CONTROL	DECON SYSTEM PFD
LO	P-04-251	LEVEL OUTPUT	LY		LEVEL CONTROL	DECON SYSTEM PFD
DI	T-05-304	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	RESIN & CHEM. STOR.
DO	P-05-304	START	ST		START	RESIN & CHEM. STOR.
DI	P-05-304	STATUS	S		RUNNING	RESIN & CHEM. STOR.
DI	P-05-304	L-O-R SW	LOR		LOCAL/REMOTE	RESIN & CHEM. STOR.
DI	T-05-305	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	RESIN & CHEM. STOR.
DI	T-05-305	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	RESIN & CHEM. STOR.
LI15	T-05-305	LEVEL INPUT	LIT		LEVEL IND.	RESIN & CHEM. STOR.
LO15	T-05-305	SOLENOID OUTPUT	LY		LEVEL SOLENOID	RESIN & CHEM. STOR.
DI	P-05-301	STATUS	S		PUMP RUNNING	RESIN & CHEM. STOR.
DI	P-05-302	STATUS	S		PUMP RUNNING	RESIN & CHEM. STOR.

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	P-05-303	STATUS	S		PUMP RUNNING	RESIN & CHEM. STOR.
DI	P-05-305	STATUS	S		PUMP RUNNING	RESIN & CHEM. STOR.
DO	CV-05-501	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-501	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-501	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-501	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	CV-05-502	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-502	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-502	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-502	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	CV-05-503	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-503	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-503	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-503	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	CV-05-505	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-505	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-505	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-505	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DI	CV-05-505	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DI	CV-05-505	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DO	LT-05-505	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-505	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-505	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-505	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD
DO	LT-05-505	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-505	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-505	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	CV-05-506	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-506	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-506	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-506	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DI	CV-05-506	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DI	CV-05-506	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DO	LT-05-506	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-506	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-506	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-506	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD
DO	LT-05-506	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-506	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-506	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	CV-05-507	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-507	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-507	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-507	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DI	CV-05-507	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DI	CV-05-507	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DO	LT-05-507	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-507	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-507	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-507	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	LT-05-507	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-507	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-507	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	LT-05-502A	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-502A	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-502A	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-502A	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD
DO	LT-05-502A	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-502A	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-502A	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	LT-05-502B	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-502B	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-502B	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-502B	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD
DO	LT-05-502B	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-502B	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-502B	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	LT-05-503	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	SIZE REDUCE & REPACK PFD
DO	LT-05-503	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	SIZE REDUCE & REPACK PFD
DI	LT-05-503	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	SIZE REDUCE & REPACK PFD
DI	LT-05-503	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	SIZE REDUCE & REPACK PFD
DO	LT-05-503	START OUTPUT	ST		START L.T. CONV.	SIZE REDUCE & REPACK PFD
DI	LT-05-503	STATUS SW	S		L.T. CONV. RUNNING	SIZE REDUCE & REPACK PFD
DI	LT-05-503	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	RT-05-501A	LOWER OUTPUT	ZY		ROTATE DOWN	SIZE REDUCE & REPACK PFD
DO	RT-05-501A	RAISE OUTPUT	ZY		ROTATE UP	SIZE REDUCE & REPACK PFD
DI	RT-05-501A	LOWERED POS. SW.	ZS		ROTATED DOWN	SIZE REDUCE & REPACK PFD
DI	RT-05-501A	RAISED POS. SW.	ZS		ROTATED UP	SIZE REDUCE & REPACK PFD
DO	RT-05-501A	MAGNET ON			ATTACH LID	SIZE REDUCE & REPACK PFD
DO	RT-05-501A	MAGNET OFF			DETATCH LID	SIZE REDUCE & REPACK PFD
DI	RT-05-501A	POSITION SW	ZS		LID ATTACHED	SIZE REDUCE & REPACK PFD
DO	RT-05-501B	LOWER OUTPUT	ZY		ROTATE DOWN	SIZE REDUCE & REPACK PFD
DO	RT-05-501B	RAISE OUTPUT	ZY		ROTATE UP	SIZE REDUCE & REPACK PFD
DI	RT-05-501B	LOWERED POS. SW.	ZS		ROTATED DOWN	SIZE REDUCE & REPACK PFD
DI	RT-05-501B	RAISED POS. SW.	ZS		ROTATED UP	SIZE REDUCE & REPACK PFD
DO	RT-05-501B	MAGNET ON			ATTACH LID	SIZE REDUCE & REPACK PFD
DO	RT-05-501B	MAGNET OFF			DETATCH LID	SIZE REDUCE & REPACK PFD
DI	RT-05-501B	POSITION SW	ZS		LID ATTACHED	SIZE REDUCE & REPACK PFD
DO	RT-05-501C	LOWER OUTPUT	ZY		ROTATE DOWN	SIZE REDUCE & REPACK PFD
DO	RT-05-501C	RAISE OUTPUT	ZY		ROTATE UP	SIZE REDUCE & REPACK PFD
DI	RT-05-501C	LOWERED POS. SW.	ZS		ROTATED DOWN	SIZE REDUCE & REPACK PFD
DI	RT-05-501C	RAISED POS. SW.	ZS		ROTATED UP	SIZE REDUCE & REPACK PFD
DO	RT-05-501C	MAGNET ON			ATTACH LID	SIZE REDUCE & REPACK PFD
DO	RT-05-501C	MAGNET OFF			DETATCH LID	SIZE REDUCE & REPACK PFD
DI	RT-05-501C	POSITION SW	ZS		LID ATTACHED	SIZE REDUCE & REPACK PFD
DO	SH-05-501	START	ST		START	SIZE REDUCE & REPACK PFD
DI	SH-05-501	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	SH-05-501	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	SH-05-501	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	SH-05-502	START	ST		START	SIZE REDUCE & REPACK PFD

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	SH-05-502	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	SH-05-502	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	SH-05-502	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	SH-05-503	START	ST		START	SIZE REDUCE & REPACK PFD
DI	SH-05-503	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	SH-05-503	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	SH-05-503	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DO	T-05-501	OPEN				SIZE REDUCE & REPACK PFD
DO	T-05-501	CLOSE				SIZE REDUCE & REPACK PFD
AI	T-05-501	WEIGHT INPUT	WT			SIZE REDUCE & REPACK PFD
DI	T-05-501	POSITION SW	ZS		OPEN	SIZE REDUCE & REPACK PFD
DO	T-05-502	OPEN				SIZE REDUCE & REPACK PFD
DO	T-05-502	CLOSE				SIZE REDUCE & REPACK PFD
AI	T-05-502	WEIGHT INPUT	WT			SIZE REDUCE & REPACK PFD
DI	T-05-502	POSITION SW	ZS		OPEN	SIZE REDUCE & REPACK PFD
DI	T-05-502	POSITION SW	ZS		CLOSED	SIZE REDUCE & REPACK PFD
DO	T-05-503	OPEN				SIZE REDUCE & REPACK PFD
DO	T-05-503	CLOSE				SIZE REDUCE & REPACK PFD
DO	AL-05-501	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-501	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-501	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-501	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-501	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-501	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-501	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-501	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-501	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-501	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-501	AGV HANDSHAKE	ZY		S1	SIZE REDUCE & REPACK PFD
DO	AL-05-501	AGV HANDSHAKE	ZY		S2	SIZE REDUCE & REPACK PFD
DI	AL-05-501	AGV HANDSHAKE	ZS		S1	SIZE REDUCE & REPACK PFD
DI	AL-05-501	AGV HANDSHAKE	ZS		S2	SIZE REDUCE & REPACK PFD
DO	AL-05-501	FWD OUTPUT	ZY		CONV. FWD.	SIZE REDUCE & REPACK PFD
DO	AL-05-501	REV OUTPUT	ZY		CONV. REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-501	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK PFD
DI	AL-05-501	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-501	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK PFD
DI	AL-05-501	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK PFD
DO	AL-05-502	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-502	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-502	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-502	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-502	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-502	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-502	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-502	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-502	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-502	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-502	AGV HANDSHAKE	ZY		S1	SIZE REDUCE & REPACK PFD
DO	AL-05-502	AGV HANDSHAKE	ZY		S2	SIZE REDUCE & REPACK PFD

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	AL-05-502	AGV HANDSHAKE	ZS		S1	SIZE REDUCE & REPACK PFD
DI	AL-05-502	AGV HANDSHAKE	ZS		S2	SIZE REDUCE & REPACK PFD
DO	AL-05-502	FWD OUTPUT	ZY		CONV. FWD.	SIZE REDUCE & REPACK PFD
DO	AL-05-502	REV OUTPUT	ZY		CONV. REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-502	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK PFD
DI	AL-05-502	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-502	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK PFD
DI	AL-05-502	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	AGV HANDSHAKE	ZY		S1	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	AGV HANDSHAKE	ZY		S2	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	AGV HANDSHAKE	ZS		S1	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	AGV HANDSHAKE	ZS		S2	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	FWD OUTPUT	ZY		CONV. FWD.	SIZE REDUCE & REPACK PFD
DO	AL-05-50X	REV OUTPUT	ZY		CONV. REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK PFD
DI	AL-05-50X	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK PFD
DO	LT-05-501	CLASP			GRAB DRUM	SIZE REDUCE & REPACK PFD
DO	LT-05-501	UNCLASP			RELEASE DRUM	SIZE REDUCE & REPACK PFD
DI	LT-05-501	DRUM IN CLASP				SIZE REDUCE & REPACK PFD
DO	LT-05-501	EXTEND			ELEVATOR UP	SIZE REDUCE & REPACK PFD
DO	LT-05-501	RETRACT			ELEVATOR DOWN	SIZE REDUCE & REPACK PFD
DI	LT-05-501	POSITION SW.	ZS		ELEVATOR ARM @ TOP	SIZE REDUCE & REPACK PFD
DI	LT-05-501	POSITION SW.	ZS		ELEVATOR ARM @ BOTTOM	SIZE REDUCE & REPACK PFD
DO	LT-05-501	EXTEND			MOVE ARM OUT	SIZE REDUCE & REPACK PFD
DO	LT-05-501	RETRACT			MOVE ARM IN	SIZE REDUCE & REPACK PFD
DI	LT-05-501	POSITION SW.	ZS		ARM IS OUT	SIZE REDUCE & REPACK PFD
DI	LT-05-501	POSITION SW.	ZS		ARM IS IN	SIZE REDUCE & REPACK PFD
DO	LT-05-501	RAISE			PULL ARM UP	SIZE REDUCE & REPACK PFD
DO	LT-05-501	LOWER			PLACE DRUM DOWN	SIZE REDUCE & REPACK PFD
DI	LT-05-501	POSITION SW.	ZS		DRUM IS DOWN	SIZE REDUCE & REPACK PFD
DO	CR-05-502A	CLASP			GRAB DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502A	UNCLASP			RELEASE DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502A	DRUM IN CLASP				SIZE REDUCE & REPACK PFD
DO	CR-05-502A	RAISE			RAISE DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502A	LOWER			LOWER DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502A	POSITION SW.	ZS		DRUM IS DOWN	SIZE REDUCE & REPACK PFD
DO	CR-05-502A	TILT DRUM				SIZE REDUCE & REPACK PFD
DO	CR-05-502A	UPRIGHT DRUM				SIZE REDUCE & REPACK PFD

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	CR-05-502A	MOVE FORWARD				SIZE REDUCE & REPACK PFD
DO	CR-05-502A	MOVE BACK				SIZE REDUCE & REPACK PFD
DO	CR-05-502A	STOP				SIZE REDUCE & REPACK PFD
DI	CR-05-502A	POSITION SW.	ZS		DRUM IS OVER SORT TABLE	SIZE REDUCE & REPACK PFD
DI	CR-05-502A	POSITION SW.	ZS		BACK TO START POSITION	SIZE REDUCE & REPACK PFD
DO	CR-05-502B	CLASP			GRAB DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502B	UNCLASP			RELEASE DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502B	DRUM IN CLASP				SIZE REDUCE & REPACK PFD
DO	CR-05-502B	RAISE			RAISE DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502B	LOWER			LOWER DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502B	POSITION SW.	ZS		DRUM IS DOWN	SIZE REDUCE & REPACK PFD
DO	CR-05-502B	TILT DRUM				SIZE REDUCE & REPACK PFD
DO	CR-05-502B	UPRIGHT DRUM				SIZE REDUCE & REPACK PFD
DO	CR-05-502B	MOVE FORWARD				SIZE REDUCE & REPACK PFD
DO	CR-05-502B	MOVE BACK				SIZE REDUCE & REPACK PFD
DO	CR-05-502B	STOP				SIZE REDUCE & REPACK PFD
DI	CR-05-502B	POSITION SW.	ZS		DRUM IS OVER CONVEYOR	SIZE REDUCE & REPACK PFD
DI	CR-05-502B	POSITION SW.	ZS		BACK TO START POSITION	SIZE REDUCE & REPACK PFD
DO	CR-05-502C	CLASP			GRAB DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502C	UNCLASP			RELEASE DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502C	DRUM IN CLASP				SIZE REDUCE & REPACK PFD
DO	CR-05-502C	RAISE			RAISE DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-502C	LOWER			LOWER DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-502C	POSITION SW.	ZS		DRUM IS DOWN	SIZE REDUCE & REPACK PFD
DO	CR-05-502C	TILT DRUM				SIZE REDUCE & REPACK PFD
DO	CR-05-502C	UPRIGHT DRUM				SIZE REDUCE & REPACK PFD
DO	CR-05-502C	MOVE FORWARD				SIZE REDUCE & REPACK PFD
DO	CR-05-502C	MOVE BACK				SIZE REDUCE & REPACK PFD
DO	CR-05-502C	STOP				SIZE REDUCE & REPACK PFD
DI	CR-05-502C	POSITION SW.	ZS		DRUM IS OVER CONVEYOR	SIZE REDUCE & REPACK PFD
DI	CR-05-502C	POSITION SW.	ZS		BACK TO START POSITION	SIZE REDUCE & REPACK PFD
DO	CR-05-501	CLASP			GRAB DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-501	UNCLASP			RELEASE DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-501	STATUS			DRUM IN CLASP	SIZE REDUCE & REPACK PFD
DO	CR-05-501	RAISE			RAISE DRUM	SIZE REDUCE & REPACK PFD
DO	CR-05-501	LOWER			LOWER DRUM	SIZE REDUCE & REPACK PFD
DI	CR-05-501	POSITION SW.	ZS		DRUM IS DOWN	SIZE REDUCE & REPACK PFD
DO	CV-05-504	START	ST		START	SIZE REDUCE & REPACK PFD
DI	CV-05-504	STATUS	S		RUNNING	SIZE REDUCE & REPACK PFD
DI	CV-05-504	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK PFD
DI	CV-05-504	SPEED SW.	SS			SIZE REDUCE & REPACK PFD
DI	CV-05-504	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DI	CV-05-504	POSITION SWITCH	ZS			SIZE REDUCE & REPACK PFD
DO	DO-05-503	FWD OUTPUT	ZY		DOOR FORWARD	SIZE REDUCE & REPACK PFD
DO	DO-05-503	REV OUTPUT	ZY		DOOR REVERSE	SIZE REDUCE & REPACK PFD
DI	DO-05-503	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK PFD
DI	DO-05-503	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK PFD
DI	DO-05-503	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK PFD
DI	DO-05-503	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK PFD
DO	DO-05-504	FWD OUTPUT	ZY		DOOR FORWARD	SIZE REDUCE & REPACK PFD

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	DO-05-504	REV OUTPUT	ZY		DOOR REVERSE	SIZE REDUCE & REPACK PFD
DI	DO-05-504	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK PFD
DI	DO-05-504	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK PFD
DI	DO-05-504	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK PFD
DI	DO-05-504	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK PFD
DO	AL-05-521	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK
DO	AL-05-521	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK
DI	AL-05-521	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK
DI	AL-05-521	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK
DI	AL-05-521	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK
DO	AL-05-521	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK
DO	AL-05-521	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK
DI	AL-05-521	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK
DI	AL-05-521	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK
DI	AL-05-521	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK
DO	AL-05-521	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK
DO	AL-05-521	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK
DI	AL-05-521	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK
DI	AL-05-521	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK
DI	AL-05-521	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK
DO	AL-05-521	AGV HANDSHAKE	ZY		S1	SIZE REDUCE & REPACK
DO	AL-05-521	AGV HANDSHAKE	ZY		S2	SIZE REDUCE & REPACK
DI	AL-05-521	AGV HANDSHAKE	ZS		S1	SIZE REDUCE & REPACK
DI	AL-05-521	AGV HANDSHAKE	ZS		S2	SIZE REDUCE & REPACK
DO	AL-05-521	FWD OUTPUT	ZY		CONV. FWD.	SIZE REDUCE & REPACK
DO	AL-05-521	REV OUTPUT	ZY		CONV. REV.	SIZE REDUCE & REPACK
DI	AL-05-521	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK
DI	AL-05-521	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK
DI	AL-05-521	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK
DI	AL-05-521	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK
DO	AL-05-502	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK
DO	AL-05-502	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK
DI	AL-05-502	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK
DI	AL-05-502	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK
DI	AL-05-502	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK
DO	AL-05-502	RAISE OUTPUT	FWD		START FWD	SIZE REDUCE & REPACK
DO	AL-05-502	LOWER OUTPUT	REV		START REV	SIZE REDUCE & REPACK
DI	AL-05-502	UP POS. SW.	ZS		DOOR UP	SIZE REDUCE & REPACK
DI	AL-05-502	DOWN POS. SW.	ZS		DOOR DOWN	SIZE REDUCE & REPACK
DI	AL-05-502	L-O-R SW	ZS		LOCAL/REMOTE	SIZE REDUCE & REPACK
DO	AL-05-502	AGV HANDSHAKE	ZY		S1	SIZE REDUCE & REPACK
DO	AL-05-502	AGV HANDSHAKE	ZY		S2	SIZE REDUCE & REPACK
DI	AL-05-502	AGV HANDSHAKE	ZS		S1	SIZE REDUCE & REPACK
DI	AL-05-502	AGV HANDSHAKE	ZS		S2	SIZE REDUCE & REPACK
DO	AL-05-502	FWD OUTPUT	ZY		CONV. FWD.	SIZE REDUCE & REPACK
DO	AL-05-502	REV OUTPUT	ZY		CONV. REV.	SIZE REDUCE & REPACK
DI	AL-05-502	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK
DI	AL-05-502	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK
DI	AL-05-502	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK
DI	AL-05-502	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	CV-05-521	START	ST		START	SIZE REDUCE & REPACK
DO	CV-05-521	STOP	SP		STOP	SIZE REDUCE & REPACK
DI	CV-05-521	STATUS	S		RUNNING	SIZE REDUCE & REPACK
DI	CV-05-521	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK
DI	CV-05-521	SPEED SW.	SS			SIZE REDUCE & REPACK
DI	CV-05-521	POSITION SWITCH	ZS		BEFORE DOOR 1	SIZE REDUCE & REPACK
DI	CV-05-521	POSITION SWITCH	ZS		AFTER DOOR 1	SIZE REDUCE & REPACK
DI	CV-05-521	START	ST		START	SIZE REDUCE & REPACK
DO	CV-05-521	STOP	SP		STOP	SIZE REDUCE & REPACK
DI	CV-05-521	STATUS	S		RUNNING	SIZE REDUCE & REPACK
DI	CV-05-521	L-O-R SW	LOR		LOCAL/REMOTE	SIZE REDUCE & REPACK
DI	CV-05-521	SPEED SW.	SS			SIZE REDUCE & REPACK
DI	CV-05-521	POSITION SWITCH	ZS		BEFORE DOOR 2	SIZE REDUCE & REPACK
DI	CV-05-521	POSITION SWITCH	ZS		AFTER DOOR 2	SIZE REDUCE & REPACK
DO	DO-05-502	FWD OUTPUT	ZY		DOOR FORWARD	SIZE REDUCE & REPACK
DO	DO-05-502	REV OUTPUT	ZY		DOOR REVERSE	SIZE REDUCE & REPACK
DI	DO-05-502	STATUS	ZS		RUNNING FWD.	SIZE REDUCE & REPACK
DI	DO-05-502	STATUS	ZS		RUNNING REV.	SIZE REDUCE & REPACK
DI	DO-05-502	POS.SW.	ZS		POS. 1	SIZE REDUCE & REPACK
DI	DO-05-502	POS.SW.	ZS		POS. 2	SIZE REDUCE & REPACK
DI	TRUCK	PIN SWITCH	ZS		FILLING T-05-101	BULK POWDER STORAGE
DI	TRUCK	PIN SWITCH	ZS		FILLING T-05-102	BULK POWDER STORAGE
DI	TRUCK	PIN SWITCH	ZS		FILLING T-05-103	BULK POWDER STORAGE
DI	TRUCK	PIN SWITCH	ZS		FILLING T-05-104	BULK POWDER STORAGE
DI	T-05-101	LEVEL SW.	LSHH		HI-HI ALARM	BULK POWDER STORAGE
DI	T-05-101	LEVEL SW.	LSH		HI ALARM	BULK POWDER STORAGE
DI	T-05-101	LEVEL SW.	LSL		LO ALARM	BULK POWDER STORAGE
DI	T-05-101	LEVEL SW.	LSLL		LO-LO ALARM	BULK POWDER STORAGE
DI	T-05-102	LEVEL SW.	LSHH		HI-HI ALARM	BULK POWDER STORAGE
DI	T-05-102	LEVEL SW.	LSH		HI ALARM	BULK POWDER STORAGE
DI	T-05-102	LEVEL SW.	LSL		LO ALARM	BULK POWDER STORAGE
DI	T-05-102	LEVEL SW.	LSLL		LO-LO ALARM	BULK POWDER STORAGE
DI	T-05-103	LEVEL SW.	LSHH		HI-HI ALARM	BULK POWDER STORAGE
DI	T-05-103	LEVEL SW.	LSH		HI ALARM	BULK POWDER STORAGE
DI	T-05-103	LEVEL SW.	LSL		LO ALARM	BULK POWDER STORAGE
DI	T-05-103	LEVEL SW.	LSLL		LO-LO ALARM	BULK POWDER STORAGE
DI	T-05-104	LEVEL SW.	LSHH		HI-HI ALARM	BULK POWDER STORAGE
DI	T-05-104	LEVEL SW.	LSH		HI ALARM	BULK POWDER STORAGE
DI	T-05-104	LEVEL SW.	LSL		LO ALARM	BULK POWDER STORAGE
DI	T-05-104	LEVEL SW.	LSLL		LO-LO ALARM	BULK POWDER STORAGE
DO	Y-05-101	START	ST		START	BULK POWDER STORAGE
DO	Y-05-102	START	ST		START	BULK POWDER STORAGE
DO	Y-05-103	START	ST		START	BULK POWDER STORAGE
DO	Y-05-104	START	ST		START	BULK POWDER STORAGE
DO	CV-05-101	START	ST		START	BULK POWDER STORAGE
DI	CV-05-101	STATUS	S		RUNNING	BULK POWDER STORAGE
DI	CV-05-101	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DI	CV-05-101	SPEED SW.	SS			BULK POWDER STORAGE
DO	CV-05-102	START	ST		START	BULK POWDER STORAGE
DI	CV-05-102	STATUS	S		RUNNING	BULK POWDER STORAGE

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	CV-05-102	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DI	CV-05-102	SPEED SW.	SS			BULK POWDER STORAGE
DO	CV-05-103	START	ST		START	BULK POWDER STORAGE
DI	CV-05-103	STATUS	S		RUNNING	BULK POWDER STORAGE
DI	CV-05-103	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DI	CV-05-103	SPEED SW.	SS			BULK POWDER STORAGE
DO	CV-05-104	START	ST		START	BULK POWDER STORAGE
DI	CV-05-104	STATUS	S		RUNNING	BULK POWDER STORAGE
DI	CV-05-104	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DI	CV-05-104	SPEED SW.	SS			BULK POWDER STORAGE
DO	P-05-101	START	ST		START	BULK POWDER STORAGE
DI	P-05-101	STATUS	S		RUNNING	BULK POWDER STORAGE
DI	P-05-101	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DO	P-05-102	START	ST		START	BULK POWDER STORAGE
DI	P-05-102	STATUS	S		RUNNING	BULK POWDER STORAGE
DI	P-05-102	L-O-R SW	LOR		LOCAL/REMOTE	BULK POWDER STORAGE
DO	C-05-101	START	ST		START	BULK POWDER STORAGE
DI	C-05-101	TROUBLE ALARM	XS		AIR COMPR. TROUBLE	BULK POWDER STORAGE
DI	T-05-201	LEVEL SW.	LSHH		HI-HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-201	LEVEL SW.	LSH		HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-201	LEVEL SW.	LSL		LO ALARM	VIBRO GROUT SYSTEM
DI	T-05-201	LEVEL SW.	LSLL		LO-LO ALARM	VIBRO GROUT SYSTEM
DI	T-05-203	LEVEL SW.	LSHH		HI-HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-203	LEVEL SW.	LSH		HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-203	LEVEL SW.	LSL		LO ALARM	VIBRO GROUT SYSTEM
DI	T-05-203	LEVEL SW.	LSLL		LO-LO ALARM	VIBRO GROUT SYSTEM
DI	T-05-210	LEVEL SW.	LSHH		HI-HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-210	LEVEL SW.	LSH		HI ALARM	VIBRO GROUT SYSTEM
DI	T-05-210	LEVEL SW.	LSL		LO ALARM	VIBRO GROUT SYSTEM
DI	T-05-210	LEVEL SW.	LSLL		LO-LO ALARM	VIBRO GROUT SYSTEM
DO	CV-05-201	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-201	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-201	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-201	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	CV-05-202	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-202	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-202	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-202	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	CV-05-203	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-203	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-203	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-203	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	CV-05-204	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-204	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-204	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-204	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	CV-05-210	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-210	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-210	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-210	SPEED SW.	SS			VIBRO GROUT SYSTEM

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	CV-05-211	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-211	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-211	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-211	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	P-05-201	START	ST		START	VIBRO GROUT SYSTEM
DI	P-05-201	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	P-05-201	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	P-05-202	START	ST		START	VIBRO GROUT SYSTEM
DI	P-05-202	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	P-05-202	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	AL-05-203	RAISE OUTPUT	FWD		START FWD	VIBRO GROUT SYSTEM
DO	AL-05-203	LOWER OUTPUT	REV		START REV	VIBRO GROUT SYSTEM
DI	AL-05-203	UP POS. SW.	ZS		DOOR UP	VIBRO GROUT SYSTEM
DI	AL-05-203	DOWN POS. SW.	ZS		DOOR DOWN	VIBRO GROUT SYSTEM
DI	AL-05-203	L-O-R SW	ZS		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	AL-05-203	RAISE OUTPUT	FWD		START FWD	VIBRO GROUT SYSTEM
DO	AL-05-203	LOWER OUTPUT	REV		START REV	VIBRO GROUT SYSTEM
DI	AL-05-203	UP POS. SW.	ZS		DOOR UP	VIBRO GROUT SYSTEM
DI	AL-05-203	DOWN POS. SW.	ZS		DOOR DOWN	VIBRO GROUT SYSTEM
DI	AL-05-203	L-O-R SW	ZS		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	AL-05-203	AGV HANDSHAKE	ZY		S1	VIBRO GROUT SYSTEM
DO	AL-05-203	AGV HANDSHAKE	ZY		S2	VIBRO GROUT SYSTEM
DI	AL-05-203	AGV HANDSHAKE	ZS		S1	VIBRO GROUT SYSTEM
DI	AL-05-203	AGV HANDSHAKE	ZS		S2	VIBRO GROUT SYSTEM
DO	AL-05-203	FWD OUTPUT	ZY		CONV. FWD.	VIBRO GROUT SYSTEM
DO	AL-05-203	REV OUTPUT	ZY		CONV. REV.	VIBRO GROUT SYSTEM
DI	AL-05-203	STATUS	ZS		RUNNING FWD.	VIBRO GROUT SYSTEM
DI	AL-05-203	STATUS	ZS		RUNNING REV.	VIBRO GROUT SYSTEM
DI	AL-05-203	POS.SW.	ZS		POS. 1	VIBRO GROUT SYSTEM
DI	AL-05-203	POS.SW.	ZS		POS. 2	VIBRO GROUT SYSTEM
DO	CV-05-216	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-216	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-216	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-216	SPEED SW.	SS			VIBRO GROUT SYSTEM
DO	CV-05-215	START	ST		START	VIBRO GROUT SYSTEM
DI	CV-05-215	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	CV-05-215	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DI	CV-05-215	SPEED SW.	SS			VIBRO GROUT SYSTEM
DI	CV-05-215	POSITION SWITCH	ZS			VIBRO GROUT SYSTEM
DI	CV-05-215	POSITION SWITCH	ZS			VIBRO GROUT SYSTEM
DO	LT-05-201	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	VIBRO GROUT SYSTEM
DO	LT-05-201	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	VIBRO GROUT SYSTEM
DI	LT-05-201	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	VIBRO GROUT SYSTEM
DI	LT-05-201	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	VIBRO GROUT SYSTEM
DO	LT-05-201	START OUTPUT	ST		START L.T. CONV.	VIBRO GROUT SYSTEM
DI	LT-05-201	STATUS SW	S		L.T. CONV. RUNNING	VIBRO GROUT SYSTEM
DI	LT-05-201	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	RT-05-201	LOWER OUTPUT	ZY		ROTATE DOWN	VIBRO GROUT SYSTEM
DO	RT-05-201	RAISE OUTPUT	ZY		ROTATE UP	VIBRO GROUT SYSTEM
DI	RT-05-201	LOWERED POS. SW.	ZS		ROTATED DOWN	VIBRO GROUT SYSTEM

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	RT-05-201	RAISED POS. SW.	ZS		ROTATED UP	VIBRO GROUT SYSTEM
DO	RT-05-201	MAGNET ON			ATTACH LID	VIBRO GROUT SYSTEM
DO	RT-05-201	MAGNET OFF			DETATCH LID	VIBRO GROUT SYSTEM
DI	RT-05-201	POSITION SW	ZS		LID ATTACHED	VIBRO GROUT SYSTEM
DO	M-05-201	START	ST		START	VIBRO GROUT SYSTEM
DI	M-05-201	STATUS	S		RUNNING	VIBRO GROUT SYSTEM
DI	M-05-201	L-O-R SW	LOR		LOCAL/REMOTE	VIBRO GROUT SYSTEM
DO	Y-05-201	START	ST		START	VIBRO GROUT SYSTEM
DO	Y-05-202	START	ST		START	VIBRO GROUT SYSTEM
DO	Y-05-203	START	ST		START	VIBRO GROUT SYSTEM
DO	Y-05-204	START	ST		START	VIBRO GROUT SYSTEM
DO	Y-05-210	START	ST		START	VIBRO GROUT SYSTEM
DO	Y-05-211	START	ST		START	VIBRO GROUT SYSTEM
LI13	FT-05-201	FLOW INPUT	FT		FLOW TOTALIZER	VIBRO GROUT SYSTEM
LO13	FV-05-201	LOOP OUTPUT	FY		FLOW TOTALIZER	VIBRO GROUT SYSTEM
LI14	FT-05-202	FLOW INPUT	FT		FLOW TOTALIZER	VIBRO GROUT SYSTEM
LO14	FV-05-202	LOOP OUTPUT	FY		FLOW TOTALIZER	VIBRO GROUT SYSTEM
AO	FV-05-203	FLOW CONTROL	FY		RETURN VALVE	VIBRO GROUT SYSTEM
DI	T-05-205	LEVEL SW.	LSHH		HI-HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-205	LEVEL SW.	LSH		HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-205	LEVEL SW.	LSL		LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-205	LEVEL SW.	LSLL		LO-LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-206	LEVEL SW.	LSHH		HI-HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-206	LEVEL SW.	LSH		HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-206	LEVEL SW.	LSL		LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-206	LEVEL SW.	LSLL		LO-LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-208	LEVEL SW.	LSHH		HI-HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-208	LEVEL SW.	LSH		HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-208	LEVEL SW.	LSL		LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-208	LEVEL SW.	LSLL		LO-LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-209	LEVEL SW.	LSHH		HI-HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-209	LEVEL SW.	LSH		HI ALARM	AGITATED GROUT SYSTEM
DI	T-05-209	LEVEL SW.	LSL		LO ALARM	AGITATED GROUT SYSTEM
DI	T-05-209	LEVEL SW.	LSLL		LO-LO ALARM	AGITATED GROUT SYSTEM
DO	Y-05-205	START	ST		START	AGITATED GROUT SYSTEM
DO	Y-05-206	START	ST		START	AGITATED GROUT SYSTEM
DO	Y-05-207	START	ST		START	AGITATED GROUT SYSTEM
DO	Y-05-208	START	ST		START	AGITATED GROUT SYSTEM
DO	Y-05-209	START	ST		START	AGITATED GROUT SYSTEM
DO	CV-05-205	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-205	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-205	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-205	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	CV-05-206	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-206	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-206	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-206	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	CV-05-209	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-209	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-209	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	CV-05-209	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	CV-05-208	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-208	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-208	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-208	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	M-05-202	START	ST		START	AGITATED GROUT SYSTEM
DI	M-05-202	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	M-05-202	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	AL-05-201	RAISE OUTPUT	FWD		START FWD	AGITATED GROUT SYSTEM
DO	AL-05-201	LOWER OUTPUT	REV		START REV	AGITATED GROUT SYSTEM
DI	AL-05-201	UP POS. SW.	ZS		DOOR UP	AGITATED GROUT SYSTEM
DI	AL-05-201	DOWN POS. SW.	ZS		DOOR DOWN	AGITATED GROUT SYSTEM
DI	AL-05-201	L-O-R SW	ZS		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	AL-05-201	RAISE OUTPUT	FWD		START FWD	AGITATED GROUT SYSTEM
DO	AL-05-201	LOWER OUTPUT	REV		START REV	AGITATED GROUT SYSTEM
DI	AL-05-201	UP POS. SW.	ZS		DOOR UP	AGITATED GROUT SYSTEM
DI	AL-05-201	DOWN POS. SW.	ZS		DOOR DOWN	AGITATED GROUT SYSTEM
DI	AL-05-201	L-O-R SW	ZS		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	AL-05-201	AGV HANDSHAKE	ZY		S1	AGITATED GROUT SYSTEM
DO	AL-05-201	AGV HANDSHAKE	ZY		S2	AGITATED GROUT SYSTEM
DI	AL-05-201	AGV HANDSHAKE	ZS		S1	AGITATED GROUT SYSTEM
DI	AL-05-201	AGV HANDSHAKE	ZS		S2	AGITATED GROUT SYSTEM
DO	AL-05-201	FWD OUTPUT	ZY		CONV. FWD.	AGITATED GROUT SYSTEM
DO	AL-05-201	REV OUTPUT	ZY		CONV. REV.	AGITATED GROUT SYSTEM
DI	AL-05-201	STATUS	ZS		RUNNING FWD.	AGITATED GROUT SYSTEM
DI	AL-05-201	STATUS	ZS		RUNNING REV.	AGITATED GROUT SYSTEM
DI	AL-05-201	POS.SW.	ZS		POS. 1	AGITATED GROUT SYSTEM
DI	AL-05-201	POS.SW.	ZS		POS. 2	AGITATED GROUT SYSTEM
DO	CV-05-210	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-210	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-210	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-210	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	CV-05-213	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-213	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-213	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-213	SPEED SW.	SS			AGITATED GROUT SYSTEM
DI	CV-05-213	POSITION SWITCH	ZS			AGITATED GROUT SYSTEM
DI	CV-05-213	POSITION SWITCH	ZS			AGITATED GROUT SYSTEM
DO	LT-05-202	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	AGITATED GROUT SYSTEM
DO	LT-05-202	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	AGITATED GROUT SYSTEM
DI	LT-05-202	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	AGITATED GROUT SYSTEM
DI	LT-05-202	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	AGITATED GROUT SYSTEM
DO	LT-05-202	START OUTPUT	ST		START L.T. CONV.	AGITATED GROUT SYSTEM
DI	LT-05-202	STATUS SW	S		L.T. CONV. RUNNING	AGITATED GROUT SYSTEM
DI	LT-05-202	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	M-05-203	START	ST		START	AGITATED GROUT SYSTEM
DI	M-05-203	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	M-05-203	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	RT-05-202	LOWER OUTPUT	ZY		ROTATE DOWN	AGITATED GROUT SYSTEM
DO	RT-05-202	RAISE OUTPUT	ZY		ROTATE UP	AGITATED GROUT SYSTEM

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	RT-05-202	LOWERED POS. SW.	ZS		ROTATED DOWN	AGITATED GROUT SYSTEM
DI	RT-05-202	RAISED POS. SW.	ZS		ROTATED UP	AGITATED GROUT SYSTEM
DO	RT-05-202	MAGNET ON			ATTACH LID	AGITATED GROUT SYSTEM
DO	RT-05-202	MAGNET OFF			DETATCH LID	AGITATED GROUT SYSTEM
DI	RT-05-202	POSITION SW	ZS		LID ATTACHED	AGITATED GROUT SYSTEM
DO	CV-05-214	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-214	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-214	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-214	SPEED SW.	SS			AGITATED GROUT SYSTEM
DI	CV-05-214	POSITION SWITCH	ZS			AGITATED GROUT SYSTEM
DI	CV-05-214	POSITION SWITCH	ZS			AGITATED GROUT SYSTEM
DO	CV-05-212	START	ST		START	AGITATED GROUT SYSTEM
DI	CV-05-212	STATUS	S		RUNNING	AGITATED GROUT SYSTEM
DI	CV-05-212	L-O-R SW	LOR		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DI	CV-05-212	SPEED SW.	SS			AGITATED GROUT SYSTEM
DO	AL-05-202	RAISE OUTPUT	FWD		START FWD	AGITATED GROUT SYSTEM
DO	AL-05-202	LOWER OUTPUT	REV		START REV	AGITATED GROUT SYSTEM
DI	AL-05-202	UP POS. SW.	ZS		DOOR UP	AGITATED GROUT SYSTEM
DI	AL-05-202	DOWN POS. SW.	ZS		DOOR DOWN	AGITATED GROUT SYSTEM
DI	AL-05-202	L-O-R SW	ZS		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	AL-05-202	RAISE OUTPUT	FWD		START FWD	AGITATED GROUT SYSTEM
DO	AL-05-202	LOWER OUTPUT	REV		START REV	AGITATED GROUT SYSTEM
DI	AL-05-202	UP POS. SW.	ZS		DOOR UP	AGITATED GROUT SYSTEM
DI	AL-05-202	DOWN POS. SW.	ZS		DOOR DOWN	AGITATED GROUT SYSTEM
DI	AL-05-202	L-O-R SW	ZS		LOCAL/REMOTE	AGITATED GROUT SYSTEM
DO	AL-05-202	AGV HANDSHAKE	ZY		S1	AGITATED GROUT SYSTEM
DO	AL-05-202	AGV HANDSHAKE	ZY		S2	AGITATED GROUT SYSTEM
DI	AL-05-202	AGV HANDSHAKE	ZS		S1	AGITATED GROUT SYSTEM
DI	AL-05-202	AGV HANDSHAKE	ZS		S2	AGITATED GROUT SYSTEM
DO	AL-05-202	FWD OUTPUT	ZY		CONV. FWD.	AGITATED GROUT SYSTEM
DO	AL-05-202	REV OUTPUT	ZY		CONV. REV.	AGITATED GROUT SYSTEM
DI	AL-05-202	STATUS	ZS		RUNNING FWD.	AGITATED GROUT SYSTEM
DI	AL-05-202	STATUS	ZS		RUNNING REV.	AGITATED GROUT SYSTEM
DI	AL-05-202	POS.SW.	ZS		POS. 1	AGITATED GROUT SYSTEM
DI	AL-05-202	POS.SW.	ZS		POS. 2	AGITATED GROUT SYSTEM
LI15	FT-05-204	FLOW INPUT	FT		FLOW TOTALIZER	AGITATED GROUT SYSTEM
LO15	FT-05-204	LOOP OUTPUT	FY		FLOW TOTALIZER	AGITATED GROUT SYSTEM
LI16	FT-05-205	FLOW INPUT	FT		FLOW TOTALIZER	AGITATED GROUT SYSTEM
LO16	FT-05-205	LOOP OUTPUT	FY		FLOW TOTALIZER	AGITATED GROUT SYSTEM
DO	LT-05-401A	EXTEND SOLENOID	ZY		EXTEND OUTPUT	POLYMER ENCAPSULATION
DO	LT-05-401A	RETRACT SOLENOID	ZY		RETRACT OUTPUT	POLYMER ENCAPSULATION
DI	LT-05-401A	EXTENDED POS. SW.	ZS		EXTENDED	POLYMER ENCAPSULATION
DI	LT-05-401A	RETRACTED POS. SW.	ZS		RETRACTED	POLYMER ENCAPSULATION
DO	LT-05-401B	EXTEND SOLENOID	ZY		EXTEND OUTPUT	POLYMER ENCAPSULATION
DO	LT-05-401B	RETRACT SOLENOID	ZY		RETRACT OUTPUT	POLYMER ENCAPSULATION
DI	LT-05-401B	EXTENDED POS. SW.	ZS		EXTENDED	POLYMER ENCAPSULATION
DI	LT-05-401B	RETRACTED POS. SW.	ZS		RETRACTED	POLYMER ENCAPSULATION
DO	LT-05-401C	EXTEND SOLENOID	ZY		EXTEND OUTPUT	POLYMER ENCAPSULATION
DO	LT-05-401C	RETRACT SOLENOID	ZY		RETRACT OUTPUT	POLYMER ENCAPSULATION
DI	LT-05-401C	EXTENDED POS. SW.	ZS		EXTENDED	POLYMER ENCAPSULATION

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	LT-05-401C	RETRACTED POS. SW.	ZS		RETRACTED	POLYMER ENCAPSULATION
DO	LT-05-401A	START	ST		START	POLYMER ENCAPSULATION
DI	LT-05-401A	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	LT-05-401A	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	LT-05-401B	START	ST		START	POLYMER ENCAPSULATION
DI	LT-05-401B	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	LT-05-401B	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	LT-05-401C	START	ST		START	POLYMER ENCAPSULATION
DI	LT-05-401C	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	LT-05-401C	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	M-05-403A	START	ST		START	POLYMER ENCAPSULATION
DI	M-05-403A	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	M-05-403A	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	M-05-403B	START	ST		START	POLYMER ENCAPSULATION
DI	M-05-403B	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	M-05-403B	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	P-05-401	START	ST		START	POLYMER ENCAPSULATION
DI	P-05-401	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	P-05-401	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	P-05-402	START	ST		START	POLYMER ENCAPSULATION
DI	P-05-402	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	P-05-402	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	P-05-403	START	ST		START	POLYMER ENCAPSULATION
DI	P-05-403	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	P-05-403	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	P-05-404	START	ST		START	POLYMER ENCAPSULATION
DI	P-05-404	STATUS	S		RUNNING	POLYMER ENCAPSULATION
DI	P-05-404	L-O-R SW	LOR		LOCAL/REMOTE	POLYMER ENCAPSULATION
DO	M-05-401	START	ST		START	POLYMER ENCAPSULATION
DO	M-05-402	START	ST		START	POLYMER ENCAPSULATION
DO	M-05-404	START	ST		START	POLYMER ENCAPSULATION
DO	M-05-405	START	ST		START	POLYMER ENCAPSULATION
DO	M-05-406	START	ST		START	POLYMER ENCAPSULATION
LI	T-05-401	FLOW INPUT	FIT		FLOW CONTROL RESIN	POLYMER ENCAPSULATION
LO	T-05-401	FLOW OUTPUT	FY		FLOW CONTROL RESIN	POLYMER ENCAPSULATION
LI	T-05-401	FLOW INPUT	FIT		FLOW CONTROL EXTENDER	POLYMER ENCAPSULATION
LO	T-05-401	FLOW OUTPUT	FY		FLOW CONTROL EXTENDER	POLYMER ENCAPSULATION
LI	T-05-401	FLOW INPUT	FIT		FLOW CONTROL CATALYST	POLYMER ENCAPSULATION
LO	T-05-401	FLOW OUTPUT	FY		FLOW CONTROL CATALYST	POLYMER ENCAPSULATION
LI	T-05-401	FLOW INPUT	FIT		FLOW CONTROL MIX	POLYMER ENCAPSULATION
LO	T-05-401	FLOW OUTPUT	FY		FLOW CONTROL MIX	POLYMER ENCAPSULATION
LI	GB-05-401	FLOW INPUT	FIT		FLOW CONTROL PROMOTER	POLYMER ENCAPSULATION
LO	GB-05-401	FLOW OUTPUT	FY		FLOW CONTROL PROMOTER	POLYMER ENCAPSULATION
AI	T-05-401	LEVEL INPUT	LIT		TANK LEVEL	POLYMER ENCAPSULATION
AI	T-05-402	LEVEL INPUT	LIT		TANK LEVEL	POLYMER ENCAPSULATION
AI	V-05-401	LEVEL INPUT	LIT		TANK LEVEL	POLYMER ENCAPSULATION
DI	T-05-401	LEVEL SW.	LSHH		HI-HI ALARM	POLYMER ENCAPSULATION
DI	T-05-402	LEVEL SW.	LSH		HI ALARM	POLYMER ENCAPSULATION
DI	T-05-402	LEVEL SW.	LSL		LO ALARM	POLYMER ENCAPSULATION
DI	T-05-402	LEVEL SW.	LSLL		LO-LO ALARM	POLYMER ENCAPSULATION

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	T-05-402	LEVEL SW.	LSHH		HI-HI ALARM	POLYMER ENCAPSULATION
DO	AL-06-101	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-101	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-101	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-101	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-101	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-101	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-101	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-101	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-101	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-101	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-101	AGV HANDSHAKE	ZY		S1	S.W. SIZE REDUCTION
DO	AL-06-101	AGV HANDSHAKE	ZY		S2	S.W. SIZE REDUCTION
DI	AL-06-101	AGV HANDSHAKE	ZS		S1	S.W. SIZE REDUCTION
DI	AL-06-101	AGV HANDSHAKE	ZS		S2	S.W. SIZE REDUCTION
DO	AL-06-101	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	AL-06-101	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	AL-06-101	STATUS	ZS		RUNNING FWD.	S.W. SIZE REDUCTION
DI	AL-06-101	STATUS	ZS		RUNNING REV.	S.W. SIZE REDUCTION
DI	AL-06-101	POS.SW.	ZS		POS. 1	S.W. SIZE REDUCTION
DI	AL-06-101	POS.SW.	ZS		POS. 2	S.W. SIZE REDUCTION
DO	AL-06-102	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-102	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-102	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-102	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-102	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-102	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-102	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-102	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-102	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-102	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-102	AGV HANDSHAKE	ZY		S1	S.W. SIZE REDUCTION
DO	AL-06-102	AGV HANDSHAKE	ZY		S2	S.W. SIZE REDUCTION
DI	AL-06-102	AGV HANDSHAKE	ZS		S1	S.W. SIZE REDUCTION
DI	AL-06-102	AGV HANDSHAKE	ZS		S2	S.W. SIZE REDUCTION
DO	AL-06-102	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	AL-06-102	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	AL-06-102	STATUS	ZS		RUNNING FWD.	S.W. SIZE REDUCTION
DI	AL-06-102	STATUS	ZS		RUNNING REV.	S.W. SIZE REDUCTION
DI	AL-06-102	POS.SW.	ZS		POS. 1	S.W. SIZE REDUCTION
DI	AL-06-102	POS.SW.	ZS		POS. 2	S.W. SIZE REDUCTION
DO	AL-06-103	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-103	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-103	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-103	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-103	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-103	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-103	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-103	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-103	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	AL-06-103	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-103	AGV HANDSHAKE	ZY		S1	S.W. SIZE REDUCTION
DO	AL-06-103	AGV HANDSHAKE	ZY		S2	S.W. SIZE REDUCTION
DI	AL-06-103	AGV HANDSHAKE	ZS		S1	S.W. SIZE REDUCTION
DI	AL-06-103	AGV HANDSHAKE	ZS		S2	S.W. SIZE REDUCTION
DO	AL-06-103	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	AL-06-103	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	AL-06-103	STATUS	ZS		RUNNING FWD.	S.W. SIZE REDUCTION
DI	AL-06-103	STATUS	ZS		RUNNING REV.	S.W. SIZE REDUCTION
DI	AL-06-103	POS.SW.	ZS		POS. 1	S.W. SIZE REDUCTION
DI	AL-06-103	POS.SW.	ZS		POS. 2	S.W. SIZE REDUCTION
DO	AL-06-104	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-104	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-104	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-104	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-104	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-104	RAISE OUTPUT	FWD		START FWD	S.W. SIZE REDUCTION
DO	AL-06-104	LOWER OUTPUT	REV		START REV	S.W. SIZE REDUCTION
DI	AL-06-104	UP POS. SW.	ZS		DOOR UP	S.W. SIZE REDUCTION
DI	AL-06-104	DOWN POS. SW.	ZS		DOOR DOWN	S.W. SIZE REDUCTION
DI	AL-06-104	L-O-R SW	ZS		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	AL-06-104	AGV HANDSHAKE	ZY		S1	S.W. SIZE REDUCTION
DO	AL-06-104	AGV HANDSHAKE	ZY		S2	S.W. SIZE REDUCTION
DI	AL-06-104	AGV HANDSHAKE	ZS		S1	S.W. SIZE REDUCTION
DI	AL-06-104	AGV HANDSHAKE	ZS		S2	S.W. SIZE REDUCTION
DO	AL-06-104	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	AL-06-104	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	AL-06-104	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	AL-06-104	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	AL-06-104	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	AL-06-104	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
DO	CV-06-101	FWD OUTPUT	ZY		XFER CAR FWD	S.W. SIZE REDUCTION
DO	CV-06-101	REV OUTPUT	ZY		XFER CAR REV	S.W. SIZE REDUCTION
DI	CV-06-101	POS. SW.	ZS		XFER CAR POS 1	S.W. SIZE REDUCTION
DI	CV-06-101	POS. SW.	ZS		XFER CAR POS 2	S.W. SIZE REDUCTION
DI	CV-06-101	POS. SW.	ZS		XFER CAR POS 3	S.W. SIZE REDUCTION
DI	CV-06-101	POS. SW.	ZS		XFER CAR POS 4	S.W. SIZE REDUCTION
DO	CV-06-101	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	CV-06-101	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
DO	CR-06-101	FWD OUTPUT	ZY		CRANE FWD	S.W. SIZE REDUCTION
DO	CR-06-101	REV OUTPUT	ZY		CRANE REV	S.W. SIZE REDUCTION
DO	CR-06-101	RAISE OUTPUT	ZY		CRANE UP	S.W. SIZE REDUCTION
DO	CR-06-101	LOWER OUTPUT	ZY		CRANE DOWN	S.W. SIZE REDUCTION
DO	CR-06-101	CLAMP OUTPUT	ZY		CLAMP	S.W. SIZE REDUCTION
DO	CR-06-101	UNCLAMP OUTPUT	ZY		UNCLAMP	S.W. SIZE REDUCTION
DO	CR-06-101	DRUM TIP OUTPUT	ZY		TIP	S.W. SIZE REDUCTION

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	CR-06-101	DRUM UNTIP OUTPUT	ZY		UNTIP	S.W. SIZE REDUCTION
DI	CR-06-101	FWD SW	ZS		FWD STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	REV SW	ZS		REV STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	RAISED SW	ZS		RAISED STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	LOWERED SW	ZS		LOWERED STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	CLAMPED SW	ZS		CLAMP STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	UNCLAMPED SW	ZS		UNCLAMP STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	TIPPED SW	ZS		DRUM TIP STATUS	S.W. SIZE REDUCTION
DI	CR-06-101	UNTIPPED SW	ZS		DRUM UNTIP STATUS	S.W. SIZE REDUCTION
DO	CV-06-101	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	CV-06-101	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
AI	CV-06-101	WEIGHT INPUT	WIT		WEIGHT	S.W. SIZE REDUCTION
DO	CV-06-105	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	CV-06-105	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	CV-06-105	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	CV-06-105	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	CV-06-105	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	CV-06-105	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
AI	CV-06-105	WEIGHT INPUT	WIT		WEIGHT	S.W. SIZE REDUCTION
DO	CV-06-101	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	CV-06-101	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	CV-06-101	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	CV-06-101	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
DO	CV-06-102	FWD OUTPUT	ZY		CONV. FWD.	S.W. SIZE REDUCTION
DO	CV-06-102	REV OUTPUT	ZY		CONV. REV.	S.W. SIZE REDUCTION
DI	CV-06-102	STATUS	ZS		CONV RUNG FWD	S.W. SIZE REDUCTION
DI	CV-06-102	STATUS	ZS		CONV RUNG REV	S.W. SIZE REDUCTION
DI	CV-06-102	POS.SW.	ZS		CONV POS. 1	S.W. SIZE REDUCTION
DI	CV-06-102	POS.SW.	ZS		CONV POS. 2	S.W. SIZE REDUCTION
DO	SH-06-101	START	ST		START	S.W. SIZE REDUCTION
DI	SH-06-101	STATUS	S		RUNNING	S.W. SIZE REDUCTION
DI	SH-06-101	L-O-R SW	LOR		LOCAL/REMOTE	S.W. SIZE REDUCTION
DO	T-06-101	EXTEND OUTPUT	ZY		SLIDE EXTENDED	S.W. SIZE REDUCTION
DO	T-06-101	RETRACT OUTPUT	ZY		SLIDE RETRACTED	S.W. SIZE REDUCTION
DO	ST-06-101	TABLE TIP OUTPUT	ZY		TIP	S.W. SIZE REDUCTION
DO	ST-06-101	TABLE UNTIP OUTPUT	ZY		UNTIP	S.W. SIZE REDUCTION
DI	ST-06-101	TIPPED SW	ZS		TABLE TIP STATUS	S.W. SIZE REDUCTION
DI	ST-06-101	UNTIPPED SW	ZS		TABLE UNTIP STATUS	S.W. SIZE REDUCTION
DO	CV-06-201	FWD OUTPUT	ZY		CONV. FWD.	S.W. MERCURY PRETREATMENT
DO	CV-06-201	REV OUTPUT	ZY		CONV. REV.	S.W. MERCURY PRETREATMENT
DI	CV-06-201	STATUS	ZS		CONV RUNG FWD	S.W. MERCURY PRETREATMENT
DI	CV-06-201	STATUS	ZS		CONV RUNG REV	S.W. MERCURY PRETREATMENT
DI	CV-06-201	POS.SW.	ZS		CONV POS. 1	S.W. MERCURY PRETREATMENT
DI	CV-06-201	POS.SW.	ZS		CONV POS. 2	S.W. MERCURY PRETREATMENT

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
AI	CV-06-201	WEIGHT INPUT	WIT		WEIGHT	S.W. MERCURY PRETREATMENT
DO	CV-06-202	FWD OUTPUT	ZY		CONV. FWD.	S.W. MERCURY PRETREATMENT
DO	CV-06-202	REV OUTPUT	ZY		CONV. REV.	S.W. MERCURY PRETREATMENT
DI	CV-06-202	STATUS	ZS		CONV RUNG FWD	S.W. MERCURY PRETREATMENT
DI	CV-06-202	STATUS	ZS		CONV RUNG REV	S.W. MERCURY PRETREATMENT
DI	CV-06-202	POS.SW.	ZS		CONV POS. 1	S.W. MERCURY PRETREATMENT
DI	CV-06-202	POS.SW.	ZS		CONV POS. 2	S.W. MERCURY PRETREATMENT
AI	CV-06-202	WEIGHT INPUT	WIT		WEIGHT	S.W. MERCURY PRETREATMENT
DO	AL-06-105	RAISE OUTPUT	FWD		START FWD	S.W. MERCURY PRETREATMENT
DO	AL-06-105	LOWER OUTPUT	REV		START REV	S.W. MERCURY PRETREATMENT
DI	AL-06-105	UP POS. SW.	ZS		DOOR UP	S.W. MERCURY PRETREATMENT
DI	AL-06-105	DOWN POS. SW.	ZS		DOOR DOWN	S.W. MERCURY PRETREATMENT
DI	AL-06-105	L-O-R SW	ZS		LOCAL/REMOTE	S.W. MERCURY PRETREATMENT
DO	AL-06-105	RAISE OUTPUT	FWD		START FWD	S.W. MERCURY PRETREATMENT
DO	AL-06-105	LOWER OUTPUT	REV		START REV	S.W. MERCURY PRETREATMENT
DI	AL-06-105	UP POS. SW.	ZS		DOOR UP	S.W. MERCURY PRETREATMENT
DI	AL-06-105	DOWN POS. SW.	ZS		DOOR DOWN	S.W. MERCURY PRETREATMENT
DI	AL-06-105	L-O-R SW	ZS		LOCAL/REMOTE	S.W. MERCURY PRETREATMENT
DO	AL-06-105	AGV HANDSHAKE	ZY		S1	S.W. MERCURY PRETREATMENT
DO	AL-06-105	AGV HANDSHAKE	ZY		S2	S.W. MERCURY PRETREATMENT
DI	AL-06-105	AGV HANDSHAKE	ZS		S1	S.W. MERCURY PRETREATMENT
DI	AL-06-105	AGV HANDSHAKE	ZS		S2	S.W. MERCURY PRETREATMENT
DO	AL-06-105	FWD OUTPUT	ZY		CONV. FWD.	S.W. MERCURY PRETREATMENT
DO	AL-06-105	REV OUTPUT	ZY		CONV. REV.	S.W. MERCURY PRETREATMENT
DI	AL-06-105	STATUS	ZS		CONV RUNG FWD	S.W. MERCURY PRETREATMENT
DI	AL-06-105	STATUS	ZS		CONV RUNG REV	S.W. MERCURY PRETREATMENT
DI	AL-06-105	POS.SW.	ZS		CONV POS. 1	S.W. MERCURY PRETREATMENT
DI	AL-06-105	POS.SW.	ZS		CONV POS. 2	S.W. MERCURY PRETREATMENT
LI	E-06-201	TEMP. INPUT	TIT		TEMP. CONTROL	S.W. MERCURY PRETREATMENT
LO	E-06-201	TEMP. OUTPUT	TY		TEMP. CONTROL	S.W. MERCURY PRETREATMENT
LI	H-06-201	TEMP. INPUT	TIT		TEMP. CONTROL	S.W. MERCURY PRETREATMENT
LO	H-06-201	TEMP. OUTPUT	TY		TEMP. CONTROL	S.W. MERCURY PRETREATMENT
DO	X-06-201A	START	ST		START	S.W. MERCURY PRETREATMENT
DI	X-06-201A	STATUS	S		RUNNING	S.W. MERCURY PRETREATMENT
DI	X-06-201A	L-O-R SW	LOR		LOCAL/REMOTE	S.W. MERCURY PRETREATMENT
DO	X-06-201B	START	ST		START	S.W. MERCURY PRETREATMENT
DI	X-06-201B	STATUS	S		RUNNING	S.W. MERCURY PRETREATMENT
DI	X-06-201B	L-O-R SW	LOR		LOCAL/REMOTE	S.W. MERCURY PRETREATMENT
LI	V-06-301	pH INPUT	AIT		pH CONTROL	REACTIVE METALS PRETREAT.
LO	V-06-301	pH OUTPUT	AY		pH CONTROL	REACTIVE METALS PRETREAT.
LI	V-06-301	LEVEL INPUT	LIT		LEVEL CONTROL	REACTIVE METALS PRETREAT.
LO	V-06-301	LEVEL OUTPUT	LY		LEVEL CONTROL	REACTIVE METALS PRETREAT.
DI	V-06-301	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	REACTIVE METALS PRETREAT.
DI	V-06-301	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	REACTIVE METALS PRETREAT.
LI	E-06-301	TEMP. INPUT	TIT		TEMP. CONTROL	REACTIVE METALS PRETREAT.
LO	E-06-301	TEMP. OUTPUT	TY		TEMP. CONTROL	REACTIVE METALS PRETREAT.
LI	C-06-301	FLOW INPUT	FIT		FLOW CONTROL	REACTIVE METALS PRETREAT.
LO	C-06-301	FLOW OUTPUT	FY		FLOW CONTROL	REACTIVE METALS PRETREAT.
LI	H-06-301	TEMP. INPUT	TIT		TEMP. CONTROL	REACTIVE METALS PRETREAT.
LO	H-06-301	TEMP. OUTPUT	TY		TEMP. CONTROL	REACTIVE METALS PRETREAT.

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DO	CR-06-301	FWD OUTPUT	ZY		CRANE FWD	REACTIVE METALS PRETREAT.
DO	CR-06-301	REV OUTPUT	ZY		CRANE REV	REACTIVE METALS PRETREAT.
DO	CR-06-301	RAISE OUTPUT	ZY		CRANE UP	REACTIVE METALS PRETREAT.
DO	CR-06-301	LOWER OUTPUT	ZY		CRANE DOWN	REACTIVE METALS PRETREAT.
DO	CR-06-301	CLAMP OUTPUT	ZY		CLAMP	REACTIVE METALS PRETREAT.
DO	CR-06-301	UNCLAMP OUTPUT	ZY		UNCLAMP	REACTIVE METALS PRETREAT.
DO	CR-06-301	DRUM TIP OUTPUT	ZY		TIP	REACTIVE METALS PRETREAT.
DO	CR-06-301	DRUM UNTIP OUTPUT	ZY		UNTIP	REACTIVE METALS PRETREAT.
DI	CR-06-301	FWD SW	ZS		FWD STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	REV SW	ZS		REV STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	RAISED SW	ZS		RAISED STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	LOWERED SW	ZS		LOWERED STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	CLAMPED SW	ZS		CLAMP STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	UNCLAMPED SW	ZS		UNCLAMP STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	TIPPED SW	ZS		DRUM TIP STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-301	UNTIPPED SW	ZS		DRUM UNTIP STATUS	REACTIVE METALS PRETREAT.
DO	LT-06-301	EXTEND SOLENOID	ZY		EXTEND LIFT TABLE	REACTIVE METALS PRETREAT.
DO	LT-06-301	RETRACT SOLENOID	ZY		RETRACT LIFT TABLE	REACTIVE METALS PRETREAT.
DI	LT-06-301	EXTENDED POS. SW.	ZS		LIFT TABLE EXTENDED	REACTIVE METALS PRETREAT.
DI	LT-06-301	RETRACTED POS. SW.	ZS		LIFT TABLE RETRACTED	REACTIVE METALS PRETREAT.
DO	LT-06-301	START OUTPUT	ST		START L.T. CONV.	REACTIVE METALS PRETREAT.
DI	LT-06-301	STATUS SW	S		L.T. CONV. RUNNING	REACTIVE METALS PRETREAT.
DI	LT-06-301	L-O-R SW	LOR		LOCAL/REMOTE	REACTIVE METALS PRETREAT.
DO	CV-06-301	FWD OUTPUT	ZY		CONV. FWD.	REACTIVE METALS PRETREAT.
DO	CV-06-301	REV OUTPUT	ZY		CONV. REV.	REACTIVE METALS PRETREAT.
DI	CV-06-301	STATUS	ZS		CONV RUNG FWD	REACTIVE METALS PRETREAT.
DI	CV-06-301	STATUS	ZS		CONV RUNG REV	REACTIVE METALS PRETREAT.
DI	CV-06-301	POS.SW.	ZS		CONV POS. 1	REACTIVE METALS PRETREAT.
DI	CV-06-301	POS.SW.	ZS		CONV POS. 2	REACTIVE METALS PRETREAT.
DO	CV-06-302	FWD OUTPUT	ZY		CONV. FWD.	REACTIVE METALS PRETREAT.
DO	CV-06-302	REV OUTPUT	ZY		CONV. REV.	REACTIVE METALS PRETREAT.
DI	CV-06-302	STATUS	ZS		CONV RUNG FWD	REACTIVE METALS PRETREAT.
DI	CV-06-302	STATUS	ZS		CONV RUNG REV	REACTIVE METALS PRETREAT.
DI	CV-06-302	POS.SW.	ZS		CONV POS. 1	REACTIVE METALS PRETREAT.
DI	CV-06-302	POS.SW.	ZS		CONV POS. 2	REACTIVE METALS PRETREAT.
AI	CV-06-302	WEIGHT INPUT	WIT		WEIGHT	REACTIVE METALS PRETREAT.
DO	S-06-301	START OUTPUT	ST		VIBRATOR START	REACTIVE METALS PRETREAT.
DO	C-06-301	START	ST		START	REACTIVE METALS PRETREAT.
DI	C-06-301	STATUS	S		RUNNING	REACTIVE METALS PRETREAT.
DI	C-06-301	L-O-R SW	LOR		LOCAL/REMOTE	REACTIVE METALS PRETREAT.
DO	P-06-301	START	ST		START	REACTIVE METALS PRETREAT.
DI	P-06-301	STATUS	S		RUNNING	REACTIVE METALS PRETREAT.
DI	P-06-301	L-O-R SW	LOR		LOCAL/REMOTE	REACTIVE METALS PRETREAT.
DO	CR-06-30X	FWD OUTPUT	ZY		CRANE FWD	REACTIVE METALS PRETREAT.
DO	CR-06-30X	REV OUTPUT	ZY		CRANE REV	REACTIVE METALS PRETREAT.
DO	CR-06-30X	RAISE OUTPUT	ZY		CRANE UP	REACTIVE METALS PRETREAT.
DO	CR-06-30X	LOWER OUTPUT	ZY		CRANE DOWN	REACTIVE METALS PRETREAT.
DO	CR-06-30X	CLAMP OUTPUT	ZY		CLAMP	REACTIVE METALS PRETREAT.
DO	CR-06-30X	UNCLAMP OUTPUT	ZY		UNCLAMP	REACTIVE METALS PRETREAT.
DI	CR-06-30X	FWD SW	ZS		FWD STATUS	REACTIVE METALS PRETREAT.

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	CR-06-30X	REV SW	ZS		REV STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-30X	RAISED SW	ZS		RAISED STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-30X	LOWERED SW	ZS		LOWERED STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-30X	CLAMPED SW	ZS		CLAMP STATUS	REACTIVE METALS PRETREAT.
DI	CR-06-30X	UNCLAMPED SW	ZS		UNCLAMP STATUS	REACTIVE METALS PRETREAT.
DO	P-07-102	PERMISSIVE	LY		OK TO RUN	ACTIVE & NONACTIVE WASTE
DI	P-07-102	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	ACTIVE & NONACTIVE WASTE
DI	P-07-102	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DO	P-07-202	PERMISSIVE	LY		OK TO RUN	ACTIVE & NONACTIVE WASTE
DI	P-07-202	LEVEL SWITCH (FLOAT)	LSHH		HIGH-HIGH LEVEL	ACTIVE & NONACTIVE WASTE
DI	P-07-202	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	T-07-101A	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	ACTIVE & NONACTIVE WASTE
DI	T-07-101A	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	ACTIVE & NONACTIVE WASTE
LI16	T-07-101A	LEVEL INPUT	LIT		LEVEL IND.	ACTIVE & NONACTIVE WASTE
LO16	T-07-101A	SOLENOID OUTPUT	LY		LEVEL SOLENOID	ACTIVE & NONACTIVE WASTE
DI	T-07-101B	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	ACTIVE & NONACTIVE WASTE
DI	T-07-101B	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	ACTIVE & NONACTIVE WASTE
LI17	T-07-101B	LEVEL INPUT	LIT		LEVEL IND.	ACTIVE & NONACTIVE WASTE
LO17	T-07-101B	SOLENOID OUTPUT	LY		LEVEL SOLENOID	ACTIVE & NONACTIVE WASTE
DI	T-07-201A	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	ACTIVE & NONACTIVE WASTE
DI	T-07-201A	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	ACTIVE & NONACTIVE WASTE
LI18	T-07-201A	LEVEL INPUT	LIT		LEVEL IND.	ACTIVE & NONACTIVE WASTE
LO18	T-07-201A	SOLENOID OUTPUT	LY		LEVEL SOLENOID	ACTIVE & NONACTIVE WASTE
DI	T-07-201B	LEVEL SW.	LSLL		LO-LO LEVEL ALARM	ACTIVE & NONACTIVE WASTE
DI	T-07-201B	LEVEL SW.	LSHH		HI-HI LEVEL ALARM	ACTIVE & NONACTIVE WASTE
LI19	T-07-201B	LEVEL INPUT	LIT		LEVEL IND.	ACTIVE & NONACTIVE WASTE
LO19	T-07-201B	SOLENOID OUTPUT	LY		LEVEL SOLENOID	ACTIVE & NONACTIVE WASTE
DO	P-07-101A	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	P-07-101A	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	P-07-101A	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	P-07-101B	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	P-07-101B	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	P-07-101B	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	P-07-201A	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	P-07-201A	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	P-07-201A	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	P-07-201B	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	P-07-201B	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	P-07-201B	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	M-07-201A	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	M-07-201A	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	M-07-201A	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	M-07-201B	START	ST		START	ACTIVE & NONACTIVE WASTE
DI	M-07-201B	STATUS	S		RUNNING	ACTIVE & NONACTIVE WASTE
DI	M-07-201B	L-O-R SW	LOR		LOCAL/REMOTE	ACTIVE & NONACTIVE WASTE
DO	CV-09-101	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-101	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-101	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-101	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-101	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
DI	CV-09-101	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA
DO	CR-09-101A	FWD OUTPUT	ZY		CRANE FWD	RECEIVING/SHIPPING AREA
DO	CR-09-101A	REV OUTPUT	ZY		CRANE REV	RECEIVING/SHIPPING AREA
DO	CR-09-101A	RAISE OUTPUT	ZY		CRANE UP	RECEIVING/SHIPPING AREA
DO	CR-09-101A	LOWER OUTPUT	ZY		CRANE DOWN	RECEIVING/SHIPPING AREA
DO	CR-09-101A	CLAMP OUTPUT	ZY		CLAMP	RECEIVING/SHIPPING AREA
DO	CR-09-101A	UNCLAMP OUTPUT	ZY		UNCLAMP	RECEIVING/SHIPPING AREA
DI	CR-09-101A	FWD SW	ZS		FWD STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101A	REV SW	ZS		REV STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101A	RAISED SW	ZS		RAISED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101A	LOWERED SW	ZS		LOWERED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101A	CLAMPED SW	ZS		CLAMP STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101A	UNCLAMPED SW	ZS		UNCLAMP STATUS	RECEIVING/SHIPPING AREA
DO	CR-09-101B	FWD OUTPUT	ZY		CRANE FWD	RECEIVING/SHIPPING AREA
DO	CR-09-101B	REV OUTPUT	ZY		CRANE REV	RECEIVING/SHIPPING AREA
DO	CR-09-101B	RAISE OUTPUT	ZY		CRANE UP	RECEIVING/SHIPPING AREA
DO	CR-09-101B	LOWER OUTPUT	ZY		CRANE DOWN	RECEIVING/SHIPPING AREA
DO	CR-09-101B	CLAMP OUTPUT	ZY		CLAMP	RECEIVING/SHIPPING AREA
DO	CR-09-101B	UNCLAMP OUTPUT	ZY		UNCLAMP	RECEIVING/SHIPPING AREA
DI	CR-09-101B	FWD SW	ZS		FWD STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101B	REV SW	ZS		REV STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101B	RAISED SW	ZS		RAISED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101B	LOWERED SW	ZS		LOWERED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101B	CLAMPED SW	ZS		CLAMP STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101B	UNCLAMPED SW	ZS		UNCLAMP STATUS	RECEIVING/SHIPPING AREA
DO	CR-09-101C	FWD OUTPUT	ZY		CRANE FWD	RECEIVING/SHIPPING AREA
DO	CR-09-101C	REV OUTPUT	ZY		CRANE REV	RECEIVING/SHIPPING AREA
DO	CR-09-101C	RAISE OUTPUT	ZY		CRANE UP	RECEIVING/SHIPPING AREA
DO	CR-09-101C	LOWER OUTPUT	ZY		CRANE DOWN	RECEIVING/SHIPPING AREA
DO	CR-09-101C	CLAMP OUTPUT	ZY		CLAMP	RECEIVING/SHIPPING AREA
DO	CR-09-101C	UNCLAMP OUTPUT	ZY		UNCLAMP	RECEIVING/SHIPPING AREA
DI	CR-09-101C	FWD SW	ZS		FWD STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101C	REV SW	ZS		REV STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101C	RAISED SW	ZS		RAISED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101C	LOWERED SW	ZS		LOWERED STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101C	CLAMPED SW	ZS		CLAMP STATUS	RECEIVING/SHIPPING AREA
DI	CR-09-101C	UNCLAMPED SW	ZS		UNCLAMP STATUS	RECEIVING/SHIPPING AREA
DO	CV-09-106A	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-106A	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-106A	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-106A	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-106A	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA
DI	CV-09-106A	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA
AI	CV-09-106A	WEIGHT INPUT	WIT		WEIGHT	RECEIVING/SHIPPING AREA
DO	CV-09-106B	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-106B	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-106B	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-106B	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-106B	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA
DI	CV-09-106B	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA

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TABLE 4.2
Instrument I/O List

TYPE	Equipment	Instrument	TAG	L/R	Comments	PFD
AI	CV-09-106B	WEIGHT INPUT	WIT		WEIGHT	RECEIVING/SHIPPING AREA
DO	CV-09-103	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-103	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-103	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-103	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-103	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA
DI	CV-09-103	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA
DO	CV-09-104	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-104	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-104	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-104	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-104	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA
DI	CV-09-104	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA
DO	CV-09-105	FWD OUTPUT	ZY		CONV. FWD.	RECEIVING/SHIPPING AREA
DO	CV-09-105	REV OUTPUT	ZY		CONV. REV.	RECEIVING/SHIPPING AREA
DI	CV-09-105	STATUS	ZS		CONV RUNG FWD	RECEIVING/SHIPPING AREA
DI	CV-09-105	STATUS	ZS		CONV RUNG REV	RECEIVING/SHIPPING AREA
DI	CV-09-105	POS.SW.	ZS		CONV POS. 1	RECEIVING/SHIPPING AREA
DI	CV-09-105	POS.SW.	ZS		CONV POS. 2	RECEIVING/SHIPPING AREA
DO	CV-09-XXX	FWD OUTPUT	ZY		CONV. FWD.	DRUM NDA (MAT'L HANDLING)
DO	CV-09-XXX	REV OUTPUT	ZY		CONV. REV.	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	STATUS	ZS		CONV RUNG FWD	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	STATUS	ZS		CONV RUNG REV	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	POS.SW.	ZS		CONV POS. 1	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	POS.SW.	ZS		CONV POS. 2	DRUM NDA (MAT'L HANDLING)
AI	CV-09-XXX	WEIGHT INPUT	WIT		WEIGHT	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	L-O-R SW	LOR		LOCAL/REMOTE	DRUM NDA (MAT'L HANDLING)
DI	CV-09-XXX	SPEED SW.	SS			DRUM NDA (MAT'L HANDLING)
	ND-09-201A	RS-232 INPUT			BAR CODE READER	DRUM NDA
	ND-09-201B	RS-232 INPUT			BAR CODE READER	DRUM NDA
	ND-09-202A	RS-232 INPUT			BAR CODE READER	DRUM NDA
	ND-09-202B	RS-232 INPUT			BAR CODE READER	DRUM NDA
DI	T-12-101	LEVEL SW.	LSH		HIGH LEVEL ALARM	AQUEOUS SOL'N MAKE-UP
DI	T-12-102	LEVEL SW.	LSH		HIGH LEVEL ALARM	AQUEOUS SOL'N MAKE-UP
DI	T-12-103	LEVEL SW.	LSH		HIGH LEVEL ALARM	AQUEOUS SOL'N MAKE-UP
DO	P-12-102	START	ST		START	AQUEOUS SOL'N MAKE-UP
DI	P-12-102	STATUS	S		RUNNING	AQUEOUS SOL'N MAKE-UP
DI	P-12-102	L-O-R SW	LOR		LOCAL/REMOTE	AQUEOUS SOL'N MAKE-UP
DO	P-12-104	START	ST		START	AQUEOUS SOL'N MAKE-UP
DI	P-12-104	STATUS	S		RUNNING	AQUEOUS SOL'N MAKE-UP
DI	P-12-104	L-O-R SW	LOR		LOCAL/REMOTE	AQUEOUS SOL'N MAKE-UP
DO	P-12-105	START	ST		START	AQUEOUS SOL'N MAKE-UP
DI	P-12-105	STATUS	S		RUNNING	AQUEOUS SOL'N MAKE-UP
DI	P-12-105	L-O-R SW	LOR		LOCAL/REMOTE	AQUEOUS SOL'N MAKE-UP
DO	P-12-107	START	ST		START	AQUEOUS SOL'N MAKE-UP
DI	P-12-107	STATUS	S		RUNNING	AQUEOUS SOL'N MAKE-UP
DI	P-12-107	L-O-R SW	LOR		LOCAL/REMOTE	AQUEOUS SOL'N MAKE-UP

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TABLE 4.3
BAR CODE EQUIPMENT LIST
5/11/92

TAG #	DESCRIPTION	SPECIFICATION	DRAWING
BR-05-501	Drum S.R. & Repack	Fixed Scanner	H-2-89XXX
BR-05-502	Pug Mill	Fixed Scanner	H-2-89XXX
BR-05-503	Box S.R. & Repack	Fixed Scanner	H-2-89XXX
BR-05-201	Vibro Grout System	Fixed Scanner	H-2-89XXX
BR-05-202	Agitated Grout Sys.	Fixed Scanner	H-2-89XXX
BR-06-101	Lead Bricks	Fixed Scanner	H-2-89XXX
BR-06-102	Lead Contam. Waste	Fixed Scanner	H-2-89XXX
BR-06-201	Amalgamated Mercury	Fixed Scanner	H-2-89XXX
BR-06-202	Retorted Mercury	Fixed Scanner	H-2-89XXX
BR-09-101	Shipping/Receiving	Handheld Scanner	H-2-89XXX
BR-09-201	PAN Equipment	Fixed Scanner	H-2-89XXX
BR-09-202	PAN Equipment	Fixed Scanner	H-2-89XXX
BR-09-203	GEA Equipment	Fixed Scanner	H-2-89XXX
BR-09-204	GEA Equipment	Fixed Scanner	H-2-89XXX
BR-08-001	Drum Lag Storage	Fixed Scanner	H-2-89XXX
BP-05-001	Sample Management	Bar Code Printer	H-2-89XXX
BP-09-001	Shipping/Receiving	Bar Code Printer	H-2-89XXX
DC-11-001	Grout / NDA	Multi-Drop Terminal	H-2-89XXX
DC-11-002	Special Waste	Multi-Drop Terminal	H-2-89XXX
DC-11-003	Shipping/Receiving	Multi-Drop Terminal	H-2-89XXX
RF-09-001	Shipping/Receiving	Radio Freq. System	H-2-89XXX

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TABLE 4.4
HEALTH PHYSICS INSTRUMENTATION COUNT
5/13/92

ITEM #	INSTRUMENT SYSTEM	QTY
1	Data Aquisition	1
2	Stack Monitors (CAEM)	1
3	Ventilation Duct Monitors Beta (CAM)	6
4	Room In-Air Monitors Beta CAM	9
5	Room Area Radiation Monitors (ARM)	8
6	Operator Air Samplers	4
7	Friskers	14
8	Hand and Foot Monitors	2
9	Smear Counters	2

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TABLE 4.5
CCTV EQUIPMENT LIST
5/12/92

TAG #	DESCRIPTION	DRAWING
TC-05-201	Vibro/Agitated Grout System Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-202	Vibro/Agitated Grout System Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-203	Vibro/Agitated Grout System Camera #3 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-204	Vibro/Agitated Grout System Camera #4 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-401	Polymer Encapsulation Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-402	Polymer Encapsulation Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-403	Polymer Encaps. Enclos. Camera #1 W/ Zoom	H-2-140683
TC-05-404	Polymer Encaps. Enclos. Camera #2 W/ Zoom	H-2-140683
TC-05-405	Polymer Encaps. Enclos. Camera #3 W/ Zoom	H-2-140683
TC-05-406	Polymer Encaps. Enclos. Camera #4 W/ Zoom	H-2-140683
TC-05-501	Drum S.R. & Repack Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-502	Drum S.R. & Repack Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-503	Pug Mill Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-504	Pug Mill Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-505	Box S.R. & Repack Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-05-506	Box S.R. & Repack Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-06-101	Special Waste Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-06-102	Special Waste Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-06-201	Special Waste Camera #3 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-06-202	Special Waste Camera #4 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-09-101	Shipping/Receiving Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-09-102	Shipping/Receiving Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-09-201	NDA Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-09-202	NDA Camera #2 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TC-08-001	Drum Lag Storage Camera #1 W/ Motorized Zoom, Pan, Tilt	H-2-140683
TM-11-001	Control Room Monitor #1	H-2-140683
TM-11-002	Control Room Monitor #2	H-2-140683
TM-11-003	Control Room Monitor #3	H-2-140683
TM-11-004	Control Room Monitor #4	H-2-140683
TM-05-501	Drum Size Red. & Repack Area Monitor #1	H-2-140683
TM-05-502	Pug Mill Monitor #1	H-2-140683
TM-05-503	Special Process Monitor #1	H-2-140683
TM-05-505	Box Size Reduce Monitor #1	H-2-140683
TCK-11-001	Control Room Camera Control Keyboard #1	H-2-140683

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TABLE 4.5
CCTV EQUIPMENT LIST
5/12/92

TAG #	DESCRIPTION	DRAWING
TCK-11-002	Control Room Camera Control Keyboard #2	H-2-140683
TCK-11-003	Control Room Camera Control Keyboard #3	H-2-140683
TCK-11-004	Control Room Camera Control Keyboard #4	H-2-140683
TCK-05-501	Drum SR.& R. Camera Control Keyboard #1	H-2-140683
TCK-05-502	Pug Mill Camera Control Keyboard #1	H-2-140683
TCK-05-503	Special Proc Camera Control Keyboard #1	H-2-140683
TCK-05-505	Box SR.& R. Camera Control Keyboard #1	H-2-140683
TCK-05-506	Box SR.& R. Camera Control Keyboard #2	H-2-140683
TVM-11-001	Video Matrix Switcher 40 Video In / 20 Video Out	H-2-140683
	Camera Controllers (21) Receiver and Cable Assembly For Cameras W/ Tilt and Pan	H-2-140683
	Camera Controllers (4) Receiver and Cable Assembly For Cameras W/O Tilt and Pan	H-2-140683
	Pan/Tilt Units (21) W/ Pole Mount	H-2-140683
VCR-11-001	Video Cassette Recorder #1	H-2-140683
VCR-11-002	Video Cassette Recorder #2	H-2-140683

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TABLE 4.6.1
COST ESTIMATE BASIS
PLANT CONTROL SYSTEM

ITEM #	DESCRIPTION	QTY	UNIT PRICE	TOTAL PRICE
1	Plant Control System hardware, controllers, I/O & communication modules, racks, monitors, keyboards & printers	1	550000	550,000
2	Enclosures including terminals, wiring, power supplies, switches, and other accessories.	1	125000	125,000
3	Application software, configuration, and factory testing.	1	2280000	2,280,000
TOTAL SYSTEM PRICE:				2,955,000

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TABLE 4.6.2
COST ESTIMATE BASIS
DATA MANAGEMENT SYSTEM

ITEM #	DESCRIPTION	QTY	UNIT PRICE	TOTAL PRICE
1	Sun MicroSystems SPARCstation 2 40 MHz CPU, 32 MB RAM 424 MB HDD , 1.44MB FDD Graphics Accelerator	1	18000	18,000
2	1.3 GB External Drive & SCSI Controller	1	4500	4,500
3	Laser Printer	3	3800	11,400
4	80386/33 CPU, 4 MB RAM 200 MB HDD, 1.44 & 1.2 FDD 14" VGA Monitor/adapter (Office Environment)	2	3000	6,000
5	80386/30 CPU, 4 MB RAM 80 MB HDD, 1.44 & 1.2 FDD 14" VGA Monitor/adaptor (Industrial Hardened)	5	7000	35,000
6	Wand Type Bar Code Reader PC Interface Keyboard Wedge including software	1	300	300
			TOTAL:	75,200

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TABLE 4.6.3
COST ESTIMATE BASIS
HEALTH PHYSICS INSTRUMENTATION

ITEM #	INSTRUMENT SYSTEM	QTY	UNIT PRICE	TOTAL PRICE
1	In-Line Gamma Monitor	1	2000	2,000
2	Stack Monitors (CAEM)	1	93000	93,000
3	Ventilation Duct Monitors (CAM)	6	4745	28,470
4	Room In-Air Monitors (CAM)	9	4245	38,205
5	Room Area Radiation Monitors (ARM)	8	1455	11,640
6	Operator Air Samplers	4	640	2,560
7	Friskers	14	795	11,130
8	Hand and Foot Monitors	2	13250	26,500
9	Smear Counters	2	3245	6,490
			TOTAL:	219,995

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TABLE 4.6.4
COST ESTIMATE BASIS
INSTRUMENTATION

Instrument	QTY	LIST PRICE	TOTAL
ANALOG INDICATOR	4	120	480
ANNUBAR	7	2200	15,400
CURRENT RELAY	10	200	2,000
CURRENT TRANSMITTER	11	550	6,050
FLOW ELEMENT	11	250	2,750
SOLID MASS FLOW METER	3	8000	24,000
FLOW SW.	7	150	1,050
FLOW TOTALIZER	3	700	2,100
FLOW TRANSMITTER	20	1200	24,000
HORN	10	150	1,500
HYDROCARBON LEL DETECTOR	3	1000	3,000
I/P CONVERTER	27	1000	27,000
LEVEL GAUGE	4	250	1,000
LEVEL SW. - CAP.	60	500	30,000
LEVEL SW. - FLOAT	44	150	6,600
LEVEL SW. - ULTRASOUND	6	525	3,150
LEVEL TRANSMITTER	11	1200	13,200
LIMIT SW.	2	120	240
LOAD CELLS	48	1200	57,600
PARTICLE DETECTOR	6	6600	39,600
PHOTOEYE	140	250	35,000
PILOT LIGHT	26	70	1,820
PRESS. DIFF. SW.	92	310	28,520
PRESS. DIFF. TRANSMITTER	14	1200	16,800
PRESS. SW.	20	300	6,000
PRESS. TRANSMITTER	13	1200	15,600
PRESS/VAC. RELIEF VALVE	8	1200	9,600
PROX. SW.	130	150	19,500
PUSHBUTTON STATION (NEMA 4)	61	290	17,690
ROPE SW.	100	200	20,000
SELECTOR SW. STATION (NEMA 4)- 2 POS.	11	144	1,584
SELECTOR SW. STATION (NEMA 4)- 3 POS.	72	144	10,368
SOL. VALVE - 2 WAY	65	100	6,500
SOL. VALVE - 3 WAY	96	100	9,600
SOL. VALVE - 4 WAY (AIR)	18	410	7,380
SOL. VALVE - 4 WAY (HYDRAULIC)	20	800	16,000
SPEED SW.	43	500	21,500
TEMP. ELEMENT	6	320	1,920
TEMP. SW.	6	175	1,050
TEMP. TRANSMITTER	6	1200	7,200
VALVE - 3 WAY BALL	4	3030	12,120
VALVE - BALL	30	1530	45,900
VALVE - BUTTERFLY	2	1600	3,200
VALVE - GATE	10	2200	22,000
WEIGHT TRANSMITTER	18	2000	36,000
ANNUNCIATOR (CONTROL ROOM)	1	4200	4,200
ANNUNCIATOR (RPT OFFICE)	1	2100	2,100
		TOTAL:	639,872

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TABLE 4.6.5
COST ESTIMATE BASIS
BAR CODE READER

ITEM #	DESCRIPTION	QTY	UNIT PRICE	TOTAL PRICE
1	Hand-held Bar Code Reader	1	2800	2,800
2	Fixed Bar Code Reader	14	3300	46,200
3	Multi-Drop Terminal Conc.	3	4000	12,000
4	Bar Code Printer	2	4000	8,000
5	Radio Frequency System	1	19000	19,000
			TOTAL:	88,000

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TABLE 4.6.6
COST ESTIMATE BASIS
CLOSED CIRCUIT TELEVISION

ITEM #	DESCRIPTION	QTY	UNIT PRICE	TOTAL PRICE
1	CCTV Camera	25	2,457	61,425
2	Monitor	9	1,005	9,045
3	Master Control Panel	1	2,640	2,640
4	Remote Control Panel	9	2,400	21,600
5	Video Matrix Switcher	1	50,000	50,000
6	Control Receiver	25	1,335	33,375
7	Cable Assembly Receiver to Camera	25	545	13,625
8	Cable Assembly Receiver to Pan/Tilt Unit	21	238	4,998
9	Pan / Tilt Unit	21	1,321	27,741
10	Pan / Tilt Mount Pole	23	105	2,205
11	Video Cassette Recorder	2	3,110	6,220
			TOTAL:	232,874

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