AUG 06 1996

ENGINEERING DATA TRANSMITTAL

1. EDT 6 5 1 3 6

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Spent Nuclear Fuels Project	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Spent Nuclear Fuels Project	6. Cog. Engr.: C. R. Miska	7. Purchase Order No.: N/A
8. Originator Remarks:		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: July 30, 1996

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-SNF-CDR-007		0	Hot Conditioning Equipment Conceptual Design Report	SQ	1		

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. C.R. Miska	J.M. Frederickson for C.R. Miska	7/29/96							
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18. [signature] 7/30/96 Signature of EDT Originator Date	19. [signature] 7/30/96 Authorized Representative for Receiving Organization Date	20. [signature] 7/30/96 Cognizant Manager Date	21. DOE APPROVAL (if required) Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (04/94) GEF097

WHC-SD-SNF-CDR-007, Rev. 0

Hot Conditioning Equipment Conceptual Design Report

Merrick and Associates
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 616136 UC: 510
Org Code: 2C400 Charge Code: LH002
B&R Code: EW3135040 Total Pages: 432

Key Words: Spent Nuclear Fuel, N Reactor Spent Nuclear Fuel, Single Pass Reactor Spent Nuclear Fuel, Hot Conditioning System Equipment, Canister Storage Building, K-Basins, Cold Vacuum Drying System

Abstract: This report documents the conceptual design of the Hot Conditioning System Equipment. The Hot Conditioning System will consist of two separate designs: the Hot Conditioning System Equipment; and the Hot Conditioning System Annex. The Hot Conditioning System Equipment Design includes the equipment such as ovens, vacuum pumps, inert gas delivery systems, etc. necessary to condition spent nuclear fuel currently in storage in the K Basins of the Hanford Site. The Hot Conditioning System Annex consists of the facility to house the Hot conditioning System. The Hot Conditioning System will be housed in an annex to the Canister Storage Building. The Hot Conditioning System will consist of pits in the floor which contain ovens in which the spent nuclear will be conditioned prior to interim storage.

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TO: Kara Broz - Westinghouse Hanford Company
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SUBJECT: Design Data Report

DATE: August 2, 1996

I am writing to inform you that it is acceptable for you to include Pall Corporation's Literature UAF-100 (Pall Ultramet™/Air Filters/Systems Brochure) in your report that discusses the use of Pall filters for the subject of HCSE Specification.

You may also use Pall Proposal Number: BP7ACDR96-129PDI for Santa Fe Engineering, with the exception of the pricing and delivery sections.

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Regards,

Pall Advanced Separations Systems

Paul Dittman/sma

Paul Dittman
Senior Applications Engineer

lotus notes/typing/dittman

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APPENDICES

ACRONYMS

acfm	Actual cubic feet per minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AI	Residual Gas Analyzer Indicator
ALARA	As Low As Reasonably Achievable
ANS	American National Standard
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
BFD	Block Flow Diagram
BLO	Blower
CAM	Continuous Air Monitors
cc/sec	Cubic centimeters per second
CDR	Conceptual Design Report
CFR	Code of Federal Regulations
CH	Chiller
CHW	Chilled Water System
CLR	Cooler
CM	Control Manual
Co	Cobalt
Cs	Cesium
CSB	Canister Storage Building
CVDM	Cold Vacuum Drying Module
CVDS	Cold Vacuum Drying System

ACRONYMS

CVS	Combined Ventilation System
DBA	Design Basis Accident
DE	Design Earthquake
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DOP	Dioctylphthalate aerosol
DOT	Department of Transportation
EDE	Effective Dose Equivalent
ERDA	Energy Research & Development Administration
ES&H	Environmental Protection, Safety and Health
EWS	Engineering Work Station
F	Filter
FI	Flow Indicator
FIC	Flow Indicating Control
FOB	Free On Board
FQIC	Totalizing Flow Indicating Control
FSF	Fuel Stabilization Facility
ft/min	Feet per minute
GDC	General Design Criteria
GOCO	Government Owned Contractor Operated
GOV	Gas Operated Valve; flow, ball
gpm	Gallons per minute
H	Hydrogen
HC2	Hazard Category 2
HC3	Hazard Category 3

ACRONYMS

HCL	Electric Heater
HCS	Hot Conditioning System
HCSA	Hot Conditioning System Annex
HCSE	Hot Conditioning System Equipment
He	Helium
HEPA	High Efficiency Particulate Air
HLAN	Hanford Local Area Networks
HSRCM	Hanford Site Radiological Control Manual
HVAC	Heating, Ventilation, and Air Conditioning
HVCE	Hot Vacuum Conditioning Equipment
I	Iodine
I/O	Input/Output
ICRP	International Commission on Radiological Protection
IEEE	Institute of Electrical & Electronics Engineers
IFMSF	Irradiated Fissile Material Storage Facilities
ISA	Instrument Society of America
ISFSI	Independent Spent Fuel Storage Installation
kg	Kilogram
Kr	Krypton
LAN	Local Area Network
LCP	Local Control Panel
lpm	Liters per minute
LPT	Liquid Penetrant Test
MCO	Multi-canister Overpack
MCS	MCO Cooling System

ACRONYMS

Mg	Magnesium
MHM	MCO Handling Machine
MMI	Man-Machine Interface
MSHA	Mine Safety and Health Administration
N	Nitrogen
NFPA	National Fire Protection Association
NGS	Non-Government Standards
NIOSH	National Institute for Occupational Safety and Health
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
O	Oxygen
OIS	Operator Interface Station
ORA	Operational Readiness Assessment
ORR	Operational Readiness Review
OSHA	Operational Safety and Health Administration
P&ID	Piping and Instrument Diagram
PC	Personal Computer
PCS	Process Control System
PCV	Constant Pressure Regulator Valve
PE	Process Enclosure
PFD	Process Flow Diagram
PFR	Purifier
PG	Process Gas
PGS	Process Gas System
PHA	Preliminary Hazards Analysis

ACRONYMS

PHS	Process Heating System
PI	Pressure Indicator
PIC	Pressure Indicating Control
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
PNL	Pacific Northwest Laboratory
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
PTFE	Teflon based solid lubricant
PV	Process Vent
QA	Quality Assurance
QAP	Quality Assurance Plan
RAS	Radiation Air Sampler
RCW	Revised Codes of Washington
SAR	Safety Analysis Report
SCADA	Supervisory Control and Data Acquisition
scfm	Standard cubic feet per minute
SDD	System Design Description
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
SMCS	System Monitoring and Control System
SNF	Spent Nuclear Fuel
SNFP	Spent Nuclear Fuel Project
SOV	Gas Operated Valve, solenoid
SSC	Structure, System and Component
SSF	Staging and Storage Facility

ACRONYMS

STD	Standard
TBD	To Be Determined
TCP/IP	Transmission Control Protocol/Internet Protocol
TEDE	Total Effective Dose Equivalent
TI	Temperature Indicator
TIC	Temperature Indicating Control
TSR	Technical Safety Requirements
UL	Underwriter's Laboratory
VAC	Vacuum
VPS	Vacuum Pumping System
WAC	Waste Acceptance Criteria
WAC	Washington State Administrative Codes
WBS	Work Breakdown Structure
WHC	Westinghouse Hanford Company
Xe	Xenon

DEFINITIONS

Annular Space Cover

A ring (that now will be 3-in thick to provide shielding) with a bellows to seal the top of the annular space between the Oven and the MCO. When not is use, the Annular Space Cover can be stored in the Process Enclosure or in a room next to the solid waste storage room. Since the cover will not normally become contaminated, it can be transferred in and out of the Process Enclosure by a heavy duty tray that slides goes in and out of the Process Enclosure. A fork lift can put it on the tray and the manipulator can place it on the MCO. This will require a larger manipulator with more lifting capability.

Cold Trap (a.k.a. "Cs/I Trap")

A water cooled unit that will be located in the Trench and that will be used to remove Iodine, Cesium and particulate from the gases being circulated through or removed from the MCO. The water cooling will be accomplished by wrapping a tube around the Cold Trap body such that a double leak would be required for water to contact the process gases (i.e., the tubing would have to leak and the Cold Trap body would also have to leak.) The Cold Trap will be changed when the Process Enclosure is positioned over the Process Pit (and thus also over the Trench Cover). The Trench Cover will be raised and the manipulator will be used to disconnect the spent Cold Trap, blank the Cold Trap end connections, place the spent Cold Trap in a shielded waste drum, and install a new Cold Trap.

Connection Valves

The valves that will be used to connect the equipment on the Process Module to the interior of the MCO. There are two such valves on each MCO, one that is connected to a dip tube that extends to the bottom of the MCO and one that is connected to a sintered metal filter that is located at the top (interior) of the MCO. The exact configuration of the Connection Valves is TBD.

Insulation Cover (a.k.a. "Insulated MCO Top Cover")

The cover that is placed on top of the MCO after all of the connections are made. Its purpose is to limit the heat loss from the top of the MCO during the heating cycle. The cover will be handled in the same manner as the Annular Space Cover except that it will be lighter in weight.

DEFINITIONS

MCO Process Heater

The electrically heated unit that will be used to heat the air that is circulated around the MCO when it is in the Oven. This unit is currently conceived as an in-duct type heater that will be located in the Process Module.

Oven (a.k.a. "furnace" and "dewar")

The vacuum insulation around the Oven is also referred to as the Oven Jacket. The current concept of the Oven is a vacuum insulated sleeve in which the MCO is placed. The annular space between the sleeve (Oven) and the MCO is connected by vacuum insulated piping to the MCO Process Heater. During the heating cycle, air is circulated between the Process Heater and the Oven to heat the MCO. Collection rings are located at the top and bottom of the Oven to distribute and collect the heating gases.

Port Covers

The covers that are on the MCO to protect the Valve Connections when the MCO arrives at the Process Pit.

Process Enclosure (a.k.a. "Cell" and "Hole Portable Operations Cell")

A shielded enclosure that is equipped with a manipulator, HEPA filtration, operator work station, personnel entry door, waste drum bagport, welder, CCTV, lighting, shelves, hangers, air monitor and radiation monitors. The Process Enclosure will be moved from Process Pit to Process Pit by a cable that is manually attached to the Enclosure. It will have limited, manual, steering capability so that it can be positioned over a Process Pit. Potentially outlines of the Process Enclosure could be painted on the floor to allow sufficiently accurate placement. Its height will be less than 10 feet so the MHM top rail can pass over it without interference. If it is necessary to move it out of the center line of the Process Pits when the MHM is present, then a floor level transfer tray can be provided for this purpose. The Process Enclosure would be parked on the transfer tray and then the tray would transport it to the South and out of the path of the MHM.

Process Module (a.k.a. "Process Bay Skid")

This is skid where the bulk of the hot vacuum conditioning process equipment is located. There will be one Process Module per Process Pit. The Process Module would contain the vacuum pumps, heat exchangers, valving, instrumentation, and other hot conditioning process equipment that does not have to be located in the Process Pit or the Trench.

DEFINITIONS

Process Pit (a.k.a. "furnace pit" "vault")

This is a hole in the CSB Annex floor that will be approximately 4-ft diameter and 20-ft deep. The oven will be located in the Process pit. It is anticipated that six Process Pits will be required with a space provided for a seventh to allow welding or active neutron interrogation of the MCO to determine residual water content.

Process Pit Cover (a.k.a. "Oven Top" and "6-in Thick Steel Covers")

A two piece unit consisting of the Process Pit Cover and the Shield Plug. The Process Pit Cover is hinged on one end and will be pivoted out of the way to allow access to the top of the MCO after the Process Enclosure has been positioned over the Process Pit. As currently envisioned, the Process Pit Cover will include a HEPA filter that is capable of allowing 150 cfm of air to be drawn from the CSB Annex operating space to the Process Pit.

Shield Plug

A unit that is centered in the Process Pit Cover and that is removed by the MHM when a MCO is placed in the Process Pit. This unit is intended to look like a storage position plug to the MHM and thus be handled by it in an identical manner. The plug will probably have to be mechanically locked to the Process Pit Cover so that it will not fall out of the cover then the Process Pit Cover is raised. The details of this mechanical interlock are TBD.

Trench (a.k.a. "Process Trench")

A rectangular cross-section space that is located below floor level and that connects the Process Pit with the Process Module. The piping that connects the MCO and Oven with equipment that is located in the Process Module is located in the Trench.

Trench Cover

A removable shield that will be located over the Trench to provide shielding should radioactive constituents from the SNF plate out in the piping or be trapped in the Cold Trap.

Vent Cover

The cover that will be placed over the HEPA filtered MCO vent port. That port must be plugged during the hot conditioning process. "

1.0 INTRODUCTION

The K Basins Spent Nuclear Fuel Removal project has been undertaken for the purposes of decommissioning K Basins, stabilizing the SNF, and placing the SNF into dry storage. The project will retrieve Spent Nuclear Fuel (SNF) elements from their storage canisters in the basins, package the SNF into vessels called Multi-Canister Overpacks (MCOs), drain and vacuum dry the MCO contents, condition (degas) the MCO contents at high temperature, and place sealed MCOs into dry storage. This Conceptual Design Report addresses the processes and equipment systems required to perform the hot conditioning.

The mission of the Hot Conditioning System Equipment (HCSE) project is to degas and passivate the SNF that has been dried by the Cold Vacuum Drying System (CVDS), and that has been stored temporarily in the Canister Storage Building (CSB) awaiting availability of a hot conditioning process station. The hot conditioning will assure that the hydrogen production arising from uranium - water vapor reaction, water radiolysis, and uranium hydride breakdown during storage will be less than the design threshold so that the MCOs can be permanently sealed. The degassing is to be accomplished by baking the SNF at a temperature of 300°C and evacuating the MCO. This recipe will release chemically bound water (waters of hydration) and also the readily releasable fraction of the hydrogen that is contained in uranium hydride. The passivation of exposed uranium will be accomplished by oxidizing with a low concentration oxygen/inert gas blend. Performance requirements for the HCSE that contain the process parameters are found in Performance Specifications for the Spent Nuclear Fuel Hot Vacuum Conditioning Equipment (WHC-S-0460, Rev 0). The hot conditioning sequence of operations and the process system design are found in Chapter 2 below.

The hot conditioning equipment is to be installed in an annex to the CSB. The construction of the annex, Hot Conditioning System Annex (HCSA) is being provided by the CSB project. This arrangement will allow the MCO Handling Machine (MHM) to perform MCO interchange between the hot treatment process stations and the CSB storage vaults. The CSB storage vaults are vertically oriented, below grade, tubes that protect the SNF from external threats such as tornadoes, earthquakes, and industrial accidents that might be initiators for an SNF release and that also provide concrete and earthen radiation shielding. The MHM is designed to lift the MCO from a below grade tube and to place the MCO into a below grade tube. Therefore, the ovens used to heat the MCO in the HCSE must be located in below grade tubes to that they emulate a storage tube to the MHM. The design requirements that define the interfaces between the HCSE and the annex conceptually are given in Chapter 3.

The hazards associated with Hot Conditioning will be described in a Preliminary Hazards Analysis (PHA). The initial conclusion of the PH are that there are both process upset and natural phenomena hazards that could cause the primary confinement to fail resulting in significant radiological consequences. Therefore, the Hot Conditioning process will be designated as a Hazard Category 2 (HC2) system per the guidance of DOE STD 1027.

1.0 INTRODUCTION

The CSB building structure was not designed to act as an accidental nuclear material release confinement barrier. It does not have a nuclear grade ventilation system that will maintain a negative pressure and collect released material in HEPA filters, nor does it have "safety class" features that might be needed to mitigate a release from the HCSE. The HCSA will not provide any secondary confinement capability to support the HCSE since it is an extension of the CSB structure. The responsibility of providing secondary confinement and of creating the safety structures, systems, and components (SSCs) that mitigate the postulated accidental release from the Hot Conditioning process is assigned to the HCSE project. This means that HCSE will include structures to provide a secondary barrier at all steps of the process that is resistant to the action of Design Basis Accidents (DBAs) including natural phenomenon events, and that traps releases. The HCSE will also include a ventilation system with HEPA filters and stack to hold the secondary confinement volume at a negative pressure. Localized "hardening" will be included in the HCSE design to provide the protection required to assure that the secondary confinement functions during and after a DBA as required by DOE 6430.1A.

The project has agreed to a policy of "Nuclear Regulatory Commission (NRC) Equivalency" in addition to satisfying the DOE criteria. For the most part the DOE criteria are more restrictive than the equivalent NRC criteria. The major impact on the HCSE project is that the NRC requires that the DBAs include a tornado that is not deemed credible in the DOE criteria for the Hanford Site.

Radiation exposure management is a key issue in the HCSE design as well as it is throughout all phase of the K Basins SNF Removal project. Because the MCO is not contained in a shield cask, the radiation exposure would be quite large in the HCSE unless special design features are implemented. The design incorporates a combination of shielding, remote operations, and automation to absorb radiation, to provide distance between the source and operator, and to minimize operator exposure time. These actions are taken in accordance with the requirements of an ALARA Plan included in the Appendix B. The radiation exposure in the HCSE has been calculated using the CDR sequence of operations (see Chapter 2) and geometry, and radiation exposure maps for the bare MCO design provided by WHC analysts. The resulting dose estimates are reported in Appendix C of this CDR.

The designs and supporting analysis presented in the CDR have been selected using the following reasonableness judgments which the designers believe does lead to a design that will support the specific acceptance criteria whenever they become available.

1. The geometry of the CSB, HCSA, and MHM supports a row of HCSE process stations spaced according to the requirement to avoid interference with the MHM. Seven HCSE stations can fit reasonably in this space.

1.0 INTRODUCTION

2. The majority of the times in the process sequence can be reasonably estimated including the heat-up and cool-down times. Although the heat-up and cool-down times are quite model dependent (flows are complex), the conservative results can be selected to assure that the design is robust enough.

3. The evacuation time is unpredictable. However, the vacuum pump selected for the CVDS where off gas rates (water evaporation) are high is a reasonable choice for the HCSE. The time estimates for the CVDS evacuation (which are highly uncertain because of unknown sludge content) have been assumed to be reasonable for the HCSE since the amount of off gas mass removed in the CVDS will certainly exceed the amount of gas drawn off by the CVDS.

4. The worst credible accidental release scenario will be limited by the amount of SNF powder that a burst of gas can carry out of the MCO. This amount is dependent on the mass of gas in the release and is not affected by excess powder in the MCO. Therefore the HCSE safety systems designs are not affected by the amount of powder in the MCO.

5. Six (6) HCSE stations were selected because process time is expected to be similar to the CVDS processing time.

The design has been selected to be a robust design that fits within the constraints of the MHM access area. If the process times turn out to be shorter than anticipated then the Hot Conditioning of the SNF will be completed early. Conversely, if the time is longer than anticipated then the Hot Conditioning will take longer than specified.

A cost estimate has been developed for the HCSE. The details of the estimate are presented in Appendix F.

2.0 PROCESS

2.1 HCSE MODEL OPERATING SEQUENCE

A model operating sequence has been developed and depicted in an Overall Block Flow Diagram (BFD) (See Drawing SK-2-300411). Rough time estimates have been assigned to each block in the sequence for the purposes of estimating equipment quantities, equipment utilization, and radiation exposure estimates. The sequence assumes the following general description of the HCSE configuration:

Treatment will take place in ovens that are located in process pits below the facility floor. An oven will essentially be a thermos bottle placed within the process pit. The MCO will be placed inside the oven. A cover ring will be placed so that hot air blown through the annular space between the MCO and the oven interior wall is not lost into the process pit. Heating will be accomplished by blowing hot air through the oven. An insulation cover will be placed over the MCO top. The process pit and oven assembly is shown in Drawing SK-2-400417.

There will be six (6) ovens in the HCSE. The number of oven stations has been determined by calculating the process duration for a single oven using the conceptual sequence of operations as a basis, and by imposing a total annual process demand of 200 MCOs.

Transactions where an MCO is either inserted into, or pulled from, an oven will be accomplished by the MCO Handling Machine (MHM) which is part of the Canister Storage Building (CSB). The HCSE will be housed in an annex of the CSB that is accessible to the MHM and that is referred to as the HCSA.

The process pits will have top covers that serve as secondary confinement and radiation shields. These covers will be different from the storage hole plugs in the CSB because the oven will have a larger diameter than the storage holes. The design incorporates a two part cover (plug within a cover) so that the plug will have the same diameter as the CSB storage hole plugs. This will allow the MHM to make the transactions while maintaining the double confinement of the SNF using the same procedure already planned in the MHM and CSB designs.

There will be a process equipment module associated with each oven. This module will contain a heater and fan that will supply hot (300°C) air to the oven. The MCO will be heated externally by this air. The process module will contain a vacuum pumping system and an inert gas purge system to handle the gas within the MCO. The oven insulation will be a vacuum jacket that is supported by a vacuum pump in one of the process modules. A service module will contain an exhaust fan and

2.0 PROCESS

air cleaning equipment for the air in the process pits and trenches. The exhausts will pass through air cleaning equipment before being discharged from the facility through a stack.

Process lines that connect the process module and the oven will run below floor level in a trench. The hot air lines will be insulated. The trench cover will be thick steel plate to shield radiation arising from condensation of volatile radioactive materials in the lines. The lines have a "cold trap" or "adsorber trap" contained within the trench.

The radiation exposure associated with making and breaking the MCO connections manually and with changing the trap is anticipated to be unacceptable. Furthermore, the connections will be made a few feet below the floor level where manual reach will be awkward. A portable process enclosure will be provided. This enclosure will be parked above the oven when needed. It will offer some shielding and it will contain a hoist and tele-operated manipulator. The hoist will be used to handle the process pit cover and the manipulators will be used to make and break the MCO connections. It has been assumed that the MCO has been designed to support remotely manipulated connections and valves. The enclosure will be ventilated so that it provides secondary confinement while the MCO top is exposed and while the MCO ports are manipulated.

The final closure of the MCO will be made by welding a cover piece on the MCO while the MCO is in the oven after the hot conditioning has been completed. This scheme has not been defined by the MCO design project. It is assumed that the weld will be similar to the multiple pass weld that holds the MCO top plug to the body and that the procedure for the two welds will be approximately the same (root pass, root pass LPT, 5 cover passes, LPT last pass). The new cover will be designed to mate with the MHM.

Given these assumptions the overall sequence is given on Drawing SK- 2-300411. The sequence description is:

ID	Name	Description
1.0	Select Oven	Choose an oven to receive the MCO. Inspect the process module, instruments, gas supplies, etc. Verify Readiness.

2.0 PROCESS

ID	Name	Description
2.0	Move-in MHM	Position the MHM over the chosen process pit.
3.0	Lower MCO	The MHM executes a sequence where it pulls the center piece from the process pit cover, lowers the MCO into the oven, and replaces the process pit cover piece.
4.0	Remove MHM	The MHM is undocked and moved out of the area.
5.0	Move-in Process Enclosure	The process enclosure is moved from its parking place into its operating position above the process pit.
6.0	Connect Process Enclosure	Make the electrical and instrumentation connections that operate the process enclosure equipment.
7.0	Open Process Pit	Actuate the process pit cover opening mechanism and expose the oven.
8.0	Place Annulus Cover	Get the annulus cover from its storage location in the enclosure and place it on the oven top using the manipulator.
9.0	Attach Annulus Cover	Use manipulator and drill motor driven socket to tighten the bolts.
10.0	Remove Port Covers	Use the manipulator and drill motor driven socket to loosen port cover bolts. Use manipulator and suction device to remove the covers.
11.0	Install Vent Cover	Use the manipulator to get a cover from its storage location in the enclosure and place it in the vent port. Use the manipulator and drill motor driven socket to tighten the bolts.
12.0	Install Valves	Use the manipulator to pick the valves from their storage ports and plug them into the MCO ports. Use the manipulator and drill motor driven socket to tighten the bolts.
13.0	Open Valves	Use the manipulator and drill motor driven sockets to drive the valve operator screws.

2.0 PROCESS

ID	Name	Description
14.0	Evacuate MCO	Remove old gas from the MCO using the system vacuum pump.
15.0	Fill MCO With He	Fill the MCO with helium.
16.0	Leak Check Ports	Use the manipulator to move the the sniffer hose attached to a helium leak detector (part of the process enclosure equipment) around the MCO ports.
17.0	Pass Leak Test ?	Determine if corrective action is required before proceeding.
18.0	Close Bad Valve	Use the manipulator and drill motor driven sockets to close the leaking port.
19.0	Disconnect Valve	Use the manipulator and drill motor driven socket to loosen the valve attachment bolts. Use the manipulator to pull the valve out of the port.
20.0	Clean Port	Use the manipulator and drill motor driven cloth pad to clean port.
21.0	Install Reserve Valve	Use the manipulator to re-install the valve or to install a reserve valve. Use the manipulator and drill motor driven socket to tighten the bolts. Open the valve using the manipulator held drill motor and sockets.
22.0	Install Insulation Cover	Use the manipulator to get the insulation cover from its storage location in the enclosure and place it on top of the MCO.
23.0	Close Process pit	Actuate the process pit cover operating mechanism.
24.0	Perform Heat-up Cycle	Hot air flows through the oven. The air temperature versus time profile will be controlled by the system PLC. The helium atmosphere will be circulated and analyzed continuously. A pressure actuated valve will relieve gas as the pressure builds due to heating. Periodic evacuation and helium refill will be triggered by build-up of water or hydrogen content.

2.0 PROCESS

ID	Name	Description
25.0	Survey Process Enclosure	Use the manipulators to swipe selected spots in the enclosure. Pass bottled swipes out of the enclosure for counting.
26.0	Disconnect Process Enclosure	Disconnect the electrical and instrumentation services.
27.0	Remove Process Enclosure	Return the enclosure to its parking place.
28.0	Purge Vacuum Cycle	When the conditioning temperature has been reached the MCO will undergo a sequence of evacuation and purge cycles.
29.0	Perform Acceptance Test	An acceptance test (unknown at this time) will be performed to determine that the hot conditioning has met acceptance criteria (undetermined at this time).
30.0	Accept ?	Determine if more conditioning is needed.
31.0	Additional Purge Vacuum Cycling	Acceptance was not achieved. Continue the purge vacuum cycle.
32.0	Cool For Passivation	Circulate cooled air through the oven. The air temperature versus time function will be controlled by the system PLC. Stop when the passivation temperature is achieved.
33.0	Evacuate MCO	Remove the conditioning gas from the MCO.
34.0	Passivation Gas Fill	Fill the MCO with inert gas/oxygen blend.
35.0	Passivation Period	Allow uranium oxidation to proceed. Add make-up gas to replenish oxygen concentration as needed.
36.0	Cool Down	Circulate cooled air through the oven. The air temperature versus time function will be controlled by the system PLC.
37.0	Evacuate MCO	Remove the passivation gas from the MCO.
38.0	Fill With He	Fill the MCO with Helium.
39.0	Move-in Process Enclosure	The process enclosure is moved from its parking place into its operating position above the process pit.

2.0 PROCESS

ID	Name	Description
40.0	Connect Process Enclosure	Make the electrical and instrumentation connections that operate the process enclosure equipment.
41.0	Open Process Pit	Actuate the process pit cover opening mechanism and expose the oven.
42.0	Remove Insul. Cover	Use the manipulator to grab the insulation cover and return it to its storage location in the process enclosure.
43.0	Close MCO Valves	Use the manipulator and drill motor driven sockets to close the valves.
44.0	Place Weld-On Cover	Use the manipulator to get the weld-on cover from its storage location in the process enclosure. Place it over the MCO.
45.0	Install Welder	Use the hoist and manipulator to get the automatic welder from its storage location in the process enclosure. Install the welder on the top of the MCO.
46.0	Weld Root Pass	Turn on the welder. Make the root pass.
47.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
48.0	Clean Weld	Clean the weld using a rotary stainless steel wire brush and the manipulator held drill motor.
49.0	Repair	Is weld repair required?
50.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
51.0	Repair Weld	Use the welder to reweld the ground out area.
52.0	Apply Dye	Apply liquid penetrant dye using a specially designed applicator held by the manipulator.
53.0	Soak	Wait the prescribed time for the dye to seep into weld defects.
54.0	Remove Dye	Using a specially designed applicator apply the cleaning fluid and wash off the dye. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor.

2.0 PROCESS

ID	Name	Description
55.0	Apply Developer	Apply the developer using a specially design applicator and the manipulator.
56.0	Bleed	Wait the prescribed time for the dye to "blot out" of weld defects.
57.0	Inspect	Inspect the developer coated weld using the manipulator mounted camera.
58.0	Clean	Using a specially designed applicator apply the cleaning fluid and wash off the developer. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor
59.0	Repair	Is weld repair required?
60.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
61.0	Repair Weld	Use the welder to reweld the ground out area.
62.0	Weld Pass 1	Turn on the welder. Make the weld pass.
63.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
64.0	Repair	Is weld repair required?
65.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
66.0	Repair Weld	Use the welder to reweld the ground out area.
67.0	Weld Pass 2	Turn on the welder. Make the weld pass.
68.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
69.0	Repair	Is weld repair required?
70.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
71.0	Repair Weld	Use the welder to reweld the ground out area.
72.0	Weld Pass 3	Turn on the welder. Make the weld pass.
73.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
74.0	Repair	Is weld repair required?

2.0 PROCESS

ID	Name	Description
75.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
76.0	Repair Weld	Use the welder to reweld the ground out area.
77.0	Weld Pass 4	Turn on the welder. Make the weld pass.
78.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
79.0	Repair	Is weld repair required?
80.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
81.0	Repair Weld	Use the welder to reweld the ground out area.
82.0	Weld Pass 5	Turn on the welder. Make the weld pass.
83.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
84.0	Repair	Is weld repair required?
85.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
86.0	Repair Weld	Use the welder to reweld the ground out area.
87.0	Apply Dye	Apply liquid penetrant dye using a specially designed applicator held by the manipulator.
88.0	Soak	Wait the prescribed time for the dye to seep into weld defects.
89.0	Remove Dye	Using a specially designed applicator apply the cleaning fluid and wash off the dye. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor.
90.0	Apply Developer	Apply the developer using a specially design applicator and the manipulator.
91.0	Bleed	Wait the prescribed time for the dye to "blot out" of weld defects.
92.0	Inspect	Inspect the developer coated weld using the manipulator mounted camera.

2.0 PROCESS

ID	Name	Description
93.0	Clean	Using a specially designed applicator apply the cleaning fluid and wash off the developer. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor
94.0	Repair	Is weld repair required?
95.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
96.0	Repair Weld	Use the welder to reweld the ground out area.
97.0	Remove Trap	Use the manipulator to disconnect the trap and set it aside.
98.0	Install New Trap	Use the manipulator to get the new trap from its storage location in the enclosure. Make the new trap connections using the manipulator.
99.0	Connect Waste Drum	Use a cart to place a shielded waste drum below the process enclosure bag port. Connect the drum and port.
100.0	Remove Top Shield	Open the bagport door. Lower a hoist into the drum and pull the top of the shield into the enclosure. Set it out of the way.
101.0	Dispose Hot Trap	Use the manipulator to place the trap into the drum.
102.0	Insert Top Shield	Use the hoist to replace the shield to in the drum.
103.0	Tie Bag	Tie off and cut the bag.
104.0	Close Drum	Place the top on the drum and attach it. Move the drum cart to the waste management area.
105.0	Undo Annulus Cover	Use the manipulator and drill motor driven socket to release the annulus cover bolts.
106.0	Remove Annulus Cover	Use the manipulator to remove the annulus cover and place it into its storage location in the enclosure.
107.0	Close Process Pit	Actuate the process pit cover mechanism to close the cover.

2.0 PROCESS

ID	Name	Description
108.0	Survey Process Enclosure	Use the manipulators to swipe selected spots in the enclosure. Pass bottled swipes out of the enclosure for counting.
109.0	Disconnect Process Enclosure	Disconnect the electrical and instrumentation services.
110.0	Remove Process Enclosure	Return the enclosure to its parking place.
111.0	Move-in MHM	Position the MHM over the chosen process pit.
112.0	Lower MCO	The MHM executes a sequence where it pulls the center piece from the process pit cover, lowers the MCO into the oven, and replaces the process pit cover piece.
113.0	Remove MHM	The MHM is undocked and moved out of the area.
114.0	Prepare For Next MCO	Perform activities such as supplies preparation to prepare for the system for its next use.

This sequence was used to model the HCSE throughput using an industrial modeling program (WITNESS Release 7.0). This model uses a random number generator to simulate real events (such as which branch paths are followed at decision points in the sequence). The calculation details are given in Appendix G. A run of 10 MCOs indicated that the average process time for an MCO is 101 hrs. This suggests that 505 oven hours are required in average week to produce the necessary average of 5 MCOs per week. Assuming a 7 day, 3 shift, operating schedule each week an average of 3.0 ovens will be occupied 100% of the time. Reasonable allowance for statistical fluctuations, maintenance, and so forth suggests that six stations is appropriate for processing 400 MCOs in two years.

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2.2 MAIN PROCESS SYSTEMS

The hot conditioning process is schematically depicted by the Process Flow Diagram (SK-2-300412), which has the Material & Energy Balance on sheet 2 and the Piping and Instrument Diagrams (SK-2-300413) of which there are 5 sheets. The hot condition process is comprised of the Vacuum and Gas Pumping System, the MCO Heating System, and the MCO Cooling system.

2.2.1 Vacuum & Gas Pumping Systems

2.2.1.1 System Function

The vacuum system function is to evacuate the MCO and connected process piping in order to remove:

A. Chemically bound water;

B. Hydrogen when the hydrides of uranium are decomposed, and

C. Oxygen following the hot conditioning sequence prior to cool-down of the MCO.

The gas pumping system provides for circulation of the helium heat transfer gas during steps in the process where the MCO and its contents are being either heated or cooled.

2.2.1.2 System Design Requirements

The vacuum system must be able to remove gaseous fission products during the treatment of the SNF as well as support the conditions necessary for optimum heat transfer during heating and cooling of the MCO. Operation at 13 psia helium pressure is the base case for this conceptual design. However the process is capable of operation at elevated pressure up to 24.7 psia should that be required to achieve the desired heat transfer rate.

2.2.1.2.1 Vacuum Operations

The system, shall be capable of evacuation of the MCO during the following three steps in the HVCS operation:

A. The initial evacuation of the MCO, as received from cold conditioning, prior to system filling with fresh helium to the prescribed pressure,

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B. Evacuation at elevated temperature for removal of the decomposition products of uranium hydrides and chemically bound water, and

C. The evacuation of residual oxygen and gaseous fission products following the hot conditioning process.

The vacuum system provides a means of system evacuation in preparation for filling with helium prior to heat transfer operations. A pressure of approximately 10 torr is sought prior to the introduction of a helium gas charge. This provides removal of over 98 percent of the constituents of the previous MCO atmosphere.

The system also provides an MCO vacuum of 5 torr which is conducive to the disassociation of chemically bound water and uranium hydrides at temperatures of 300°C and above (see Figure 2.2-1 for the Van't Hoff curve for the uranium-hydrogen system). The Van't Hoff curve shows that the vapor pressure of hydrogen over uranium hydride is about 28 Torr at 300°C. The vacuum system is held at this condition for approximately 48 hours, sufficient time to allow for water release, hydride decomposition and for hydrogen diffusion to the gas space of the MCO.

During the lower temperature partial oxidation phase of the hot conditioning process, low concentrations of oxygen are introduced into the MCO in an inert carrier gas stream. This low concentration of oxygen consumes highly reactive sites on the fuel inside the MCO, reducing the chemical reactivity of the damaged fuel matrix that may be present in the MCO. Not the reactive sites consumed by this partial oxidation may include small fuel fragments, high surface area uranium hydride particles, and high surface area uranium metal particles created by the thermal decomposition of uranium hydride. During oxide formation, gaseous fission products diffuse through the oxide and are released to the gas phase. These fission products, which are radioactive, are removed in a product purifier by either sorption, reaction, or condensation. Equipment for gas purification is part of the vacuum system.

During vacuum operations as well as during operations with gas circulation, fission products are removed from the gas phase.

2.2.1.2.2 Gas Circulation

Helium gas is charged to the MCO void space to promote heat transfer from the MCO wall to the fuel elements. The rate of this heat transfer may be the limiting factor which determines the time for MCO heating and cooling. To increase the likelihood of heat transfer operations taking place at a rate which is conducive to achieving a faster throughput, forced convective heat transfer from the MCO wall to the fuel will be used. The characterization of this heat transfer operation is quite

2.0 PROCESS

definitive design, advanced thermal analysis using finite element techniques will be use to predict the composite internal heat transfer coefficient for MCO to fuel heat transfer. This conceptual design provides a vacuum system that is capable of heating the MCO and SNF with recirculating helium at pressures ranging from 13 psia to 24.7 psia. The baseline pressure for the CDR is 13 psia.

Helium circulation is employed in all heat transfer operations, so that heat can be added or removed from by transfer in external heat exchangers. Fission products are removed in a cold trap during gas circulation.

Table 2.2-1 provides key design parameters for the Vacuum System.

Parameter	Units	Specified Rating
Evacuation prior to helium fill	torr	10
Design pressure range	psia	0.1 to 24.7
Material of construction	NA	304 or 316 SS
Maximum design temp. for:		
vacuum pump	°C	40
circulation blower	°C	
heat exchangers	°C	375
Operating temperature for:		
vacuum pump	°C	25
circulation blower	°C	100
heat exchangers	°C	40 to 300
Time at vacuum:		
pre He fill prior to heat-up	min.	15
hydride removal	hrs.	48
pre He fill following O_2 passivation	min.	15
Time at He circulation		
heating to 300°C	hrs.	12
cooling to 150°C	hrs	12
He circulation rate	ACFM	<10

Table 2.2-1 Vacuum & Gas Pumping System Design Specifications

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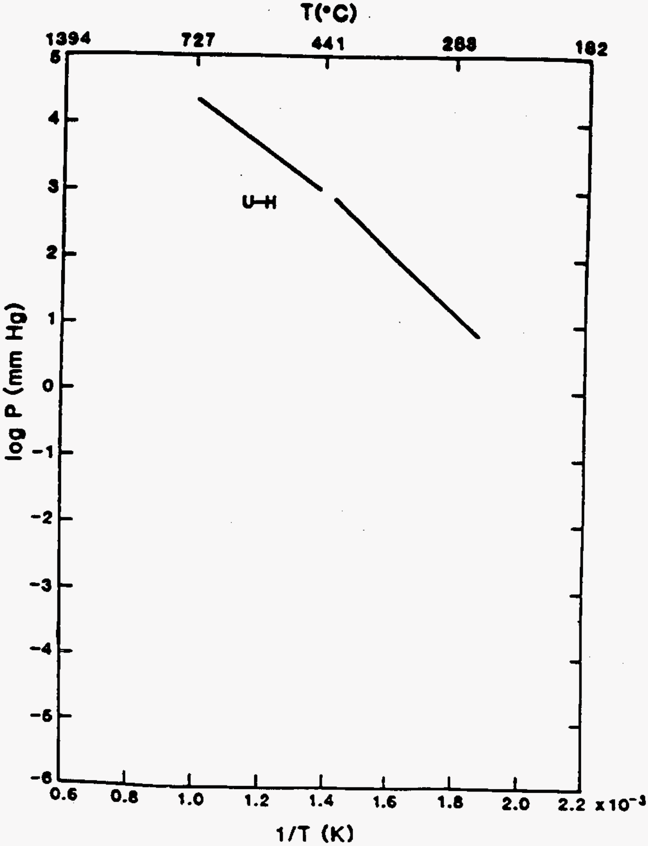
Figure 2.2-1

Van't-Hoff Curve



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The vacuum and gas pumping system will interface with the following other process systems:

A. the MCO heating system

B. the MCO cooling system

C. the process gas system

D. the process module system

E. the combined ventilation system

F. the HVCS control system

2.2.1.3 Equipment Arrangement and Response to Design Requirements

Equipment required for the HCSE is identified on the Piping and Instrument Diagrams (SK-2-300413). The following major equipment components comprise the MCO vacuum pumping system on each of the six process modules or in each of the six MCO trenches:

A. VPS-VAC-1104, the scroll-type vacuum pump.

B. VPS-BLO-1106, the Rotron recirculation blower.

C. VPS-PFR-1101, the purifier/cooler/filter containing copper gauze and activated charcoal.

D. VPS-CLR-1103, the cooler, a plate-type heat exchanger.

E. VPS-HCL-1105, the electrical heater.

F. VPS-F-1102, VPS-F-1107 HEPA filters.

2.2.1.3.1 Gas pumps

Two gas pumps are used in the vacuum system, one a vacuum pump and the other a circulating blower. Vacuum pump VPS-VAC-1104 is a scroll-type pump, capable of pumping 500 liters per minute at inlet pressures above 1 torr with reduced pumping rates at higher vacuum levels. When properly installed and operated, this pump has an expected life of 6,000 hours before minor maintenance is required for shaft bearing replacement and of 12,000 hours before requiring major maintenance. With an MCO total process cycle time of 150 hours and an expectation of up to 68 MCO process events per bay over the life of the campaign, the vacuum pump will have to be either idled during portions of cycle, operated to an estimated 10,000 hours without performing the minor maintenance suggested by the manufacturer, or replaced once during the life of the MCO hot vacuum conditioning program. Because the level of vacuum required of VPS-VAC-1104 is moderate in comparison to its capability, it is likely that the pump will be operated without minor maintenance for the required period without serious impact to ongoing operations. Once a vacuum pump is taken out of service, it will be discarded as radioactive waste.

Helium circulation blower VPS-BLO-1106 is a magnetically coupled regenerative unit capable of operating under vacuum or at pressure up to 10 psig. The unit is constructed for intrinsically safe operation. The magnetic drive provides freedom from seal leakage worries.

2.2.1.3.2 Heat Exchangers

Proper operation of VPS-VAC-1104 requires precooling during the 48-hour vacuum phase of chemically bound water and hydride removal which takes place at or above 300°C. To accomplish this, two stages of cooling are provided. The first stage is the cold trap which serves as the vent purifier VPS-PFR-1101. This unit reduces temperature from a nominal inlet temperature of 300°C to 100°C. Further cooling is provided by a plate-type heat exchanger VPS-CLR-1103 which achieves an intended outlet temperature of 38°C. Both exchangers are cooled with streams of exhaust air from the ventilation the MCO pit before it is passed to the central process ventilation system for HEPA filtration and discharge through the stack.

The exchangers of the vacuum system are designed to accommodate heat transfer operations with helium atmospheres from 13 to 24.7 psia.

2.2.1.3.3 Cold Trap & Gas Purification Equipment

Cold trap VPS-PFR-1101 contains copper gauze to react with iodine fission product, chilling to capture cesium fission product and activated carbon for both cesium and iodine secondary capture. The cold trap may become contaminated with high level fission products and thus is installed in the MCO trench where it will be serviced by the process enclosure. It is anticipated that this unit may have to be changed for each MCO which is processed. Included in the purifier is a HEPA filter.

2.2.1.3.4 Instrumentation and Control Requirements

The module control configuration and logic are shown on the P&IDs and are discussed in the Operating Sequence Section. Programmable Logic Controllers, one at each process module, are used to assure proper operation and reliability. Each communicates with each instrument element via local connection and with the control center via one line on which signals are multiplexed. Several interlocks are provided to assure the proper sequence is followed. While direct operator intervention for many operating steps is available to override control logic, the areas where serious safety implications are involved cannot be overridden without the approval from a second authority. Data logging as well as process control is available.

2.2.2 MCO Heating System

2.2.2.1 System Function

The MCO heating system heats the MCO and its fuel contents to a processing temperature of above 300°C within the required cycle time. Heating is indirect, via hot air circulation around the MCO and circulation of the helium contained in the MCO through an external electric heater. The system must be able to heat the MCO at a rate which does not exceed 50°C/hr. It must also function through a wide range of internal helium pressures. Heating is to be electrically powered.

The system shall be designed so that it has little if any impact upon the air balance in the HCSA.

2.2.2.2 System Design Requirements

There are several restrictions on the heating of the MCO as specified by WHC-S-0460, revision A and summarized in Table 2.2-2.

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Parameter	Units	Specified Rating
Maximum MCO temperature	°C	375
Minimum MCO temperature	°C	300
Maximum MCO heating rate	°C/hr	50
Maximum temperature change over MCO	°C	100
Duration for MCO heating	hrs	~12

Table 2.2-2 MCO Heating System Design Specifications

2.2.2.3 Equipment Arrangement

It was originally conceived that the MCO would be heated with clamping band-type electrical resistance heaters. Upon further consideration of this method it became apparent that it would be difficult to assure even heating and the ability to stay within the 50°C/hr limitation. Also, the mechanical complexity of direct contact conductive heat transfer was significantly greater than alternative options using convective transfer. On this basis the determination was made to proceed with forced convection for heating of the outer shell with supplemental heating of the circulating helium stream via circulation through an electrical resistance heating element.

2.2.2.3.1 Heating of the MCO Shell

Heating the MCO with forced hot air is a two stage process. The shell is heated and the hot shell transfers its heat to the internal SNF. Transfer from the shell to the SNF occurs principally through convection of the internal gas. Helium is chosen for the heat transfer fluid because, next to hydrogen it has the highest thermal conductivity and unlike hydrogen it is safe to handle, at all concentrations.

Primary heating of the MCO was chosen to be via forced air convective heat transfer. Air is circulated and heat is applied at each pass with an electrically powered unit called the MCO Process Heater. The clearance between the oven wall and the outer surface of the MCO is one inch. The air flow rate is 750 acfm which is sufficient to produce turbulence in the annular space.

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Calculation of the MCO outside and inside heat transfer coefficients indicated that heat transfer from the shell to the fuel would be the limiting factor with sub-atmospheric internal helium pressure. Heat transfer coefficients are shown in the following equation:

$$Q = U * A * (T_1 - T_2)$$

where:
Q = heating rate in Btu/hour
U = heat transfer coefficient in Btu/hour * sq. ft. * °F
A = area of heat transfer in sq. ft.
$(T_1 - T_2)$ = temperature difference between the heat source and the heat sink in °F

The outside coefficient was calculated, using the Colburn j factor , and found to be 5. The inside coefficient was calculated from a modified Nusselt number for convection in annular spaces and found to be 1.77 which was discounted to 1.0 due to the complex internal geometry. These two transfer coefficients were used in calculating both heating and cooling temperature profiles. At sub-atmospheric pressure there is less than a 10 percent contribution to heating from the heat applied to the circulating helium. This contribution would increase if a pressure of 24.7 psia were used for the circulating helium.

The temperature profile for a MCO helium pressure of 13 psia is shown as Figure 2.2-2. It does not account for the minor contribution by heating of the circulating helium, but does allow for internal heating due to nuclear decay. It shows that heating to above 300°C may be accomplished in under 14 hours from a starting temperature of 40°C. The actual starting temperature is expected to be about 140°C since the precooling step that was initially thought to be required is not necessary. Thus the heat up time will be about 10 hours. When the SNF removal project was originally conceived it was though that connections to the MCO would be made manually so the MCO would have to be cooled from its equilibrium storage temperature to 40°C. All remote operations from the Process Enclosure are now planned so the connections can be made at 140°C.

As shown on the heating temperature profile, incrementally changing the temperature of the heating air is necessary to assure that the MCO heating rate does not exceed the 50°C per hour specification. The control is accomplished via a programmed ramping function. Feedback to the controller is obtained by monitoring the temperature of the circulating helium gas. The ramping rate can be revised based on experience with the first MCOs that are processed.

2.2.3 MCO Cooling System

2.2.3.1 MCO Cooling System Design Description

2.2.3.1.1 System Function

The MCO cooling system is to cool the MCO from 300°C to 150°C within an approximately 12 hour period, while not exceeding the 50-degree per hour specification.

2.2.3.1.2 System Design Requirements

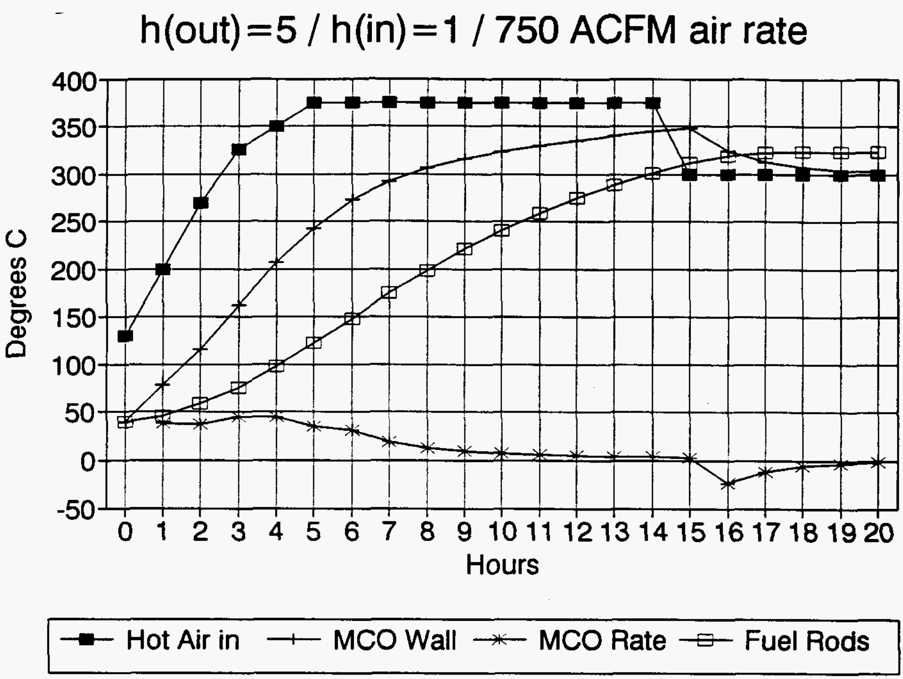
The design requirements are presented in the table below:

Parameter	Units	Specified Rating
Maximum MCO cooling rate	°C/hr	50
Maximum temperature change over MCO	°C	100
Duration for MCO cooling	hrs	12

Table 2.2-3 MCO Cooling System Design Specifications

Figure 2.2-2

Heating Temperature Profile



2.2.3.1.3 Equipment Arrangement

2.2.3.1.3.1 MCO Shell Cooling

Air that circulates through the oven is cooled by exchanger MCS-CLR-1153. The cooled air is recirculated back to the MCO. MCS-CLR-1153 may be supplied with chilled water coolant from either or both of the central chillers CHW-CH-2023 and CHW-CH-2024. The temperature of the air exiting the cooling system is programmed to allow MCO cooling without exceeding the 50°C per hour temperature change specification.

The largest influence on MCO cooling will be the interior film coefficient. The base case design assumes an interior film coefficient on/when the internal helium atmosphere is 13 psia.

Cooling air is circulated to the MCO shell at a minimum temperature of 40°C. Should a lower temperature be desired, it is easily achieved.

The cooling temperature profile is shown as Figure 2.2-3 on the following page.

2.2.3.1.3.2 Helium Circulation Cooling

Cooling of the circulating helium stream takes place in two stages. The cooling is primarily used to allow low temperature operation of the vacuum pump and circulating blower. The first stage cold trap, VPS-PFR-1101, provides a degree of purification as well as provides cooling to 100°C or lower so that VPS-BLO-1106 may safely operate within its temperature limit.

The second stage of cooling allows the scroll vacuum pump, VPS-VAC-1104 to operate below its maximum inlet temperature of 40°C. Chilled water cools the circulating helium to 25°C before its introduction to the vacuum pump.

During the MCO heating cycle, the cooled helium is electrically reheated by VPS-HCL-1105 prior to its introduction back into the MCO, however in the cooling cycle it is introduced at the temperature at which it discharges from VPS-BLO-1106. The temperature rise through this blower is nominally 2°C.

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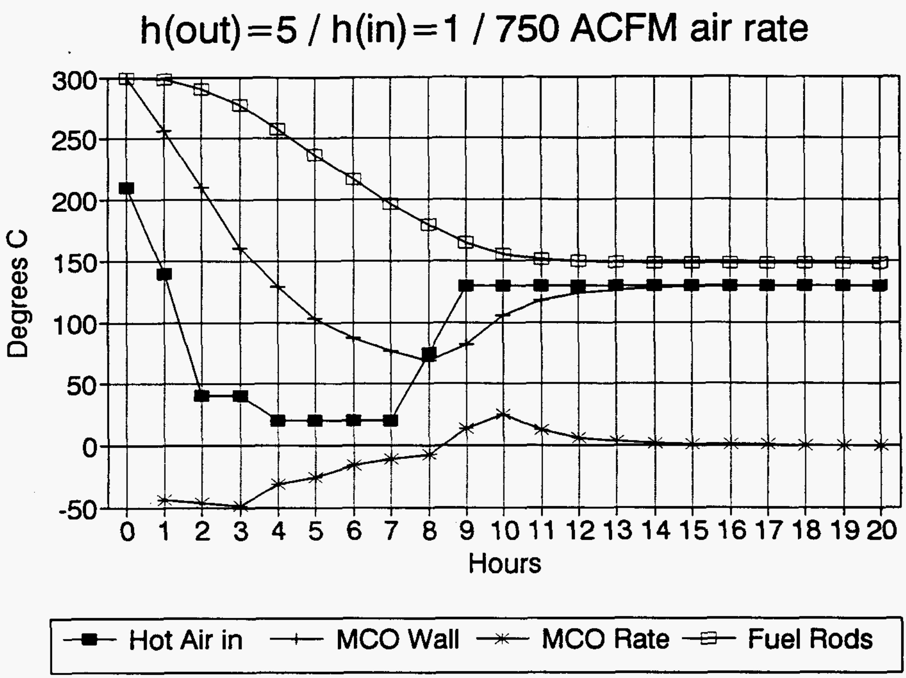
Figure 2.2-3

Cooling Temperature Profile



2.2.3.1.3.3 Instrumentation and Control Requirements

Ramped temperature control is also used for MCO cooling for staying within the rate of temperature change specification. This is pre-programmed in the units PLC. Suggested ramping temperatures are shown on the temperature profile of the following page.

Control interlocks assure that heater PHS-HCL-1152 remains off during the cooling cycle.

2.2.4 Sequence of Operation

The sequence of operation for the HCSE is as follows. Please refer to P&ID drawing SK-2-300413 sheet 2, Appendix A to follow these steps.

A. MCO vault ventilation air flow is initiated by selecting and starting either Process Vent Blower (PV-BLO-2043 or PV-BLO-2046), if not already running, and drawing air through the MCO vault and the vault trench, and checking that the flow is about 1000 cfm on FI-1174;

B. The MCO is placed into the oven by the MHM and the process enclosure is positioned over the oven.

C. The block valve for the Oven (PHS-OVEN-1154) is opened if not already open, holding a vacuum of less than 10^{-4} torr measured on PIC-1181. The HCS Oven Vacuum System, VAC-VAC-3041,3042, should be functional;

D. The MCO is connected to process gas piping by swinging the connection valves and quick disconnects into place over the valve ports and fastening remotely. Anytime the MCO valves and quick disconnects are being manipulated, vacuum should be applied by running the MCO Vacuum Pump (VPS-VAC-1104), closing GOV-1112,1120 and opening GOV-1105,1121. Once the quick disconnect is secured, the valves are opened followed by immediate evacuation using MCO Vacuum Pump. The MCO Vault Cover is re-seated. During the evacuation, the MCO Vacuum Pump is exhausted through PV-1109, GOV-1112,1120,1121 are closed, GOV-1105 is opened and GOV-1136 is opened to allow a small process gas (He or N_2) purge. Once a vacuum of 10 torr (PI-1102) is achieved, PV-1109 is closed, GOV-1105 is closed, MCO Vacuum Pump stopped, GOV-1120 is opened, GOV-1133 is opened and process gas is added through FIC-1134 at 280 lpm until PIC-1115 reaches ~ -0.1 psig;

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E. The MCO process heating system is changed from "STARTUP" to "HEATING" mode by closing GOV-1155, maintaining about a 750 cfm Process Heating Loop flowrate with FIC-1153 and the Process Heating Loop Blower (PHS-BLO-1151) operating. TIC-1154, which now controls the MCO Process Heater, (PHS-HCL-1152), is setting FIC-1122 to "AUTO" (process gas added only for pressure control and water hydrogen dilution) with a setpoint determined by a prescribed temperature rise profile;

F. Circulating helium is heated using the MCO Circulating Heater (PG-HCL-1105). Temperature exiting the heater is controlled by TIC-1119 according to a prescribed temperature rise profile. The MCO exit gas is passed through a Cold Trap (VPS-PFR-1101), where the gas is cooled to ~100°C to protect downstream equipment and to adsorb volatile components such as H_2O, iodine, cesium, etc.;

G. Pressure and composition control of the MCO process gas loop is accomplished during heat-up by maintaining PI-1115 at about ~0.1 psig by bleeding MCO gas through SOV-1118, and by adding purge helium through either FI-1136 (preset to ~0.9 lpm) or through FIC-1134 at higher rates. Helium purge may be needed to control H_2O, O_2 or H_2 levels as measured by AI-1117 residual gas analyzer;

H. Once the MCO core has reached approximately 300°C, as indicated by the temperature of the MCO exit gas, TI-1101, and the patterned heat transfer calculations, the helium is evacuated from the system to a pressure of ~5 torr using the MCO Vacuum Pump with GOV-1112,1120,1121 closed and GOV-1105 opened. FI-1136 is used to bleed helium in at a rate of 0.9 lpm (10 acfm MCO internal gas rate). The MCO is maintained at ~5 torr and 300-350°C for a period of 48 hours. H_2 and H_2O are monitored using AI-1117. When H_2 and H_2 generation ceases, it is assumed that all hydrides anc chemically bound water have been decomposed.

I. During withdrawal of the water and hydrogen with the vacuum pump, several fission products may be extracted. These could include gaseous Cs^{137} and $I_2{}^{129}$ and Kr^85 as well as isotopes of magnesium and cobalt which are in particulate form. Cs^{137} and $I_2{}^{12}9$ are adsorbed in the Cold Trap. The Kr^{85} passes through to the stack via the HEPA filters. Particulate Mg and Co are captured in the HEPA filter (VPS-F-1102).

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J. The MCO heating and cooling system is changed to "COOLING" mode with a TIC-1154 setpoint of 300°C and GOV-1155 opened. A prescribed cool down rate is followed until the MCO core temperature is reduced to 150°C (TI-1101). The MCO process gas loop is returned to loop flow during this time, and the process system pressure adjusted to ~-0.1 psig, PIC-1115, using purge helium as above. The MCO Process Heater, is disabled during the cool down period;

K. Oxygen sufficient to bring the composition of the MCO process gas to ~2 % is through an open GOV-1142 and FQIC-1141. The oxygen totalizer will close when the calculated amount of oxygen has been added, or the analyzer, AI-1117, indicates >2.5% O_2 or the system pressure, PIC-1115, has risen to a greater gas pressure that calculations permit. Once the oxygen has been introduced, the process gas loop is circulated at 150°C until the oxygen level drops below 0.5% (the system pressure should record a calculated pressure drop in rough agreement). The process is repeated until the oxygen level fails to decrease appreciably below 2%. At this point the system is held for an additional 12 hours with the oxygen concentration continuously monitored;

L. Following the 12 hour passivation period, the oxygen is displaced by helium by purging as above and evacuating the MCO to a pressure <50 torr, and refilling with helium. Once O_2 levels have been verified to below 0.1%, process is complete.

The MCO vault cover is removed. The MCO valves and quick disconnects are disconnected.

M. The MCO ports are covered and seal-welded according to procedures;

N. The welds are inspected.

O. The top of the MCO is surveyed and decontaminated as necessary prior to transfer to a storage position in the CSB;

P. The cold trap will need to be periodically replaced according to procedures between MCO runs. The replacement schedule will depend upon the quantity of material that is collected in the trap as determined by radiation readings.

2.2.5 DESCRIPTION OF SAFETY SYSTEMS

Overall, the PLC control system will provide a high degree of non-passive control and coordination. Interlocks will include these important loops:

A. All operations will be structured to allow PLC computer control of sequencing, valve positioning and other important parameter setting. Operators will interact with the system by changing the sequencing mode to various allowed states such as "IDLE", "STARTUP", "HEATUP", "VACUUM_PURGE", "COOLDOWN", "PASSIVATE", etc. Within each of these states, are allowed valve positions, controller states, process conditions, etc. If these conditions are not correct progress through the process is held. The control system will normally function without operator intervention. If operators wish, they can override most PLC functions. Exceptions are required interlocks.

B. All operations will be tied into the utilities status. If utility systems including the oven vacuum, process vent, process gases and cooling water systems are malfunctioning, operation of the HCSE system will be limited to essential operations.

C. Oxygen addition during passivation is set up with several layers of protection. The first is that the addition controller, FQIC-1131 is a totalizing controller which feeds only a pre-calculated amount of oxygen into known conditions, the second is the protection of the gas analyzer, AI-1117, and the third is the secondary check of rising system gas pressure beyond the bounds of a 2% pressure rise. Any violation of these checks will cause the isolation valve, GOV-1142 to close and the output mode of the controller, FQIC-1131 to change to "MANUAL" with an output of 0.0.

D. To avoid excessive dust migration within the MCO, the flow rate of circulating gas is limited to 10 scfm at ambient pressures and 10 acfm at low pressures. This is accomplished using FIC-1114 to control the flowrate (calculated flow internal to MCO).

E. MCO gas composition control is accomplished by using analyzer, AI-1117, to sense high levels of hydrogen or water. When these gas levels reach a threshold, purge gas is added using either FIC-1134 or FI-1136. Excess, pressure is then bled off through SOV-1118. The MCO could also be evacuated and refilled at this point.

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F. In the event of an electrical or instrument air failure, FI-1136 will purge the MCO system with process gas up to a pressure of 0.5 psig. This protects the situation when a full vacuum is being held on a hot MCO and the control systems fail. If a leak were to develop, air would begin leaking into the MCO leading to rapid oxidation reaction. This system prevents this by purging the MCO with inert gas.

G. In the event that the internal MCO filter becomes plugged, a blowback system exists to clear the blockage. An accumulator holds sufficient gas inventory to supply a pulse of inert gas through GOV1132. In order to prevent gas bypassing or passage of dust into the draw tube, valves GOV-1105, 1112, 1120, 1121 will be closed during blowback operations.

H. FI-1136 is a rotameter set at 0.9 lpm. This rate is equivalent to 10 acfm through the MCO at 5 torr and 300°C.

I. The MCO heating system uses flow control, FIC-1153, in the circulation loop. This allows for a wider range of heating and cooling situations to be met. Additionally, the heating system used temperature control, TIC-1154 to control the heater input while holding TV-1154 wide open. The cooling system uses TIC-1154 to disable the heater while modulating cooling temperature with TV-1154.

J. Pressure control of the heating system is by bleeding pressures over 0.1 psig, PCV-1159, into the process vent system (usually during startup and during heating cycles) and by allowing air into the system through PCV-1156 set at -0.1 psig. Air inlet will be required during cooling and when air leakage from between the MCO/OVEN annulus into the vault is excessive.

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2.3 COMBINED VENTILATION SYSTEM (CVS) CONFIGURATION

The conceptual design for the HCSE exhaust gas system consists of a HEPA filter intake, ducted manifold for up to six bays, isolation nuclear grade dampers, two stage testable HEPA filter plenum with pre-filter, variable speed drive exhaust fan, static pressure senors, and exhaust stack.

2.3.1 Reference Standards

ERDA 76-21
ACGIH
ASHRAE
SMACNA
NFPA
ASME
40CFR61

2.3.2 System Design Parameters

The CVS shall:

Minimize particulate hold up by use of smooth duct transitions and maintaining a minimum duct velocity of 2000 fpm.

Minimize contamination spread and prevent the backflow of gases and particulate.

Provide a constant stack flow for proper stack discharge velocity and for stack monitoring.

Provide sufficient volume for dilution of the process gas system to 25 % of the lower explosion limit for hydrogen.

Limit particulate discharge through the use of a two stage HEPA filter plenum.

2.3.3 Process Description

The CVS is designed to exhaust six process pit/trench spaces and the process gas exhaust from six MCOs. Air is drawn through a HEPA filter into the process pit space at a nominal rate of 150 CFM per process pit. The HEPA filter serves as an isolation, backdraft and filtering device. The air moves through the process pit and trench space to the exhaust duct inlet manifold, through an isolation damper, prefilter and two stages of HEPA filters with isolation dampers, exhaust fan, and finally exits the HCSA through a dedicated stack. Twenty CFM of process exhaust gas from each of the six MCOs may enter the process exhaust stream at any time. Variable speed drives on the exhaust fan motors, with control based on pressure sensors will adjust air flow to keep the exhaust flow in the stack constant.

Motorized dampers on the exhaust from each process pit will be modulated using pressure sensors with integral controllers to maintain a nominal 150 CFM flow rate.

2.3.4 Equipment description

2.3.4.1 Exhaust Fan

Backwardly inclined, class III centrifugal fan, standard application for hot gases to 200 degrees F, intrinsically safe construction, with belt drive and variable frequency motor controller.

2.3.4.2 HEPA Filter Housing

Type 304 stainless steel, bag in/out type, transition on both ends, assembled in the direction of air flow as follows: prefilter section, test section, first stage HEPA filter section, test section, second stage HEPA filter section, and final test section.

2.3.4.3 HEPA Filters

24 x 24 x 11.5 inches thick, UL Class 1, 99.97% efficiency per DOP test, and stainless steel frame.

2.3.4.4 Prefilter

24 x 24 x 6 inches thick, UL Class 1, 65% efficiency per ASHRAE standard 52-76.

2.3.4.5 Isolation Dampers

ANSI class 150 butterfly valves with motorized actuators and will meet the requirements of ASME N 509-1989, leakage class I.

2.3.4.6 Centrifugal Pumps

Nominal 24 GPM each.

2.4 PROCESS CONTROL

2.4.1 Control System Design

The System Monitoring and Control System (SMCS) design is based on integrated Programmable Logic Controllers (PLC's), Personal Computers (PC's), and Man-Machine Interfaces (MMI's). The SMCS Architecture is based on Supervisory control and Data Acquisition (SCADA) type of control system. The SMCS will be capable of handling all process controls, data acquisition, reporting, and archiving. Process control, supervisory, and Management Data Communications will be handled via standard ethernet with Transmission Control Protocol/Internet Protocol (TCP/IP). TCP/IP is the standard communications protocol used by the Internet and Hanford Local Area Networks (HLAN).

The recommended hardware are IBM compatible PC's with a 200 MHZ Pentium Pro, 64 MB ram, 2.5 GB of hard drive primary, 2.5 GB hard drive backup, 3.5" floppy drive, 6x CD-ROM drive, 21" SVGA monitor. A Laser Printer will be required for report printing. The operating system platform will be on the Windows NT. Each PC will have a dynamic graphical display of process parameters and other system variables. The MMI will animate the process variables to show process states such as an open valve or flow through a pipe. There will be a total of 3 PC's, one Operator Interface Stations (OIS), one Process Enclosure (PE) Local Control Panel (LCP), Operator, and one Engineering Work Station (EWS).

2.4.2 Programmable Logic Controllers

The process control will be handled by the PLC processors which will be located in a panel that will be installed in the control room. Each Process Module and the Service Module will have remote I/O stations that communicate to the PLC. The control system provides redundant PLC controllers which will be located in a control room PLC panel. The primary processor maintains independent control of the process and monitoring. The hot standby processor maintains a mirror of the primary PLC program and a real time data image table via a fiber optic link. Should an upset occur within the primary processor, the hot standby will immediately take control within a few milliseconds. The availability of real time data and quick response time by the hot standby will allow for a bumpless transfer of control. Also provided are redundant communications cabling to the remote I/O racks in each bay/skid.

All Local Process Modules and Service Module and skid I/O points will be field terminated at the respective remote I/O panels. The system HVAC, Chiller, Air

Monitor, and other system I/O will be field terminated at the control room PLC I/O. The PE will have a remote I/O rack which will communicate to the PLC processor via radio modem. The radio modem will take advantage of Spread-Spectrum transmission technology.

2.4.3 PLC Programming Interface

Logic diagrams and PLC programming will be configured by graphical methods using AutoCAD with pre-designed blocks having pre-configured attributes. Examples of logic and control blocks are, but not limited to; AND, OR, Analog I/O, Sequential Step, PID, and Digital I/O Blocks. A commercially available software package will be used to compile the AutoCAD drawing into a function block which can be downloaded to the PLC. There will be no PLC relay ladder logic to program. As such, when the logic changes, the drawing follows suit and the program recompiled. The program will have a supporting I/O data base and program de-bugging tools. Run-Time simulations and PID Control Loop Tuning tools will be available.

2.4.4 Man-Machine Interface

The OIS will handle concurrent processing of the Modules. The OIS and the EWS will have the capability of handling full operation of all six Process Modules and all other system controls including, but not limited to, archiving, reporting and alarming. The EWS will normally show the System HVAC process and system alarming. Generating alarm, event, graphic, and analysis reports will normally be an EWS task. The EWS will be used by the Operations System Engineer to facilitate run-time and enhancement changes to the MMI and PLC.

2.4.5 Communications

Communications will be through an ethernet network using Microsoft (MS) TCP/IP protocol. This ensures compatibility for communications to Hanford Local Area Network (HLAN). Communications from the PLC to the PC's will be via a separate LAN to isolate the process communications from the management and HLAN system. Printing communications will be handled through the ethernet network.

The PMC will communicate to the PLC using a spread spectrum radio modem. The interface to the control system network will be standard ethernet with TCP/IP protocol. The radio modem communications design will facilitate control, interlocking, and alarming requirements from the PMC while maintaining mobility.

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2.5 OVEN ASSEMBLY DESCRIPTION

The MCOs will be heated in six(6) ovens which will be installed in process pits that will be located below the HCSA floor level. As indicated in the P&IDs (SK-2-300413), the MCO will be heated by forced hot air that is blown through the oven. The heater and blower will be located on the process module and the pipes that carry the circulating air will run from the process module through a below grade trench to the oven. The general arrangement of the oven in the pit, the trench, and the connecting piping is shown on SK-2-300422.

The oven will be an insulated stainless steel cylinder with an insulation jacket. The proposed insulation is vacuum. In other words, the oven will be constructed as a thermos bottle. The outer vessel will be stainless steel and super insulation will be attached to the inside surface of the outer vessel. The space between the inner and outer vessel will be constantly evacuated by a vacuum pump so that gas release promoted by the heating of the vessel will be drawn away. Two variations of the concept that are under consideration are given Drawings SK-2-300417 and SK-2-300418. The selection will be made once the MCO neck design has been settled.

This basic design concept was selected for a number of reasons:

A. The rate of temperature rise of the MCO is limited to 50°C per hour. The heat transfer from the MCO into the SNF is slow because the transfer is effected by a nearly static gas. Therefore the MCO wall is easily heated. Radiation from heaters could easily overwhelm the heating rate limitation, whereas heat transfer from forced air is easy to control. Furthermore, there would be no simple way to measure the MCO surface temperature if it was exposed to radiation from heaters. Measurement of the inlet and outlet air temperatures in the proposed design is simple and is a good measure of the MCO temperature because heat transfer is effected by convection and gas conduction.

B. There are no heaters and no electrical distribution in the oven. This means that there is no opportunity to have a heater failure that would take the oven out of service or cause it to be pulled from the pit for repair.

C. Vacuum insulation was chosen because it is effective. It makes the oven easily constructable as a single stainless steel assembly. It is the lightest insulation choice which will make the assembly easier to install. And, most importantly it has few contamination traps and smooth and hard surfaces that can be decontaminated.

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In both design alternatives, the hot air enters into a ring contained in the upper portion of the vacuum jacket. This ring distributes air to three downcomer pipes that carry the hot air to an insertion ring located in the bottom of the vacuum jacket. The distribution ring allows the air to enter into the oven uniformly around the base of the MCO through perforations into the oven interior. The downcomer pipes contain bellows expansion sections and are mounted to allow for vertical motion.

The MCO concept where the vessel has straight walls from top to bottom is shown on Drawing SK-2-300417. The MCO rests on a ring which transfers the load to a ring between the inner and outer oven vessels. The oven outer vessel rests on an impact limiter that transfers the load to the pit foundation. The impact limiter, which is for the purposes of protecting the MCO in the event of an accidental drop, will be the same one used in the CSB storage vaults. Both the ring between the MCO and the oven and the one in the vacuum jacket will be perforated to allow for airflow. The air will flow upward through the annulus between the MCO and the oven. Heat transfer calculations (see Appendix G) indicate that a 1" annulus with an airflow of 750 CFM will be appropriate. When the air reaches the top of the annulus it is blocked by an annulus cover piece that will be installed after the MCO is lowered into the oven. The cover side wall will be a bellows to allow for differential expansion between the MCO and the oven. The top plate of the cover will be 3" thick to create some shielding for the radiation stream coming up through the annulus. It will also provide enough weight to hold it against the MCO top as the oven grows faster than the MCO. The air will flow through perforations into a collection ring located in the top of the vacuum jacket. The collection ring feeds the return pipe to the process module. The air circulation pipes run within a vacuum jacket in the trench. The outer vessel of the oven will have a bellows to allow for thermal expansion of the oven. This bellows will have a restraint so that the oven can be lifted during installation. The top ring of the oven that holds the inner an outer vessels of the vacuum jacket will be thick stainless steel in order to shield the radiation stream rising from the MCO.

Air flowing through the top of the oven pit and through the trench will be diverted from the MCO top by an insulation cover so that the MCO top temperature is not significantly cooler than the body.

The oven concept shown on Drawing SK-2-300418 assumes an MCO design where the upper part of the MCO has a small flare. In this case, the MCO flare rests on a beveled flange on the top of the oven. There is no support at the bottom of the MCO. The weight is carried though the inner vessel of the oven to a ring in the vacuum jacket base and then to the impact limiter. There is no need for a special

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annulus cover. Otherwise the design is the same. With this design the thermal growth of the MCO is accommodated by the space between the MCO bottom and the oven.

The final closure of the MCO will be accomplished by welding a cover over the MCO top. This weld will be made while the MCO is in the HCSE oven after the hot conditioning process has been completed. The geometry of the cover, weld, and welding machine have not been defined at this time. This means that the relative vertical dimensions of the oven top and the MCO top cannot be defined at this time and assembly concept sketches cannot be developed for the welder/oven interface. Resolution of this interface will be required to complete the detailed design of the oven.

2.6 PROCESS MODULE

2.6.1 Process Module Description

The process module contains most of the equipment shown on the piping and instrument drawing sheet #1. With the exception of central and combined service equipment, the MCO, its oven and the cold trap, all equipment servicing an MCO is part of this module.

Module equipment includes:

A. Vacuum pump (VPS-VAC-1104).

B. Recirculation blower (VPS-BLO-1106).

C. The vacuum system cooler (VPS-CLR-1103).

D. The vacuum system heater (VPS-HCL-1105).

E. The MCO cooling system cooler (MCS-CLR-1153).

F. The MCO heating system heater (PHS-HCL-1152).

G. The MCO heating system circulating blower (PHS-BLO-1151).

H. The process vent HEPA filter (PV-F-1171).

I. A control panel for the module which includes input/output interfaces to a central programmable logic controller.

The module measures six feet by nine feet in the plan dimension and is eight feet high. Some equipment items are vertically installed to conserve space. Except for the module's vacuum pump, rotating mechanical equipment is mounted on one side for accessibility and ease of maintenance. The skid is placed in the CSB annex with ample accessibility to all its sides. It is located behind the service crane's area of influence so as not to be of concern.

Process piping to and from the module proceeds in the trench to the MCO. Service utilities are run to the module above grade.

Structural elements for its fabrication are standard AISC shapes. Deck plating covers the service area. It is intended that the process module be fabricated and assembled in a local shop and then shipped to the site where it is to be leveled and affixed to steel plates imbedded in the CSB annex floor.

The module requires operator attention only for maintenance. All controls are accessed from a remote central control station which is capable of monitoring and controlling each of the six process modules plus the central utilities.

The operation of the process module equipment is described in Section 2.2. Cut sheets for the equipment are available in Appendix H.

While each module, trench and vault unit have three HEPA filters, only one is installed on the process module. That filter provides suction air to its associated MCO. Installation at the MCO was considered but abandoned when it was apparent that the filter would have to be installed at grade elevation and would thus be subject to contamination from the adjacent floor area. Its installation on the process module allows longer life and ease in servicing the filter. The piping from the filter to the MCO vault is accommodated in the trench.

HEPA filters VPS-F-1102 and VPS-F-1107 are the bag-out type and are pressure rated to 100 psig. This rating increases the cost of these units considerably. It is made necessary because of the current uncertainty about heat transfer rates in the sub-atmospheric MCO. Should this issue become resolved prior to detailed design and pressure operation not be required, these filters can be simplified considerably with a commensurate reduction in module cost. At this time they are shown installed in the trench.

2.6.2 Equipment Description

2.6.2.1 Vacuum Pump Selection (VPS-VAC-1104)

This section discusses the basis for selection of the scroll type vacuum pump for the HCS project. The starting point for this discussion is the alternatives study performed for the Cold Vacuum Drying System (CVDS) project. That study

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evaluated eight alternatives involving different pump combinations. The rotary scroll pump was selected on the basis of operational simplicity , cleanliness and the wide pressure range covered by a single stage of pumping. A staged Roots blower was the second choice. The intent of the current study is to expand upon the earlier work by focusing on germane operating conditions in the CVDS and determining if changes in these conditions are required for the Hot Vacuum Conditioning System (HVCS) project are required and if so, are the changes detrimental to the pump. Germane operating conditions which could compromise the reliability of a rotary scroll pump are:

Elevated Temperatures
Presence of Particulates
Water Vapor Condensing Within the Pump
Materials Incompatibility

During the CVDS development testing program, the scroll pump's ability to operate for long periods while pumping water vapor at temperatures in excess of 100 C will be demonstrated. The concern is that bearings within the pump may fail at the elevated temperature. Discussions with the manufacturer's representative identified that the stated operating limit of the pump (40 C) is a limiting condition only when combined with high vacuum at the pump inlet. Under these conditions, cooling of the pump bearings relies mainly on conductive heat transfer to the pump body. When pumping at higher pressures the situation is relieved due to convective transfer on the bearings directly. As part of the CVDS, a pump will be tested to demonstrate long term pumping of water vapor at 100°C or above to verify that pump life is not compromised. If this demonstration is assumed to be successful, utilization of the pump for the HVCS process does not present any increase in severity as regards the operating temperature.

Particulates are a concern for a rotary scroll pump because of the close tolerances within the interleaved scrolls which could bind if subjected to particulates in the gas stream. Filters will be installed upstream of the pump inlet to protect the pumping surfaces. Additionally, the scroll pump that was selected for the CVDS has Teflon tip seals that are more tolerant of particulate than an all metal design. If necessary, the pump can be repaired should damage due to particulate be incurred. Routine replacement of some pump parts is recommended at 6,000 and 12,000 hour intervals. The development testing program will demonstrate pump life under particulate conditions that are comparable to the actual pumping environment.

For the CVDS application, a heater was provided immediately upstream of the pump to ensure that the pump inlet temperature was high enough to preclude condensation of water vapor as the pressure increased within the pump housing. Since the pressure at the pump exhaust is atmospheric, condensation can be avoided by maintaining the pump inlet temperature above 100 C. As for the HVCS process, that concern is reversed. With cask temperatures of up to 350 C and very small quantities of residual water after cold vacuum drying, the possibility of water condensing within the pump is remote. The water which is pumped will mix with helium purge gas so that, after compression, the relative humidity is still low.

The wetted surfaces of the scroll pump are hard coat anodized aluminum and a Teflon compound. The gases being pumped, helium, hydrogen, water vapor, and trace quantities of tritium, air and fission gases are all compatible with these materials. Bearings are housed in a separate chamber and are lubricated with inorganic PTFE. The gases being pumped during hot vacuum conditioning should have no detrimental effect on the pump. Radioactive gases and particulate that may be released by oxidation of the SNF during the HVCS process (I, Cs, Mg) will be removed before they reach the pump.

It is recommended that the rotary scroll pump that was selected for the CVDS process be used for the water HVCS process. No changes in operating conditions have been identified that would be deleterious to pump operation. If it is assumed that pump performance will be satisfactory during development testing for the CVDS project, then the transition to the HVCS process presents no risk relative to pumping performance. As in the CVDS, the fall back pump for HVCS is a multistage Roots pump.

2.6.2.2 Recirculation Blower (VPS-BLO-1106)

The recirculation blower is a magnetically coupled regenerative-type blower which circulates helium through the MCO and through external treatment in the trench and through heat exchange units on the process module. It has been specified to handle 13 to 25 psia of helium pressure. The blower has no seal and consequently no leakage. The pump can deliver 20 ACFM of helium against a 4-inch WC static head

2.6.2.3 Vacuum System Cooler (VPS-CLR-1103)

The cooler is a plate-type unit. Its duty is highly dependent upon the pressure in the helium recirculation system; the duty increases with increasing pressure.

The system is sized at a duty of 2,000 Btu per hour at pressure service.

2.6.2.4 Vacuum System Heater (VPS-HCL-1105)

As with the cooler, the duty of the heater increases significantly with increasing helium pressure. The heater is electrically powered and is sized at 3 kW.

2.6.2.4 MCO System Cooler (MCS-CLR-1153)

The cooler is an air to water heat exchanger. It is sized at 83,000 Btu per hour to remove the appropriate amount of heat during the MCO cooling cycle.

2.6.2.5 MCO Heating System Heater (PHS-HCL-1152)

The heater is an electrically powered 25 kW unit. It is normally operating at less than half of its capacity during the major portion of the MCO heat up process.

2.6.2.6 MCO Heating System Circulating Blower (PHS-BLO-1151)

The blower is designed to work at the high temperature (375 C) that will be encountered in heat up. It is powered by a 5-horsepower motor which draws its maximum load at ambient temperature during startup.

2.6.2.7 Process Vent HEPA Filter (PV-F-1171)

This filter draws air from the building in the area of the process module and after passing it through the HEPA, pipes it to the MCO vault. Installation of this filter on the process module avoids problems which are inherent in mounting this filter at the MCO at floor level.

2.7 SERVICE MODULE

The service module contains all utility systems which are common to each of the process modules, with the exception of the chiller system, the process gas system and the vent stack, all of which are outside the CSB. These outside systems are described in Section 3.3 as auxiliary facilities.

The service module is located at the mezzanine level in the southwest corner of the HCSA. It contains the following components:

A. Chilled water pumps, expansion tank and heat exchanger;

B. Cooling water pumps, expansion tank and heat exchanger;

C. Combined ventilation system blowers and HEPA filter;

D. MCO oven vacuum pumps; and

E. Instrument air system

The equipment, piping and instrumentation that are in the service module are identified on the P&IDs (SK-2-300413).

2.7.1 Chilled Water Systems

The chilled water system provides cooling for the MCO cool down cycle and for protection of gas circulation and vacuum pumps during other portions of the HCSE operation.

In order to achieve adequate confinement from the radioactive systems which require cooling, a chiller system is used which provides three levels of isolation from the process heat load. The first level exchanges heat directly with the Freon® loop of the package chillers and the atmosphere. Inside the HCSA the Freon® loop exchanges heat with a chilled water loop that provides cooling for the water loop. The cooled water loop extends to each of the modules and exchanges heat directly with the process heat exchangers. This multiple level system provides multiple barriers to prevent radioactive material from contaminating either the chilled water loop or the Freon® loop. Redundant pumps piped in parallel will be provided on the water side of each heat exchanger in order to provide operating flexibility during maintenance periods.

The chiller equipment is described as follows:

Compressor/Condensing Unit: Scroll compressor, air-cooled condensing unit, single circuit with 2 steps of capacity. Nominal 25 ton capacity at 105°F. Supply with 25 ton evaporator chiller.

Centrifugal Pumps: Nominal 24 GPM each.

2.7.2 HCSE Process Vent System

The process vent system discharges to the combined ventilation system as described in Section 2.3. Process exhaust gases include those vented from pressure relief valves and discharge from the vacuum pumps. the pressure relief valve vents and vacuum pump exhaust are located at the process modules. A collection manifold extends from the combined ventilation system on the service module to each of the process modules. All of the process ventilation gases pass through HEPA filters that are located in the Trench before they are vented to the final set of HEPA filters in the combined ventilation system.

2.7.3 MCO Oven Insulating Vacuum System

Insulation for the MCO ovens is provided by a vacuum jacket that is designed into each oven. This vacuum jacket is evacuated by a central MCO Oven Insulating Vacuum system. The function of the MCO Oven Insulating Vacuum System is to maintain a vacuum of 10^{-4} torr in the oven jackets and in the jackets of the process piping that is vacuum insulated. Two vacuum pumps, operating in series, serve all MCO ovens. The fore pump is the same scroll pump unit used on each process module. It is used to bring the vacuum to the operating range of the turbomolecular pump. The turbomolecular maintains the vacuum system at approximately 10^{-4} torr. Installed spares are not provided for these vacuum pumps. The pumps discharge to the combined ventilation system.

2.7.4 Instrument Air System

The instrument air system consists of a 45 CFM compressor, an air receiver, and a molecular sieve dryer. The compressor is powered by a 10 horsepower electric motor and produces air to the 200 gallon ASME-stamped receiver at 100 psi. In-line between the receiver and the dryer is a deoiler. The air dryer has two molecular sieve columns, one which is on-line while the other is regenerating. Regeneration is accomplished on a timed cycle.

2.8 PROCESS ENCLOSURE DESCRIPTION

Each HCSE oven will be imbedded in a process pit so that the top of an oven will be a few feet below the facility floor. It is necessary to access the top of the MCO to make and break connections, to assemble and disassemble oven top pieces, to change the Cs/I trap, and to weld the final cover over the MCO . This access requires that the process pit cover (shield) be opened and that a means of manipulating items inside the process pit be provided.

A portable process enclosure is to be used while working in the open process pit. When not in use the enclosure will be parked out of the way. When access is required to an oven the enclosure will moved over the process and lowered so that it seals against the facility floor. An actuator located within the enclosure will be used to open the process pit cover. An operator using a tele-operated manipulator arm and a variety of tools and fixtures carried in the enclosure will perform a list of operations to either prepare for conditioning or to tear down after conditioning is complete as detailed in the HCSE Model Operating Sequence (see Section 2.1)

The enclosure performs the following basic functions:

A. Secondary Confinement: It acts as the secondary radioactive material confinement structure when the process pit cover is open. It will prevent accidental releases from the MCO during connect/disconnect operations from spreading into the HCSA.

B. Radiation Exposure Management: It removes the operator a reasonable distance from the radiation area immediately above the process pit and it provides shielding in front of the operator.

C. Remote Operations Tool Chest: It provides manipulation capability needed for a number of specific activities and it provides the structure required to mount the manipulators, hoists, and auxiliary tools and equipment.

2.0 PROCESS

The process steps to be performed with the process enclosure are:

ID	Name	Description
5.0	Move-in Process Enclosure	The process enclosure is moved from its parking place into its operating position above the process pit.
6.0	Connect Process Cell	Make the electrical and instrumentation connections that operate the process enclosure equipment.
7.0	Open Process Pit	Actuate the process pit cover opening mechanism and expose the oven.
8.0	Place Annulus Cover	Get the annulus cover from its storage location in the enclosure and place it on the oven top using the manipulator.
9.0	Attach Annulus Cover	Use manipulator and drill motor driven socket to tighten the bolts.
10.0	Remove Port Covers	Use the manipulator and drill motor driven socket to loosen port cover bolts. Use manipulator and suction device to remove the covers.
11.0	Install Vent Cover	Use the manipulator to get a cover from its storage location in the enclosure and place it in the vent port. Use the manipulator and drill motor driven socket to tighten the bolts.
12.0	Install Valves	Use the manipulator to pick the valves from their storage ports and plug them into the MCO ports. Use the manipulator and drill motor driven socket to tighten the bolts.
13.0	Open Valves	Use the manipulator and drill motor driven sockets to drive the valve operator screws.
14.0	Evacuate MCO	Remove old gas from the MCO using the system vacuum pump.
15.0	Fill MCO With He	Fill the MCO with helium.

2.0 PROCESS

16.0	Leak Check Ports	Use the manipulator to move the the sniffer hose attached to a helium leak detector (part of the process enclosure equipment) around the MCO ports.
17.0	Pass Leak Test ?	Determine if corrective action is required before proceeding.
18.0	Close Bad Valve	Use the manipulator and drill motor driven sockets to close the leaking port.
19.0	Disconnect Valve	Use the manipulator and drill motor driven socket to loosen the valve attachment bolts. Use the manipulator to pull the valve out of the port.
20.0	Clean Port	Use the manipulator and drill motor driven cloth pad to clean port.
21.0	Install Reserve Valve	Use the manipulator to re-install the valve or to install a reserve valve. Use the manipulator and drill motor driven socket to tighten the bolts. Open the valve using the manipulator held drill motor and sockets.
22.0	Install Insulation Cover	Use the manipulator to get the insulation cover from its storage location in the enclosure and place it on top of the MCO.
23.0	Close Process Pit	Actuate the process pit cover operating mechanism.
25.0	Survey Process Cell	Use the manipulators to swipe selected spots in the cell. Pass bottled swipes out of the enclosure for counting.
26.0	Disconnect Process Cell	Disconnect the electrical and instrumentation services.
27.0	Remove Process Cell	Return the enclosure to its parking place.

2.0 PROCESS

39.0	Move-in Process Cell	The process enclosures moved from its parking place into its operating position above the process pit.
40.0	Connect Process Cell	Make the electrical and instrumentation connections that operate the process enclosure equipment.
41.0	Open Process Pit	Actuate the process pit cover opening mechanism and expose the oven.
42.0	Remove Insul. Cover	Use the manipulator to grab the insulation cover and return it to its storage location in the process cell.
43.0	Close MCO Valves	Use the manipulator and drill motor driven sockets to close the valves.
44.0	Place Weld-On Cover	Use the manipulator to get the weld-on cover from its storage location in the process cell. Place it over the MCO.
45.0	Install Welder	Use the hoist and manipulator to get the automatic welder from its storage location in the process cell. Install the welder on the top of the MCO.
46.0	Weld Root Pass	Turn on the welder. Make the root pass.
47.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
48.0	Clean Weld	Clean the weld using a rotary stainless steel wire brush and the manipulator held drill motor.
49.0	Repair	Is weld repair required?
50.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
51.0	Repair Weld	Use the welder to reweld the ground out area.

2.0 PROCESS

52.0	Apply Dye	Apply liquid penetrant Dye using a specially designed applicator held by the manipulator.
53.0	Soak	Wait the prescribed time for the Dye to seep into weld defects.
54.0	Remove Dye	Using a specially designed applicator apply the cleaning fluid and wash off the Dye. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor.
55.0	Apply Developer	Apply the developer using a specially design applicator and the manipulator.
56.0	Bleed	Wait the prescribed time for the Dye to "blot out" of weld defects.
57.0	Inspect	Inspect the developer coated weld using the manipulator mounted camera.
58.0	Clean	Using a specially designed applicator apply the cleaning fluid and wash off the developer. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor
59.0	Repair	Is weld repair required?
60.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
61.0	Repair Weld	Use the welder to reweld the ground out area.
62.0	Weld Pass 1	Turn on the welder. Make the weld pass.
63.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
64.0	Repair	Is weld repair required?
65.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.

2.0 PROCESS

66.0	Repair Weld	Use the welder to reweld the ground out area.
67.0	Weld Pass 2	Turn on the welder. Make the weld pass.
68.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
69.0	Repair	Is weld repair required?
70.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
71.0	Repair Weld	Use the welder to reweld the ground out area.
72.0	Weld Pass 3	Turn on the welder. Make the weld pass.
73.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
74.0	Repair	Is weld repair required?
75.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
76.0	Repair Weld	Use the welder to reweld the ground out area.
77.0	Weld Pass 4	Turn on the welder. Make the weld pass.
78.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.
79.0	Repair	Is weld repair required?
80.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
81.0	Repair Weld	Use the welder to reweld the ground out area.
82.0	Weld Pass 5	Turn on the welder. Make the weld pass.
83.0	Visual Inspect	Inspect the weld using a television camera on the manipulator arm.

2.0 PROCESS

84.0	Repair	Is weld repair required?
85.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
86.0	Repair Weld	Use the welder to reweld the ground out area.
87.0	Apply Dye	Apply liquid penetrant Dye using a specially designed applicator held by the manipulator.
88.0	Soak	Wait the prescribed time for the Dye to seep into weld defects.
89.0	Remove Dye	Using a specially designed applicator apply the cleaning fluid and wash off the Dye. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor.
90.0	Apply Developer	Apply the developer using a specially design applicator and the manipulator.
91.0	Bleed	Wait the prescribed time for the Dye to "blot out" of weld defects.
92.0	Inspect	Inspect the developer coated weld using the manipulator mounted camera.
93.0	Clean	Using a specially designed applicator apply the cleaning fluid and wash off the developer. Finish with a cleaning fluid soaked rotary buffing pad driven by the manipulator held drill motor
94.0	Repair	Is weld repair required?
95.0	Grind	Grind out the defect area using a small grinder (dremel tool) held by the manipulator.
96.0	Repair Weld	Use the welder to reweld the ground out area.
97.0	Remove Trap	Use the manipulator to disconnect the trap and set it aside.

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98.0	Install New Trap	Use the manipulator to get the new trap from its storage location in the cell. Make the new trap connections using the manipulator.
99.0	Connect Waste Drum	Use a cart to place a shielded waste drum below the process enclosure bag port. Connect the drum and port.
100.0	Remove Top Shield	Open the bagport door. Lower a hoist into the drum and pull the top of the shield into the cell. Set it out of the way.
101.0	Dispose Hot Trap	Use the manipulator to place the trap into the drum.
102.0	Insert Top Shield	Use the hoist to replace the shield to in the drum.
103.0	Tie Bag	Tie off and cut the bag.
104.0	Close Drum	Place the top on the drum and attach it. Move the drum cart to the waste management area.
105.0	Undo Annulus Cover	Use the manipulator and drill motor driven socket to release the annulus cover bolts.
106.0	Remove Annulus Cover	Use the manipulator to remove the annulus cover and place it into its storage location in the cell.
107.0	Close Process Pit	Actuate the process pit cover mechanism to close the cover.
108.0	Survey Process Cell	Use the manipulators to swipe selected spots in the cell. Pass bottled swipes out of the enclosure for counting.
109.0	Disconnect Process Cell	Disconnect the electrical and instrumentation services.
110.0	Remove Process Cell	Return the enclosure to its parking place.

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In order to accomplish these process steps the enclosure must have the following functions and capabilities:

Function ID	Affected Sequence Steps	Description
F1	5,27,39,110	The enclosure must be movable with x, y axis motion. It must be able to move over each of the HCSE process pits and to a storage location where it does not interfere with the MHM. It may be either self motivated or towed.
F2	6,26,40,109	The enclosure must have vertical motion so that it can be lifted while traveling and lowered to rest on the floor when over a process pit. An elastomer seal is required between the enclosure base perimeter and the floor.
F3	7,23,41,107	The enclosure must contain a mechanism for opening and closing the process pit cover. The cover weight estimate is 5,000 lbs.
F4	8,9,105,106	The enclosure must have a position for storing one annulus space cover.
F5	10,11	The enclosure must have positions for storing three port covers.
F6	8,9,10,11,12,13, 16,18,19,20,21, 22,25,42,43,44, 45,47,48,50,52, 54,55,57,58,60, 63,65,68,70, 73,75,78,80,83, 85,87,89,90,92, 93,95,97,98,101 ,105,106,108	The enclosure must have dextrous tele-operated hydraulic manipulator with force feedback controls. The manipulator must be able to reach the MCO top surface, the trap, the drum output port, and the various tool and accessory storage locations in the cell. The largest and heaviest item that it must be able to lift and place will be the annulus space cover. It must be able to hold a wide variety of tools.

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F7	9,10,11,12,13, 18,19,21,43,105	A drill motor and socket attachments are needed to drive various bolts. There must be a manipulator friendly system and there must be a storage rack in the enclosure for these items.
F8	16	A helium leak detector equipped for operating in the sniffing mode must be mounted to the cell. The manipulator must be able to direct the sniffer hose around the MCO port connections.
F9	20,48,54,58,89, 93	A rotary buffing pad that can be attached to the drill motor is required in the tool storage rack.
F10	48	A rotary stainless steel wire brush that can be attached to the drill motor is required in the tool storage rack.
F11	50,60,65,70,75, 80,85,95	A small grinder (dremel tool) that can be manipulator held is required in the tool rack.
F12	47,48,50,51,52, 54,55,57,58,60, 61,63,65,66,68, 70,71,73,75,76, 78, 80,81,83,85,86, 87,89,90,92,93, 95,96	A manipulator mounted television camera is required to perform visual inspection of the weld and the liquid penetrant developer. A monitor is required at the operator station.
F13	7,23,41,107	A process pit cover actuator is required to open and close the process pit.
F14	52,87	A liquid penetrant dye applicator that can be remotely handled with a manipulator is required in the cell.
F15	55,90	A liquid penetrant developer applicator that can be remotely handled with a manipulator is required in the cell.
F16	99,103	A waste drum bag port connection is required.

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F17	100,102	A hoist to pull the shield from the waste drum is required.
F18	45,46,51,61,62, 66,67,71,72,76, 77,81,82,86,96	An automatic tube welder and fixture is required. The head and fixture must be stored in the enclosure and the manipulator must be able to place and attach it. the power supply should be mounted on the outside of the cell.
F19		Television cameras that can see the top of the MCO and into the waste drum are required. The operator station monitor must be able to display multiple cameras.
F20	22,42	The enclosure must be able to store an insulation cover.
F21	98	The enclosure must be able to store a new trap.
F22		The enclosure must have a pass through door that allows the insulation cover, annulus cover, trap, and various miscellaneous supplies to be passed.
F23		The enclosure must have shielding built into the walls and ceiling as determined by the radiation exposure analysis.
F24		The enclosure must have an operator station with a shielded viewing window, TV monitor, manipulator control, motor control, valve control, welder control, and communication with the process control PLC.

A process enclosure concept that incorporates these functions is shown on Drawing SK-2-300420. The enclosure will be a floorless steel plate enclosure with a corner operator station and a recess for the drum bag port. The viewing station will have a leaded Lexan window. The enclosure will contain a hydraulic manipulator similar to the Schilling Titan VII depicted. The drum bagport system will be the Central Research system. The enclosure vertical motion can be accomplished with manually pumped hydraulic jacks. The enclosure rides on an open frame supported on four wheels. There is limited turning capability for positioning the cell. The

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enclosure will be moved along the process pit centerline by towing with a hand operated electric tow motor. A battery charging station for the tow motor will be provided at the enclosure parking station. As indicated on the HCSE floor plan the parking space will be to the (Southeast) of the process modules. A shuttle table will move the enclosure from the process pit centerline to the parking location.

2.9 SOLID WASTE

The solid waste handling system and requirements will be designed in accordance with the requirements outline in WAC 173-303, Dangerous Waste Regulations and WHC EP 0063, Waste Acceptance Criteria. This system shall provide the equipment and local storage necessary to prepare all solid waste produced by the Hot Conditioning Equipment System (HCSE) for transfer to the appropriate storage and or treatment facility.

The sources of solid routine waste generated by the HCSE fall into two categories. The first is waste generated as a direct result of operating the conditioning equipment (i.e. HEPA filters, iodine traps, and filters used by the radioactive monitoring equipment) and the second is from general cleaning and inspection (i.e. welding rods, kim wipes, swipe tests, etc.). If a accidental breach occurs additional solid waste would be generated from the decontamination operations such as absorbent materials, swipe test papers, kim wipes, etc.

The amount of solid waste expected to contain potentially low levels of contamination has been estimated as follows:

A. Contaminated HEPA Filters (adjacent to the exhaust stack)
Changed on average .... 2 times yearly

B. Contaminated HEPA Filters (inlet to the process trench)
Changed on average .... 4 times yearly

C. Getter and Charcoal Beds (HVAC), if required
Changed on average .... 2 times yearly

D. Filters Incorporated in the Radiation Monitors
Changed on average .... Monthly

E. Filters Used by the RAS Monitors
Changed on average .... Weekly

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F. Process Filters VPS-PFR-1101 and VPS-F-1107
Changed on average .... Monthly

G. Vacuum Pump Filters
Changed on average .... Monthly

H. Spent Welding Rods
Approximately .... ½ lbs per MCO

I. Kim Wipes for General Cleaning
Approximately .... 15 per MCO

J. Swipe Papers
Approximately .... 10 per MCO

K. Soiled Protective Clothing
Approximately .... 1 per Operator per month

L. Dye Penetrant Testing Materials
Approximately .... 1/4 lbs per MCO

The amount of solid waste expected to contain potentially moderate to high levels of contamination has been estimated as follows:

A. Iodine/Cesium Traps
Approximately .... 1 per MCO

Failed equipment can potentially fall into both low and high levels of contamination. The process equipment that is used to pump the gases and moisture from the MCO (vacuum pumps and blowers), the piping used to convey these gases, and the valves and fittings in this portion of the system have the potential to become moderately contaminated if the MCO internal filter fails. Other equipment such as radiation monitors, gas supply system components, and heating elements do not have a potential to become moderately or highly contaminated. An analysis of the average expected lifetime of the process equipment will be performed as part of the detailed design effort to estimate the frequency of equipment failure and thus the amount of waste generated as a result of the failure.

The Hot Conditioning System Annex will be provided with appropriate storage containers for both low level waste and moderately contaminated wastes. Failed equipment will be disposed of appropriately based on a radiation survey. The waste storage area will also provide functions for characterizing the waste materials before shipment to storage (i.e., burial ground, WRAP, etc.).

3.0 FACILITIES/UTILITIES SUPPORT

3.1 HCSE LAYOUT

3.1.1 Functions and Requirements

The function of the HCSE layout is to configure the process equipment and other components to best support maintenance and operation of the system. This includes providing; sufficient access to each component, optimizing the flow of process materials, and matching the requirements for interfacing with the MHM. A secondary requirement is to configure the system to be compatible with future SNF storage in a vault that could be constructed on the south end of the Annex.

3.1.2 HCSE Layout Description

The HCSA will be located on the south end of the CSB. The layout of the process pits, trenches, process modules, service module and solid waste storage area are shown on Drawing No. SK-2-300421.

The six process pits and the spare are aligned in a row to facilitate access by the process enclosure. The pits must also be accessed by the MHM so they are located between the MHM rails. Clearance distances for the MHM are maintained from the MHM rails and between the centerline of the pits and the edge of the process modules. The distance between pits is mainly driven by the access area required around the process modules. This distance is larger than the distance between CSB storage holes so it is compatible with the MHM space requirements.

The trenches join the process pits with the process modules where the bulk of the process equipment is located. The trenches are required because a flat floor is required for all areas serviced by the MHM. It is anticipated that the trenches will be 24-in wide and 51-in deep. The length is dictated by the MHM clearance requirements.

The process modules will be 6-ft wide by 9-ft long by 8-ft. high. They are laid out with a 4-ft wide aisle all around to provide access for maintenance. A module is not shown for the spare process pit but space is provided for it. The process modules are located as close to the process pits as allowed by the MHM to minimize the size of the HCSA.

The service module will be in the southeast corner of the CSB annex at floor level. An aisle way is provided all around the service module to allow access for maintenance.

3.0 FACILITIES/UTILITIES SUPPORT

The bottom surface of the MHM bridge will be 9 feet off the floor. This will allow the bridge to clear the process enclosure. The process enclosure will be parked over an MCO pit when it is not in use.

All of the HCSE components that will be located outside of the HCSA are classified as auxiliary facilities. These include the ventilation stack, the refrigerant condenser for the chilled water system, the gas bottles, and the tube trailers.

INTERFACE	HCSE	HCSA
General Arrangement - Oven	Ovens including self-contained insulation & shielding, will be installed in process pit by HCSE.	No HCSA design team involvement.
General Arrangement - Process Module	Process Modules will be installed. Size to fit within 6-ft wide by 9-ft long by 8-ft 6-in high space.	No HCSA design team involvement.
General Arrangement - Process Module Mounting Plates	HCSE to provide installation details to weld process modules to mounting plates.	Mounting plates are to be cast in HCSA floor to support Process Modules. Plates to be located as shown on HCSE layout Dwg No. SK-2-300430 Sheet 1.
General Arrangement - Trench	HCSE to provide all supports, conduits, piping, insulation, instrumentation and equipment that will be located in trenches.	Trenches to be formed in HCSA floor and located as shown on HCSE layout Dwg No. SK-2-300430, Sheets 1 and 2. Dimensions will be standard for 7 Trenches.
General Arrangement - Trench Cover	Trench cover to be 6-in thick with metal edges and sealing surfaces.	No HCSA design team involvement.
General Arrangement - Process Pit	HCSE to provide design details for installing ovens and associated piping and instrumentation in the process pits.	Seven identical process pits to be formed in HCSA floor and located per HCSE layout Dwg No. SK-2-300340, Sheets 1and 2.
General Arrangement - Process Pit Cover	Process pit cover to be 6-in thick with metal edges and sealing surfaces.	No HCSA design team involvement.
General Arrangement - Process Pit Impact Limiters	HCSE to design impact limiters that are essentially identical to overpack storage hole impact limiters, H-2-120142.	No HCSA design team involvement.
General Arrangement - Service Module	Service Module will be installed by HCSE.	No HCSA design team involvement.
General Arrangement - Process Enclosure	Process Enclosure will be installed by HCSE.	No HCSA design team involvement.
General Arrangement - Floor	HCSE design team to develop equipment and module loads and to determine locations for Process Pits, Trenches and Mounting Plates	HCSA to develop drawings, specifications and design analysis for HCSA floor.
Process Piping	Process piping and piping supports in process pit, trench and on process skids to be provided by HCSE.	No HCSA design team involvement.
Process HVAC	HCSE to provide all ventilation systems required to support HCSE including stack, ductwork and monitoring equipment and solid waste handling area ventilation.	HCSE system will draw approximately 1500 cfm from HVSA. Heat load will be from air convection cooling of electric motors (TBD) Btu/hr.
Building HVAC	No HCSE design team involvement.	HCSA to develop drawings, specifications and design analysis for annex HVAC system.

INTERFACE	HCSE	HCSA
Electrical Power - Normal	HCSE to provide all electrical gear required to interface the 480 vac supply with the connected loads.	480 vac, 3-phase provided to 8 boxes located on south HCSA wall (7 process modules, 1 service module) in close proximity to modules as shown on HCSE layout Dwg No. SK-2-300421, Sheet 1. 40 kW connected load per box. Total demand load is 175 kW.
Electrical Power - Uninterruptible	HCSE to provide dedicated uninterruptible power to all equipment that requires it.	No HCSA design team involvement.
Electrical Power - Standby	Not required	Not required
Grounding Systems	HCSE design team to connect to grounding systems from process equipment and instrumentation.	Two grounding systems, one for power and one for sensitive instruments. Access points to be provided in proximity to modules. On south end of HCSA.
Lighting	No HCSE design team involvement.	HCSA to provide general building lighting and outdoor lighting.
Process Gases	HCSE to provide any required specialty gases and the pads, tanks, piping, instrumentation, wall penetrations, etc. required to store and distribute them.	No HCSA design team involvement
Instrument Air	HCSE to provide any instrument air required for the HCSE process including distribution piping.	No HCSA design team involvement
Instrumentation & Control - Process Modules and Service Module	HCSE to provide hardware and software required at both ends of the Ethernet cables.	HCSA design team to provide one conduit per module from HCSA control room to proximity of modules as shown on HCSE layout Dwg No. SK-2-300321, Sheet 1. Conduit to contain two Ethernet cables per IEEE 802.3, cable type (TBD).
Process Cooling System	HCSE to provide process cooling system including outside air exchanger, wall penetrations, transfer fluid piping, pumps, instrumentation and other heat exchange equipment.	No HCSA design team involvement
Safety Signals such as Stack Monitor and Radiation Monitoring	HCSE provides monitors and signal generators and conductors, cables and conduits to transmit signals to common point in proximity of south side of Service Module. HCSE to provide hardware and software in control room to process signals.	HCSA to provide cable with 50 conductors to hard wire safety signals to CSB control room from south wall in proximity of service module.
MHM Interface	HCSE to provide process pit cover with MCO access cover that emulates storage hole cover.	No HCSA design team involvement.

INTERFACE	HCSE	HCSA
Water	Not required, water not allowed in storage vaults and combustibles not present in HCSE. If water is used in closed loop cooling systems it will be trucked in. Spills will be contained by HCSE and mopped up.	No HCSA design team involvement.
Occupancy	No HCSE design team involvement.	CSB change room and lavatory facilities to accommodate 4 additional people per shift, 21 shifts per week to supplement CSB staff who will also operate and maintain the HCSE.
Equipment Installation	HCSE responsible for installing all hot conditioning systems and equipment.	Building access to accommodate the largest HCSE unit which will be the Process Enclosure , SK-2-300420.
Sewer	No HCSE design team involvement.	HCSA to provide if necessary
Access Roads	No HCSE design team involvement.	HCSA to provide roads and truck apron on west side of annex.
HCSE Ventilation Stack	HCSE to provide ductwork, wall penetrations, stack monitors, support structure and ventilation stack for HCSE exhaust gases.	No HCSA design team involvement
Staging Areas	HCSE to provide any staging areas required for solid waste, service equipment, samples and other miscellaneous items.	No HCSA design team involvement
Auxiliary Crane	Not required for HCSE process or equipment, fork lifts can handle all transfer duties.	Not required.
MHM Rails	No HCSE design team involvement.	HCSA design team to extend MHM rails from CSB to annex.
Doors	HCSE to design equipment and modules to fit through doors for initial installation.	HCSA design team to provide all access doors to HCSA. Door on west wall of annex must be large enough to allow the Process Enclosure (SK-2-300420) to pass through.
Communications, Fire Alarms, Security Alarms	No HCSE design team involvement.	HCSA design team to provide all communication systems, fire alarm connections and interties to the site security system.

3.0 FACILITIES/UTILITIES SUPPORT

3.2 HCSE/HCSA INTERFACES

The HCSE project is being developed as a project separate from the HCSA of the CSB that will house it. This is because the HCSA interacts structurally with the CSB and services must be extended from the CSB, while the HCSE is a process equipment development activity that is not dependent on the detailed characteristics of the HCSA building. The HCSE will be stand-alone process systems designed to operate as independently from the HCSA as possible. The HCSA will be a building with properties that are similar to the CSB. It will be open to the CSB storage area to allow the MCO Handling Machine (MHM) to move MCOs between the storage vaults and the HCSE. Therefore, the criteria for the CSB regarding design features such as structure, ventilation, radiation monitoring, and so forth that define the nuclear facility characteristics of the building apply to the HCSA. The existing CSB design and partially complete construction assume criteria that do not require the building envelope to act as a nuclear material release confinement structure. In principle, the HCSE will be a miniature nuclear system with confinement and safety class SSCs housed within the HCSA shell. Generally the HCSA will be a minimal building shell and the HCSE will provide its own amenities after the HCSA is completed. This approach allows the HCSA to catch up with the CSB so that it can be built as part of completing the CSB construction while the HCSE progresses through its design and safety analysis activities without impacting the construction of the CSB. The HCSA must provide a number of services that are to be connected to the HCSE. In addition, the HCSE will generate loads such as heat and weight on the HCSA. The HCSE also requires service by the MHM in order to make MCO input/output transactions. This discussion describes the basic interfaces.

The HCSE/HCSA interfaces and responsibilities are given in Table 3.2-1.

3.2.1 General Arrangement

The general arrangement of the HCSE is given by Drawing SK-2-300421 (Building Layout). The HCSA project will be responsible for providing the process pits (without covers), trenches (without covers), floor, mounting pads, and other features needed to obtain this arrangement.

3.2.2 Process Station Arrangement

A process station consists of the process pit, oven, and process trench. The process station plan and elevation views are given in Drawing SK-2-300422. The HCSA project will be responsible for providing the vaults (without covers), trenches (without covers), mounting pads, and other structural features required to attain this arrangement. The HCSA project will perform the structural design, such as concrete specification, while preserving the critical dimensions called out on the Drawings.

3.2.3 Oven Interface

The oven will be a jacketed vessel with a smooth stainless steel skin. The process pit in which it will reside shall have cast concrete walls and bottom. The interior dimensions shall be as given on Drawing SK-2-300422. The concrete surfaces shall be sealed with an epoxy paint. The oven outer skin temperature will not exceed 50°C. The empty oven weight will not exceed 5,000 lbs. The weight of the loaded oven will not exceed 25,000 lbs. The estimated weight of the vault cover is 5,000 lbs. The foundation shall support these loads. The 20,000 lb MCO may be accidentally dropped onto the bottom of the oven from a height of 14 ft. The hole assembly will contain the same shock absorber utilized in the CSB overpack storage holes. The HCSE project shall provide these shock absorbers. The foundation design shall be able to absorb the drop load without sustaining structural failure.

The HCSE will provide and install the oven, process pit cover, process trench cover, other items contained within the process pit and process trench, the process enclosure, and the process module.

3.2.4 Process Piping Interface

The HCSA project shall provide a trench with interior dimensions as given on Drawing SK-2-300430. The trench floor and sides shall be cast concrete sealed with epoxy paint. The exterior temperature of the pipes in the trench will not exceed 50°C. Mounting hardware for the pipes and conduit will be attached using concrete anchors to be located at the time of installation by the HCSE project. The estimated weight of the piping is 75 lbs per foot. The trench design shall support a cover that will weigh approximately 500 lbs per foot.

The HCSE project shall supply all piping, conduit, supports, and trench covers.

3.2.5 HVAC Interface

The HCSA is not required to provide any nuclear material confinement capability. Nuclear material confinement will be provided within the HCSE.

The HCSE will contain its own exhaust fans, ducts, and nuclear grade filtration systems. Intake air will be drawn from the HCSA volume, through HEPA filters (provided by the HCSE) into potentially contaminated pit space, through the potentially contaminated vault and process trench, through an HCSE provided

HEPA filter, through an HCSE provided fan, and out a stack provided by the HCSE. This scheme assures a negative pressure in the potentially contaminated pit and process trench. Hardening of the HVAC system to protect it from adverse effects arising from Design Basis Accidents (DBAs) and its safety features will be the responsibility of the HCSE project.

The HCSE will design and construct its own exhaust stack for the potentially contaminated exhaust generated by the HCSE process. Penetration in the pre-existing HCSA structure for the stack, stack, pipe, stack foundation, stack support, stack feed ducting, and so forth will be part of the HCSE scope. The air volume drawn from the HCSA will range from 1000 to 1500 CFM.

The estimated heat load of the HCSE equipment that will be discharged to the HCSA will be (TBD) BTU. This heat will be from the process modules where motors and heat exchangers will be located.

The HCSE will provide safety interlock signals, such as HVAC flow loss, to be used in the CSB control room when monitoring the facility.

3.2.6 Electrical Interface

3.2.6.1 Normal Power

The HCA shall provide 480 VAC three phase power for use by the HCSE. The power shall be provided to eight (8) disconnect switches (one for each process module, including the spare and one for service module). The HCSA provided power will terminate in these eight boxes to be located on the HCSA wall near each of the process modules. The HCSE will be responsible for transformation and distribution of power within the HCSE systems.

The power requirements are:

A. Process Module Supply: Average Demand = (TBD) Amps, Peak Demand = (TBD) Amps

B. Central Service Supply: Average Demand = (TBD) Amps, Peak Demand = (TBD) Amps

3.2.6.2 Grounding

Two grounding systems shall be provided. An isolated ground that is not connected to power circuits shall be provided for use by sensitive instruments. The HCSA shall provide ground and isolated ground connections near each process module.

3.2.7 Process Gas Interface

The HCSE will require a source of Helium and Inert Gas/Oxygen Blend. These are to be provided from tube trailers parked immediately outside the HCSA. The HCSA project shall provide aprons for truck access. The HCSE will be responsible for penetrating the HCSA wall and for distribution of the gases within the facility.

3.2.8 I&C Interface

Each skid will contain its own PLC and data collection capability. The HCSA will provide cabling only to support Ethernet connection of the HCSE processors (located on the process modules) and the process monitoring station to be located in the CSB control room. All computing equipment, control logic, sensors, etc. are the responsibility of the HCSE.

Safety signals, such as stack monitor signals, fire detectors, and radiation monitors, will be hard wired to the CSB control room. The HCSA shall provide 50 conductors for these signals that will be collected on the central services skid. The patterns, "rules of thumb", and instrument models selected in the CSB design shall be followed by the HCSE project. CSB data collection and facility monitoring equipment will accept the safety system detector signals.

The HCSE will provide all radiation monitoring. The HCSE will provide the stack monitoring system.

The HCSA will provide security systems components such as TV cameras. The HCSA shall provide cabling between a collection box located in the HCSA and the CSB control room. The HCSA shall coordinate provision of TV monitors and security alarm monitoring equipment in the CSB control room.

3.2.9 MHM Interface

The HCSE will design the process pit cover so that it simulates the top of a storage hole in the CSB. The MHM will not have to take any special actions when loading or unloading the HCSE ovens.

The MHM collision avoidance system must allow the MHM to load or unload an oven when the process enclosure is located over another oven. The box beam of the MHM will be located at 9-ft above the floor to allow this.

3.0 FACILITIES/UTILITIES SUPPORT

3.2.10 Water

No process water connection will be required by the HCSE. The chilled water system will be filled from a portable water tank.

No fire water will be required in the HCSE.

3.2.11 Occupancy

Occupancy will be 4 additional people per shift to the CSB operating staff working three shifts per day and 7 days per week. CSB facilities such as change rooms and bathrooms must be able to accommodate this staff in addition to CSB operations staff.

3.2.12 Equipment Installation Interface

The HCSA shall provide an equipment access door with an opening large enough for the process enclosure to pass through. The maximum estimated module weight is (TBD)) lbs. Equipment movement and placement will be accomplished using forklifts. No overhead crane will be required in the HCSA. The process skids will be mounted to imbedded steel floor plates. Attachment will be made by welding the equipment skid steel to the floor plates. The floor plates are located on Drawing SK-2-300430. The HCSE will be responsible for installing the equipment.

3.2.13 HCA Structural Requirements

The HCSA will be a structure designed to meet the same load, earthquake, wind, missile, criteria as the CSB to which it is attached. The HCSE shall provide local secondary confinement that shall meet the necessary safety class/safety significant criteria.

3.3 AUXILIARY FACILITIES

Auxiliary facilities are defined as those that are located outside of the HCSA building. These include the tube trailers and gas bottles for the process gas system, the stack for the combined ventilation system and the refrigerant to air portion of the chilled water system.

3.3.1 Process Gas System

3.3.1.1 Function and Requirements

The process gas system includes items necessary for the storage, pressure reduction and manifolding of all process gasses for the HCSE. The system should function on demand from each of the individual process modules.

3.3.1.2 Process Gas System Description

The equipment and instrumentation used in the process gas system is identified on the P&IDs, SK-2-300413. The following major equipment components comprise the process gas system:

The process gas system is installed on a pad located outside of the HCSA. The system consists of the following gases:

A. Helium

B. Nitrogen

C. Oxygen/inert gas blend

Nitrogen and helium are supplied by tube trailers while oxygen is supplied at premixed concentrations in cylinders. Oxygen and an inert gas wili be preblended to an oxygen concentration of 2 percent for fuel oxidation. Pressure from each station is reduced to 5 psi above the internal pressure of the MCO prior to introduction to the process area.

3.3.2 Stack

3.3.2.1 Functions and Requirements

The function of the ventilation stack is to exhaust the HEPA filtered effluent from the combined ventilation system to the atmosphere. The stack is to be provided with an isokinitic sampling system as described in Section 2.3 and shall be 1-½ times the HCSA height. Effluent from the stack is to have a minimum exit velocity of 3000 ft/min.

3.3.2.2 Stack Description

The stack is anticipated to be 90-ft high with an internal diameter of 8-inches. It will be construction of steel and will be located on concrete pad. Guy wires will be attached as appropriate to stabilize it such that it will withstand the postulated DBAs.

3.3.3 Water Chiller

3.3.3.1 Functions and Requirements

The function of the water chiller system is to provide cooling to the process equipment. The requirements for the system are shown in Section 2.7 since parts of the system are located in the service module. The system is also discussed as part of the auxiliary facilities because the refrigerant condenser will be located on a pad outside of the HCSA to allow air cooling.

3.3.3.2 Water Chiller Description

The refrigerant condenser will be a 25-ton unit designed for exterior air cooling. A concrete pad will be provided for mounting of the condenser. Electrical power for the condenser will be supplied from the HCSE and refrigerant piping will connect the condenser with the service module.

4.0 INTERFACES

4.1 HCSE INTERFACES

The HCSE will interact primarily with three subprojects. These are the HCSA, the MHM, and the MCO. The HCSA interfaces are required to define the facility and services that must be provided to house the HCSE. They are described in the Section 3.2 of the facility chapter. The MHM interface is required because the MHM will perform the MCO input / output transactions with the HCSE. The MCO interfaces are defined by the physical mating of the MCO and the oven assembly, by the need to have a scheme for connecting the HCSE to the MCO, by the need to make the final closure of the MCO in the HCSE ovens, and by the operating temperature and pressure design limitations of the MCO. The interfaces are given Table 4.0-1 below.

Interface Number	Name	Description	Requirement
MCO1	MCO Body Size	The MCO diameter and height are important for determining the oven dimensions.	Dimensions must be constant after oven detailed design is complete or after HCSA design is complete.
MCO2	MCO Neck Shape	The MCO neck shape is not finalized. If the flared design is selected the MCO will hang from a beveled flange and no annulus cover will be required. If the MCO neck is straight, the MCO will rest on its base and an annulus cover will be required.	If flare design is selected - flare dimensions and oven flange dimensions must agree. If the straight body design is selected the top surface must allow the annulus cover to sit without interference.
MCO3	MCO Weight	The MCO weight must be constant after oven detail design is complete. The oven structure and shock absorber are dependent upon the weight.	None
MCO4	Draw Tube and Head Space Port Cover	The ports are covered by a bolted identical bolted plates which must be removed for access to MCO connectors.	Bolts must be hexhead type. Bolts must be captured and spring loaded so that they cannot fall out and so that they pop-up when disengaged.

4.0 INTERFACES

Interface Number	Name	Description	Requirement
MCO5	Draw Tube and Head Space Connections	The connectors allow the HCSE process lines to be connected to the MCO.	Connectors must be remotely (manipulator and tools) operable. Connectors should have a flow cross sectional area as close to 0.8 sq. in. as possible. Connector seals must be capable of operating at 350°C. Connector must be helium leak tight. Connector must be tolerant to dirt (SNF corrosion dust). The connector must be helium leak tight measured with a helium sniffer (max leak rate 10E-06 std. cc/sec at 100PSI).
MCO6	Final Closure Design	The final closure of the MCO will be a cover welded in the HCSE.	Weld must be circumferential so that it can be accomplished with the same welding head/ fixture as used in the CVDS. Weld procedure using ultra-sonic inspection is preferable to LPT because remote execution is easier. The cover must include features to allow the MHM to lift the MCO out of the oven.
MCO7	Temperature Restraints	The MCO has design ratings for maximum operating temperature, rate of temperature rise, and point to point temperature difference.	The limits are 325°C, 50°C between any two points, and 50°C per hour.

4.0 INTERFACES

Interface Number	Name	Description	Requirement
MCO7	Operating Pressure	The MCO pressure is limited by its design pressure and its rupture disk.	The HCSE desires to have the ability to operate at 25 psia at 300°C so that it has the flexibility to improve the heat transfer rate if it proves to be necessary to meet processing time budgets.
MCO8	Head Space Vent Filter	Dust entrained in the helium flow must be filtered inside the MCO.	Micron type filter. Capable of operating at 300°C.
MHM1	MCO Alignment	The angular position of the port pattern on the top of the MCO cannot vary form MCO to MCO because the HCSE process connections have a limited range of motion.	No more than +/- 15 degrees.
MHM2	Plug Docking	The MHM will locate above the process pit center plug. Its grapple will lock onto the plug and pull it. After the sequence is completed it will replace the plug.	Plug top must be a replica of the CSB storage vault covers that the MHM is capable of handling.
MHM3	MHM - Process Enclosure Collision Avoidance	The MHM may require access to one oven while the process enclosure is over the other. The MHM bridge and enclosure cannot collide.	Can be administratively controlled.
MHM4	MHM Lockout	The MHM should not be able to access a hot oven by error.	HCSE to provide an actuator that indicates visually to MHM operator that the oven is active. HCSE to provide actuator that prevents MHM grapple from attaching to plug.

5.0 COST AND SCHEDULE

5.1 METHOD OF ACCOMPLISHMENT

The HCSE project will be a joint effort between the DOE as the owner, WHC as the operator, Merrick as the architect-engineer, and a yet to be determined prime construction contractor. The responsibilities of each organization are as follows.

Department of Energy

DOE will furnish overall project coordination, review all conceptual design and definitive design documents and based on their review authorize the definitive design, construction and operation of the HCSE. DOE administers the WHC prime contract to operate the Hanford facilities.

Westinghouse Hanford Company

WHC will provide design criteria and engineering management services during the conceptual design, definitive design and construction project phases. WHC will review all design documents and based on this review recommend to DOE that the definitive design, construction and operation of the HCSE be authorized. WHC will award and administer the architect-engineer and prime construction contracts. If it is determined that government furnished equipment is required, WHC will be responsible for procuring this equipment and providing it to the prime construction contractor. Following construction of the HCSE, WHC will be responsible for HCSE operations.

Merrick & Company

Merrick is under contract to WHC to perform all conceptual engineering services. Engineering required to develop the definitive design packages and construction support engineering are options under this contract. Merrick will be responsible for identifying and recommending to WHC items that should be classified as government furnished equipment. Merrick administers the subcontracts of the speciality design firms that support the architect-engineering work.

Prime Construction Contractor

A prime construction contractor will be selected and placed under contract to WHC to construct the HCSE. This contractor will be responsible for procuring materials and supplies and constructing the HCSE in accordance with the definitive design packages. The contractor will also be responsible for installing any government furnished equipment and administering the subcontracts of the speciality firms that will support the construction activities.

5.0 COST AND SCHEDULE

5.2 SCHEDULE

The key milestones in the HCSE design and construction schedule are as follows.

Conceptual Design Complete	July 31, 1993
Authorization to Proceed with Definitive Design	August 1, 1996
Definitive Design Complete	March 25, 1997
Authorization to Proceed with Construction	October 2, 1997
Construction Complete	June 30, 1998
Beneficial Occupancy	September 30, 1998

5.3 SUMMARY COST ESTIMATE

The project cost estimate has been developed by the individual designers and utilizes a factored approach where the installed cost is based upon the cost of the equipment. The costs for the process modules and the central service module have been developed with the following criteria:

A. The cost estimate is developed for the pressure system, operating at an internal helium pressure of 25 psia. This was done because this option is the more expensive of the two cases. For an atmospheric system, deduct $60,000 from the overall cost.

B. All installed costs are factored to equipment cost. All equipment cost is obtained from a vendor unless otherwise noted on the equipment list.

C. Cost factors are taken from the method of Miller (Perry, Table 25-51) for battery-limit installations. As skids will be factory assembled, the lower range of factors is normally used. In the event of significant complexity, the factor is adjusted to the higher end of the range. When extraordinary costs are involved for support equipment, as in the case of specific instrumentation, these items will be costed separately.

D. The structural estimate is applied once for each skid assembly.

E. Installed cost assumes FOB Richland, WA. A local skid fabricator is assumed.

5.0 COST AND SCHEDULE

Contingency, Engineering, Project Management, Insurance, etc. are factored to Construction Cost Estimate.

The auxiliary area estimate was developed from Means *Construction Cost Estimator*. The cost estimate for the Process Enclosure was developed from the experience of Paul Smith on like projects. Engineering cost and contingency are factored to the constructed cost of the equipment.

Backup information used to develop the estimate is found in the Appendix F.

The summary of the construction cost estimate is shown in Table 5.3 below:

Table 5.3
Project Cost Estimate
(all costs in thousand $)

	Item Cost	No. Items	Total Cost
Construction Costs			
Process Module	300	6	2,318
Service Module	150	1	328
Process Enclosure	550	1	620
Auxiliary Facilities	130	1	622
Process Pit Compnts	210	6	1,635
Subtotal Const. Cost			5,523
Project Management (8%)			442
Eng. Design & Insp. (22%)			1,215
Bond & Insurance (2%)			110
Contingency (30%)			1,657
TOTAL PROJECT COST			**8,947**

APPENDICES

APPENDIX A

DRAWINGS

HOT CONDITIONING SYSTEM EQUIPMENT

DRAWING NUMBER	SHEET NUMBER	DESCRIPTION
SK-2-300410	1	DRAWING INDEX
SK-2-300411	1	BLOCK FLOW DIAGRAM
SK-2-300412	1	PROCESS FLOW DIAGRAM
SK-2-300412	2	MASS BALANCE TABLE
SK-2-300413	1	HCSE P&ID LEGEND
SK-2-300413	2	HCSE PROCESS MODULE P&ID
SK-2-300413	3	HCSE PROCESS MODULE P&ID
SK-2-300413	4	HCSE PROCESS MODULE P&ID
SK-2-300413	5	HCSE PROCESS MODULE P&ID
SK-2-300414	1	CONTROL SYSTEM DIAGRAM
SK-2-300417	1	OVEN ASSEMBLY OPT 1
SK-2-300418	1	OVEN ASSEMBLY OPT 2
SK-2-300420	1	PROCESS ENCLOSURE
SK-2-300421	1	BUILDING LAYOUT
SK-2-300421	2	AUX PROCESS LAYOUT
SK-2-300421	3	CENTRAL PROCESS LAYOUT
SK-2-300422	1	OVEN INSTALLATION
SK-2-300423	1	PROCESS MODULE
SK-2-300425	1	ELECTRICAL ONE-LINES (BAYS 1-4)
SK-2-300425	2	ELECTRICAL ONE-LINES (BAYS 5-8)
SK-2-300426	1	COMBINED VENTILATION SYSTEM
SK-2-300430	1	PROCESS PIT & TRENCH LAYOUT
SK-2-300430	2	PROCESS PIT & TRENCH PLAN AND SECTIONS

C. GUSTAFSON 7/27/96

U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company

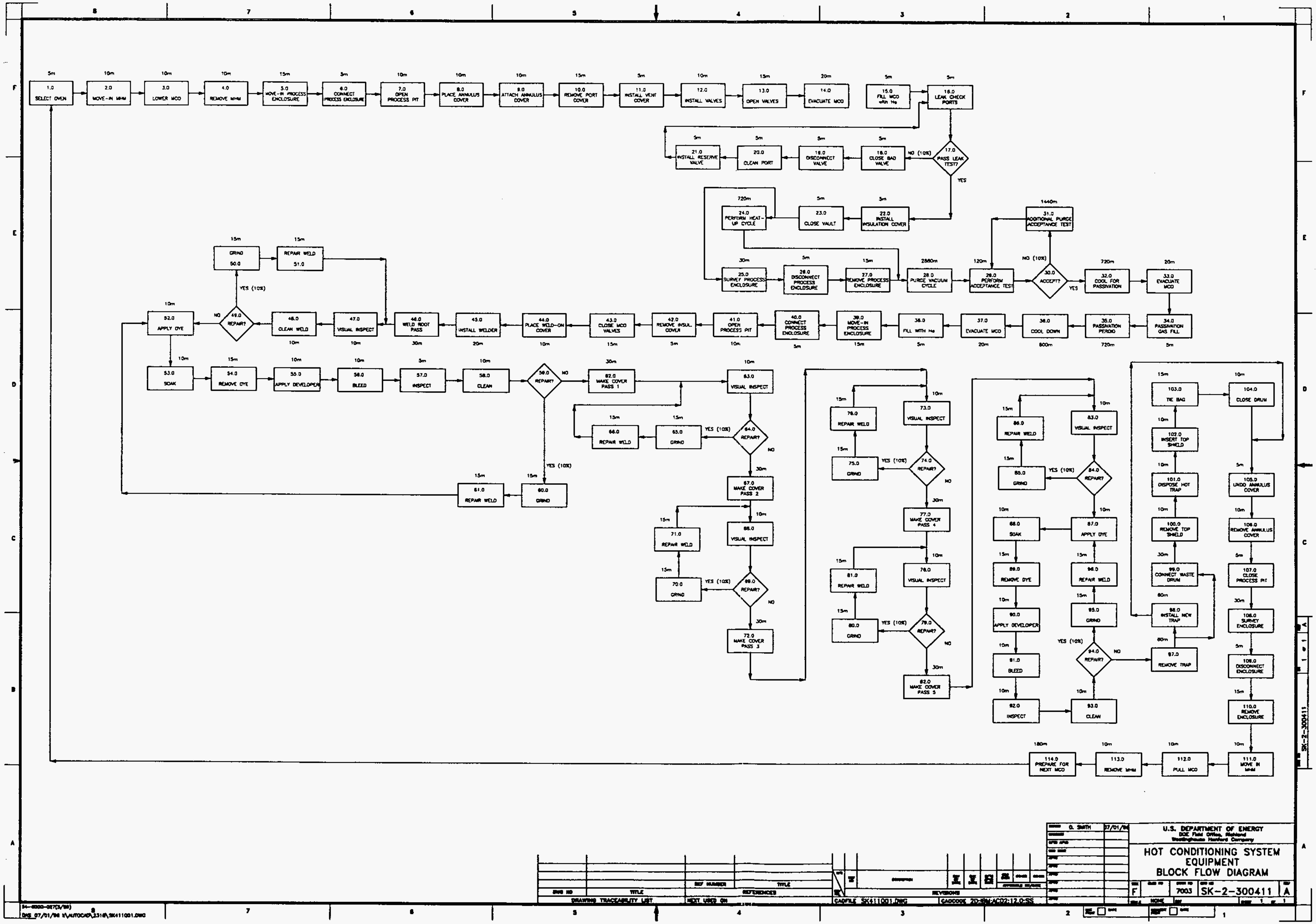
HOT CONDITIONING SYSTEM EQUIPMENT DRAWING INDEX

F | 7003 | SK-2-300410 | B

SCALE: NONE | SHEET 1 OF 1

DRAWING TRACEABILITY LIST | NEXT USED ON | REVISIONS

CADFILE SK410T01.DWG | CADCODE 2D:IBM:ACD2:12.0:SS


1.0 SELECT OVEN
2.0 MOVE-IN MHM
3.0 LOWER MCO
4.0 REMOVE MHM
5.0 MOVE-IN PROCESS ENCLOSURE
6.0 CONNECT PROCESS ENCLOSURE
7.0 OPEN PROCESS PIT
8.0 PLACE ANNULUS COVER
9.0 ATTACH ANNULUS COVER
10.0 REMOVE PORT COVER
11.0 INSTALL VENT COVER
12.0 INSTALL VALVES
13.0 OPEN VALVES
14.0 EVACUATE MCO
15.0 FILL MCO with He
16.0 LEAK CHECK PORTS
17.0 PASS LEAK TEST?
18.0 CLOSE BAD VALVE
19.0 DISCONNECT VALVE
20.0 CLEAN PORT
21.0 INSTALL RESERVE VALVE
22.0 INSTALL INSULATION COVER
23.0 CLOSE VAULT
24.0 PERFORM HEAT-UP CYCLE
25.0 SURVEY PROCESS ENCLOSURE
26.0 DISCONNECT PROCESS ENCLOSURE
27.0 REMOVE PROCESS ENCLOSURE
28.0 PURGE VACUUM CYCLE
29.0 PERFORM ACCEPTANCE TEST
30.0 ACCEPT?
31.0 ADDITIONAL PURGE ACCEPTANCE TEST
32.0 COOL FOR PASSIVATION
33.0 EVACUATE MCO
34.0 PASSIVATION GAS FILL
35.0 PASSIVATION PERIOD
36.0 COOL DOWN
37.0 EVACUATE MCO
38.0 FILL WITH He
39.0 MOVE-IN PROCESS ENCLOSURE
40.0 CONNECT PROCESS ENCLOSURE
41.0 OPEN PROCESS PIT
42.0 REMOVE INSUL. COVER
43.0 CLOSE MCO VALVES
44.0 PLACE WELD-ON COVER
45.0 INSTALL WELDER
46.0 WELD ROOT PASS
47.0 VISUAL INSPECT
48.0 CLEAN WELD
49.0 REPAIR?
50.0 GRIND
51.0 REPAIR WELD
52.0 APPLY DYE
53.0 SOAK
54.0 REMOVE DYE
55.0 APPLY DEVELOPER
56.0 BLEED
57.0 INSPECT
58.0 CLEAN
59.0 REPAIR?
60.0 GRIND
61.0 REPAIR WELD
62.0 MAKE COVER PASS 1
63.0 VISUAL INSPECT
64.0 REPAIR?
65.0 GRIND
66.0 REPAIR WELD
67.0 MAKE COVER PASS 2
68.0 VISUAL INSPECT
69.0 REPAIR?
70.0 GRIND
71.0 REPAIR WELD
72.0 MAKE COVER PASS 3
73.0 VISUAL INSPECT
74.0 REPAIR?
75.0 GRIND
76.0 REPAIR WELD
77.0 MAKE COVER PASS 4
78.0 VISUAL INSPECT
79.0 REPAIR?
80.0 GRIND
81.0 REPAIR WELD
82.0 MAKE COVER PASS 5
83.0 VISUAL INSPECT
84.0 REPAIR?
85.0 GRIND
86.0 REPAIR WELD
87.0 APPLY DYE
88.0 SOAK
89.0 REMOVE DYE
90.0 APPLY DEVELOPER
91.0 BLEED
92.0 INSPECT
93.0 CLEAN
94.0 REPAIR?
95.0 GRIND
96.0 REPAIR WELD
97.0 REMOVE TRAP
98.0 INSTALL NEW TRAP
99.0 CONNECT WASTE DRUM
100.0 REMOVE TOP SHIELD
101.0 DISPOSE HOT TRAP
102.0 INSERT TOP SHIELD
103.0 TIE BAG
104.0 CLOSE DRUM
105.0 UNDO ANNULUS COVER
106.0 REMOVE ANNULUS COVER
107.0 CLOSE PROCESS PIT
108.0 SURVEY ENCLOSURE
109.0 DISCONNECT ENCLOSURE
110.0 REMOVE ENCLOSURE
111.0 MOVE IN MHM
112.0 PULL MCO
113.0 REMOVE MHM
114.0 PREPARE FOR NEXT MCO
YES
NO (10%)
YES (10%)
NO
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENT BLOCK FLOW DIAGRAM
D. SMITH 07/01/96
7003
SK-2-300411
A
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NEXT USED ON
REFERENCES
REVISIONS
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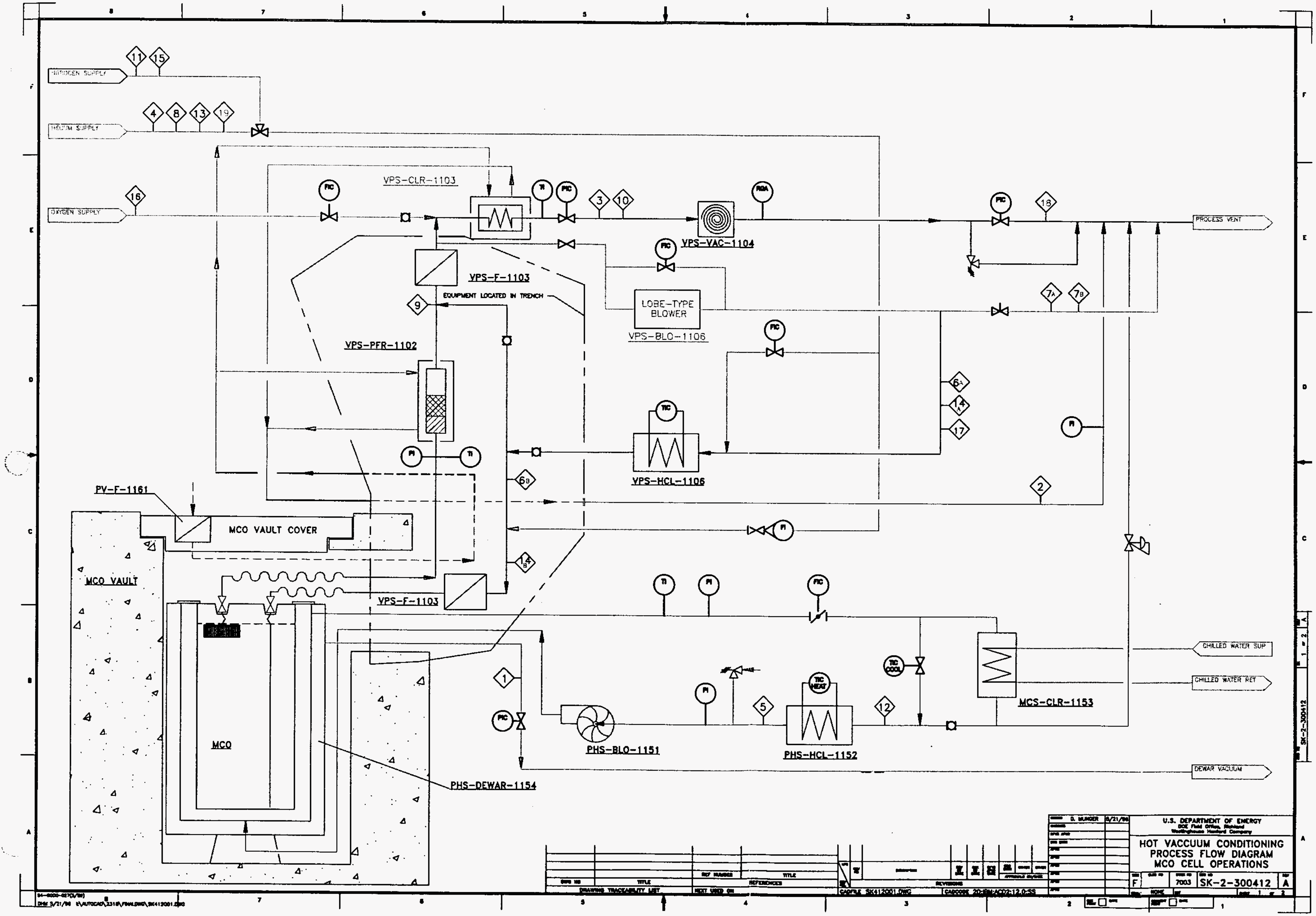
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HELIUM SUPPLY
OXYGEN SUPPLY
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VPS-VAC-1104
PROCESS VENT
VPS-F-1103
EQUIPMENT LOCATED IN TRENCH
LOBE-TYPE BLOWER
VPS-BLO-1106
VPS-PFR-1102
VPS-HCL-1106
PV-F-1161
MCO VAULT COVER
MCO VAULT
VPS-F-1103
MCO
PHS-DEWAR-1154
PHS-BLO-1151
PHS-HCL-1152
MCS-CLR-1153
CHILLED WATER SUP
CHILLED WATER RET
DEWAR VACUUM
U.S. DEPARTMENT OF ENERGY
HOT VACCUUM CONDITIONING
PROCESS FLOW DIAGRAM
MCO CELL OPERATIONS
SK-2-300412

Operating Cycle		Ongoing utility				Preparation for heating cycle				Heating of MCO (40C to 300+C)													
Stream Description	MWt	Dewar vacuum draw		MCO area hood vent		Initial vacuum evacuation		Helium filling of MCO		MCO heating air		Helium heating (Heater inlet)		Helium heating (Heater outlet)		Periodic helium purging to 200 C		Helium purging 200 C to 300 C		Helium for purge during heat-up		Purifier Outlet	
Stream No.		1		2		3		4		5		6A		6B		7A		7B		8		9	
Temp. C (F)		20-375	68-707	20	68	40	104	20	68	375 Note 5	707	102	216	325	617	200	392	300	572	20	68	100	212
Press Torr (psia)		1.00E-04	1.93E-06	760	14.7	10	0.193	931	18	760	14.7	688	13.3	672	13	688	13.3	688	13.3	931	18		
Flow rate std l/sec (scfm)		nil	nil	66	140	0.067	0.142	5.32	11.29	149	316	1.90	4.037	1.90	4.037	0.005	0.011	0.003	0.006	0.004	0.009	1.90	4.037
Vac rate l/min						350																	
H_2 kg/hr (lbs/hr)	2																						
O_2 kg/hr (lbs/hr)	32																						
N_2 kg/hr (lbs/hr)	28																						
He kg/hr (lbs/hr)	4							3.42	7.55			1.22	2.70	1.22	2.70	0.003	0.007	0.002	0.004	0.003	0.006		
I^{131} gram/hr (lbs/hr)	131																						
Kr^{85} gram/hr (lbs/hr)	86																						
Cs^{137} gram/hr (lbs/hr)	137																						
Max heat rate kcal/hr (Btu/hr)										17,640	70,000			142	562	0.002	0.007	0.001	0.004				
Process Duration (Note 4)		ongoing		130 hr		6.80	min.	12.95	min.	13.2 hr	(Note 3)	13.2	hr.	13.2	hr.	8	hr.	5.3	hr.	13.3	hr.		
Approx. Total Duration		ongoing		130 hr		15	min.	15	min.	14	hr.	14	hr.	14	hr.	8	hr.	6	hr.				
Water Removed kg																		1.814					
Hydrogen Removed kg																		0.165					

Operating Cycle		Vacuum condition				Cooling of MCO to 150 C								Oxygen passivation						Inert Gas Packing			
Stream Description	MWt	Vacuum draw		Inert gas purge during vacuum		Cooling air		Helium added for cool-down		Helium cooling		Helium cooling		Nitrogen added		Oxygen added		Circulating passivation gas		Oxygen Evacuation		Helium Fill	
Stream No.		10		11		12		13		14A		14B		15		16		17		18		19	
Temp. C (F)		300	572	20	68	80 Note 6	176	20	68	100	212	102	216	20	68	20	68	150	302	150	302	150	302
Press Torr (psia)		5	0.097	931	18	760	14.7	931	18	672	13	688	13.3	931	18	931	18	688	13.3	5	0.097	1137	22
Flow rate std l/sec (scfm)		0.032	0.067	0.030	0.064	256	542	5.324	11.288	3.053	6.473	3.053	6.473	3.482	7.382	0.071	0.151	2.576	5.462	0.067	0.142	4.667	9.894
Vac rate l/min		350																		350			
H_2 kg/hr (lbs/hr)	2	0.0005	0.001																				
O_2 kg/hr (lbs/hr)	32															0.365	0.806						
N_2 kg/hr (lbs/hr)	28	0.135	0.298	0.135	0.298									15.668	34.548								
He kg/hr (lbs/hr)	4							3.423	7.547	2.006	3.143	2.006	3.143									3.000	6.615
I^{131} gram/hr (lbs/hr)	131																						
Kr^{85} gram/hr (lbs/hr)	86																						
Cs^{137} gram/hr (lbs/hr)	137																						
Max heat rate kcal/hr (Btu/hr)						18,144	72,000																
Process Duration (Note 4)		7.9	min	48	hr.	14	hr.	0.957	min.	13	hr.	13	hr.	12	hr.	12	hr.	12	hr.	7.90	min.	1.958	min.
Approx. Total Duration		48	hr.	48	hr.	14.5	hr.	15	min.	13.5	hr.	13.5	hr.	12	hr.	12	hr.	12	hr.	15	min.	15	min.
Water Removed kg		0.056																					
Hydrogen Removed kg		0.003999375																					

Notes:

1. Although hydrogen may be present at concentrations greater than 5%v, it is inherently safe because its concentration when diluted would be less than 1%, significantly below its LEL.
2. Run 23 data assumed to be at MCO operating conditions.
3. Heating rate is determined with an internal heat transfer coefficient of 1 Btu / pound degree F sq. ft. hr and external heat transfer coefficient of 5 Btu / pound degree F sq. ft. hr.
4. Mass rate times process duration equals mass. Approximate total duration is for cycle time determination only.
5. This is the maximum of a programmed temperature schedule
6. This is the minimum of a programmed temperature schedule

U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company

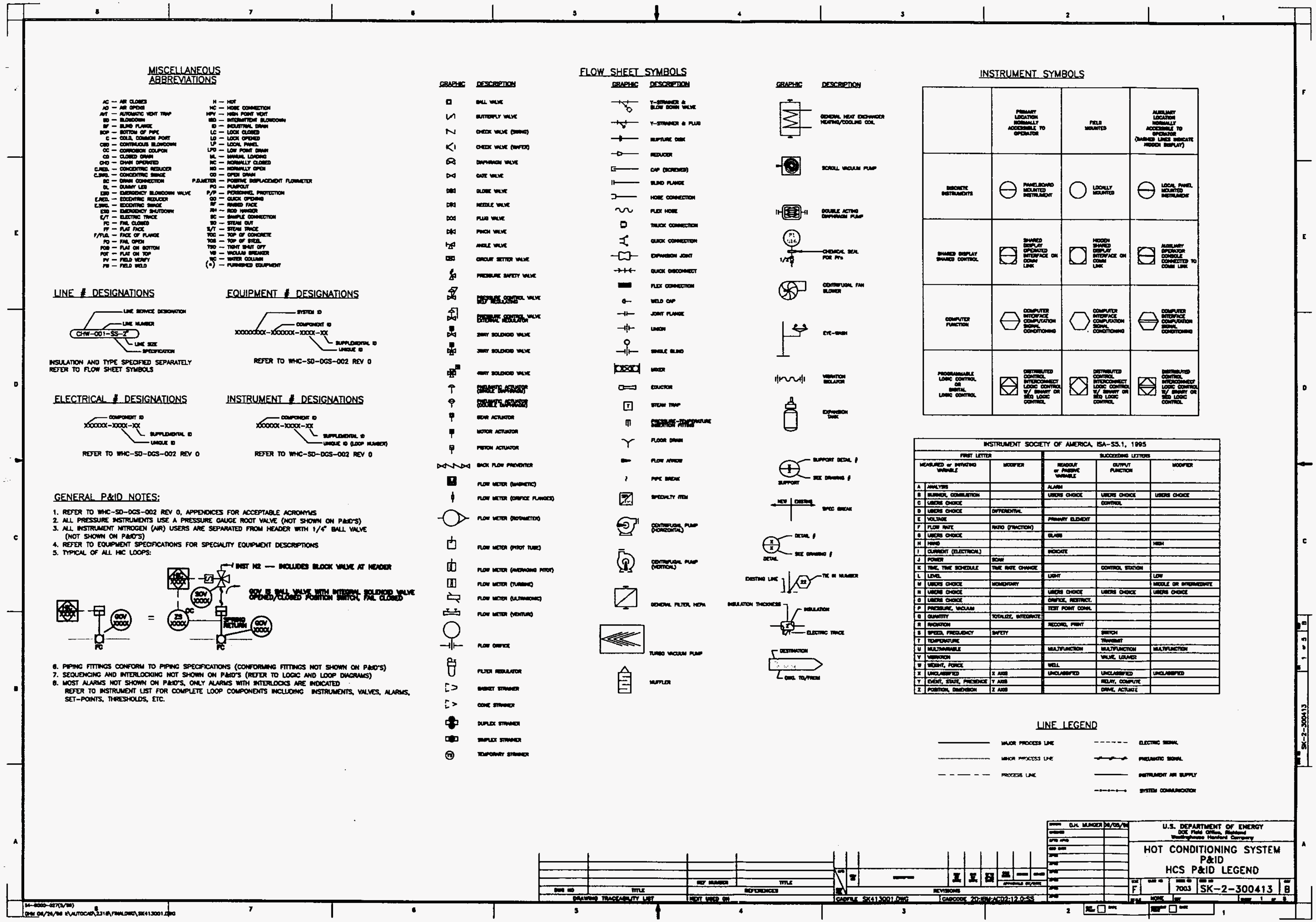
VACUUM CONDITIONING SYSTEM
EQUIPMENT
MASS BALANCE TABLE

F 7003 SK-2-300412 A

CADFILE SK412002.DWG CADCODE 20:IBM:AC02:12.0:SS

DRAWING TRACEABILITY LIST

SK-2-300412

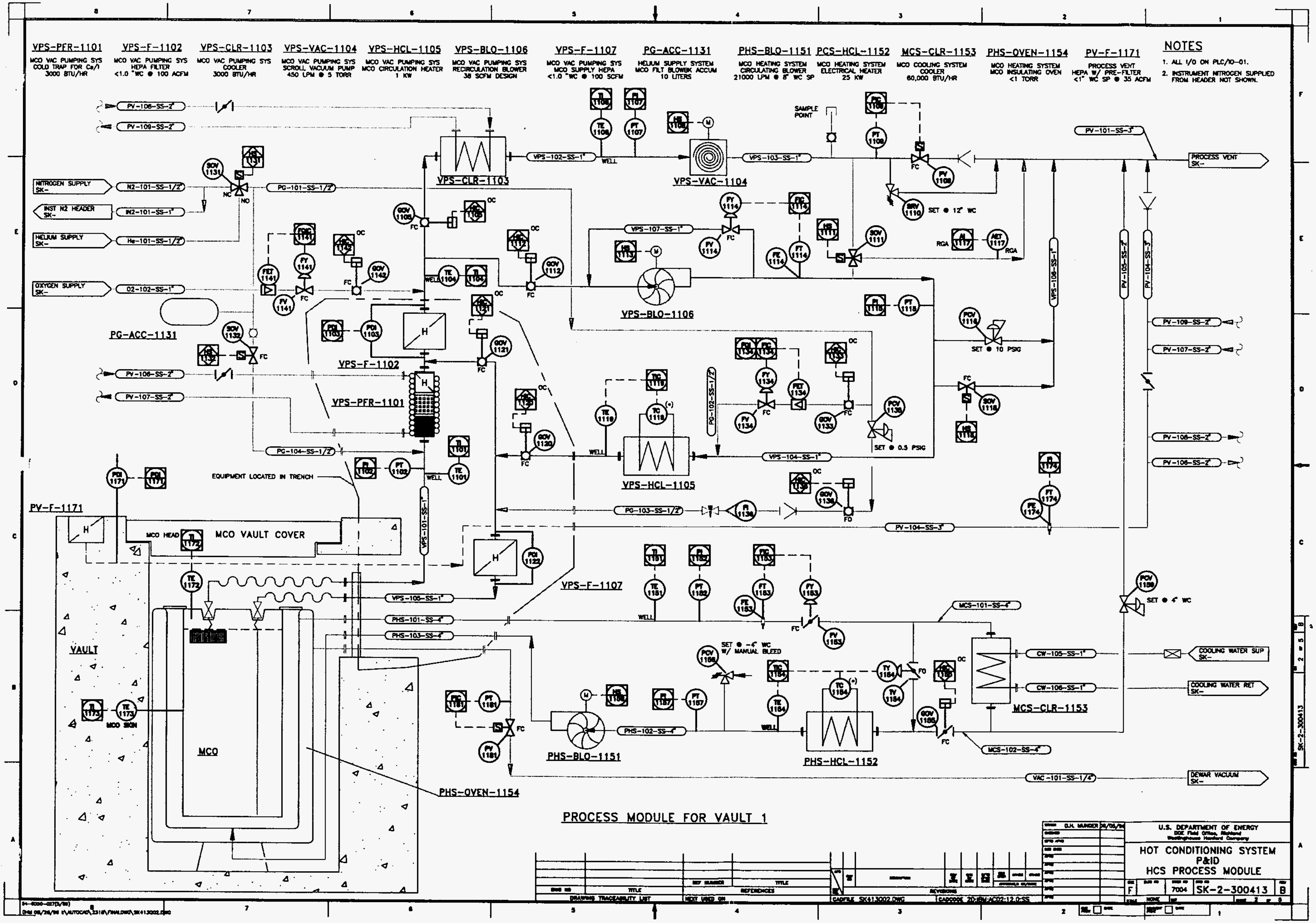


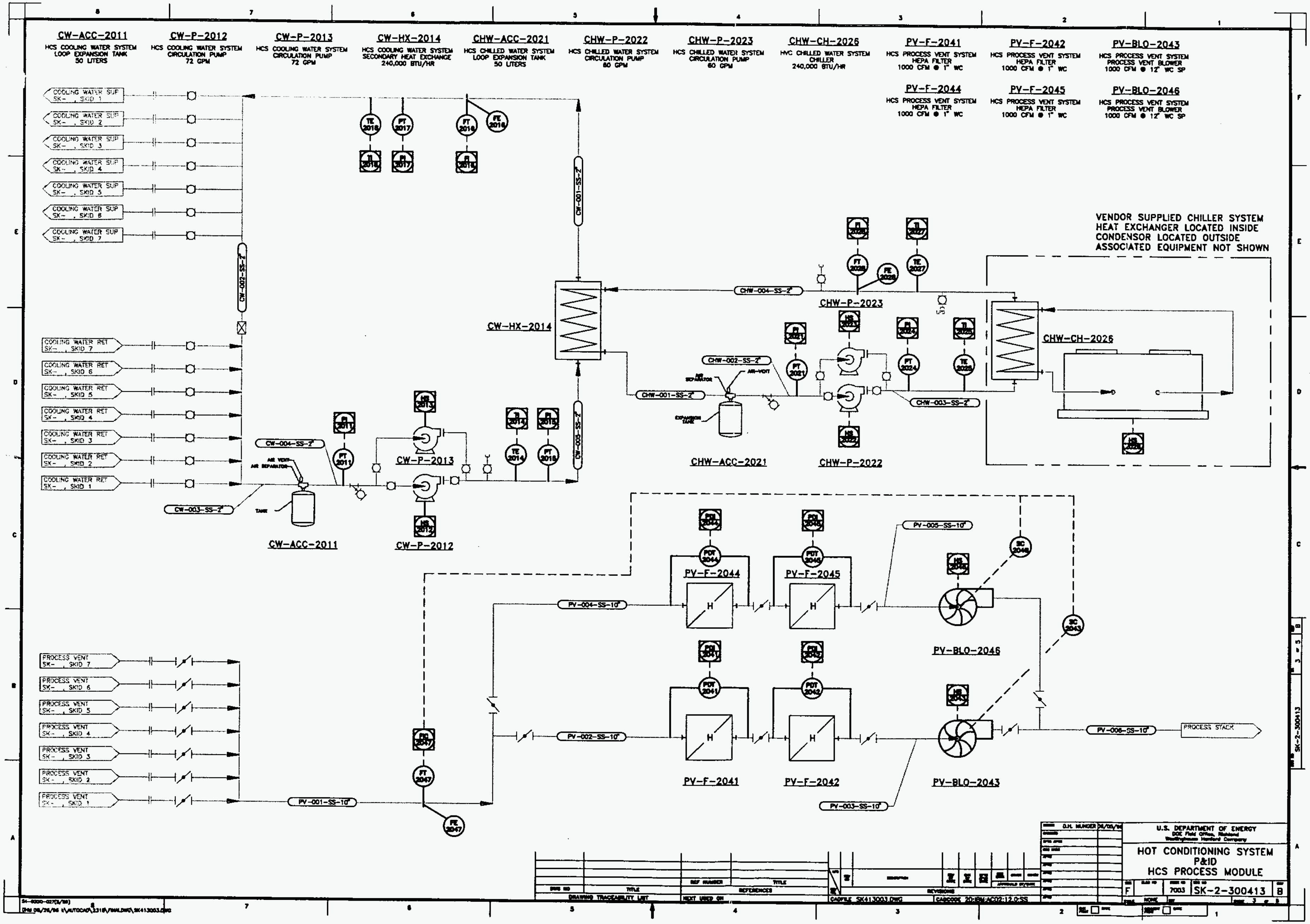
GENERAL P&ID NOTES:

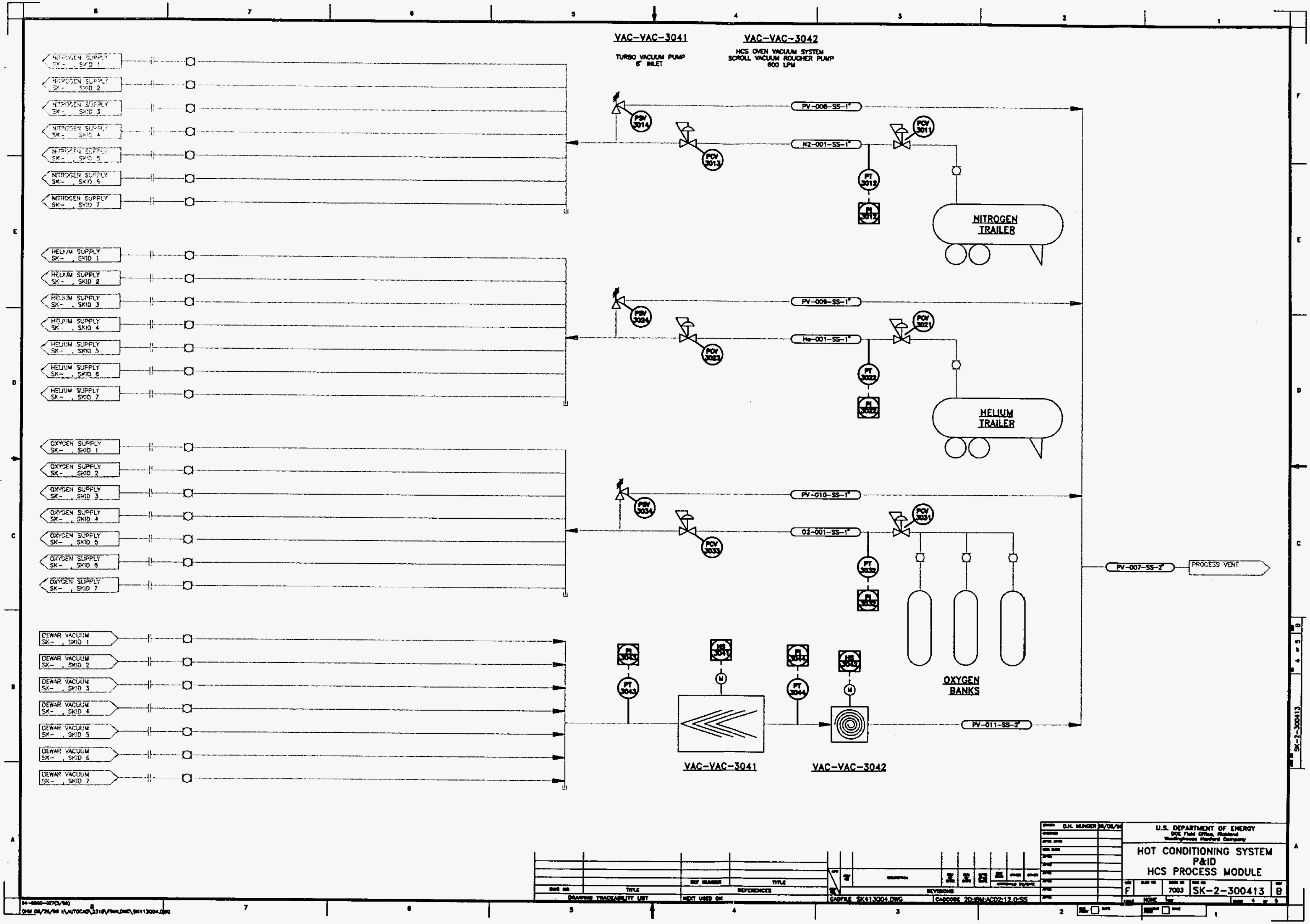
1. REFER TO WHC-SD-DGS-002 REV 0, APPENDICES FOR ACCEPTABLE ACRONYMS
2. ALL PRESSURE INSTRUMENTS USE A PRESSURE GAUGE ROOT VALVE (NOT SHOWN ON P&ID'S)
3. ALL INSTRUMENT NITROGEN (AIR) USERS ARE SEPARATED FROM HEADER WITH 1/4" BALL VALVE (NOT SHOWN ON P&ID'S)
4. REFER TO EQUIPMENT SPECIFICATIONS FOR SPECIALITY EQUIPMENT DESCRIPTIONS
5. TYPICAL OF ALL HIC LOOPS:
6. PIPING FITTINGS CONFORM TO PIPING SPECIFICATIONS (CONFORMING FITTINGS NOT SHOWN ON P&ID'S)
7. SEQUENCING AND INTERLOCKING NOT SHOWN ON P&ID'S (REFER TO LOGIC AND LOOP DIAGRAMS)
8. MOST ALARMS NOT SHOWN ON P&ID'S, ONLY ALARMS WITH INTERLOCKS ARE INDICATED
   REFER TO INSTRUMENT LIST FOR COMPLETE LOOP COMPONENTS INCLUDING INSTRUMENTS, VALVES, ALARMS, SET-POINTS, THRESHOLDS, ETC.

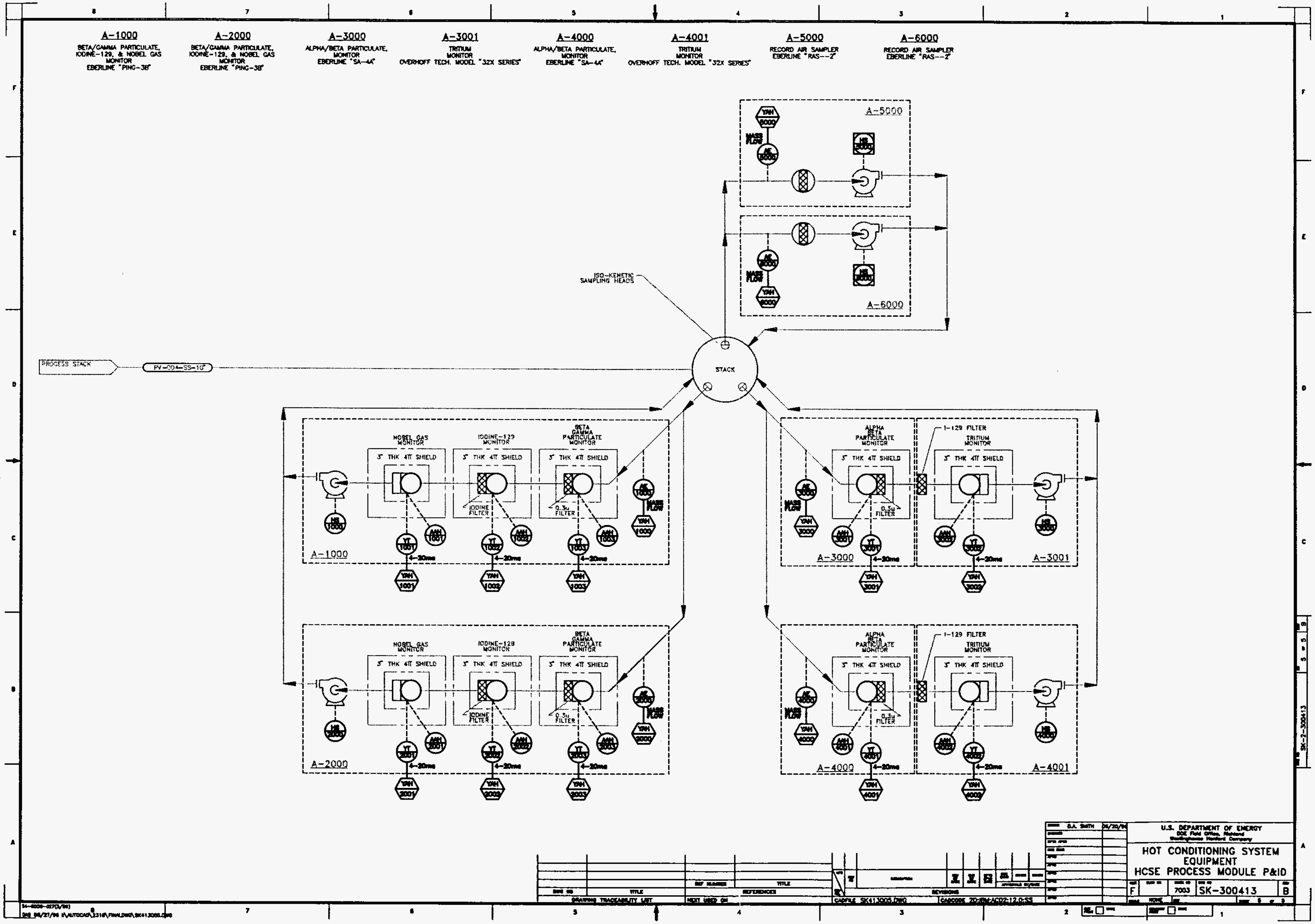
INSTRUMENT SOCIETY OF AMERICA, ISA-S5.1, 1995

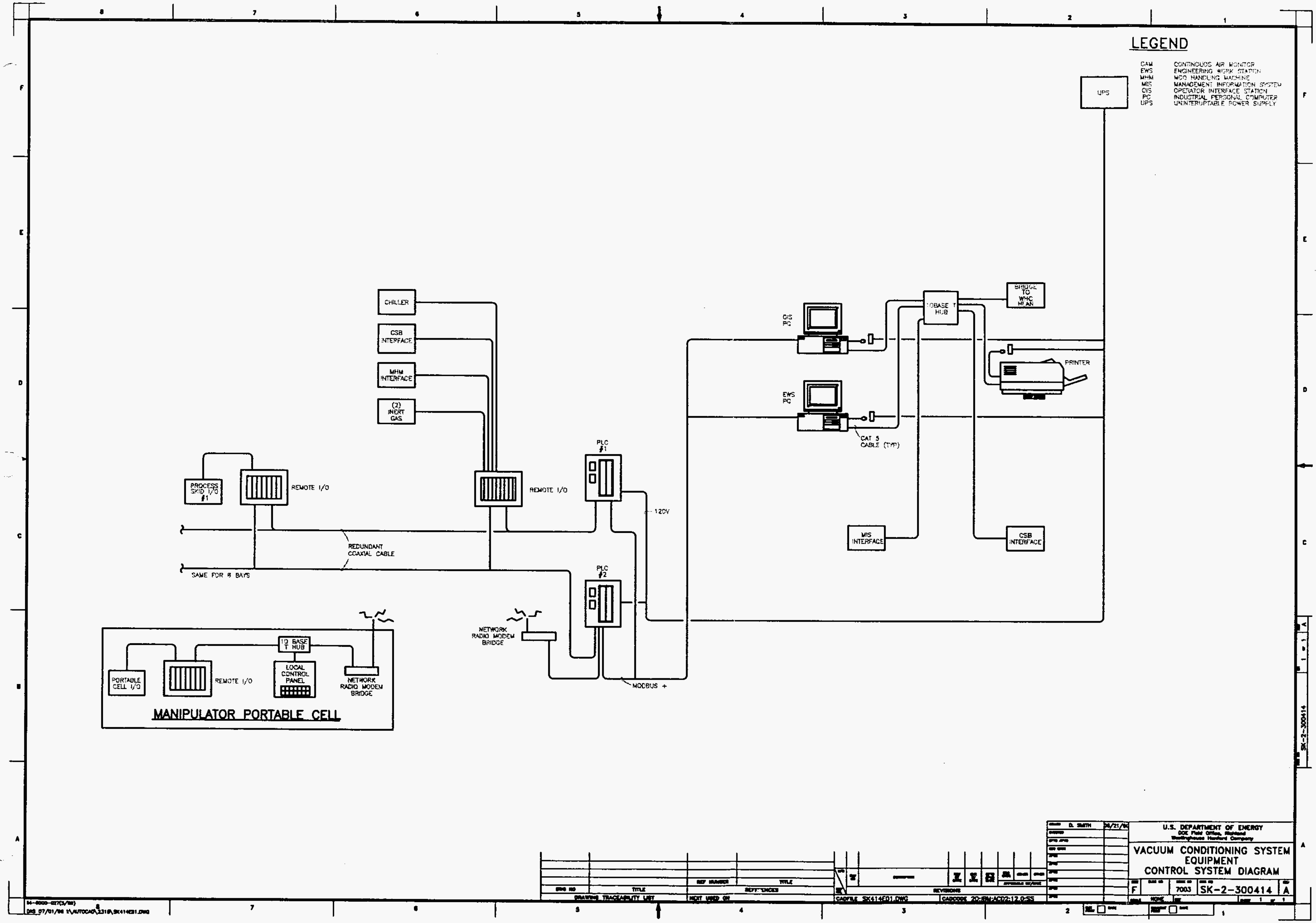
	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED or INITIATING VARIABLE	MODIFIER	READOUT or PASSIVE VARIABLE	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USERS CHOICE	USERS CHOICE	USERS CHOICE
C	USERS CHOICE			CONTROL	
D	USERS CHOICE	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G	USERS CHOICE		GLASS		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USERS CHOICE	MOMENTARY			MIDDLE OR INTERMEDIATE
N	USERS CHOICE		USERS CHOICE	USERS CHOICE	USERS CHOICE
O	USERS CHOICE		ORIFICE, RESTRICT.		
P	PRESSURE, VACUUM		TEST POINT CONN.		
Q	QUANTITY	TOTALIZE, INTEGRATE			
R	RADIATION		RECORD, PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION			VALVE, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, PRESENCE	Y AXIS		RELAY, COMPUTE	
Z	POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATE	

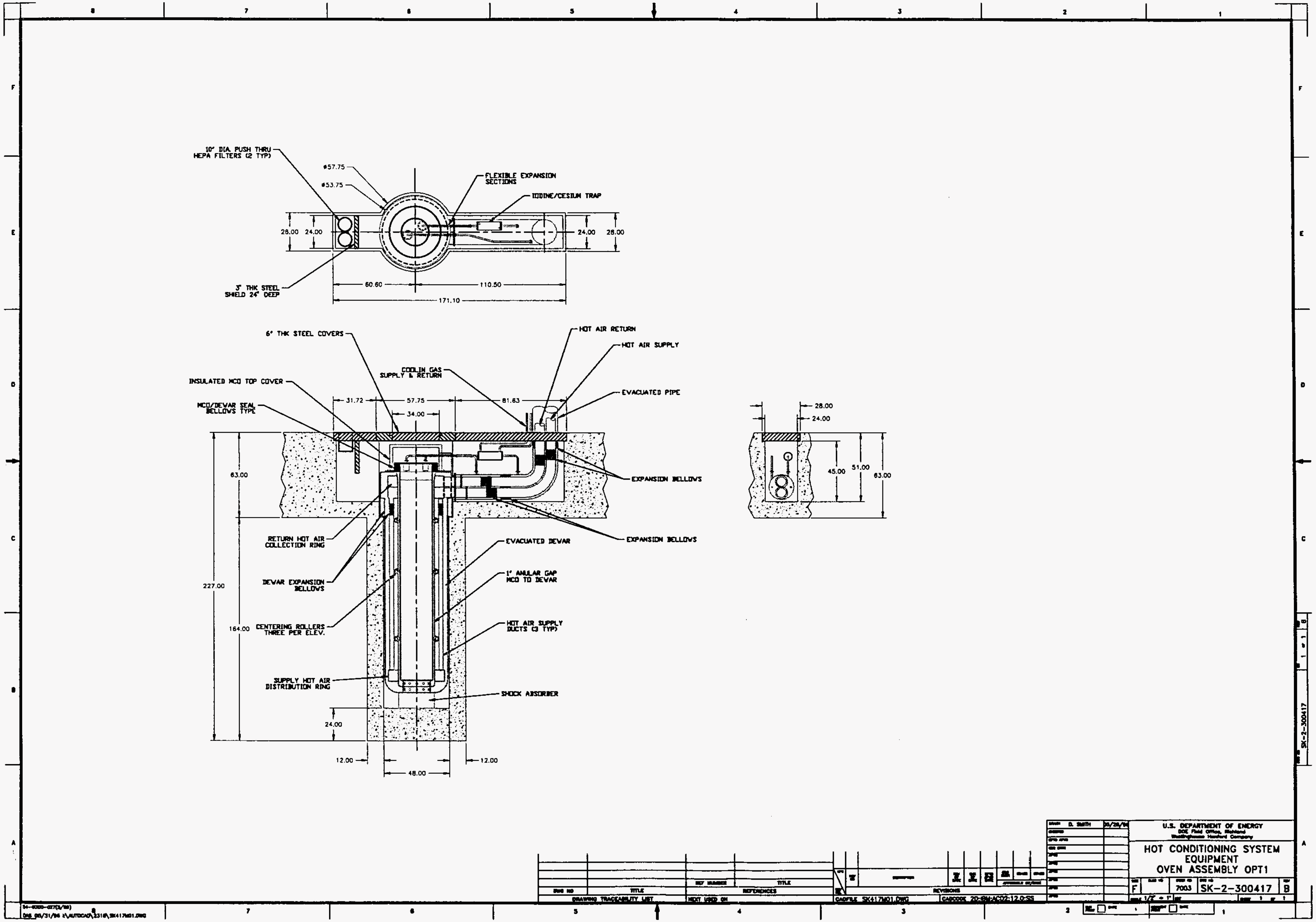

VPS-PFR-1101
MCO VAC PUMPING SYS COLD TRAP FOR Cs/I 3000 BTU/HR
VPS-F-1102
MCO VAC PUMPING SYS HEPA FILTER <1.0 "WC @ 100 ACFM
VPS-CLR-1103
MCO VAC PUMPING SYS COOLER 3000 BTU/HR
VPS-VAC-1104
MCO VAC PUMPING SYS SCROLL VACUUM PUMP 450 LPM @ 5 TORR
VPS-HCL-1105
MCO VAC PUMPING SYS MCO CIRCULATION HEATER 1 KW
VPS-BLO-1106
MCO VAC PUMPING SYS RECIRCULATION BLOWER 38 SCFM DESIGN
VPS-F-1107
MCO VAC PUMPING SYS MCO SUPPLY HEPA <1.0 "WC @ 100 SCFM
PG-ACC-1131
HELIUM SUPPLY SYSTEM MCO FILT BLOWBK ACCUM 10 LITERS
PHS-BLO-1151
MCO HEATING SYSTEM CIRCULATING BLOWER 21000 LPM @ 8" WC SP
PCS-HCL-1152
MCO HEATING SYSTEM ELECTRICAL HEATER 25 KW
MCS-CLR-1153
MCO COOLING SYSTEM COOLER 60,000 BTU/HR
PHS-OVEN-1154
MCO HEATING SYSTEM MCO INSULATING OVEN <1 TORR
PV-F-1171
PROCESS VENT HEPA W/ PRE-FILTER <1" WC SP @ 35 ACFM
NOTES
1. ALL I/O ON PLC/IO-01.
2. INSTRUMENT NITROGEN SUPPLIED FROM HEADER NOT SHOWN.
NITROGEN SUPPLY SK-
INST N2 HEADER SK-
HELIUM SUPPLY SK-
OXYGEN SUPPLY SK-
PROCESS VENT SK-
COOLING WATER SUP SK-
COOLING WATER RET SK-
DEWAR VACUUM SK-
SAMPLE POINT
SET @ 12" WC
SET @ 10 PSIG
SET @ 0.5 PSIG
SET @ 4" WC
SET @ -4" WC W/ MANUAL BLEED
EQUIPMENT LOCATED IN TRENCH
MCO VAULT COVER
MCO HEAD
MCO SKIN
VAULT
MCO
PROCESS MODULE FOR VAULT 1
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM
P&ID
HCS PROCESS MODULE
SK-2-300413
B
DRAWING TRACEABILITY LIST
NEXT USED ON
REFERENCES
REVISIONS
CADFILE SK413002.DWG

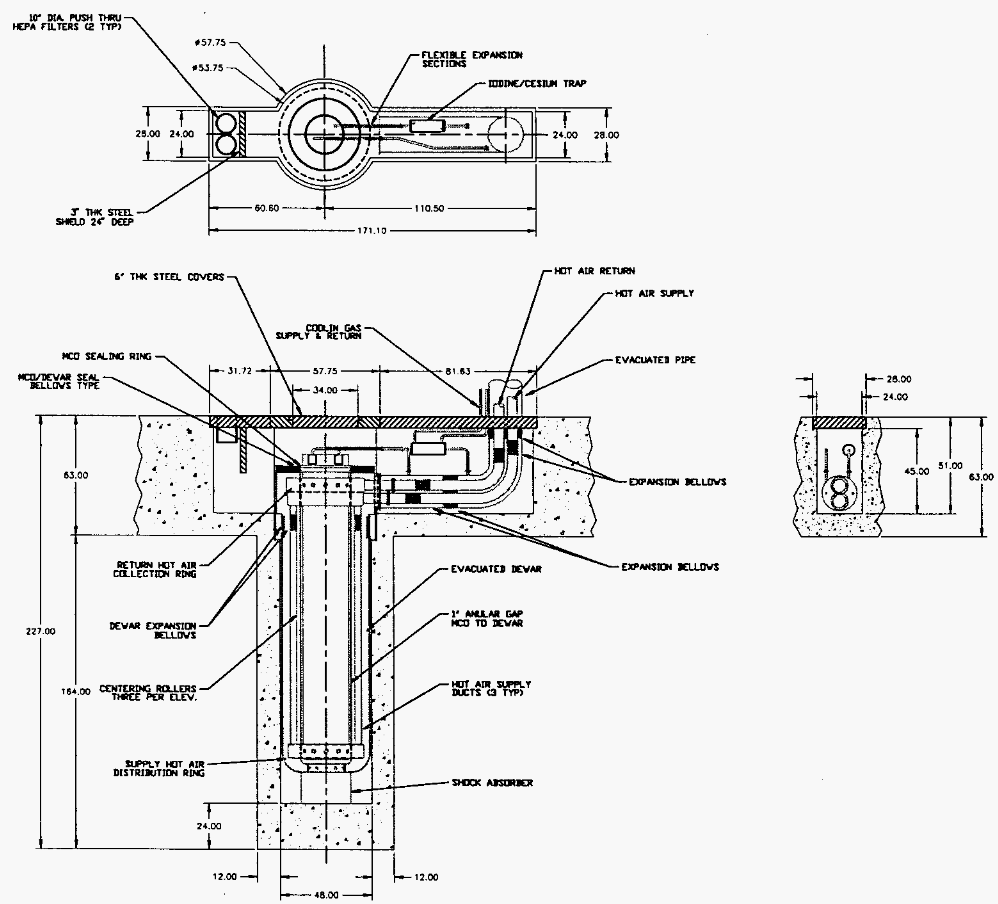

CW-ACC-2011
HCS COOLING WATER SYSTEM LOOP EXPANSION TANK 50 LITERS
CW-P-2012
HCS COOLING WATER SYSTEM CIRCULATION PUMP 72 GPM
CW-P-2013
HCS COOLING WATER SYSTEM CIRCULATION PUMP 72 GPM
CW-HX-2014
HCS COOLING WATER SYSTEM SECONDARY HEAT EXCHANGE 240,000 BTU/HR
CHW-ACC-2021
HCS CHILLED WATER SYSTEM LOOP EXPANSION TANK 50 LITERS
CHW-P-2022
HCS CHILLED WATER SYSTEM CIRCULATION PUMP 60 GPM
CHW-P-2023
HCS CHILLED WATER SYSTEM CIRCULATION PUMP 60 GPM
CHW-CH-2026
HVC CHILLED WATER SYSTEM CHILLER 240,000 BTU/HR
PV-F-2041
HCS PROCESS VENT SYSTEM HEPA FILTER 1000 CFM @ 1" WC
PV-F-2042
HCS PROCESS VENT SYSTEM HEPA FILTER 1000 CFM @ 1" WC
PV-BLO-2043
HCS PROCESS VENT SYSTEM PROCESS VENT BLOWER 1000 CFM @ 12" WC SP
PV-F-2044
HCS PROCESS VENT SYSTEM HEPA FILTER 1000 CFM @ 1" WC
PV-F-2045
HCS PROCESS VENT SYSTEM HEPA FILTER 1000 CFM @ 1" WC
PV-BLO-2046
HCS PROCESS VENT SYSTEM PROCESS VENT BLOWER 1000 CFM @ 12" WC SP
VENDOR SUPPLIED CHILLER SYSTEM
HEAT EXCHANGER LOCATED INSIDE
CONDENSOR LOCATED OUTSIDE
ASSOCIATED EQUIPMENT NOT SHOWN
COOLING WATER SUP SK- , SKID 1
COOLING WATER SUP SK- , SKID 2
COOLING WATER SUP SK- , SKID 3
COOLING WATER SUP SK- , SKID 4
COOLING WATER SUP SK- , SKID 5
COOLING WATER SUP SK- , SKID 6
COOLING WATER SUP SK- , SKID 7
COOLING WATER RET SK- , SKID 7
COOLING WATER RET SK- , SKID 6
COOLING WATER RET SK- , SKID 5
COOLING WATER RET SK- , SKID 4
COOLING WATER RET SK- , SKID 3
COOLING WATER RET SK- , SKID 2
COOLING WATER RET SK- , SKID 1
PROCESS VENT SK- , SKID 7
PROCESS VENT SK- , SKID 6
PROCESS VENT SK- , SKID 5
PROCESS VENT SK- , SKID 4
PROCESS VENT SK- , SKID 3
PROCESS VENT SK- , SKID 2
PROCESS VENT SK- , SKID 1
CW-001-SS-2"
CW-002-SS-2"
CW-003-SS-2"
CW-004-SS-2"
CW-005-SS-2"
CHW-001-SS-2"
CHW-002-SS-2"
CHW-003-SS-2"
CHW-004-SS-2"
PV-001-SS-10"
PV-002-SS-10"
PV-003-SS-10"
PV-004-SS-10"
PV-005-SS-10"
PV-006-SS-10"
PROCESS STACK
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM P&ID HCS PROCESS MODULE
SK-2-300413
DRAWING TRACEABILITY LIST
CADFILE SK413003.DWG


VAC-VAC-3041
TURBO VACUUM PUMP
6" INLET
VAC-VAC-3042
HCS OVEN VACUUM SYSTEM
SCROLL VACUUM ROUGHER PUMP
600 LPM
NITROGEN SUPPLY SK- , SKID 1
NITROGEN SUPPLY SK- , SKID 2
NITROGEN SUPPLY SK- , SKID 3
NITROGEN SUPPLY SK- , SKID 4
NITROGEN SUPPLY SK- , SKID 5
NITROGEN SUPPLY SK- , SKID 6
NITROGEN SUPPLY SK- , SKID 7
HELIUM SUPPLY SK- , SKID 1
HELIUM SUPPLY SK- , SKID 2
HELIUM SUPPLY SK- , SKID 3
HELIUM SUPPLY SK- , SKID 4
HELIUM SUPPLY SK- , SKID 5
HELIUM SUPPLY SK- , SKID 6
HELIUM SUPPLY SK- , SKID 7
OXYGEN SUPPLY SK- , SKID 1
OXYGEN SUPPLY SK- , SKID 2
OXYGEN SUPPLY SK- , SKID 3
OXYGEN SUPPLY SK- , SKID 4
OXYGEN SUPPLY SK- , SKID 5
OXYGEN SUPPLY SK- , SKID 6
OXYGEN SUPPLY SK- , SKID 7
DEWAR VACUUM SK- , SKID 1
DEWAR VACUUM SK- , SKID 2
DEWAR VACUUM SK- , SKID 3
DEWAR VACUUM SK- , SKID 4
DEWAR VACUUM SK- , SKID 5
DEWAR VACUUM SK- , SKID 6
DEWAR VACUUM SK- , SKID 7
PV-006-SS-1"
N2-001-SS-1"
PSV 3014
PCV 3013
PCV 3011
PT 3012
PI 3012
NITROGEN TRAILER
PV-009-SS-1"
He-001-SS-1"
PSV 3024
PCV 3023
PCV 3021
PT 3022
PI 3022
HELIUM TRAILER
PV-010-SS-1"
O2-001-SS-1"
PSV 3034
PCV 3033
PCV 3031
PT 3032
PI 3032
OXYGEN BANKS
PV-007-SS-2"
PROCESS VENT
PI 3043
PT 3043
HS 3041
PI 3044
PT 3044
HS 3042
PV-011-SS-2"
VAC-VAC-3041
VAC-VAC-3042
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM
P&ID
HCS PROCESS MODULE
D.H. MUNGER
7003
SK-2-300413
B
F
DRAWING TRACEABILITY LIST
NEXT USED ON
REFERENCES
REVISIONS
CADFILE SK413004.DWG
SK-2-300413


A-1000
BETA/GAMMA PARTICULATE, IODINE-129, & NOBEL GAS MONITOR EBERLINE "PING-3B"
A-2000
BETA/GAMMA PARTICULATE, IODINE-129, & NOBEL GAS MONITOR EBERLINE "PING-3B"
A-3000
ALPHA/BETA PARTICULATE, MONITOR EBERLINE "SA-4A"
A-3001
TRITIUM MONITOR OVERHOFF TECH. MODEL "32X SERIES"
A-4000
ALPHA/BETA PARTICULATE, MONITOR EBERLINE "SA-4A"
A-4001
TRITIUM MONITOR OVERHOFF TECH. MODEL "32X SERIES"
A-5000
RECORD AIR SAMPLER EBERLINE "RAS--2"
A-6000
RECORD AIR SAMPLER EBERLINE "RAS--2"
ISO-KENETIC SAMPLING HEADS
STACK
PROCESS STACK
PV-004-SS-10"
NOBEL GAS MONITOR
IODINE-129 MONITOR
BETA GAMMA PARTICULATE MONITOR
ALPHA BETA PARTICULATE MONITOR
TRITIUM MONITOR
I-129 FILTER
5" THK 4π SHIELD
IODINE FILTER
0.3u FILTER
4-20ma
MASS FLOW
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENT
HCSE PROCESS MODULE P&ID
SK-300413
DRAWING TRACEABILITY LIST
NEXT USED ON
REVISIONS
CAPFILE SK413005.DWG


LEGEND
CAM CONTINUOUS AIR MONITOR
EWS ENGINEERING WORK STATION
MHM MCO HANDLING MACHINE
MIS MANAGEMENT INFORMATION SYSTEM
OIS OPERATOR INTERFACE STATION
PC INDUSTRIAL PERSONAL COMPUTER
UPS UNINTERRUPTABLE POWER SUPPLY
UPS
BRIDGE TO WHC WLAN
10BASE T HUB
PRINTER
OIS PC
EWS PC
CAT 5 CABLE (TYP)
MIS INTERFACE
CSB INTERFACE
CHILLER
CSB INTERFACE
MHM INTERFACE
(2) INERT GAS
REMOTE I/O
PLC #1
PLC #2
120V
MODBUS +
NETWORK RADIO MODEM BRIDGE
PROCESS SKID I/O #1
REMOTE I/O
REDUNDANT COAXIAL CABLE
SAME FOR 8 BAYS
PORTABLE CELL I/O
REMOTE I/O
10 BASE T HUB
LOCAL CONTROL PANEL
NETWORK RADIO MODEM BRIDGE
MANIPULATOR PORTABLE CELL
D. SMITH
U.S. DEPARTMENT OF ENERGY
VACUUM CONDITIONING SYSTEM EQUIPMENT CONTROL SYSTEM DIAGRAM
F
7003
SK-2-300414
A
DRAWING TRACEABILITY LIST
NEXT USED ON
REVISIONS
CADFILE SK414E01.DWG
SK-2-300414


10" DIA. PUSH THRU HEPA FILTERS (2 TYP)
ø57.75
ø53.75
FLEXIBLE EXPANSION SECTIONS
IODINE/CESIUM TRAP
3" THK STEEL SHIELD 24" DEEP
28.00
24.00
60.60
110.50
171.10
6" THK STEEL COVERS
HOT AIR RETURN
HOT AIR SUPPLY
COOLIN GAS SUPPLY & RETURN
INSULATED MCO TOP COVER
EVACUATED PIPE
MCO/DEVAR SEAL BELLOWS TYPE
31.72
57.75
34.00
81.63
63.00
EXPANSION BELLOWS
RETURN HOT AIR COLLECTION RING
EVACUATED DEVAR
1" ANULAR GAP MCO TO DEVAR
DEVAR EXPANSION BELLOWS
227.00
164.00
CENTERING ROLLERS THREE PER ELEV.
HOT AIR SUPPLY DUCTS (3 TYP)
SUPPLY HOT AIR DISTRIBUTION RING
SHOCK ABSORBER
12.00
48.00
45.00
51.00
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENT OVEN ASSEMBLY OPT1
D. SMITH
7003
SK-2-300417
B
DRAWING TRACEABILITY LIST
NEXT USED ON
REFERENCES
REVISIONS
CADFILE SK417M01.DWG



U.S. DEPARTMENT OF ENERGY	DOE Field Office, Richland
Westinghouse Hanford Company	
DRAWN	D. SMITH

HOT CONDITIONING SYSTEM EQUIPMENT
OVEN ASSEMBLY OPT2

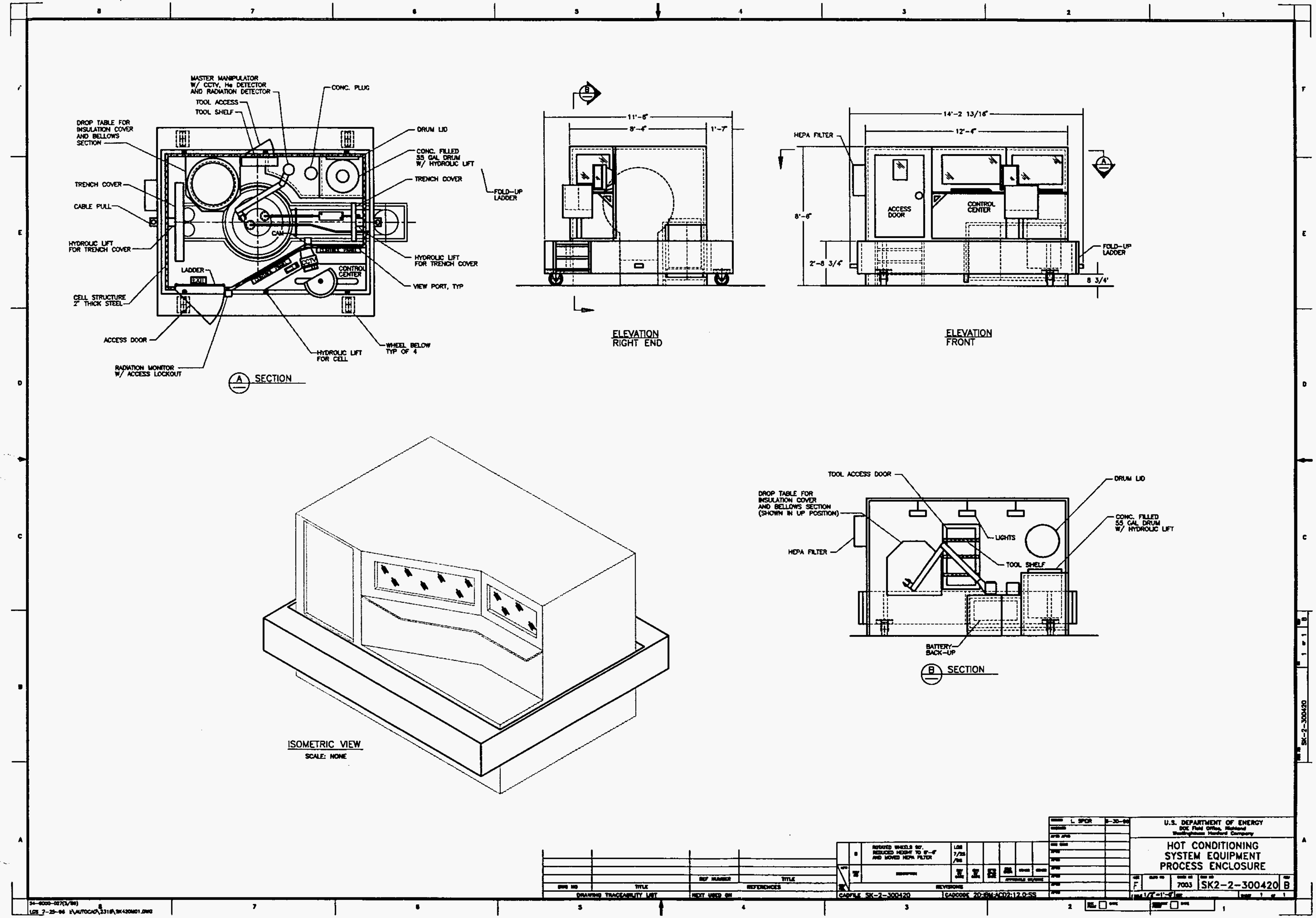
SIZE F — 7003 — SK-2-300418 — REV B

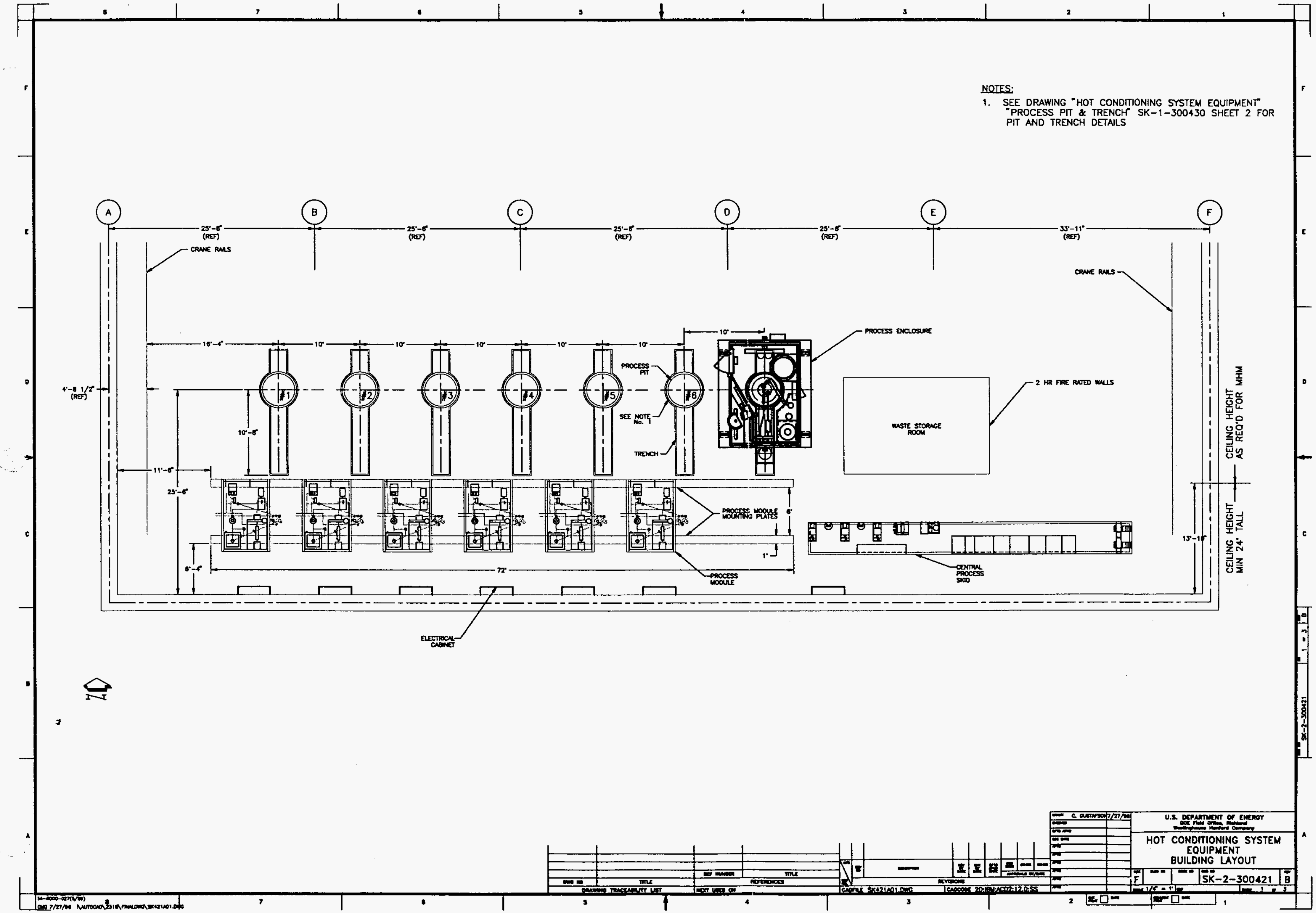
SCALE 1/2" = 1'

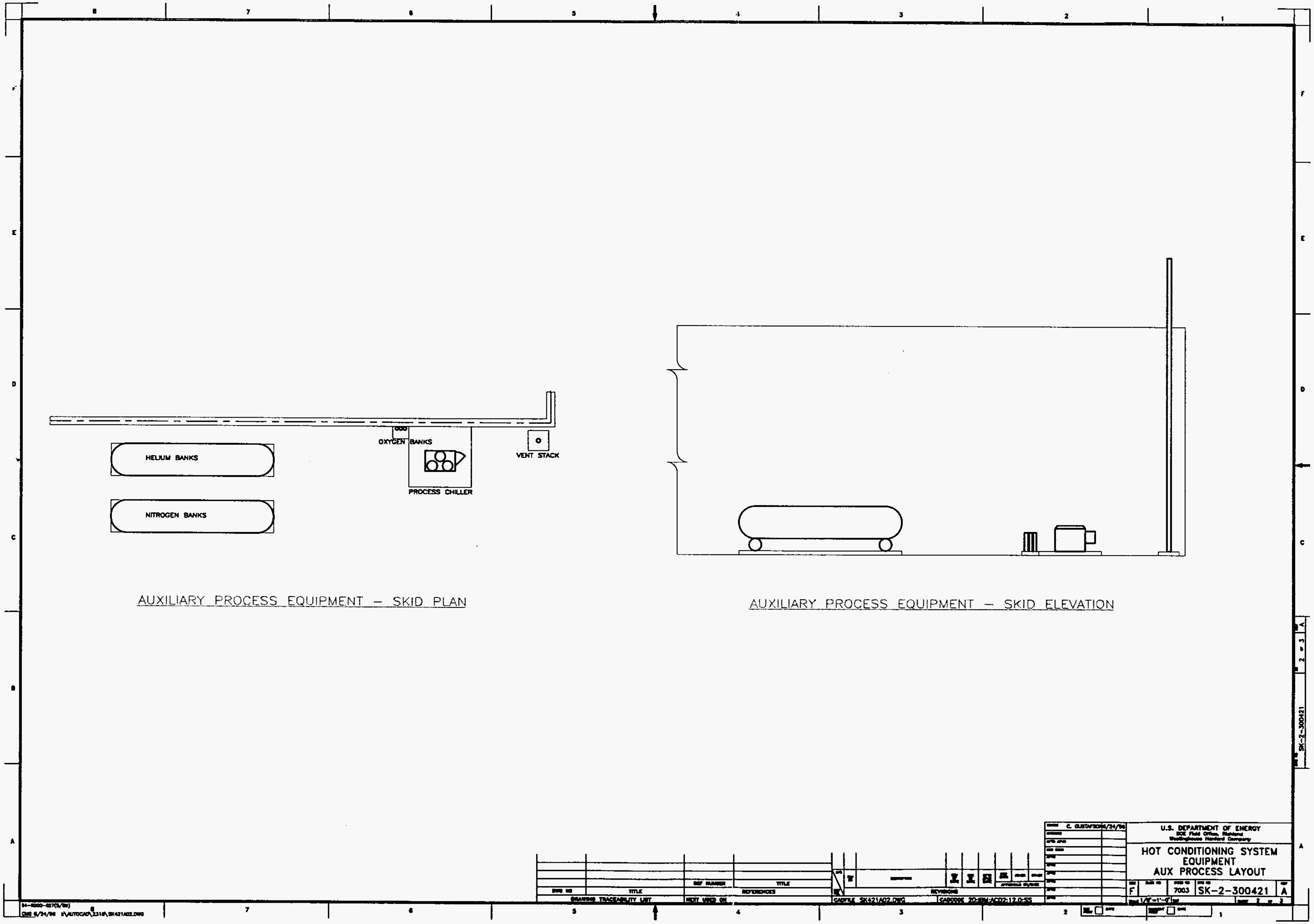
CADFILE SK418M01.DWG — CADCODE 20:RM-ACO2:12.0:SS

DRAWING TRACEABILITY LIST — NEXT USED ON — REFERENCES — REVISIONS

SK-2-300418


MASTER MANIPULATOR W/ CCTV, He DETECTOR AND RADIATION DETECTOR
TOOL ACCESS
TOOL SHELF
CONC. PLUG
DROP TABLE FOR INSULATION COVER AND BELLOWS SECTION
DRUM LID
CONC. FILLED 55 GAL DRUM W/ HYDROLIC LIFT
TRENCH COVER
CABLE PULL
HYDROLIC LIFT FOR TRENCH COVER
FOLD-UP LADDER
CAM
CONTROL CENTER
LADDER
EXIT
VIEW PORT, TYP
CELL STRUCTURE 2" THICK STEEL
ACCESS DOOR
HYDROLIC LIFT FOR CELL
WHEEL BELOW TYP OF 4
RADIATION MONITOR W/ ACCESS LOCKOUT
A SECTION
11'-6"
8'-4"
1'-7"
ELEVATION RIGHT END
14'-2 13/16"
12'-4"
HEPA FILTER
8'-6"
2'-8 3/4"
ACCESS DOOR
FOLD-UP LADDER
8 3/4"
ELEVATION FRONT
TOOL ACCESS DOOR
DROP TABLE FOR INSULATION COVER AND BELLOWS SECTION (SHOWN IN UP POSITION)
LIGHTS
TOOL SHELF
BATTERY BACK-UP
B SECTION
ISOMETRIC VIEW
SCALE: NONE
L. SPOR
U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company
HOT CONDITIONING SYSTEM EQUIPMENT PROCESS ENCLOSURE
F
7003
SK2-2-300420
B
ROTATED WHEELS 90°, REDUCED HEIGHT TO 8'-6" AND MOVED HEPA FILTER
DRAWING TRACEABILITY LIST
NEXT USED ON
REFERENCES
REVISIONS
CADFILE SK-2-300420
CADCODE 20:IBM:ACD2:12.0:SS
SK-2-300420


NOTES:
1. SEE DRAWING "HOT CONDITIONING SYSTEM EQUIPMENT" "PROCESS PIT & TRENCH" SK-1-300430 SHEET 2 FOR PIT AND TRENCH DETAILS
A
B
C
D
E
F
25'-6" (REF)
33'-11" (REF)
CRANE RAILS
16'-4"
10'
4'-8 1/2" (REF)
10'-8"
11'-6"
25'-6"
6'-4"
72'
6"
1'
13'-10"
PROCESS PIT
SEE NOTE No. 1
TRENCH
PROCESS ENCLOSURE
2 HR FIRE RATED WALLS
WASTE STORAGE ROOM
PROCESS MODULE MOUNTING PLATES
PROCESS MODULE
CENTRAL PROCESS SKID
ELECTRICAL CABINET
CEILING HEIGHT AS REQ'D FOR MHM
CEILING HEIGHT MIN 24' TALL
#1
#2
#3
#4
#5
#6
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENT BUILDING LAYOUT
SK-2-300421
B
C. GUSTAFSON 7/27/96
CADFILE SK421A01.DWG
DRAWING TRACEABILITY LIST
REFERENCES
REVISIONS
NEXT USED ON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VENT STACK
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C. GUSTAFSON 6/24/96
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM
EQUIPMENT
AUX PROCESS LAYOUT
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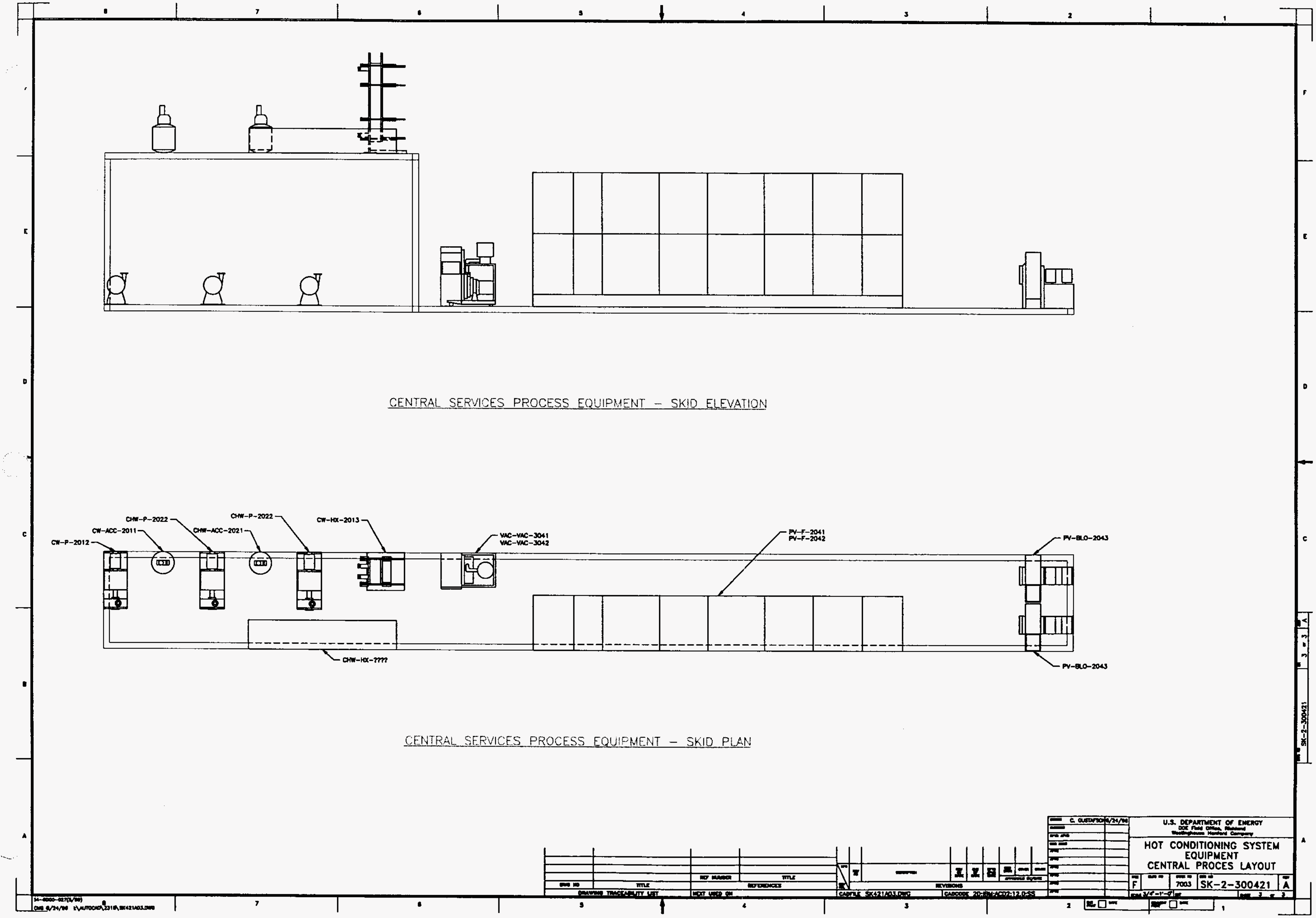
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VAC-VAC-3041
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PV-F-2041
PV-F-2042
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PV-BLO-2043
CHW-HX-????
C. GUSTAFSON 6/24/96
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM
EQUIPMENT
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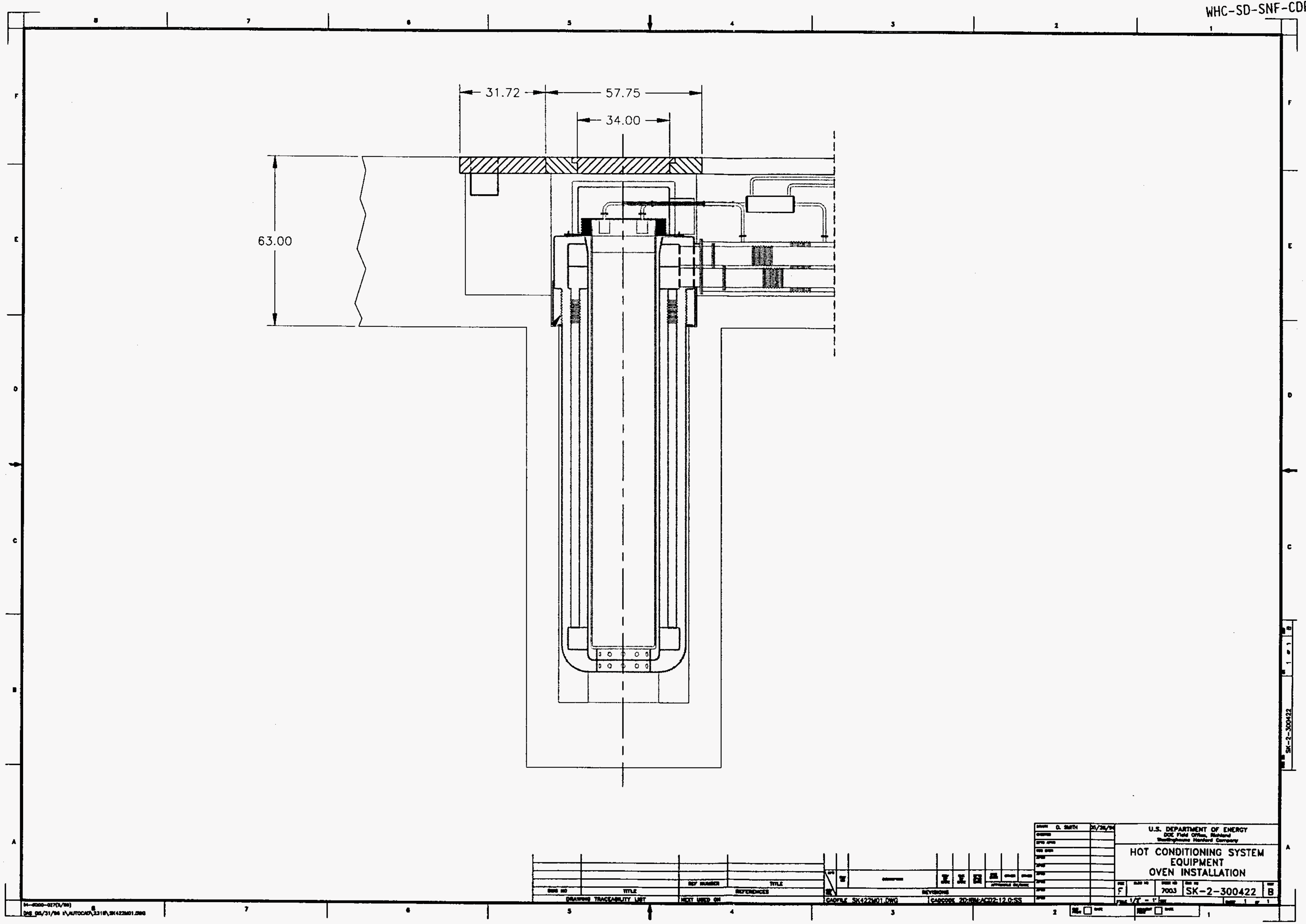

31.72
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63.00
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM
EQUIPMENT
OVEN INSTALLATION
D. SMITH
7003
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NEXT USED ON
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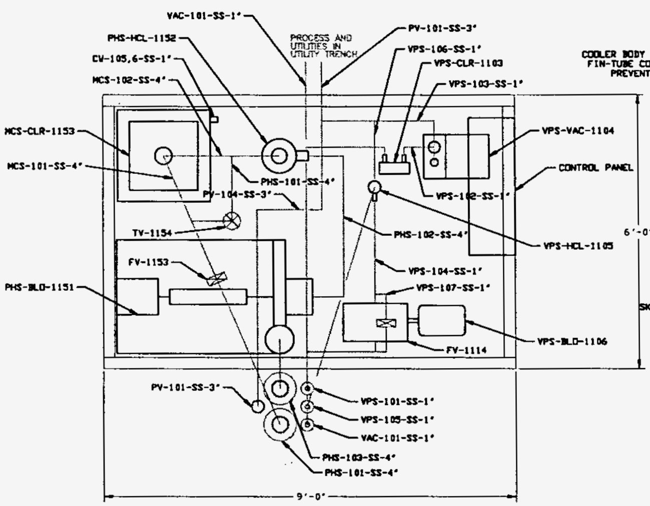

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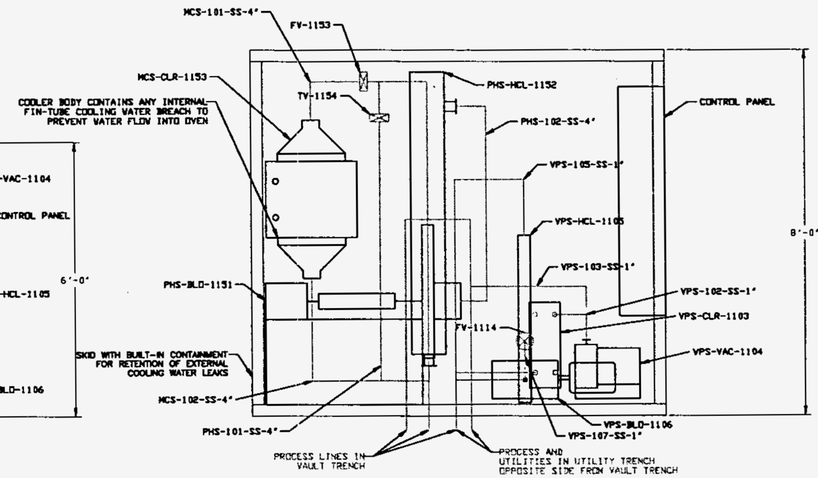

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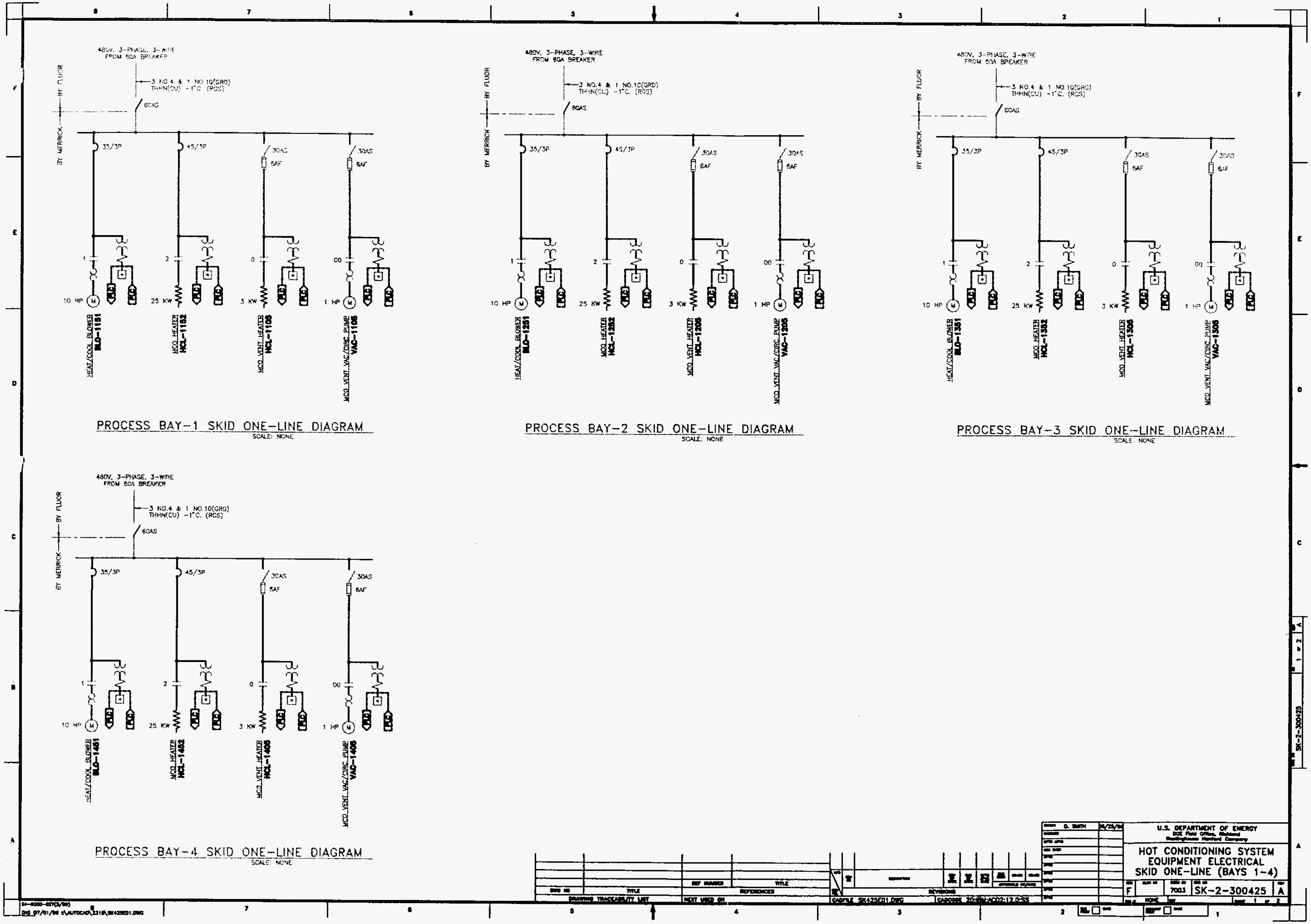
D. MUNGER 6/25/96

U.S. DEPARTMENT OF ENERGY

HOT CONDITIONING SYSTEM LAYOUT PROCESS MODULE

F 7003 SK-2-300423 A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3 NO.4 & 1 NO.10(GRD)
THHN(CU) -1"C. (RGS)
60AS
BY MERRICK
BY FLUOR
35/3P
45/3P
30AS
6AF
1
2
0
00
10 HP
25 KW
3 KW
1 HP
HEAT/COOL BLOWER
BLO-1151
MCO HEATER
HCL-1152
MCO VENT HEATER
HCL-1105
MCO VENT VAC/CIRC PUMP
VAC-1105
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SCALE: NONE
HEAT/COOL BLOWER
BLO-1251
MCO HEATER
HCL-1252
MCO VENT HEATER
HCL-1205
MCO VENT VAC/CIRC PUMP
VAC-1205
PROCESS BAY-2 SKID ONE-LINE DIAGRAM
SCALE: NONE
HEAT/COOL BLOWER
BLO-1351
MCO HEATER
HCL-1352
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MCO VENT VAC/CIRC PUMP
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NEXT USED ON
REFERENCES
REVISIONS
CADFILE SK425E01.DWG
D. SMITH
U.S. DEPARTMENT OF ENERGY
DOE Field Office, Richland
Westinghouse Hanford Company
HOT CONDITIONING SYSTEM
EQUIPMENT ELECTRICAL
SKID ONE-LINE (BAYS 1-4)
F
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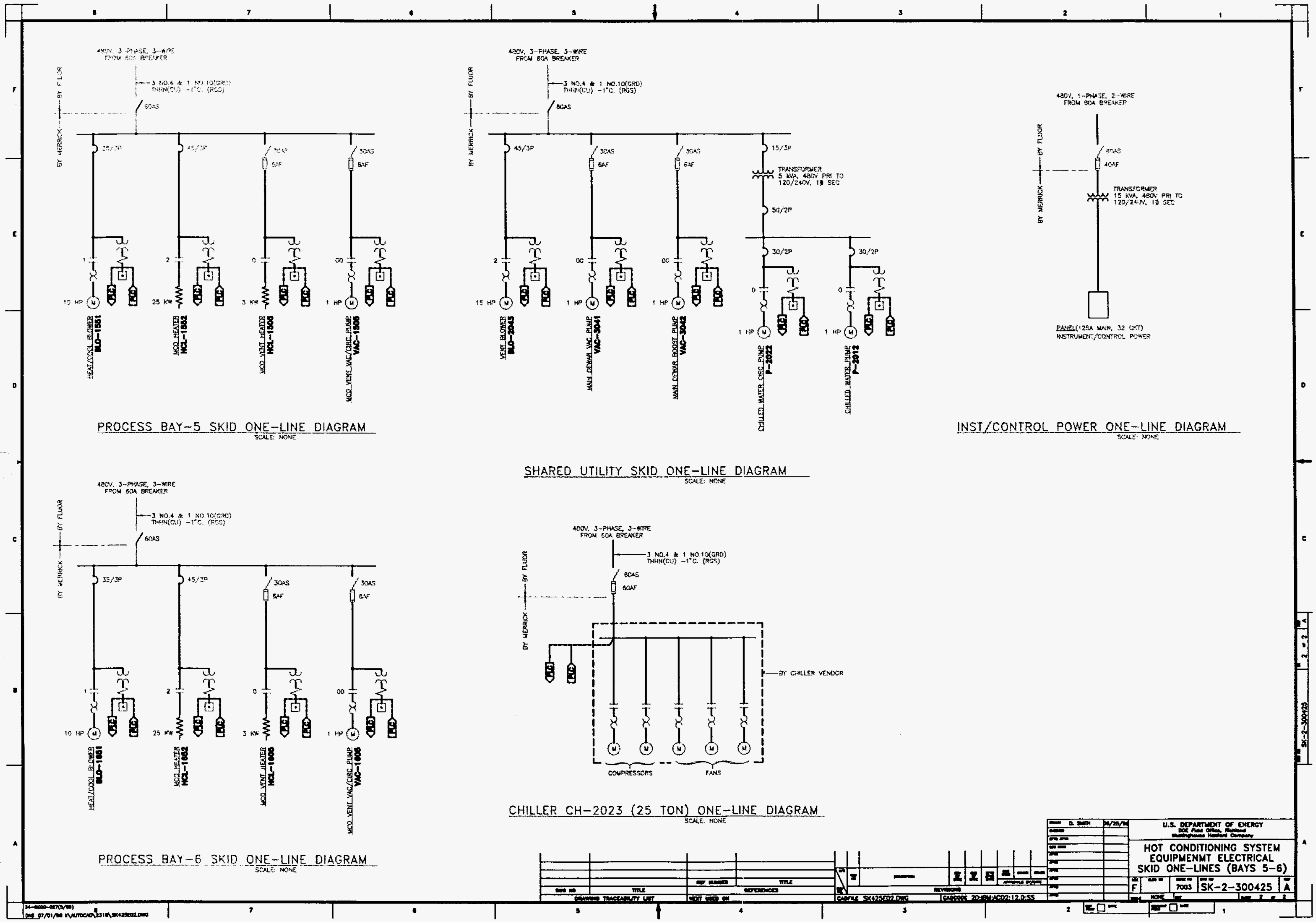
SK-2-300425
A
NONE
SK-2-300425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3 NO.4 & 1 NO.10(GRD) THHN(CU) -1"C. (RGS)
BY MERRICK
BY FLUOR
HEAT/COOL BLOWER BLO-1551
MCO HEATER HCL-1552
MCO VENT HEATER HCL-1505
MCO VENT VAC/CIRC PUMP VAC-1506
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MCO HEATER HCL-1652
MCO VENT HEATER HCL-1605
MCO VENT VAC/CIRC PUMP VAC-1606
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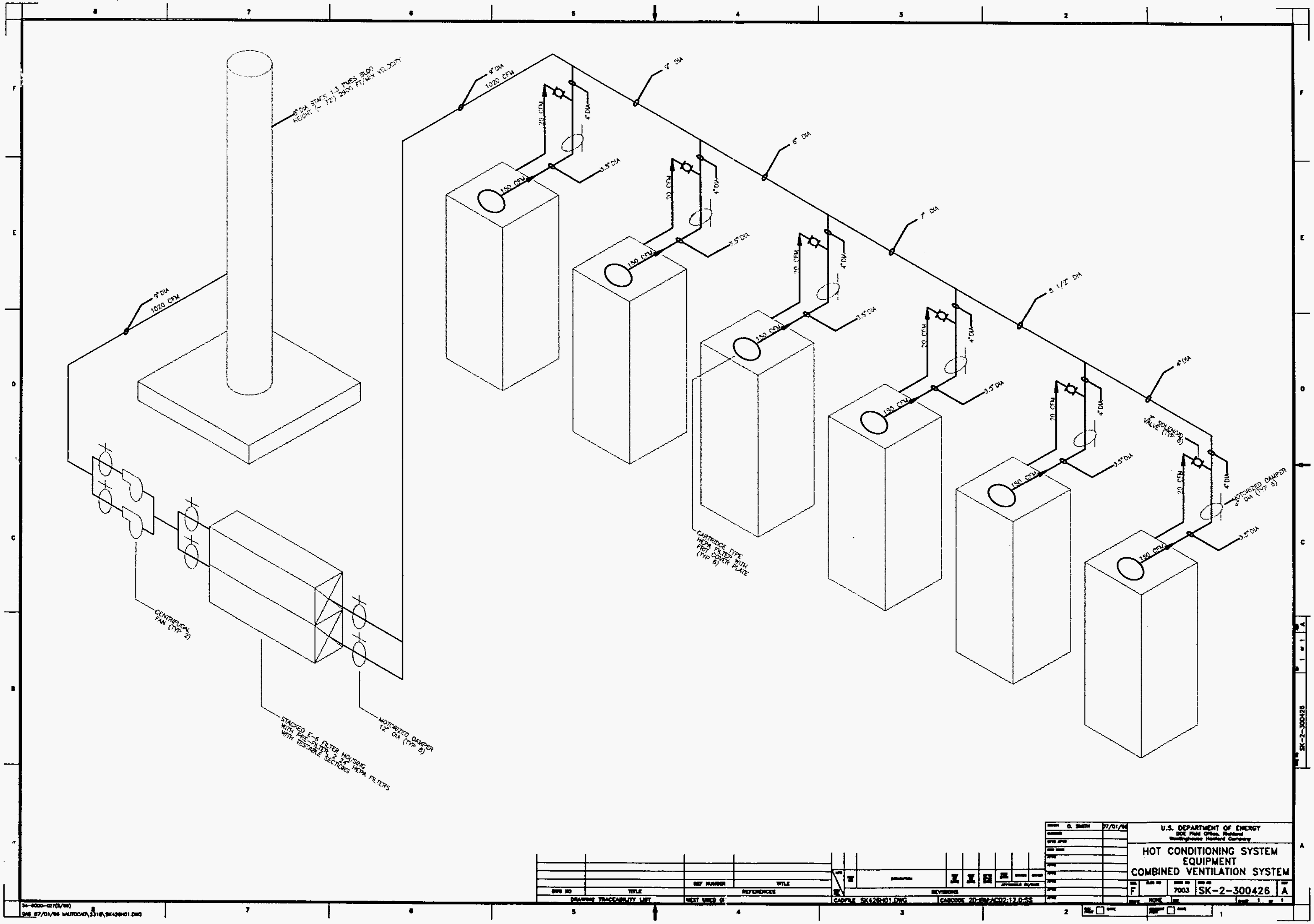
SCALE: NONE
TRANSFORMER 5 KVA, 480V PRI TO 120/240V, 1Ø SEC
VENT BLOWER BLO-2043
MAIN DEWAR VAC PUMP VAC-3041
MAIN DEWAR BOOST PUMP VAC-3042
CHILLED WATER CIRC PUMP P-2022
CHILLED WATER PUMP P-2012
INST/CONTROL POWER ONE-LINE DIAGRAM
SCALE: NONE
480V, 1-PHASE, 2-WIRE FROM 60A BREAKER
TRANSFORMER 15 KVA, 480V PRI TO 120/240V, 1Ø SEC
PANEL(125A MAIN, 32 CKT) INSTRUMENT/CONTROL POWER
CHILLER CH-2023 (25 TON) ONE-LINE DIAGRAM
SCALE: NONE
BY CHILLER VENDOR
COMPRESSORS
FANS
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENMT ELECTRICAL SKID ONE-LINES (BAYS 5-6)
7003
SK-2-300425
A
D. SMITH
DRAWING TRACEABILITY LIST
REVISIONS
CADFILE SK425E02.DWG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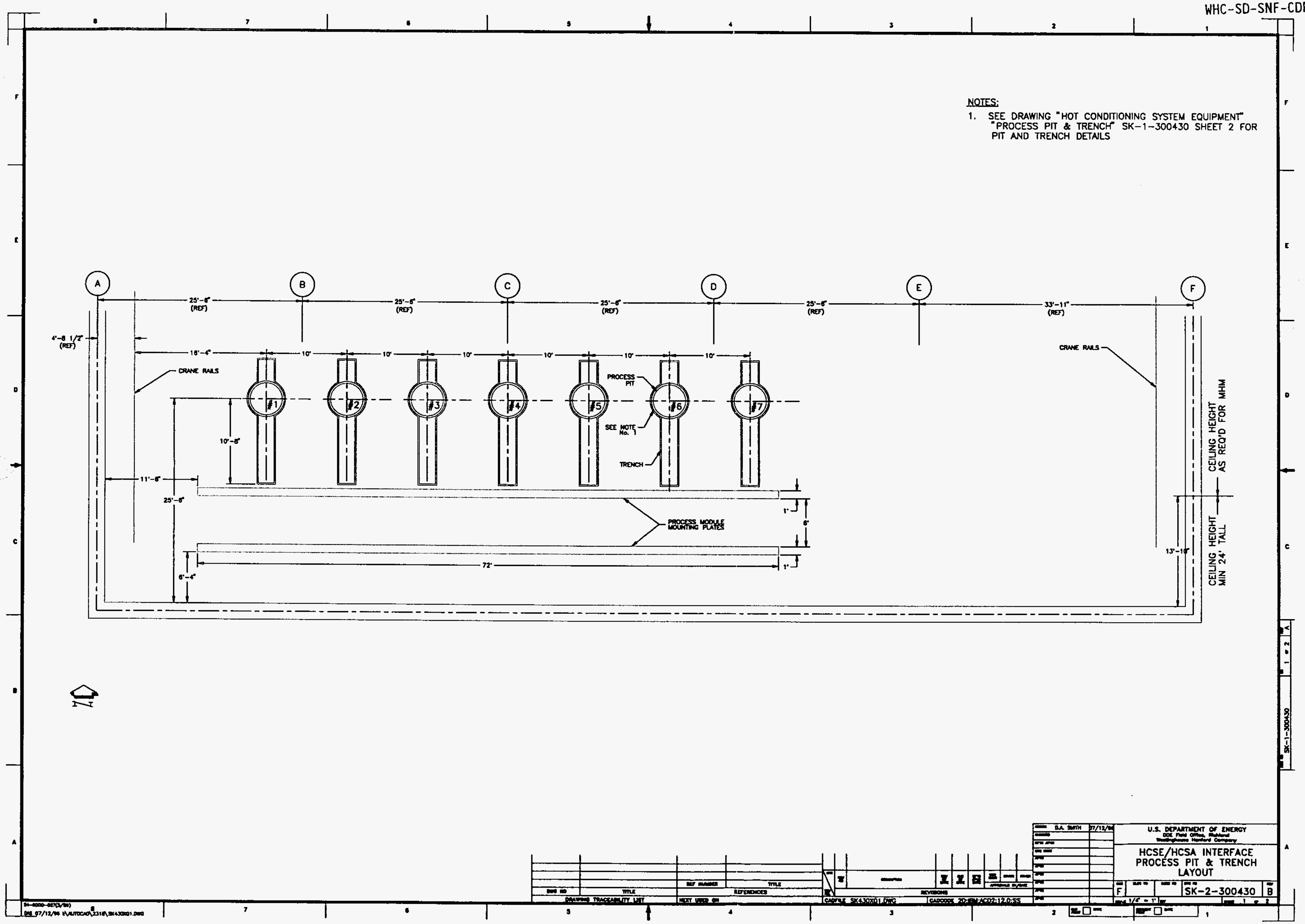
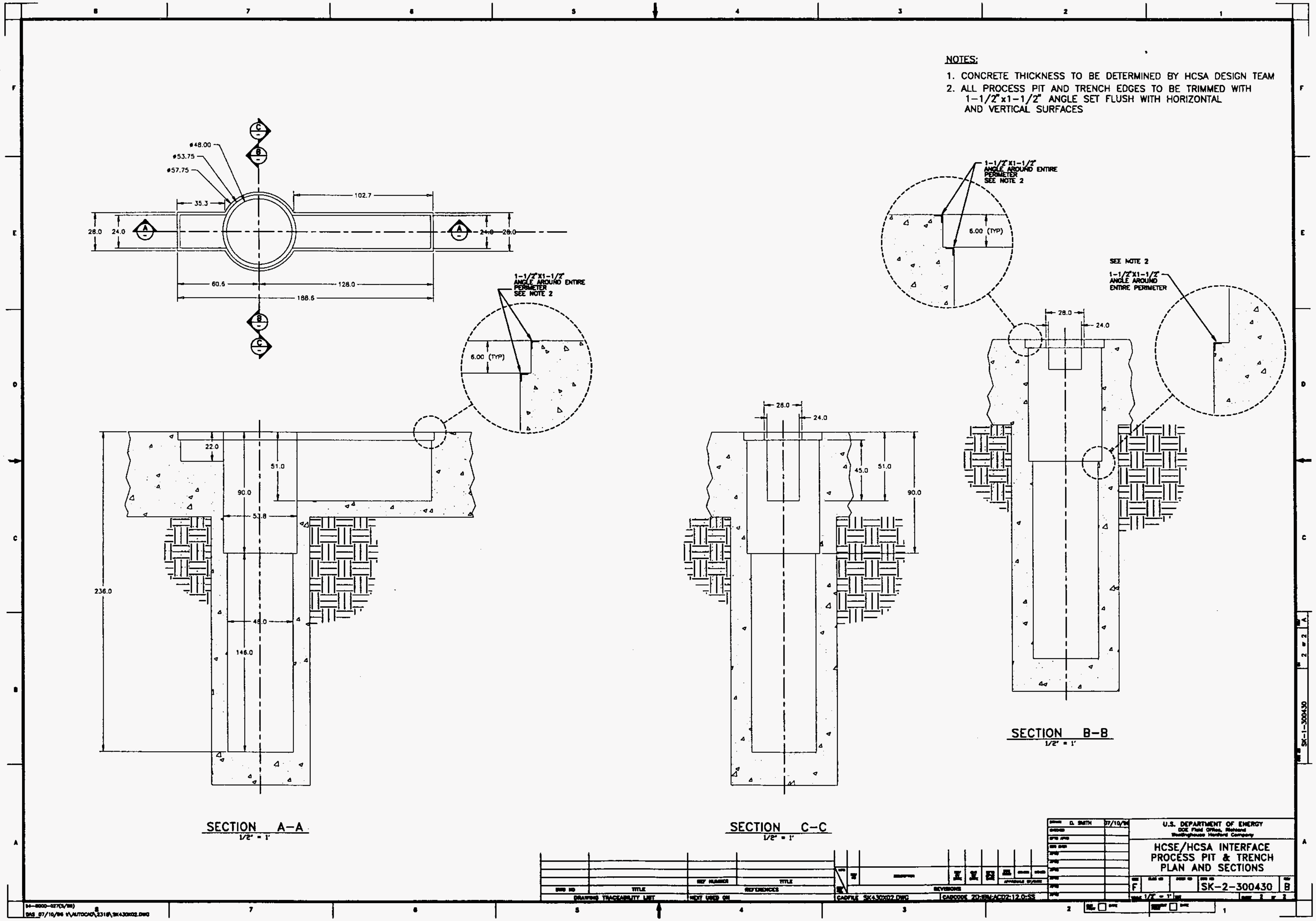
9" DIA 1020 CFM
150 CFM
20 CFM
4" DIA
3.5" DIA
9" DIA
8" DIA
7" DIA
5 1/2" DIA
4" DIA
4" SOLENOID VALVE (TYP 6)
MOTORIZED DAMPER 4" DIA (TYP 6)
CARTRIDGE TYPE HEPA FILTER WITH FRONT COVER PLATE (TYP 6)
CENTRIFUGAL FAN (TYP 2)
STACKED E-5 FILTER HOUSING WITH PRE-FILTER & 2 2'x2' HEPA FILTERS WITH TESTABLE SECTIONS
MOTORIZED DAMPER 12" DIA (TYP 6)
U.S. DEPARTMENT OF ENERGY
HOT CONDITIONING SYSTEM EQUIPMENT
COMBINED VENTILATION SYSTEM
D. SMITH 07/01/96
7003 SK-2-300426 A
DRAWING TRACEABILITY LIST
REFERENCES
REVISIONS
CADFILE SK426H01.DWG


NOTES:
1. SEE DRAWING "HOT CONDITIONING SYSTEM EQUIPMENT" "PROCESS PIT & TRENCH" SK-1-300430 SHEET 2 FOR PIT AND TRENCH DETAILS
A
B
C
D
E
F
25'-6" (REF)
33'-11" (REF)
4'-8 1/2" (REF)
16'-4"
10'
CRANE RAILS
PROCESS PIT
SEE NOTE No. 1
TRENCH
#1
#2
#3
#4
#5
#6
#7
10'-6"
11'-6"
25'-6"
6'-4"
72'
1'
6'
PROCESS MODULE MOUNTING PLATES
13'-10"
CEILING HEIGHT AS REQ'D FOR MHM
CEILING HEIGHT MIN 24' TALL
U.S. DEPARTMENT OF ENERGY
HCSE/HCSA INTERFACE PROCESS PIT & TRENCH LAYOUT
SK-2-300430
B
D.A. SMITH
1/4" = 1'
DRAWING TRACEABILITY LIST
REFERENCES
REVISIONS
NEXT USED ON
CADFILE SK430X01.DWG
SK-1-300430


NOTES:
1. CONCRETE THICKNESS TO BE DETERMINED BY HCSA DESIGN TEAM
2. ALL PROCESS PIT AND TRENCH EDGES TO BE TRIMMED WITH 1-1/2"x1-1/2" ANGLE SET FLUSH WITH HORIZONTAL AND VERTICAL SURFACES
1-1/2"X1-1/2" ANGLE AROUND ENTIRE PERIMETER SEE NOTE 2
6.00 (TYP)
SEE NOTE 2
ø48.00
ø53.75
ø57.75
35.3
102.7
60.6
128.0
188.6
28.0
24.0
22.0
51.0
90.0
53.8
48.0
146.0
236.0
45.0
SECTION A-A
1/2" = 1'
SECTION C-C
1/2" = 1'
SECTION B-B
1/2" = 1'
U.S. DEPARTMENT OF ENERGY
HCSE/HCSA INTERFACE
PROCESS PIT & TRENCH
PLAN AND SECTIONS
SK-2-300430
B
D. SMITH
DRAWING TRACEABILITY LIST
NEXT USED ON
REFERENCES
REVISIONS
SK-1-300430

APPENDIX B

ALARA IMPLEMENTATION PLAN

APPENDIX B - ALARA IMPLEMENTATION PLAN

ALARA IMPLEMENTATION PLAN for the HOT CONDITIONING SYSTEM EQUIPMENT of the K-BASIN SPENT NUCLEAR FUEL STORAGE PROJECT

1.0 INTRODUCTION

Approximately 2100 tons of SNF are stored in the K-Basins. The DOE has agreed to an accelerated schedule to move this material from the basins into interim dry storage. The project requires the construction of a process facility, called the Cold Vacuum Drying Module (CVDM), to dewater and dry the fuel outside of the basin buildings, before shipment to a distant storage facility. The SNF elements will be placed within a container called the Multiple Canister Overpack (MCO) in the basin. The MCO, which will be full of basin water as well as fuel, will be placed in a shielded shipping cask on a transport trailer at the basin. This assembly will be transported to the CVDM where it will be drained and dried by a vacuum process. When processing is complete in the CVDM, the MCO and cask are transported to the Canister Storage Building (CSB) where the MCO is placed in interim storage to await further drying by the Hot Conditioning System Equipment (HCSE). The HCSE is located in an annex to the CSB and is served by the CSB MCO Handling Machine (MHM).

There are two important radiation sources associated with the hot vacuum drying process. The principle source will be the MCO filled with spent nuclear fuel. The shielding integral to the MHM and oven will reduce the dose to relatively low levels in the area that the workers will occupy during the hot vacuum drying process. The second source will be the process equipment. Fission products from leaking fuel and activation products will accumulate in the process equipment, creating a source. Controls will be required to protect staff from inhaling or spreading releasable contamination that could be released when MCO connections are made or broken during the hot vacuum drying process.

The federal law governing design objectives for radiation exposure for this type of work is 10 CFR 835, Occupational Radiation Protection. This is the code that establishes radiation protection standards for the conduct of Department of Energy activities. The annual limit for total effective dose equivalent (TEDE) is 5 rems. Administrative limits are imposed by DOE Notice 441.1, Radiological Protection for DOE Activities. A guide to useful practices for achieving the objective of the ALARA process is DOE publication PNL-6577, "Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)". The purpose of this plan is to provide the framework for a design and operations planning program which assures that the ALARA requirements will be met.

This ALARA Implementation plan provides guidance during the design phase for estimating the expected radiation doses and for selecting appropriate remote or automated operations and shielding features for the Hot Conditioning System Equipment. It also provides input for decision making while writing operational procedures.

2.0 ALARA PRINCIPLES

The following documents serve as references for ALARA considerations:

10 CFR 835	Occupational Radiation Protection
ASME NQA-1	Quality Assurance Program Requirements for Nuclear Facilities
DOE Notice 441.1	Radiological Protection for DOE Activities
DOE Order 6430.1A	General Design Criteria
PNL-6577	Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)
WHC-IP-1043	WHC Occupational ALARA Program
WHC-CM-4-29	Nuclear Criticality Safety
WHC-CM-4-46	Nonreactor Facility Safety Analysis Manual
WHC-CM-7-5	Environmental Compliance
WHC-SD-GN-30011	Radiological Design Guide
DOE/EH-0256T	DOE Radiological Control Manual
HSRCM-1	Hanford Site Radiological Control Manual

In combination, the DOE Orders and Guidelines generally require the following radiological design criteria:

A. Individual worker dose shall be ALARA and should be less than 500 mrem per year.

B. Control of contamination should be achieved by containment of radioactive material.

C. Efficiency of maintenance, decontamination, operations, and decommissioning shall be maximized.

The basic principles that are to be adhered to in the design of the Hot Vacuum Conditioning Equipment are to: 1) determine the major contributors to the dose and examine methods for making the process more efficient, 2) provide shielding to reduce the dose, 3) examine the cost-effectiveness of using robotics, and 4) examine the cost-effectiveness of using remote controls where possible. These determinations should include assessment of normal operations exposure and maintenance/repair exposure.

3.0 HOT VACUUM DRYING EQUIPMENT MODULE DESCRIPTION

A. Process Description

The purpose of the Hot Treatment Process is to dry the SNF by driving off water vapor trapped in pores that may remain after Cold Vacuum Drying has been completed and releasing chemically bound water (water of hydration). In addition to completing the drying, the process will break down uranium hydride and release the hydrogen. After drying has been completed the exposed uranium surfaces will be oxidized by a controlled reaction. These processes are designed to remove hydrogen, eliminate further hydrogen production during storage, and reduce the reactivity of the uranium surfaces prior to storage.

The process involves heating the SNF to 300 °C with a Helium atmosphere, then evacuating the vessel to a pressure of 5 torr. The SNF is then cooled somewhat and a Helium / Oxygen mixture is added to oxidize the exposed uranium. When the process is completed a cover is placed over the MCO ports. The cover is welded in place.

The hot treatment process will be executed in an extension of the Canister Storage Building. This building covers an array of subterranean holes into which the Multiple Canister Overpacks (MCOs) are placed for storage. Removal of the MCO from the shipping cask that it arrives in and input / output transactions with the storage holes is effected with a special remotely operated machine (within a shield cask) called the MCO Handling Machine (MHM). The Hot Treatment Process ovens will be located in subterranean holes similar to the storage holes. The MHM will get an MCO from storage, insert it into an oven for treatment, and return it to storage after hot treatment is completed.

The key elements of a Hot Treatment Process station will be:

1. An oven will be located below the facility floor level in a hole. The oven will hold an MCO. Hot air circulated between the oven vessel

APPENDIX B - ALARA IMPLEMENTATION PLAN

wall and the MCO outer surface will heat the MCO to 300 °C. The bottom of the oven will be approximately 16 ft below grade. The top of the MCO will be about 30" below grade. The hole will be covered by a thick steel plate which will be selected to control radiation exposure rate above the oven.

2. A process skid containing the hot air source, the vacuum pump and miscellaneous items will be located on the floor a few feet distant from the oven.

3. Hot air and process lines running between the furnace and the process equipment skid will be in a trench below floor level. The trench will be covered with steel to provide shielding from radioactivity which may be caught in in-line traps and filters built into the MCO exhaust line. These devices will be located in the trench. Their purpose is to prevent contamination of the process equipment.

4. The space above the oven within the hole will be ventilated through the trench. Thus the covers for the hole and trench will form the secondary confinement barrier for the process.

5. A portable process enclosure will be provided. This enclosure will be stationed over the oven after the MHM has departed in order to prepare for the Hot Treatment Process and will also be stationed over the oven to remove process connections after the process is completed. The process enclosure will also be used to change and package hot traps that are in the trench. The process enclosure will contain tele-operated manipulators so that the operator using CCTV guidance can reach down into the oven hole to place fixtures, make MCO valve connections, and place insulation cover pieces. The enclosure will contain the hoist required to lift the oven hole lid and place it out of the way. The enclosure will also include equipment such as a helium leak detector, a welder, drum-out port, etc. needed to complete the process. The thickness of the cell walls and the selection of window materials and thickness will be determined by radiation exposure analysis. An important function of the enclosure is to provide secondary confinement for the process when the oven hole top is off. The air drawn through the trench will create a negative pressure and airflow in the enclosure when it is parked over the oven.

It is expected that six (6) of the HTP stations will be required to meet the throughput requirements.

The overall sequence of operations is given in block flow diagram form on drawing SK-2-300411. A summary of the sequence is :

1. The MHM moves in, opens the hole, places the MCO into the oven, closes the hole, and leaves.
2. The process enclosure is moved in and parked over the hole.
3. The hole cover is pulled and the manipulator is used to install the top of oven parts and the MCO process connections.
4. The hole cover is replaced and the process enclosure is moved away.
5. The treatment process is run and controlled from the CSB control room via computer.
6. The process enclosure is returned after the process is complete.
7. The hole is opened, the process connections and oven parts are removed, the cover is placed and welded, the traps are replaced if necessary and packaged for waste shipment, and the hole cover is replaced.
8. The process enclosure is removed.
9. The MHM moves in, pulls the MCO, and places it in storage.

B. Hot Vacuum Drying Equipment Radiation Hazards

There are two important radiation sources associated with the hot vacuum drying process. The principle source will be the MCO filled with spent nuclear fuel. The shielding integral to the MHM and oven will reduce the dose to relatively low levels in the area that the workers will occupy during the hot vacuum drying process. The second source will be the process equipment. Fission products from leaking fuel and activation products will accumulate in the process equipment, creating a source. This is anticipated to be significantly below the radiation levels at the top of the MCO during the connect/disconnect operations.

4.0 RADIATION SAFETY DESIGN

DOE Order 5480.11 paragraph 9.j addresses Design and Control. The means for maintaining exposures ALARA are to be through physical controls - confinement, ventilation, remote handling and shielding. Administrative and procedural controls provide supplemental means of controlling exposure and maintaining exposures ALARA.

In the design phase, the following objectives shall be applied:

A. Optimization. Optimization principles, as discussed in ICRP Publication 37, shall be utilized in developing and justifying design and physical controls.

B. External Exposure should not exceed 2.5 mrem/hr on the average.

C. Internal Exposure should be limited to zero under normal operating conditions.

D. Maintenance. Ease of maintenance, decontamination and decommissioning shall be considered in the facility design and selection of materials.

Radiation Exposure shall be monitored, recorded and controlled in accordance with the Hanford Site Radiological Control Manual, HSRCM-1.

1. Normal Operations Design

Each process step will be analyzed as part of the analysis. Each step will be characterized by:

- The position of the operator(s)
- The dose rate contribution from the MCO
- The dose rate contribution from the process equipment
- The amount of operator time anticipated
- The total operator dose attributable to performing the step
- A description of potential ingestion paths
- A description of mitigating features incorporated in the design or recommended

The total dose for the process will be estimated by summing the expected dose calculated for each step of the process.

The dose rates at various distances from the MCO as well as dose rates for spots of lesser shielding (MCO nozzle locations) have been previously calculated. If the dose rate for any specific location has not been determined by the provided calculations, these will need to be calculated using a conservative model for the source.

The dose to any given worker by the HCSE will be determined by the staff size, the extent of cross training allowing for rotation of tasks, and the rotation among shifts. An operating staff plan will be developed during detailed design. Radiation exposure considerations may be used in developing the plan in order to determine how tasks will be grouped for training and assignment. Local and temporary shielding features will be planned and implemented so that the staff is not increased (beyond the amount that would be planned if there were no radiation exposure limitation) for the purposes of spreading the dose.

Airborne release may occur when MCO connections are made or broken. The process enclosure and ventilation design features will be used to capture any releases that may occur.

2. Maintenance Design

The process flow diagrams and equipment design will be reviewed on a component by component basis during the definitive design to assess likely modes of failure and the implied maintenance/repair activities. Routine maintenance activities will be addressed as well. Each of the anticipated activities will be described, exposure rates will be estimated, and activity durations will be estimated. The combination of these estimates will yield a maintenance exposure estimate for the most likely occurrences. Design features such as temporary shielding, decontamination, or mechanical assistance/ special tools incorporated in the design to reduce the activity time will be described. Control of airborne and releasable contamination will be planned for the maintenance activities. Local or temporary ventilation may be incorporated in the design.

3. Radiation Monitoring Instrumentation

Radiation monitoring and alarm instrumentation will be located at key locations around the process. The design will include source specific radiation detectors to monitor build-up of material in the system (such as on the filters). These will be used to determine when system cleaning or filter changes are required. The design will include ionization detectors in the area where staff is working to monitor the radiation field and to warn of unacceptable dose rate. The design will include Continuous Air Monitors (CAMs) capable of detecting airborne particles that emit alpha or beta radiation. These will be located at strategic points near potential release points.

5.0 LESSONS LEARNED PROGRAM

One of the greatest potentials for reducing dose is the application of lessons learned from operational experience. The lessons learned from Duke Power Company's Oconee Nuclear Station during the process of loading and storing casks of spent nuclear fuel into the Independent Spent Fuel Storage Installation (ISFSI) on-site at the station will be considered. Other commercial nuclear facilities such as Arkansas Nuclear One, Palisades, and Surry that may have lessons learned will be investigated in the design phase of this project. The experience at these plants is likely to show system modification and optimization actions that have reduced radiation exposure. The crews performing the operation for the first casks will be debriefed immediately after the operation to determine what may be done to improve the efficiency of the process. The ideas from these crews will provide the information necessary to modify equipment and procedures to improve efficiency and thus reduce dose. A video tape of the process will be made. It will be reviewed for additional improvements by others not directly involved in the actual process. Video taping later cold vacuum drying processes after modifications have been implemented will also aid in training additional workers.

APPENDIX C

SHIELDING AND RADIATION EXPOSURE ANALYSIS

APPENDIX C - SHIELDING AND RADIATION EXPOSURE ANALYSIS

SHIELDING AND RADIATION EXPOSURE ANALYSIS
for the
HOT CONDITIONING SYSTEM EQUIPMENT
of the
K-BASIN SPENT NUCLEAR FUEL STORAGE PROJECT

1.0 INTRODUCTION

The purpose of this analysis is to evaluate the radiation exposure received by workers during each step of the hot vacuum drying process, and to determine the total cumulative exposure (person-rem) for the process. The results of this analysis will be used during the detailed design phase of the Hot Conditioning System Equipment (HCSE) to reduce exposure where appropriate, in keeping with the ALARA (As Low As Reasonably Achievable) principle.

The radiological design of the HCSE will incorporate the criteria specified in the applicable orders, regulations, and publications listed in the Performance Specification for the Spent Nuclear Fuel Hot Vacuum Conditioning Equipment, WHC-S-0460, Rev. A. Also, the facility will be designed in accordance with the following documents: HSRCM-1, Hanford Site Radiological Control Manual; WHC-SC-GN30011, Radiological Design Guide; 10CFR835, Occupational Radiation Protection; DOE Order 6430.1A, General Design Criteria; and the ALARA Implementation Plan for the K-Basin Spent Fuel Storage Project.

This analysis will be updated during the detailed design of the HCSE to ensure that the radiological design criteria for the facility are met.

2.0 SUMMARY

The total exposure received from processing one MCO in the HCSE is approximately 80 person-mrem (0.080 person-rem). This number is based on the average shielding source term and assumes one inch of steel shielding integral to the hot cell enclosure.

3.0 DISCUSSION

3.1 Methodology

All activities to be performed are listed in Table 1. These activities are from the Hot Conditioning System Equipment Block Flow Diagram, SK-2-

300-411, Reference 1. Each activity was evaluated to determine if the location at which the activity is to be performed would result in any radiation exposure to the personnel performing that specific activity. If it was determined that there would be exposure from that activity, the location and dose rate associated with that location was listed in Table 1 for that activity. The estimated dose rate for each location was calculated from source term information from Reference 2. The workforce and time required to perform each exposure activity was estimated and the frequency of each activity was determined from the Block Flow Diagram. These values are listed in Table 2. The exposure (person-mrem) for each activity was then calculated and those were summed to determine the total exposure from processing one cask.

3.2 Assumptions

It is conservatively assumed that 100% of the duration for each activity is spent in the radiation field.

One inch of steel shielding is assumed to be incorporated in the process enclosure design.

Tasks performed over the top of the Multi-Canister Overpack (MCO) are performed with manipulators inside the process enclosure. This is required because the streaming dose rate directly over the annular space between the cask and MCO is estimated to be on the order of 1500 mrem/hr.

3.3 Results

The exposures for each process task are given in Tables 1 and 2.

The total exposure received from processing one MCO in the HCSE is approximately 80 person-mrem (0.080 person-rem). This number is based on the average shielding source term and assumes one inch of steel shielding integral to the hot cell enclosure.

The dose budget for the HCSE is 49.0 person-rem (Reference 3). The total dose budget for welding in the K-Basins Spent Nuclear Fuel Project is 30.0 person-rem (Reference 3). Assuming the welding budget can be split between the Cold and Hot Conditioning Projects, the total available dose budget for HCSE is 64.0 person-rem. Assuming a total of 400 MCOs, the total exposure for HCSE is approximately 32.0 person-rem. While this is well within the dose budget, it does not include exposure from airborne activity in the CSB. This exposure issue must be evaluated and included in the exposure analysis during the definitive design phase of the HCSE.

While the calculated total exposure is within the dose budget, it is likely now as low as reasonably achievable (ALARA) when considering that the oven shielding design is not optimized due to the unresolved interface details with the MCO design. Also, the current analysis indicates that the 0.25 mrem/hr general area dose rate criteria for the floor area is not met. Additional shielding will be incorporated into the oven design and the process enclosure design during the definitive design to ensure that dose rate criteria are met and that exposures are ALARA.

4.0 REFERENCES

1) Drawing SK-2-300411.

2) 3/14/96 Memo from R.A. Schwarz to J.S. Lan regarding Neutron and Photon Source for Safeguards.

3) 4/30/96 Memo from J.A. Swenson, Manager, Project Integration regarding Individual Design Project Target Cumulative Dose Values for the Spent Nuclear Fuel Project.

Table 1

Exposure Locations and Dose Rates

Action	Exposure Activity?	Exposure Location	Dose Rate (mrem/hr)
Select Oven	No	N/A	N/A
Move in the MHM	Yes	Oven Deck Area	2.0
Lower MCO into Oven	Yes	Oven Deck Area	2.0
Remove the MHM	Yes	Oven Deck Area	2.0
Move in Process Enclosure	Yes	Oven Deck Area	2.0
Connect Process Enclosure	Yes	Oven Deck Area	2.0
Open Process Pit	Yes	Process Enclosure Control Station	5.0
Place Annulus Cover	Yes	Process Enclosure Control Station	5.0
Attach Annulus Cover	Yes	Process Enclosure Control Station	5.0
Remove Port Cover	Yes	Process Enclosure Control Station	5.0
Install Vent Cover	Yes	Process Enclosure Control Station	5.0
Install Valves	Yes	Process Enclosure Control Station	5.0
Open Valves	Yes	Process Enclosure Control Station	5.0
Evacuate MCO	No	N/A	N/A
Fill MCO with Helium	No	N/A	N/A
Leak Check Ports	Yes	Process Enclosure Control Station	5.0
Close Bad Valve	Yes	Process Enclosure Control Station	5.0
Disconnect Valve	Yes	Process Enclosure Control Station	5.0
Clean Port	Yes	Process Enclosure Control Station	5.0
Install Reserve Valve	Yes	Process Enclosure Control Station	5.0
Install Insulation Cover	Yes	Process Enclosure Control Station	5.0
Close Process Pit	Yes	Process Enclosure Control Station	5.0
Perform Heat-up Cycle	No	N/A	N/A
Survey Process Enclosure	Yes	Process Enclosure Control Station	5.0
Disconnect Process Enclosure	Yes	Oven Deck Area	2.0
Remove Process Enclosure	Yes	Oven Deck Area	2.0
Purge/Vacuum Cycle	No	N/A	N/A
Perform Acceptance Test	No	N/A	N/A
Cool for Pasivation	No	N/A	N/A
Evacuate MCO	No	N/A	N/A
Fill with Passivation Gas	No	N/A	N/A
Passivation Period	No	N/A	N/A
Cool Down	No	N/A	N/A
Evacuate MCO	No	N/A	N/A
Fill MCO with Helium	No	N/A	N/A
Move in Process Enclosure	Yes	Oven Deck Area	2.0
Connect Process Enclosure	Yes	Oven Deck Area	2.0
Open Process Pit	Yes	Process Enclosure Control Station	5.0
Remove Insullation Cover	Yes	Process Enclosure Control Station	5.0
Close Valves	Yes	Process Enclosure Control Station	5.0
Disconnect Valves	Yes	Process Enclosure Control Station	5.0
Place Weld-on Cover	Yes	Process Enclosure Control Station	5.0
Install Welder	Yes	Process Enclosure Control Station	5.0
Weld Root Pass	No	N/A	N/A
Visual Inspection	Yes	Process Enclosure Control Station	5.0
Clean Weld	Yes	Process Enclosure Control Station	5.0

Table 1

Exposure Locations and Dose Rates

Action	Exposure Activity?	Exposure Location	Dose Rate (mrem/hr)
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Apply Dye	Yes	Process Enclosure Control Station	5.0
Soak	No	N/A	N/A
Remove Dye	Yes	Process Enclosure Control Station	5.0
Apply Developer	Yes	Process Enclosure Control Station	5.0
Bleed	No	N/A	N/A
Inspect	Yes	Process Enclosure Control Station	5.0
Clean	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Make Cover Pass 1	No	N/A	N/A
Visual Inspection	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Make Cover Pass 2	No	N/A	N/A
Visual Inspection	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Make Cover Pass 3	No	N/A	N/A
Visual Inspection	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Make Cover Pass 4	No	N/A	N/A
Visual Inspection	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Apply Dye	Yes	Process Enclosure Control Station	5.0
Soak	No	N/A	N/A
Remove Dye	Yes	Process Enclosure Control Station	5.0
Apply Developer	Yes	Process Enclosure Control Station	5.0
Bleed	No	N/A	N/A
Inspect	Yes	Process Enclosure Control Station	5.0
Clean	Yes	Process Enclosure Control Station	5.0
Grind	Yes	Process Enclosure Control Station	5.0
Repair Weld	Yes	Process Enclosure Control Station	5.0
Remove Welder	Yes	Process Enclosure Control Station	5.0
Remove Trap	Yes	Process Enclosure Control Station	5.0
Install New Trap	Yes	Process Enclosure Control Station	5.0
Connect Waste Drum	Yes	Process Enclosure Control Station	5.0
Remove Top Shield	Yes	Process Enclosure Control Station	5.0
Dispose Hot Trap	Yes	Process Enclosure Control Station	5.0
Insert Top Shield	Yes	Process Enclosure Control Station	5.0
Tie Bag	Yes	Process Enclosure Control Station	5.0
Close Drum	Yes	Process Enclosure Control Station	5.0
Undo Annulus Cover	Yes	Process Enclosure Control Station	5.0

Table 1

Exposure Locations and Dose Rates

Action	Exposure Activity?	Exposure Location	Dose Rate (mrem/hr)
Remove Annulus Cover	Yes	Process Enclosure Control Station	5.0
Close Process Pit	Yes	Process Enclosure Control Station	5.0
Survey Process Enclosure	Yes	Process Enclosure Control Station	5.0
Disconnect Process Enclosure	Yes	Oven Deck Area	2.0
Remove Process Enclosure	Yes	Oven Deck Area	2.0
Move in the MHM	Yes	Oven Deck Area	2.0
Pull the MCO	Yes	Oven Deck Area	2.0
Remove the MHM	Yes	Oven Deck Area	2.0
Prepare for next MCO	No	N/A	N/A

Table 2

Exposure per MCO

Action	Exposure Activity?	Workforce	Duration (min.)	Frequency (per Cask)	Dose Rate (mrem/hr)	Exposure (person mrem)
Select Oven	No	N/A	N/A	N/A	N/A	—
Move in the MHM	Yes	2	10	1.0	2.0	0.7
Lower MCO into Oven	Yes	2	10	1.0	2.0	0.7
Remove the MHM	Yes	2	10	1.0	2.0	0.7
Move in Process Enclosure	Yes	2	15	1.0	2.0	1.0
Connect Process Enclosure	Yes	2	5	1.0	2.0	0.3
Open Process Pit	Yes	1	10	1.0	5.0	0.8
Place Annulus Cover	Yes	1	10	1.0	5.0	0.8
Attach Annulus Cover	Yes	1	10	1.0	5.0	0.8
Remove Port Cover	Yes	1	15	1.0	5.0	1.3
Install Vent Cover	Yes	1	5	1.0	5.0	0.4
Install Valves	Yes	1	10	1.0	5.0	0.8
Open Valves	Yes	1	15	1.0	5.0	1.3
Evacuate MCO	No	N/A	N/A	N/A	N/A	—
Fill MCO with Helium	No	N/A	N/A	N/A	N/A	—
Leak Check Ports	Yes	1	15	1.1	5.0	1.4
Close Bad Valve	Yes	1	5	0.1	5.0	0.0
Disconnect Valve	Yes	1	5	0.1	5.0	0.0
Clean Port	Yes	1	5	0.1	5.0	0.0
Install Reserve Valve	Yes	1	5	0.1	5.0	0.0
Install Insulation Cover	Yes	1	5	1.0	5.0	0.4
Close Process Pit	Yes	1	5	1.0	5.0	0.4
Perform Heat-up Cycle	No	N/A	N/A	N/A	N/A	—
Survey Process Enclosure	Yes	2	30	1.0	5.0	5.0
Disconnect Process Enclosure	Yes	2	5	1.0	2.0	0.3
Remove Process Enclosure	Yes	2	15	1.0	2.0	1.0
Purge/Vacuum Cycle	No	N/A	N/A	N/A	N/A	—
Perform Acceptance Test	No	N/A	N/A	N/A	N/A	—
Cool for Passivation	No	N/A	N/A	N/A	N/A	—
Evacuate MCO	No	N/A	N/A	N/A	N/A	—
Fill with Passivation Gas	No	N/A	N/A	N/A	N/A	—
Passivation Period	No	N/A	N/A	N/A	N/A	—
Cool Down	No	N/A	N/A	N/A	N/A	—
Evacuate MCO	No	N/A	N/A	N/A	N/A	—
Fill MCO with Helium	No	N/A	N/A	N/A	N/A	—
Move in Process Enclosure	Yes	2	15	1.0	2.0	1.0
Connect Process Enclosure	Yes	2	5	1.0	2.0	0.3
Open Process Pit	Yes	1	10	1.0	5.0	0.8
Remove Insulation Cover	Yes	1	5	1.0	5.0	0.4
Close Valves	Yes	1	15	1.0	5.0	1.3
Disconnect Valves	Yes	1	10	1.0	5.0	0.8
Place Weld-on Cover	Yes	1	10	1.0	5.0	0.8
Install Welder	Yes	1	20	1.0	5.0	1.7
Weld Root Pass	No	N/A	N/A	N/A	N/A	—
Visual Inspection	Yes	1	10	1.1	5.0	0.9
Clean Weld	Yes	1	10	1.1	5.0	0.9

Table 2

Exposure per MCO

Action	Exposure Activity?	Workforce	Duration (min.)	Frequency (per Cask)	Dose Rate (mrem/hr)	Exposure (person mrem)
Grind	Yes	1	15	0.1	5.0	0.1
Repair Weld	Yes	1	15	0.1	5.0	0.1
Apply Dye	Yes	1	10	1.1	5.0	0.9
Soak	No	N/A	N/A	N/A	N/A	—
Remove Dye	Yes	1	15	1.1	5.0	1.4
Apply Developer	Yes	1	10	1.1	5.0	0.9
Bleed	No	N/A	N/A	N/A	N/A	—
Inspect	Yes	1	5	1.1	5.0	0.5
Clean	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	0.1	5.0	0.1
Repair Weld	Yes	1	15	0.1	5.0	0.1
Make Cover Pass 1	No	N/A	N/A	N/A	N/A	—
Visual Inspection	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	1.1	5.0	1.4
Repair Weld	Yes	1	15	1.1	5.0	1.4
Make Cover Pass 2	No	N/A	N/A	N/A	N/A	—
Visual Inspection	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	1.1	5.0	1.4
Repair Weld	Yes	1	15	1.1	5.0	1.4
Make Cover Pass 3	No	N/A	N/A	N/A	N/A	—
Visual Inspection	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	1.1	5.0	1.4
Repair Weld	Yes	1	15	1.1	5.0	1.4
Make Cover Pass 4	No	N/A	N/A	N/A	N/A	—
Visual Inspection	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	1.1	5.0	1.4
Repair Weld	Yes	1	15	1.1	5.0	1.4
Apply Dye	Yes	1	10	1.1	5.0	0.9
Soak	No	N/A	N/A	N/A	N/A	—
Remove Dye	Yes	1	15	1.1	5.0	1.4
Apply Developer	Yes	1	10	1.1	5.0	0.9
Bleed	No	N/A	N/A	N/A	N/A	—
Inspect	Yes	1	5	1.1	5.0	0.5
Clean	Yes	1	10	1.1	5.0	0.9
Grind	Yes	1	15	0.1	5.0	0.1
Repair Weld	Yes	1	15	0.1	5.0	0.1
Remove Welder	Yes	1	15	1.0	5.0	1.3
Remove Trap	Yes	1	60	1.0	5.0	5.0
Install New Trap	Yes	1	60	1.0	5.0	5.0
Connect Waste Drum	Yes	1	30	1.0	5.0	2.5
Remove Top Shield	Yes	1	10	1.0	5.0	0.8
Dispose Hot Trap	Yes	1	10	1.0	5.0	0.8
Insert Top Shield	Yes	1	10	1.0	5.0	0.8
Tie Bag	Yes	1	15	1.0	5.0	1.3
Close Drum	Yes	1	10	1.0	5.0	0.8
Undo Annulus Cover	Yes	1	10	1.0	5.0	0.8

Table 2

Exposure per MCO

Action	Exposure Activity?	Workforce	Duration (min.)	Frequency (per Cask)	Dose Rate (mrem/hr)	Exposure (person mrem)
Remove Annulus Cover	Yes	1	5	1.0	5.0	0.4
Close Process Pit	Yes	1	5	1.0	5.0	0.4
Survey Process Enclosure	Yes	2	30	1.0	5.0	5.0
Disconnect Process Enclosure	Yes	2	5	1.0	2.0	0.3
Remove Process Enclosure	Yes	2	15	1.0	2.0	1.0
Move in the MHM	Yes	2	10	1.0	2.0	0.7
Pull the MCO	Yes	2	10	1.0	2.0	0.7
Remove the MHM	Yes	2	10	1.0	2.0	0.7
Prepare for next MCO	No	N/A	N/A	N/A	N/A	—
			Total Exposure per MCO			80.2

APPENDIX D

OPERATIONS AND MAINTENANCE PHILOSOPHY

APPENDIX D - OPERATIONS AND MAINTENANCE PHILOSOPHY

OPERATIONS AND MAINTENANCE PHILOSOPHY
for the
HOT CONDITIONING SYSTEM EQUIPMENT
of the
K-BASIN SPENT NUCLEAR FUEL STORAGE PROJECT

1.0 INTRODUCTION

The purpose of this document is to set forth operating and maintenance philosophies to guide the Hot Conditioning System Equipment (HCSE) design and operations planning process. In the modern DOE nuclear facility project environment, the transition from the engineering/construction phase of the project to operations is critical to project success. It is essential that this transition be planned, that safety documentation including a SAR and TSRs are complete when needed, that operations testing procedures be written, that staff is hired and trained before while construction is ongoing so that they are ready to take the reigns when the facility is ready, and that an appropriate Operations Readiness verification process as required by DOE 5480.31 and guided by DOE STD-3011 is completed smoothly. This philosophy document is a first step in the process of planning for operations.

The operations and maintenance philosophy for the HCSE should reflect the following facts about the facility:

A. The HCSE is located in the Canister Storage Building (CSB). The facility is a nuclear facility. It must be operated with the rigor and controls normally associated with a nuclear facility. Only qualified, trained radiation workers shall be allowed into the facility. Workers will wear protective clothing when required (routine operational activities will not require protective clothing). There will be personnel radiation monitoring programs. Areas of potential contamination or radiation fields will be specially controlled, etc.

B. The radiation dose of a given worker will be administratively controlled per HSRCM-1.

C. The active processing life of the equipment is scheduled to be 2 years with a 10 year design life for the equipment and a 75 year design life for the HCSE annex to the CSB.

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D. The project is schedule driven. Payment is determined by meeting work-off milestones. Lost time for responding to abnormal drying conditions or results, and for repairing essential components must be minimized. The design team needs to attempt to plan for the most likely upsets and incorporate "work arounds" into the design process.

2.0 INDEPENDENCE OF OPERATIONS IN THE HCSE

The HCSE will be designed to have independent process ovens that will allow for the drying of more than one MCO simultaneously. Each oven will have its own ventilation system, its own drying system, and its own control station in the CSB control room. Redundancy of key components should be a design strategy where a central service feeds all ovens (chilled water for example) so that its failure could potentially take the entire facility out of service for a duration greater than a single shift. The decision driver during design of the facility regarding provision of redundant components should be consideration of lost process time.

3.0 EQUIPMENT SELECTION AND DEVELOPMENT

The drying process equipment will be a collection of common commercial components arranged on a skid, connected by pipes and conduits. The equipment should be selected for operations in a radiation field and a contaminated environment. Typical features of equipment suitable for this type of service are:

A. Minimize the use of rubbers, plastics, and polymers that degrade as a result of radiation damage.

B. Sealed equipment, with secondary seals, where contaminated leakage may occur.

C. Avoid equipment that requires oil changes or greasing.

D. Smooth, impervious surfaces that allow for decontamination.

E. Easy replacement (as opposed to repair in place) - flange or union connections, clamp hold-downs, electrical and signal cable plugs, etc.

F. Sealed bagging schemes should be utilized where regular change-outs will be required - MCO connectors, filters.

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G. A high degree of reliability should be required. Mean time between failure data should be requested from potential component vendors. The goal will be to assure that all components have at least a 90% likelihood of operating for the design life without a failure.

H. Components potentially requiring maintenance or replacement in the oven should be designed for remote manipulator replacement, if possible. Contact maintenance of this equipment would only be possible after removal of the MCO and shielding or removal of accumulated dose contributors such as contaminated process lines, cold traps, and filters.

The equipment arrangement on the skids should allow for easy accesses to components. Clearances should be checked during the detail design to assure that reasonable paths for component access and removal exist, that allowance has been made for bags and tents that may be used to limit the spread of contamination when a component is being used, and that lifting aids can access the maintenance activity when a component may be too heavy to be lifted manually. Items requiring frequent access, such as filters should be located conveniently near an outer edge of the skid. Shielding that may surround some components (filters for example) should be modular and should be easily moved or swung out of the way (hinged).

Equipment should be selected to minimize manual operation or verification. A primary design goal is to minimize the presence of staff in the processing area where they may be exposed to radiation. The operation and status monitoring of the drying system and components should be accomplished from a remote control room. Sensor failure and repair is a potential negative impact that must be considered as the design is developed.

The process equipment system should contain radiation monitors for points in the system where radioactive material may accumulate, such as filters. These monitors should be used to determine when filters are to be changed.

An important goal is to limit the spread of radioactive contamination to the maximum extent possible. Ideally all contamination would be trapped in the MCO or within the first few feet of process line immediately above the MCO. Filters are to be installed to accomplish this goal. Contamination may be released and spread when MCO connections are made and broken. A connection design that incorporates an operations within a bag technique are to be implemented to contain potential releases. The process enclosure will contain any contaminated air that may be present in the area.

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Ventilation system HEPA filters that may become contaminated shall include a bag-in/bag-out filter changing system that will allow filter changes without release of contamination and without shutting down the ventilation system. HEPA filters will be equipped with DOP test capability so that their efficiency can be certified while in operation.

4.0 RADIATION SAFETY AND EXPOSURE CONTROL

The administrative radiation exposure limitation for the HCSE will be per HSRCM-1. Preliminary exposure estimates suggest that this can be achieved through a combination of shielding near the MCO integral to the oven assembly, and shielding provided by the process pit covers and the process enclosure. Detailed operations recipes need to be written for each activity to assess whether it is reasonable to reduce exposure estimates. The operations staff must be thoroughly cross trained so that they can be rotated among all the jobs in the facility. Also, the operations scheduling must distribute the steps where doses are received among all shifts and days uniformly (in other words an MCO received on Friday evening may be held until Saturday afternoon so that the dose loading of all staff is uniform).

In order to promote cross training of staff so that they can perform several functions, the design should attempt to minimize actions requiring decisions or actions by the staff. The use of Process Logic Controller software and simplified user friendly control screens are techniques to be used to reduce dependence on specialized training. The implementation of a human factors engineering program in the detailed design (as required by DOE 6430.1A) can also contribute to increasing operator flexibility.

The following radiation safety features will be provided in the HCSE to aid in operating the facility:

4.1 Emergency Respiratory Protection

The facility shall be capable of providing as emergency devices only respiratory protection equipment that has been specifically certified or had certification extended for emergency use by NIOSH/MSHA. 10 CFR 20.1703©

4.2 Radiological Alarm System

Radiological alarm systems shall be provided in accessible work areas as appropriate to warn operating personnel of radiation and airborne radioactive material concentrations above a given set point and of

concentrations of radioactive material in effluent above control limits.
10 CFR 72.126(b)

Radiation alarm systems shall be designed with provisions for calibration and testing their operability.
10 CFR 72.126(a), (b)

Set points shall be established to ensure that exposures are kept below the allowable limits.
10 CFR 72.126(a), (b)

4.3 Direct Radiation Monitoring

Areas containing radioactive materials shall be provided with systems for measuring the direct radiation levels in and around these areas.
10 CFR 72.126(c)(2)

The facility shall provide capability to monitor the external surfaces of a package known to contain radioactive material for radioactive contamination and radiation levels if the package is labeled as containing radioactive material; or has evidence of potential contamination, such as packages that are crushed, wet, or damaged.
10 CFR 20.1906(b)

4.4 Effluent Monitoring

The facility shall monitor the amount of radionuclides in effluents during normal and off-normal conditions.
10 CFR 72.126(c)(1)

Systems designed to monitor the release of radioactive materials shall have means to calibrate and test their operability.
10 CFR 72.126(d)

4.5 Airborne Radioactive Material Control

The design of the facility shall use, to the extent practicable, process or other engineering controls (e.g., containment or ventilation) to control the concentrations of radioactive material in air.
10 CFR 20.1701

When it is not practical to apply process or other engineering controls to control the concentrations of radioactive material in the air to values

below those that define an airborne radioactivity area, the design of the facility shall, consistent with maintaining the total effective dose equivalent ALARA, have the capability to increase monitoring and limit intakes by: control of access, limitation of exposure times, use of respiratory protection equipment, or other controls.
10 CFR 20.1702

4.6 Personnel Dosimeters

The facility shall provide capability for processing and evaluating all personnel dosimeters that require processing to determine the radiation dose, and that are used by the facility to comply with 10 CFR 20.1201 or with conditions specified in the facility license. this capability does not apply to direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities.
10 CFR 20.1501(c)(1), (2)

4.7 Shielding and Protective Clothing

Normally Occupied Areas. The shielding design basis shall limit the maximum exposure to an individual worker to one-fifth of the annual occupational external exposure limits. Within this design basis, personnel exposures must be maintained ALARA. Specifically, the shielding must be designed with the objective of limiting the total EDE (Effective Dose Equivalent) to less than one rem per year to workers, based on their predicted exposure time in the normally occupied area. The EDE is the sum of all contributing external penetrating radiation (gamma and neutron). In addition, appropriate shielding must be installed, if necessary, to minimize non penetrating external radiation exposures to the skin and lens of the eye of the worker. In most cases, the confinement barrier or process equipment provides this shielding.
DOE Order 6430.1 1300-6.2

Intermittently Occupied Areas. Shielding and other radiation protection measures shall be provided for areas requiring intermittent access, such as for preventive maintenance, component changes, adjustment of systems and equipment, and so forth, so that the projected dose rates based on occupancy, time, and frequency of exposure do not exceed one rem per year.
DOE Order 6430.1 1300-6.2

Concrete radiation shielding design shall comply with ANS 6.4 and ACI 349 where it provides a critical confinement or structural function.
ANSI/ANS 6.4 Sec. 1
ACI 349 Pt. 1 Sec. 1.1
DOE Order 6430.1 1300-6.2

Concrete radiation shielding design shall consider the material specifications of ANS 6.4.2 where it provides a critical confinement or structural function.
ANSI/ANS-6.4.2 Sec. 1
DOE Order 6430.1 1300-6.2

ACI 318 shall be considered for radiation shields, used for other than critical confinement or structural function, since ACI 318 is appropriate and provides adequate strength for design earthquake (DE) loads.
ANSI/ACI-318 Pt. 1 Sec. 1.1.1
DOE Order 6430.1 1300-6.2

Penetrations. Straight line penetration of shield walls shall be avoided to prevent radiation streaming.
DOE Order 6430.1 1300-6.2

4.8 Remote Shield Operation

Remote shielded operation (i.e., with remote handling equipment such as remote manipulators) shall be considered where it is anticipated that exposures to hands and forearms would otherwise approach the dose guidance in Section 3.2.2 or where contaminated puncture wounds could occur.
DOE Order 6430.1 1300-6.3

4.9 Posting

The facility shall be posted with radiation area, contamination area, and airborne contamination area signs in accordance with federal law.
10 CFR 20.1902(a), (b), (c), (d)

5.0 MAINTENANCE PHILOSOPHY

Generally, and to the maximum extent possible, equipment should be selected that will not require routine maintenance during the processing lifetime of the HCSE. Equipment with a high degree of reliability should be chosen to reduce the likelihood of breakage. Policy such as requesting warranties and reviewing

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failure data should be instituted when selecting equipment in order to improve reliability. When repair is needed it should be accomplished by replacement of defective components (ie, pump) instead of repair in place procedures (ie. Pump bearing rebuild). Equipment system designers should recommend a spare components list to be kept on site and should attempt to select components that can be obtained from manufacturers in 24 hours should an emergency arise.

Maintenance or repair of contaminated items is a particularly hazardous activity because it is not a routine operation that can be included in the training program and because it involves opening a path between the contaminated equipment interior cavity and inhabited space. Provision must be made in the design anticipating the use of bags and tents for contamination control. Provision should also be made for temporary shielding and for lifting assistance.

6.0 OPERATIONS READINESS VERIFICATION

DOE 5480.31 requires that a new nuclear facility undergo an Operations Readiness verification process (either an ORR or ORA depending on the nature of the facility and its associated hazards). The extent of the verification process is to be determined by the nuclear safety issues associated with the facility. The facility will be considered an HC-2 facility with low potential for severe accidents. There are three operations program activities that must be accomplished prior to initiating the verification process. First, an Operations Readiness plan must be written and approved by whatever review agency (DOE - HQ, DOE - RL, WHC) is required to certify readiness. Second, test procedures must be prepared so that the verification can be conducted. Third, staff must be trained so that they can demonstrate readiness.

The engineering team should support this process as follows:

A. Write System Design Descriptions (SDDs) with thorough operating recipes included.

B. Write the Operations Readiness Plan draft.

C. Write the test procedures.

Writing these documents in conjunction with the design development/construction will help to assure that the design has the appropriate features to support the facility operations.

APPENDIX D - OPERATIONS AND MAINTENANCE PHILOSOPHY

7.0 OPERATIONS SUPPORT

The HCSE will share operations support functions with the CSB.

APPENDIX E

PERFORMANCE SPECIFICATIONS REPORT

APPENDIX E - PERFORMANCE SPECIFICATIONS REPORT

UNDERSTANDING OF K-BASIN SPENT NUCLEAR FUEL HOT VACUUM CONDITIONING EQUIPMENT PERFORMANCE SPECIFICATIONS REPORT

1.0 INTRODUCTION

The objectives of the Department of Energy (DOE) at Hanford include cleanup of the site, protecting the health and safety of workers and the public, and protecting the environment. The cleanup will be accomplished in accordance with the Hanford Federal Facility Agreement and Consent Order (the Tri Party Agreement), and in compliance with applicable Federal, State, local laws, and American Indian Treaty Rights. The Hanford cleanup must also comply with DOE policies and directives.

The Hot Vacuum Conditioning Equipment (HVCE) Subproject is an important step in the cleanup of Spent Nuclear Fuel (SNF). In order for the HVCE to safely and efficiently accomplish its functions, the equipment designer must have a complete understanding of the functions and performance requirements of the equipment. The Performance Specification for the Spent Nuclear Fuel Hot Vacuum Conditioning Equipment, WHC-S-0460 Rev. A, March 11, 1996, states the intended functional design and performance specifications for the HVCE. These specifications provide the basis for the design, operation, and monitoring of the process and equipment. The Performance Specification also identifies federal, state, and local regulations that may be applicable to the design basis for the HVCE.

The scope of this evaluation is to: (a) demonstrate Merrick's understanding of the performance specifications for the HVCE that must be reflected in the equipment design and (b) demonstrate Merrick's understanding of regulations that impact design of the HVCE.

2.0 IDENTIFICATION OF FUNCTIONS AND PERFORMANCE SPECIFICATIONS

Hot vacuum conditioning of SNF is the last of several processes to be performed to package the spent fuel for transportation, interim dry storage, and eventual final disposition. The HVCE provides the system to remove chemically bound water (by heat and vacuum) from SNF, to condition the fuel (decompose uranium hydrides), and to passivate metal fuel (oxidize exposed uranium metal surfaces). The HVCE, as conceived, is multiple modular structures located in the Canister Storage Building. The HVCE consists of a Process Station (heating coils, shielding thermal insulation), a cooling system, measurement and control instrumentation, a Process Module (vacuum pumps, HEPAs, fans, instrumentation), a Combined Ventilation System for process off-gas management, and a Solid Waste Handling System. In the following paragraphs, each conceptual operating phase is described, on the bases of phase duration, process steps, required subsystems, functions of each subsystem, and design points to be controlled.

Receipt. The first operating phase consists of receiving Multi-Canister Overpacks (MCO) from the staging area and placing an MCO into a Process Station (PS). The duration of the receipt operating phase is 8 hours. The system components involved in this operating phase are: a) the multi-canister overpack, which provides primary containment of radionuclides. Allowable external contamination levels for the MCO are not defined in the Performance Specifications; b) The MCO Handling Machine (MHM), which provides secondary containment of radionuclides and shielding of direct radiation. Allowable external contamination levels for the MHM are not defined in the Performance Specifications; shielding performance must result in general room β/γ doses < 0.5 mrem/hr and contact β/γ doses <10 mrem/hr. The MHM also provides the capability to move and manipulate the MCO; however, this capability is not within the scope of this task; c) The MHM Process Station (PS) holds the MCO during processing and provides the support structure for the heating coils and thermal insulation, discussed in the *Heatup* operating phase; and d) The Process Control System (PCS), which has four design points for the operating phase - MCO temperature <140°C as staged or <75°C at receipt, initial H_2 concentration <100 volume %, initial O_2 concentration < 5 volume %, MCO internal pressure approximately 14.7 psia (vented) or <150 psia (as received).

Cool Down for Connection. The second operating phase consists of cooling each received MCO sufficiently to permit initial connection of process piping to the MCO. The duration of this operating phase is 8 hours. The system components involved in this operating phase are: a) The MCO Cooling System (MCS), which draws ambient HEPA-filtered air from the CSB across the outside of the MCO. The initial MCO temperature is ≤140°C and the design point for the final MCO temperature is 40°C (measured at the MCO head, which is the point of greatest thermal mass). The MCS nominal design cooling rate is approximately 10°C/hour, with a maximum cooling rate of <50°C/hour, and a maximum temperature difference between the MCO head and sidewall of 100°C; b) The Combined Ventilation System (CVS), which receives, filters (redundant HEPAs) and discharges the MCS air flows.

Hookup and Purge. This operating phase consists of connecting the inert and oxidizing gas supplies, connecting the conditioning off gas lines, connecting the vacuum lines, and preparing the Process Heating System. The total phase duration is 8 hours. The system components involved in this phase are: a)Process Gas System, supplying inert and oxygen gases; and b) The Vacuum Pumping System.

Heat Up. The next operating phase is heat up of the SNF in an MCO. The duration of this operating phase is 12 hours. The system components involved in this phase are: a) The Process Heating System (PHS), which heats, controls and maintains the temperature of the MCO. The final fuel temperature is 300°C within a range of +50°C, -0°C. The fuel heating rate is 20° C/hour (nominal), 50°C/hour (maximum). The maximum temperature difference between separate points on the MCO is 100°C; b) The Process Gas System (PGS), supplying an inert gas purge at up to 10 SCFM, maintaining a maximum hydrogen concentration of 2 volume %, a nominal oxygen concentration of zero, and a maximum oxygen concentration of 5 volume %; and c) the Vacuum Pumping System (VPS), which maintains an MCO internal pressure of approximately 13 PSIA during this phase.

Drying and UH_3 Decomposition. This operating phase holds the fuel at a high temperature and low pressure for an extended time, thus removing water, decomposing uranium hydrides, and removing the resultant hydrogen. The duration of this phase is 48 hours. The system components involved in this phase are: a) The PHS, which maintains an MCO set point of 350°C, an MCO maximum of 375°C, and a fuel temperature of 300+50,-0°C; b) The PGS, which maintains a purge gas flow rate of up to 10 ACFM, a maximum hydrogen concentration of 2 volume %, a nominal oxygen concentration of zero, and a maximum oxygen concentration of 5 volume %; and c) The VPS, which maintains a final pressure of 0.1 PSIA and a final hydrogen partial pressure of 0.05 PSI.

Cool Down Prior to Partial Oxidation. This operating phase accomplishes a partial cooldown and partial repressurization of the MCO, to prepare for the next operating phase of *Partial Oxidation*. The duration of this phase is 12 hours. The system components necessary for this phase are: a) The MCS, which cools the MCO from 300°C to 150°C at a maximum cooling rate of 50°C/hour. The maximum temperature difference allowable between any two points on the MCO is 100°C; b) The PGS, with a purge rate of up to 10 ACFM, to maintain a maximum hydrogen concentration of 2 volume % (nominal zero) and a maximum oxygen concentration of 5 volume % (nominal zero); and c) The VPS, which achieves and maintains a final MCO internal pressure of approximately 13 PSIA (the rate of pressure change from 0.1 to 13 PSIA is not specified).

Partial Oxidation. This operating phase passivates exposed surfaces of uranium metal by formation of oxides. The duration of this phase is 12 hours. The system components involved are: a) The MCS, only if required to prevent the final fuel temperature from exceeding 250°C, as the oxidation reaction heats the fuel; b) The

PGS, with a gas flow rate of u to 10 SCFM, to maintain a maximum hydrogen concentration of 2 volume % and to achieve a final oxygen concentration of up to approximately 20 volume %; and c) The VPS, to maintain an MCO internal pressure of approximately 13 PSIA.

Final Cool Down. This operating phase cools the MCO containing conditioned and passivated SNF to near ambient temperatures, which allow the final processing phase, *Backfill, Disconnect, Seal*, to be safely accomplished. The duration of this phase is 10 hours. The involved system components are: a)The MCS, which cools the MCO from ≤250°C to 40°C, at a cooling rate of 10°C/hour nominal (50°C/hour maximum, with a maximum MCO temperature delta of 100°C; and b) the PGS, which provides purge gas to achieve final oxygen concentration < 5 volume % and final hydrogen concentration of <2 volume %.

Backfill, Disconnect, Seal. This is the last operating phase of the SNF Hot Vacuum Conditioning and Passivation process. The functions of this step are to backfill the MCO void volume with an inert gas (helium at 99.995 volume % purity) , to disconnect the MCO from process connections, and to weld all MCO openings closed. The estimated duration of this phase is 24 hours. The system component involved in this phase is the PGS, which supplies the backfill helium.

3.0 IDENTIFICATION OF REGULATORY REQUIREMENTS

The Performance Specification outlines the HVCE functions and traces the relationship to the Spent Nuclear Fuel Project (SNFP) through the Work Breakdown Structure (WBS) and organizational block diagrams. The technical requirements and descriptions are organized by WBS number and the associated requirement references are listed.

The requirements listed include Federal, State, and local laws and regulations as well as Westinghouse Hanford Company (WHC) rules and regulations. The functions and requirements in the Performance Specification report implement the requirements set forth in the Spent Nuclear Fuel Program Project Management Plan, which requires management, development, and maintenance of baseline documentation.

The requirements listed in the Performance Specification report mainly consist of the Code of Federal Regulations (CFRs), DOE Orders, Washington State Administrative Codes (WACs) including Revised Codes of Washington (RCW), WHC control manuals (WHC-CM), and other miscellaneous documents.

APPENDIX E - PERFORMANCE SPECIFICATIONS REPORT

The Code of Federal Regulations is a codification of applicable regulations promulgated by an issuing Federal Agency and published in the Federal Register. The Code is divided into 50 titles which represent broad areas subject to Federal Regulations. Each title is divided into chapters which usually bear the name of the issuing agency. Each chapter is further subdivided into several parts to address specific regulations. Historically, CFRs have applied to commercial nuclear reactor facilities but not to Government Owned Contractor Operated (GOCO) sites such as Hanford. The Federal Government desires to provide adequate protection of the public from radioactive material releases associated with normal operations and accident/natural phenomena. To this end, the Congress has legislated that this is generally the responsibility of the DOE where DOE facilities are involved and generally the responsibility of the NRC where commercial facilities are involved. The Congress has further established the DNFSB as the watch dog over the DOE. 10 CFR 30.12 indicates that prime contractors of the DOE are exempt from the regulations to the extent that the contractor working under his prime contract manufactures, produces, transfers, receives, acquires, owns, possesses, or uses byproduct material for the performance of work for the DOE at a GOCO site. The wording very specifically says prime contractors because such contractors operate DOE owned facilities on the DOE's behalf. This exemption applies to the HVCE. The DOE established in the K-Basin Spent Nuclear Fuel Project - Regulatory Policy, dated August 4, 1995, the requirement for the SNFP facilities to achieve "nuclear safety equivalency" comparable to NRC licensed facilities. An evaluation was performed to identify any additional requirements that were needed to supplement the existing and applicable DOE requirements to establish nuclear safety equivalency with the NRC licensed facilities. The additional requirements were consolidated into 29 items. All items are to be implemented per the NRC regulations with the exception of the design earthquake which will be implemented in a manner that established equivalence in safety, as opposed to direct equivalence to the regulation.

The DOE Orders establish policies, guidelines, and requirements for the safe operation and maintenance of DOE owned facilities. Historically, these orders have been considered to be the governing regulations, and not the CFRs, for the DOE GOCO sites. In addition to DOE orders, several supplemental guidance documents, which are specific to Hanford, are also listed in the Performance Specification report.

The Washington Administrative Codes (WACs) and Revised Codes of Washington (RCWs) are compiled by the various agencies of the State of Washington. WACs and RCWs are normally considered to be additional requirements to Federal guidelines rather than as replacements. However, WACs promulgate similar requirements as CFRs for many instances. Hence, compliance with either Federal or State regulations is normally considered adequate. Since 10 CFR 30.12 exempts the HVCE from the CFRs, in this case it is the State regulations that apply.

The goals of WHC are to make the Hanford site a model for environmental management, demonstrate and apply advanced and innovative technologies for cleanup, and restore the land for productive use. To accomplish these goals, WHC has created several control manuals (CMs). The purpose of these control manuals is to establish various compliance requirements and guidelines in conjunction with applicable DOE Orders, and Federal, State, and local laws and regulations.

4.0 CLASSIFICATION OF REQUIREMENTS

DOE Order 6430.1A (General Design Criteria) gives the main requirements needed for the design. The quality assurance requirements are given in 10 CFR Part 830.120. These and other applicable requirements are listed in Appendices A and B. Requirements that do not have any significant direct impact, but may affect the design process, are listed in Appendix C. These requirements are maintained for reference. Although these requirements may not have direct influence on the actual design of the Hot Vacuum Conditioning Equipment, each requirement may impact the design process. The extent of impact will be determined later.

5.0 DESCRIPTION OF APPLICABLE REQUIREMENTS

Five requirements listed in Appendix A are judged to be applicable for the Hot Vacuum Conditioning Equipment design. Of these five, DOE 6430.1A and 10 CFR Part 830.120 are the two significant documents. Detailed descriptions of each of the five requirements are given below.

A. 10 CFR Part 830.120, Quality Assurance

The ten criteria of 10 CFR Part 830.120 prescribe a comprehensive management system for DOE work. The quality management program described in 10 CFR Part 830.120 provides a results-oriented management system that focuses on the customer while providing a method for the organization to become more efficient through constant process improvement. The ten criteria are as follows:

APPENDIX E - PERFORMANCE SPECIFICATIONS REPORT

1. Program: The contractor shall develop and maintain a written Quality Assurance Plan (QAP). The QAP shall describe the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing adequacy of work. The QAP shall describe the contractors management system, including planning, scheduling, and cost control considerations.

2. Personnel Training and Qualifications: Personnel shall be trained and qualified to ensure that they are capable of performing their assigned work. Personnel shall be provided continuing training to ensure that job proficiency is maintained.

3. Quality Improvement: The contractor shall establish and implement processes to detect and prevent quality problems and to ensure quality improvement. Items and processes that do not meet established requirements shall be identified, controlled, and corrected. Correction shall include identifying the causes of problems and preventing recurrence. Item reliability, process implementation, and other quality-related information shall be reviewed and the data analyzed to identify items and processes needing improvement.

4. Documents and Records: Documents shall be prepared, reviewed, approved, issued, used, and revised to prescribe processes, specify requirements, or establish design. Records shall be specified, prepared, reviewed, approved, and maintained.

5. Work Processes: Work shall be performed to establish technical standards and administrative controls. Work shall be performed under controlled conditions using approved instructions, procedures, or other appropriate means. Items shall be identified and controlled to ensure their proper use. Items shall be maintained to prevent their damage, loss, or deterioration. Equipment used for process monitoring or data collection shall be calibrated and maintained.

6. Design: Items and processes shall be designed using sound engineering/scientific principles and appropriate standards. Design work, including changes, shall incorporate applicable requirements and design bases. Design interfaces shall be identified and controlled. The adequacy of design products shall be verified or validated by individuals or groups other than those who performed the work. Verification and validation work shall be completed before approval and implementation of the change.

7. Procurement: Procured items and services shall meet established requirements and perform as specified. Prospective suppliers shall be evaluated and selected on the basis of specified criteria. The contractor shall ensure that approved suppliers can continue to provide acceptable items and services.

8. Inspection and Acceptance Testing: Inspection and acceptance testing of specified items and processes shall be conducted using established acceptance and performance criteria. Equipment used for inspections and tests shall be calibrated and maintained.

9. Management Assessment: Management at all levels shall periodically assess the integrated quality assurance program and its performance. Problems that hinder the organization from achieving its objectives shall be identified and corrected.

10. Independent Assessment: Planned and periodic independent assessments shall be conducted to measure items' quality and process effectiveness and to promote improvement. The organization performing independent assessments shall have sufficient authority and freedom from the line organization to carry out its responsibilities. Persons conducting independent assessments shall be technically qualified and knowledgeable in the areas assessed.

Merrick will develop a QAP that is in accordance with these criteria and that shows how the criteria will be satisfied. A QA matrix will also be developed to provide a cross walk between the criteria and the Merrick quality assurance, administrative, and design procedures.

B. DOE 6430.1A General Design Criteria

This DOE Order provides General Design Criteria (GDC) for various engineering disciplines. This GDC is mandatory for all DOE related work and provides minimal acceptable design requirements for DOE Facilities. Although DOE facilities are not mandated to follow state, county, and other requirements, it is recommended to interface with the non-DOE authorities to accommodate their intent as much as possible. The GDC contains 16 numerical divisions devoted to major building systems or design specialities. According to DOE instructions, GDC must be used in the planning, design, and development of specifications for facilities, including the development of site and equipment-specific designs. Provided the GDC is not adequate, supplemental standards may be used. The ASME B31.3 Chemical Plant and Petroleum Refinery Piping standard and the Industrial Vacuum Practices are considered to be supplemental standards that will be used for the HVCE design.

The following sections of the GDC are considered applicable for the Hot Vacuum Conditioning Equipment Design. The criteria evaluation document developed for the Hot Vacuum Conditioning Equipment goes into the applicability of the GDC in more extensive detail.

Division 1. General Requirements

Section 0111-99.0.1, Non-Reactor Nuclear Facilities
Paragraphs 1, 4, 5, and 6 on Page 1-97,
Paragraphs 2 and 3 on Page 1-98.
Section 0111-99.0.2, Tornado of Extreme Wind
Portions of this section are applicable.
Section 0111-99.0.4, Earthquakes
The entire section is applicable.
Section 0111-99.0.7, Explosion, Internal Pressurization, Criticality, and Other DBA Causes.
Section 0140 on Quality Assurance.

Division 13. Special Facilities

Section 1300-1, Coverage and Objectives
Many sub-sections are applicable.
Section 1300-2, Safety Analysis
Section 1300-3.2, Safety Class Items
Most of this section's contents are applicable. This section also proposes the use of ASME Boiler and Pressure Vessel Codes wherever they are applicable.
Section 1300-3.3, Single Failure Criterion and Redundancy
Section 1300-3.4, Equipment Environment Considerations
Most of the requirements specified in the three subsections are applicable.
Section 1300-3.5, Maintenance
Second paragraph of this section is especially applicable.
Section 1300-3.6, Testing
Portions of first and second paragraphs are applicable.

Section 1300-4, Nuclear Criticality Safety

This section describes the procedures to assess as early as possible if the potential for nuclear criticality exists. Several portions of this section may be applicable.

Section 1320 Irradiated Fissile Material Storage Facilities

This section describes irradiated fissile material storage facilities (ISMSF). Portion of subsections 1320-1, -2, and -3 are applicable.

C. WHC-CM-4-2 Quality Assurance Manual

This manual describes the requirements that apply to WHC Divisions and Departments which prescribe, perform, or verify activities affecting quality including operations, decommissioning and decontamination, and environmental activities. This manual emphasizes that quality assurance controls must be applied to any items and activities performed under WHC Management. The manual consists of 19 sections with each section dedicated to a certain aspect of quality control.

This is a compulsory requirement for each operation involved in the SNF transfer from K-Basins. Requirements of this manual in conjunction with 10 CFR Part 830.120 should provide more than adequate quality control.

D. WHC-CM-6-1 Standard Engineering Practices

This manual establishes the engineering practices which ensure that uniform methods are in place for performing all tasks under WHC Control. These procedures provide methodologies for tasks such as design review, configuration management, change control, specification preparation, and review and approval requirements. The use of this document is strongly recommended on all engineering, development, and project tasks which culminate in a document design and/or deliverable hardware end items.

Of several sections in this manual, Section 4 on Design Verification Requirements is the most applicable for Hot Vacuum Conditioning Equipment Design. This section provides methods and procedures governing design verification measures to verify the design adequacy. This requirement and DOE Order 6430.1A provide comprehensive guidelines for the design task.

E. NRC Regulations

The DOE established in the K-Basin Spent Nuclear Fuel Project - Regulatory Policy, dated August 4, 1995, the requirement for the SNFP facilities to achieve "nuclear safety equivalency" comparable to NRC licensed facilities. An evaluation was performed to identify any additional requirements that were needed to supplement the existing and applicable DOE requirements to establish nuclear safety equivalency with the NRC licensed facilities. The additional requirements were consolidated into 29 items. All items are to be implemented per the NRC regulations with the exception of the design earthquake which will be implemented in a manner that established equivalence in safety, as opposed to direct equivalence to the regulation.

6.0 DESCRIPTION OF REFERENCE REQUIREMENTS

The requirements listed in Appendix C will be used as reference documents. These requirements have no direct impact on the design, but may affect the design methodologies.

10 CFR 20 and 10 CFR 71 are promulgated by the Nuclear Regulatory Commission (NRC). It should be noted that DOE nuclear facilities are not required to comply with NRC regulations. DOE, however, use the NRC requirements as a source of guidance and good practice for the SNF transfer program.

10 CFR 20, Standards for Protection Against Radiation, establishes standards for individual protection from ionizing radiation resulting from activities conducted under licenses issued by NRC. These regulations quantify the permissible radiation doses to various body parts of an individual. The prescribed dose limits do not apply to doses due to background radiation and radiation received as part of a medical therapy or due to voluntary participation in medical research programs.

This regulation does not have direct impact on the Hot Vacuum Conditioning Equipment Design. However, this regulation will be maintained for reference as dose rates may have to be considered in the design process.

10 CFR 71, Packaging and Transportation of Radioactive Material, is also an NRC Regulation which establishes requirements for packaging, preparation for shipment, and transportation of licensed material. This regulation also describes procedures and standards for NRC approval of packaging and shipping procedures for fissile material. The packaging and shipping aspects are also subject to other NRC

regulations and requirements of other agencies, such as the Department of Transportation.

This regulation does not have direct bearing on the Hot Vacuum Conditioning Equipment Design. However, these regulations may have to be consulted to verify that the Hot Vacuum Conditioning Equipment Design poses no problems for packaging and transportation.

A. DOE Regulations

10 CFR 835, Occupational Radiation Protection, is a DOE Regulation which is very similar to 10 CFR 20. 10 CFR 835 promulgates radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Activities conducted under NRC license are not covered by this regulation. Like 10 CFR 20, this requirement is also considered as a reference requirement.

B. OSHA Requirements

29 CFR 1910, Occupational Safety and Health Standard, is promulgated by the Occupational Safety and Health Administration of the Department of Labor. The intent of this directive is to carry out OSHA requirements which have been found to be National Consensus Standards or Established Standards. All routine industrial operations are covered under this requirement. From a simple administrative function such as maintaining worker's exposure and medical surveillance records to complex operations such as handling hazardous materials are covered by 29 CFR 1910. Minimum environmental controls required for a work area, provisions of proper personal protective equipment, fire protection requirements, noise control, and providing medical and first aid during emergencies are also covered under this requirement. These regulations may be exempt if it is determined that these standards do not improve health and safety for specially designated employees.

These is no direct impact of these regulations on the Hot Vacuum Conditioning Equipment Design, but the design may have to be accomplished such that the Hot Vacuum Conditioning Equipment usage adheres to 29 CFR 1910. Hence, this regulation is maintained for reference.

C. DOE 1300.2A Department of Energy Technical Standards Programs

This DOE Order sets forth policies and responsibilities for development and application of technical standards under DOE controlled programs. This order stipulates that any applicable Non-Government Standards (NGSs) must be used and the usage must be properly documented. This Order also states that all DOE facilities, programs, and projects will use NGSs in their design, construction, testing, modification, operation, decommissioning, decontamination, and remediation when such standards are adequate. If the existing Federal Standards is more conservative than NGSs, DOE requirements will be used. Uses of all standards in the design have to be properly documented.

This DOE Order is a general guideline for using the Technical Standards. This document is kept on the reference list.

D. DOE 1540.2 Hazardous Material Packaging for Transport - Administrative Procedures

This Order establishes administrative procedures for the certification and use of packaging methods for radioactive and hazardous materials. The administrative procedures also summarize the actions associated with the review and approval of packaging for the transportation of radioactive and hazardous materials. This Order details the review and approval procedure that provides a basis for DOE to assure DOT, NRC, and other agencies that regulations are compiled with and the entire process is relevant to that of NRC.

This DOE Order has no direct impact on the Hot Vacuum Conditioning Equipment Design. As the packaging process has very little effect on the Hot Vacuum Conditioning Equipment Design, it is unlikely that this Order will be used during the design process. However, DOE 1540-2 is retained for reference.

E. DOE 1540.3A Base Technology for Radioactive Material Transportation Packaging Systems

DOE 1540-A is a culmination of DOE Orders 1330.1D, 1540.1A, 15402, and 5480.3; 10 CFR 71 and 49 CFR 171 through 179; Atomic Energy Act; and the Department of Energy Organization Act of 1977. This Order establishes DOE policies and responsibilities for coordinating and planning base technology for radioactive material, transportation packaging systems. Radioactive material is defined as any material having a specific activity greater than 0.002 microcuries per gram.

This DOE Order is more of an administrative document than a design document. Consequently, this Order will have very little impact on either the Hot Vacuum Conditioning Equipment Design or the design process. However, this document is maintained for reference purposes.

F. DOE 5480.4 Environmental Protection, Safety, and Health

This DOE Order provides listing of requirements for the application of the mandatory Environmental Protection, Safety, and Health (ES&H) Standards applicable to all DOE Operations. This Order must be followed during design, construction, modification, and decommissioning. All permanent and temporary facilities must comply with this Order. The requirements listed in this DOE Order are divided into the following three categories:

1. <u>Mandatory ES&H Standards (Statutory Requirements)</u>: Those standards that are mandatory as a result of Non-DOE Federal or State Statutes are addressed in this category. None of these standards are applicable to Hot Vacuum Conditioning Equipment Design.

2. <u>Mandatory ES&H Standards (Policy Requirements)</u>: Standards that are mandatory because of DOE Policies are listed under this category. Subsection F which addresses Nuclear Safety may be used for guidance for Hot Vacuum Conditioning Equipment Design. However, these standards are mainly oriented for nuclear reactors.

3. <u>Reference ES&H Standards</u>: Those standards that are not mandatory but are useful to refer to as good practice and for general ES&H purposes. None are directly applicable for Hot Vacuum Conditioning Equipment Design.

This DOE Order does not appear to have any direct impact on the Hot Vacuum Conditioning Equipment Design. However, this document will be retained as reference.

G. Fiscal Year 1995, Hanford Mission Plan, Volume 1, Site Guidance, September 1994

The Hanford Mission is to cleanup the site, develop new technologies, and to help the economic diversification of the region. The transfer of K-Basin fuel is a part of the cleanup mission. This document has no impact on either HVCE design or the design process. However, this document is the basic report in which all Hanford cleanup programs are described. This document is maintained on the reference list.

H. WHC-CM-2-14 Hazardous Material Packaging and Shipping

This WHC Manual describes requirements and procedures for packaging and shipping hazardous wastes both on-site and off-site of Hanford. This manual has been prepared by WHC based on several CFRs, DOE Orders, WACs, and other pertinent documents including WHC-CMs. In addition to other requirements, instructions of this requirement have to be followed only when the SNF is categorized as hazardous material.

This requirement has no direct impact on the Hot Vacuum Conditioning Equipment Design. This document is maintained for reference.

I. WHC-CM-3-5 Document Control and Records Management Manual

This manual was developed to provide requirements and procedures for maintaining the information that is produced for any project. The information could be as paper, punched cards, magnetic tapes, computer disks, etc. The main objective of this program is to preserve records that may be useful and of future value in a proper manner.

There is no impact of this requirement on the Hot Vacuum Conditioning Equipment Design. However, all the paper work and computer formatted data will be transferred to WHC for up keeping the records. This manual is retained for reference purposes only.

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ADDENDUM 1

APPLICABLE REQUIREMENTS FOR THE VACUUM DRYING MODULE SUBPROJECT DESIGN

1. 10 CFR Part 830.120, Quality Assurance
2. DOE 6430.1A, General Design Criteria
3. WHC-CM-4-2, Quality Assurance Manual
4. WHC-CM-6-1, Standard Engineering Practices
5. WHC-SD-SNF-DB-003, Rev 1, Additional NRC Requirements

ADDENDUM 2

MISCELLANEOUS APPLICABLE DOCUMENTS

1. DNFSB letter of May 26, 1994, to Secretary O'Leary recommending expediting the SNF removal from K-Basins to an interim storage until an option is chosen for ultimate disposal.

2. J. E. Lytle letter to T. P. Grumbly, Approval of Path Forward for N-Reactor Spent Fuel Interim Storage, DOE EM-36, 9 November 1994, regarding the expeditious transfer of N-Reactor SNF to interim storage, but still within the applicable regulatory requirements.

3. SNF Project K-Basins Path Forward Acquisition Strategy (WHC-SP-1144, December 1994 draft) which describes the following four key interconnecting subsystems:

   - Staging and Storage Facility (SSF)
   - Multi-canister Over packs (MCO)
   - Transportation System
   - Fuel Stabilization Facility (FSF)

4. U. S. Department of Energy (DOE) October 1994, Spent Nuclear Fuel Program Requirements Document (SNF-RD-PM-001), Revision 1, describing the management approach to integrate, coordinate, and optimize activities necessary for conditioning, handling, and transporting SNF to interim storage and preparing SNF for final disposal.

5. WHC-EP-009, WHC Reference Guide Acronyms and Abbreviations, Vol. 1, part 1.

6. WHC-IP-0117, Procedure Development Specification Manual.

7. WHC-SP-0708, Westinghouse Hanford Company Conduct of Operation.

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ADDENDUM 3

REQUIREMENTS FOR REFERENCE

1. 10 CFR 20, Standards for Protection Against Radiation
2. 10 CFR 71, Packaging and Transportation of Radioactive Material
3. 10 CFR 835, Occupational Radiation Protection Standards
4. 20 CFR 1910, Occupational Safety and Health Act of 1976
5. DOE 1300.2A, Department of Energy Technical Standards Program
6. DOE 1540.2, Hazardous Material Packaging for Transportation
7. DOE 1540.3A, Base Technology for Radioactive Material Transportation Packaging Systems
8. DOE 5480.4, Environmental Protection, Safety, and Health Protection
9. Fiscal Year 1995 Hanford Mission Plan, Volume 1, Site Guidance, September 1994
10. MRP 5.20, Packaging and Transportation of Hazardous Material
11. DOE 5480.28, Natural Phenomena Hazards Mitigation
12. Spent Nuclear Fuel Project, K-Basins Path Forward Acquisition Strategy, WHC-SP-1144, December 1994 (Draft)
13. WHC-CM-2-14, Hazardous Material Packaging and Shipping
14. WHC-CM-3-5, Document Control and Records Management Manual

APPENDIX F

COST ESTIMATE BACKUP

DESCRIPTION	QTY	UNIT	EQUIPMENT UNIT	EQUIPMENT TOTAL	DUCTING/PIPING UNIT	DUCTING/PIPING TOTAL	INSULATION UNIT	INSULATION TOTAL	ELECTRICAL UNIT	ELECTRICAL TOTAL	INSTRUMENT UNIT	INSTRUMENT TOTAL	ASSEMBLY UNIT	ASSEMBLY TOTAL	INSTALLATION UNIT	INSTALLATION TOTAL
CONSTRUCTION																
PROCESS MODULE	6	EA	$ 97,603	$ 585,618	$ 52,890	$ 317,342	$ 14,271	$ 85,626	$ 10,577	$ 63,461	$ 117,883	$ 707,299	$ 6,500	$ 39,000	$ 12,850	$ 77,100
PROCESS PIT COMPONENTS	1	LOT	$ 1,260,000	$ 1,260,000	$ 180,000	$ 180,000	$ 12,000	$ 12,000	$ -	$ -	$ -	$ -		$ -		$ -
SERVICE MODULE	1	EA	$ 69,950	$ 69,950	$ 61,650	$ 61,650	$ 5,750	$ 5,750	$ 18,120	$ 18,120	$ 73,635	$ 73,635	$ 20,000	$ 20,000	$ 14,110	$ 14,110
AUXILIARY FACILITIES	1	EA	$ 59,601	$ 59,601	$ 50,593	$ 50,593	$ 9,409	$ 9,409	$ 40,799	$ 40,799	$ 157,727	$ 157,727	$ 20,000	$ 20,000	$ 150,000	$ 150,000
PROCESS ENCLOSURE	1	EA	$ 490,000	$ 490,000	$ -	$ -	$ -	$ -	$ 2,500	$ 2,500	$ 10,000	$ 10,000	$ 50,000	$ 50,000		$ -
SUB-TOTAL				$ 2,465,169		$ 609,585		$ 112,785		$ 124,880		$ 948,660		$ 129,000		$ 241,210

CONSTRUCTION SUMMARY SUB-TOTAL

EQUIPMENT SUB-TOTAL		$ 2,465,169
DUCTING/PIPING SUB-TOTAL		$ 609,585
INSULATION SUB-TOTAL		$ 112,785
ELECTRICAL SUB-TOTAL		$ 124,880
INSTRUMENT SUB-TOTAL		$ 948,660
ASSEMBLY SUB-TOTAL		$ 129,000
INSTALLATION SUB-TOTAL		$ 241,210
CONSTRUCTION SUB-TOTAL		**$ 4,631,288**
OVERHEAD LESS EQUIPMENT	18%	$ 389,901
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 502,119
CONSTRUCTION TOTAL		**$ 5,523,309**

DESCRIPTION		QTY	UNIT	EQUIPMENT UNIT	EQUIPMENT TOTAL	DUCTING/PIPING FACTOR	DUCTING/PIPING TOTAL	INSULATION FACTOR	INSULATION TOTAL	ELECTRICAL FACTOR	ELECTRICAL TOTAL	INSTRUMENT FACTOR	INSTRUMENT TOTAL
PROCESS MODULE													
BLOWER - SINGLE STAGE	PHS-BLO-1X51	1	EA	$ 11,000	$ 11,000	0.70	$ 7,700	0.15	$ 1,650	0.10	$ 1,100	0.13	$ 1,430
BLOWER - SINGLE STAGE	VPS-BLO-1X06	1	EA	$ 24,068	$ 24,068	0.70	$ 16,848	0.15	$ 3,610	0.10	$ 2,407	0.13	$ 3,129
HEAT EXCHANGER - PLATE	MCS-CLR-1X53	1	EA	$ 5,073	$ 5,073	1.00	$ 5,073	0.20	$ 1,015		$ -	0.25	$ 1,268
HEAT EXCHANGER - PLATE	VPS-CLR-1X03	1	EA	$ 1,500	$ 1,500	1.00	$ 1,500	0.20	$ 300		$ -	0.25	$ 375
HEAT EXCHANGER - TRAP	VPS-PFR-1X01	1	EA	$ 10,000	$ 10,000	0.80	$ 8,000	0.20	$ 2,000		$ -	0.25	$ 2,500
TANK - EXPANSION	PG-ACC-1X31	1	EA	$ 1,000	$ 1,000	1.20	$ 1,200		$ -		$ -		$ -
PUMP - SCROLL VACUUM	VPS-VAC-1X04	1	EA	$ 8,000	$ 8,000	0.70	$ 5,600	0.25	$ 2,000	0.10	$ 800	0.30	$ 2,400
HEATER - ELECTRICAL	PHS-HCL-1X52	1	EA	$ 8,800	$ 8,800	0.50	$ 4,400	0.10	$ 880	0.15	$ 1,320	1.50	$ 13,200
HEATER - ELECTRICAL	VPS-HCL-1X05	1	EA	$ 2,000	$ 2,000	0.50	$ 1,000	0.10	$ 200	0.15	$ 300	1.50	$ 3,000
FILTER - HEPA	PV-F-1X71	1	EA	$ 1,000	$ 1,000	0.06	$ 60	0.10	$ 100		$ -	0.50	$ 500
FILTER - HEPA	VPS-F-1X02	1	EA	$ 12,581	$ 12,581	0.06	$ 755	0.10	$ 1,258		$ -	0.50	$ 6,291
FILTER - HEPA	VPS-F-1X07	1	EA	$ 12,581	$ 12,581	0.06	$ 755	0.10	$ 1,258		$ -	0.50	$ 6,291
SPECIALTY INSTRUMENTS										0.06	$ 4,650		$ 77,500
PROCESS MODULE SUB-TOTAL					$ 97,603		$ 52,890		$ 14,271		$ 10,577		$ 117,883

PROCESS MODULE SUB-TOTAL SUMMARY

EQUIPMENT SUB-TOTAL		$ 97,603
DUCTING/PIPING SUB-TOTAL		$ 52,890
INSULATION SUB-TOTAL		$ 14,271
ELECTRICAL SUB-TOTAL		$ 10,577
INSTRUMENT SUB-TOTAL		$ 117,883
SKID ASSEMBLY COST		$ 6,500
SKID INSTALLATION COST		$ 12,850
SUB-TOTAL PER PROCESS MODULE		$ 312,574
MULTIPLIED BY 6 BAYS		6
PROCESS MODULE SUB-TOTAL		$ 1,875,445
OVERHEAD LESS EQUIPMENT	18%	$ 232,169
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 210,761
PROCESS MODULE TOTAL		$ 2,318,376

Merrick Engineers and Architects
Construction Cost Estimate

7/28/96
Prepared By: C.Gustafson

DESCRIPTION	QTY	UNIT	EQUIPMENT UNIT	EQUIPMENT TOTAL	DUCTING/PIPING UNIT	DUCTING/PIPING TOTAL	INSULATION UNIT	INSULATION TOTAL	ELECTRICAL UNIT	ELECTRICAL TOTAL	INSTRUMENT UNIT	INSTRUMENT TOTAL
PROCESS PIT COMPONENTS												
OVEN	6	EA	$ 140,000	$ 840,000	$ 30,000	$ 180,000	$ 2,000	$ 12,000				
PROCESS PIT COVER	7	EA	$ 35,000	$ 245,000								
TRENCH COVER	7	EA	$ 25,000	$ 175,000								
PROCESS PIT COMPONENTS SUB-TOTAL				$ 1,260,000		$ 180,000		$ 12,000		$ -		$ -

PROCESS PIT COMPONENTS SUB-TOTAL SUMMARY

EQUIPMENT SUB-TOTAL		$ 1,260,000
DUCTING/PIPING SUB-TOTAL		$ 180,000
INSULATION SUB-TOTAL		$ 12,000
ELECTRICAL SUB-TOTAL		$ -
INSTRUMENT SUB-TOTAL		$ -
PROCESS PIT COMPONENTS SUB-TOTAL		$ 1,452,000
OVERHEAD LESS EQUIPMENT	18%	$ 34,560
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 148,656
PROCESS PIT COMPONENTS TOTAL		$ 1,635,216

DESCRIPTION		QTY	UNIT	EQUIPMENT UNIT	EQUIPMENT TOTAL	DUCTING/PIPING FACTOR	DUCTING/PIPING TOTAL	INSULATION FACTOR	INSULATION TOTAL	ELECTRICAL FACTOR	ELECTRICAL TOTAL	INSTRUMENT FACTOR	INSTRUMENT TOTAL
SERVICE MODULE													
PUMP - TURBO VACUUM	VAC-VAC-3041	1	EA	$14,350	$ 14,350	2.00	$28,700		$ -	0.10	$ 1,435	0.30	$ 4,305
PUMP - SCROLL ROUGHER	VAC-VAC-3042	1	EA	$ 8,100	$ 8,100	2.00	$16,200		$ -	0.10	$ 810	0.30	$ 2,430
FILTER - HEPA TRAIN	PV-F-2041,2,4,5	4	EA	$ 6,875	$ 27,500	0.10	$ 2,750	0.10	$ 2,750	0.05	$ 1,375	0.52	$14,300
BLOWER - SINGLE STAGE	PV-BLO-2043,6	2	EA	$10,000	$ 20,000	0.70	$14,000	0.15	$ 3,000	0.10	$ 2,000	0.13	$ 2,600
SPECIAL INSTRUMENTS										0.25	$12,500		$50,000
SERVICE MODULE SUB-TOTAL					$ 69,950		$61,650		$ 5,750		$18,120		$73,635

SERVICE MODULE SUB-TOTAL SUMMARY

EQUIPMENT SUB-TOTAL		$ 69,950
DUCTING/PIPING SUB-TOTAL		$ 61,650
INSULATION SUB-TOTAL		$ 5,750
ELECTRICAL SUB-TOTAL		$ 18,120
INSTRUMENT SUB-TOTAL		$ 73,635
SKID ASSEMBLY COST		$ 20,000
SKID INSTALLATION COST		$ 14,110
SERVICE MODULE SUB-TOTAL		$263,215
OVERHEAD LESS EQUIPMENT	18%	$ 34,788
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 29,800
SERVICE MODULE TOTAL		$327,803

DESCRIPTION		QTY	UNIT	EQUIPMENT UNIT	EQUIPMENT TOTAL	DUCTING/PIPING FACTOR	DUCTING/PIPING TOTAL	INSULATION FACTOR	INSULATION TOTAL	ELECTRICAL FACTOR	ELECTRICAL TOTAL	INSTRUMENT FACTOR	INSTRUMENT TOTAL
AUXILIARY FACILITIES													
CHILLER - SPLIT SYSTEM	CHW-CH-2026	1	EA	$38,540	$ 38,540	1.00	$38,540	0.20	$ 7,708	0.10	$ 3,854	0.25	$ 9,635
TANK - EXPANSION	CHW-ACC-2021	1	EA	$ 1,629	$ 1,629	1.20	$ 1,955		$ -		$ -		$ -
PUMP - CHILLED WATER	CHW-P-2022	1	EA	$ 2,000	$ 2,000	0.70	$ 1,400	0.15	$ 300	0.10	$ 200	0.50	$ 1,000
PUMP - CHILLED WATER	CHW-P-2023	1	EA	$ 2,000	$ 2,000	0.70	$ 1,400	0.15	$ 300	0.10	$ 200	0.50	$ 1,000
TANK - EXPANSION	CW-ACC-2011	1	EA	$ 1,629	$ 1,629	1.20	$ 1,955		$ -		$ -		$ -
HEAT EXCHANGER - GLYCOL	CW-HX-2014	1	EA	$ 3,103	$ 3,103	1.00	$ 3,103	0.20	$ 621		$ -	0.25	$ 776
PUMP - COOLING WATER	CW-P-2012	1	EA	$ 1,600	$ 1,600	0.70	$ 1,120	0.15	$ 240	0.10	$ 160	0.13	$ 208
PUMP - COOLING WATER	CW-P-2013	1	EA	$ 1,600	$ 1,600	0.70	$ 1,120	0.15	$ 240	0.10	$ 160	0.13	$ 208
PROCESS STACK		1	EA	$ 7,500	$ 7,500		$ -		$ -		$ -		$ -
STACK MONITORING										0.25	$36,225		$144,900
AUXILIARY FACILITIES SUB-TOTAL					$ 59,601		$50,593		$ 9,409		$40,799		$157,727

AUXILIARY FACILITIES SUB-TOTAL SUMMARY

EQUIPMENT SUB-TOTAL		$ 59,601
DUCTING/PIPING SUB-TOTAL		$ 50,593
INSULATION SUB-TOTAL		$ 9,409
ELECTRICAL SUB-TOTAL		$ 40,799
INSTRUMENT SUB-TOTAL		$ 157,727
SKID ASSEMBLY COST		$ 20,000
SKID INSTALLATION COST		$ 150,000
AUXILIARY FACILITIES SUB-TOTAL		$ 488,128
OVERHEAD LESS EQUIPMENT	18%	$ 77,135
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 56,526
AUXILIARY FACILITIES TOTAL		$ 621,789

DESCRIPTION	EQUIPMENT UNIT	DUCTING/PIPING TOTAL	INSULATION TOTAL	ELECTRICAL TOTAL	INSTRUMENT TOTAL
PROCESS ENCLOSURE					
TITAN VII MANIPULATOR	$ 250,000				
HELIUM LEAK DETECTOR	$ 20,000				
WELDER WITH SUPPLY	$ 15,000				
DRUM BAG STATION	$ 45,000				
TOW MOTOR	$ 10,000				
ENCLOSURE	$ 150,000				
CONTROLS				$ 2,500	$ 10,000
PROCESS ENCLOSURE SUB-TOTAL	$ 490,000	$ -	$ -	$ 2,500	$ 10,000

PROCESS ENCLOSURE SUB-TOTAL

EQUIPMENT SUB-TOTAL		$ 490,000
DUCTING/PIPING SUB-TOTAL		$ -
INSULATION SUB-TOTAL		$ -
ELECTRICAL SUB-TOTAL		$ 2,500
INSTRUMENT SUB-TOTAL		$ 10,000
ASSEMBLY COST		$ 50,000
PROCESS ENCLOSURE SUB-TOTAL		$ 552,500
OVERHEAD LESS EQUIPMENT	18%	$ 11,250
PROFIT (SUB-TOTAL & OVERHEAD)	10%	$ 56,375
PROCESS ENCLOSURE TOTAL		$ 620,125

TAG #			ITEM	EQUIPMENT SPECIFICATIONS	ELECTRICAL LOAD/SERVICE	EQUIPMENT COST
A	1000		Beta/Gamma Particulate Monitor		115 VAC/60 Hz/15 A	$54,700
A	2000		Beat/Gamma Particulate Monitor		115 VAC/60 Hz/15 A	$54,700
A	3000		Alpha/Beta Particulate Monitor		120/240 VAC / 50/60 Hz	$5,000
A	3000		Tritium Monitor		150/230 VAC / 50/60 Hz	$6,000
A	4000		Alpha/Beta Particulate Monitor		120/240 VAC / 50/60 Hz	$5,000
A	4001		Tritium, Monitor		150/230 VAC / 50/60 Hz	$6,000
A	5000		Record Air Sampler		1/4 hp/115V/60Hz/5A	$1,250
A	6000		Record Air Sampler		1/4 hp/115V/60Hz/5A	$1,250
CHW	ACC	2021	Expansion Tank	72 liter capacity	None	$1,629
CHW	CH	2026	Chiller	25 ton	30 KW/440V/3 phase	$38,450
CHW	P	2022	Chilled Water Circ.Pump	15gpm @ 40 ft TDH	1/2 hp/20 V/1 phase	$2,000
CHW	P	2023	Chilled Water Circ.Pump	15gpm @ 40 ft TDH	1/2 hp/20 V/1 phase	$2,000
CW	ACC	2011	Expansion Tank	72 liter capacity	None	$1,629
CW	HX	2014	Glycol/CW Exchr	240,000 BTU/hr	None	$3,103
CW	P	2012	CW Pump	50 gpm @ 115 ft TDH	3 hp/230 V/1 phase	$1,582
CW	P	2013	CW Pump	50 gpm @ 115 ft TDH	3 hp/230 V/1 phase	$1,582
MCS	CLR	1153	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
MCS	CLR	1253	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
MCS	CLR	1353	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
MCS	CLR	1453	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
MCS	CLR	1553	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
MCS	CLR	1653	MCO Chiller Exchanger	94,000 BTU/hr	None	$5,073
PG	ACC	1131	Filter Blowback Reservoir	10 liters	None	$1,000
PG	ACC	1231	Filter Blowback Reservoir	10 liters	None	$1,000
PG	ACC	1331	Filter Blowback Reservoir	10 liters	None	$1,000
PG	ACC	1431	Filter Blowback Reservoir	10 liters	None	$1,000
PG	ACC	1531	Filter Blowback Reservoir	10 liters	None	$1,000
PG	ACC	1631	Filter Blowback Reservoir	10 liters	None	$1,000
PHS	BLO	1151	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	BLO	1251	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	BLO	1351	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	BLO	1451	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	BLO	1551	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	BLO	1651	Heat/Cool Blower	750 ACFM@ 8 in sp - 375 deg. C	5 HP/240 V/1 phase	$11,000
PHS	OVEN	1154	MCO Oven		None	$140,000
PHS	OVEN	1254	MCO Oven		None	$140,000
PHS	OVEN	1354	MCO Oven		None	$140,000
PHS	OVEN	1454	MCO Oven		None	$140,000
PHS	OVEN	1554	MCO Oven		None	$140,000
PHS	OVEN	1654	MCO Oven		None	$140,000
PHS	HCL	1152	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800

TAG #			ITEM	EQUIPMENT SPECIFICATIONS	ELECTRICAL LOAD/SERVICE	EQUIPMENT COST
PHS	HCL	1252	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800
PHS	HCL	1352	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800
PHS	HCL	1452	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800
PHS	HCL	1552	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800
PHS	HCL	1652	MCO Heating Element	60 W/in^2	25 KW/240 V/1 phase	$8,800
PV	F	1171	MCO Vault Filter	150 ACFM	None	$1,000
PV	F	1271	MCO Vault Filter	150 ACFM	None	$1,000
PV	F	1371	MCO Vault Filter	150 ACFM	None	$1,000
PV	F	1471	MCO Vault Filter	150 ACFM	None	$1,000
PV	F	1571	MCO Vault Filter	150 ACFM	None	$1,000
PV	F	1671	MCO Vault Filter	150 ACFM	None	$1,000
PV	BLO	2043	Vent Blower	1000 CFM @ 9 in sp	3 HP/440v/3 phase	$10,000
PV	BLO	2046	Vent Blower	1000 CFM @ 9 in sp	3 HP/440v/3 phase	$10,000
PV	F	2041	Main Vent HEPA	1000 CFM	None	$6,875
PV	F	2042	Main Vent HEPA	1000 CFM	None	$6,875
PV	F	2044	Main Vent HEPA	1000 CFM	None	$6,875
PV	F	2045	Main Vent HEPA	1000 CFM	None	$6,875
VAC	VAC	3041	Main Dewar Vac Pump	Base pressure < 1x10^ -10 torr	600 W/240 V/1 phase	$14,350
VAC	VAC	3042	Main Dewar Boost Pump	Ultimate total pressure < 10^ -2 torr	1HP/230 V/1 phase	$8,100
VPS	BLO	1106	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	BLO	1206	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	BLO	1306	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	BLO	1406	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	BLO	1506	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	BLO	1606	He Recirculation Blower	20 ACFM	1/4 hp/115 V/1 phase	$24,000
VPS	CLR	1103	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	CLR	1203	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	CLR	1303	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	CLR	1403	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	CLR	1503	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	CLR	1603	MCO Vent Cooler	560 BTU/hr	None	$1,500
VPS	F	1102	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1202	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1302	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1402	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1502	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1602	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1107	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1207	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1307	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1407	MCO Vent HEPA	20 ACFM	None	$12,581

TAG #			ITEM	EQUIPMENT SPECIFICATIONS	ELECTRICAL LOAD/SERVICE	EQUIPMENT COST
VPS	F	1507	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	F	1607	MCO Vent HEPA	20 ACFM	None	$12,581
VPS	HCL	1105	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	HCL	1205	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	HCL	1305	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	HCL	1405	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	HCL	1505	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	HCL	1605	MCO Vent Heater	50 W/in^2	1 KW/120 V/1 phase	$2,000
VPS	PFR	1101	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	PFR	1201	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	PFR	1301	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	PFR	1401	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	PFR	1501	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	PFR	1601	MCO Vent Purifier	1500 BTU/hr/copper gauze/active C	None	$10,000
VPS	VAC	1104	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
VPS	VAC	1204	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
VPS	VAC	1304	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
VPS	VAC	1404	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
VPS	VAC	1504	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
VPS	VAC	1604	MCO Vent Vac/Circ Pump	Ultimate total pressure < 10^ -2 torr	1 HP/230 V/1 phase	$8,000
			Skid I/O Interface			$10,000
			Skid I/O Interface			$10,000
			Skid I/O Interface			$10,000
			Skid I/O Interface			$10,000
			Skid I/O Interface			$10,000
			Skid I/O Interface			$10,000
			Misc Instrument & Control Central System	PLC; Operator Console, Panel	15 KVA to 1 phase lighting pane	$50,000

APPENDIX G

CALCULATIONS

Appendix G
CALCULATIONS

CALCULATION LOG

Calc No.	Rev. No.	Description	Date	Page
HVC-1	Initial	General Comments	5/20/96	G-1
HVC-2	Initial	MCO Heat Transfer Coefficients	5/7/96	G-2
HVC-3	Initial	MCO Heating Temperature Profile	5/13/96	G-8
HVC-4	Initial	MCO Cooling Temperature Profile	5/13/96	G-16
HVC-5	Initial	Material Balance Calculations	6/12/96	G-24
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MERRICK Engineers & Architects

Engineering Calculation Sheet Date 5/20/96 Sheet 1 of 1
Contract 30012318
By LBA Chk'd DAM

Subject:

Revision	Date	By
0	5/20/96	LBA

HVC-1
5/20/96
LBA

General Comments Relating to the Heating of Nuclear Fuel in the MCO

It is proposed that the nuclear fuel contained in the MCO be heated by forced convection on both the outside of the MCO and on the inside of the MCO. The following calculations will show the temperature profiles associated with both heating and cooling by this method. These profiles were developed through the use of an iterative spreadsheet heat balance. Steady state heating is defined by the overall heat transfer equation which states that $Q = U A \Delta T$ where

Q = rate of heat transfer
U = overall coefficient of heat transfer
A = surface area through which heat transfer occurs
ΔT = temperature difference between source of heat and the receptor of heat

Because heat transferred through the MCO to the fuel is not steady state, an integral form of this relationship is used. That form divides the heat transfer process into 6 minute increments and assumes steady state of each increment. By summing all increments a heat transfer profile may be obtained. This profile reflects the unsteady state nature of the heat transfer process which should approximate the actual heat transfer in the HVCE process.

References:

Kern, D. Q., *Process Heat Transfer*. New York: McGraw Hill, 1950.

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McCabe and Smith. *Unit Operations of Chemical Engineering*. New York: McGraw Hill, 1956.

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MERRICK Engineers & Architects

Engineering Calculation Sheet Date 5/7/96 Sheet 1 of 6
Contract 3001 2318
By LBA Chk'd DHM

Subject:

Revision	Date	By
0	5/7/96	LBA

HVCE-2
5/7/96

Calculation of Heat Transfer Coefficients for Heating and Cooling the MCO with Air

The relationships shown here test the annular space for different rates of air flow in a cross-flow configuration.

The findings show that an exterior MCO heat transfer coefficient (h_o) of 5 Btu/hr ft^2 °F may be achieved with an annular spacing of 1" and an air-flow rate of 750 ACFM.

While 250 ACFM was originally considered, it was shown that the heating cycle was extended two hours due to the lower external film coefficient and heat capacity of air. Increasing the air flow to 750 ACFM provides a profile more in line with the HVCE performance specifications, albeit still 1.2 hours longer on heat up than desired.

It should be noted that the air-flow rate has an effect on both heating and cooling times.

The key remains the interior transfer coefficient. Any result in increasing that parameter will have a clear effect on reducing the heating cycle time. An interior heat transfer coefficient (h_i) of 1.77 Btu/hr ft^2 °F was calculated using a relationship for laminar flow in annuli. Because of the complex interior geometry and its effect upon convective heat transer, this value was reduced to 1.0.

The interior heat transfer coefficient remains as the controlling factor in full heating and cooling operations. Further detailed calculation of this value is recommended.

Calculated by:	Lauren Ames	5/7/96
Checked by:	David Munger	5/29/96

Calculation of Interior Heat Transfer Coefficient for MCO to Fuel Heating

The relationships used here are taken from Perry, pages 10-13 and 10-14, as well as the sections dealing with convection appearing in the other referenced texts on heat transfer. Because the area of the fuel is so much greater than the area of the interior surface of the MCO, the rate of transfer from the MCO to the helium controls, not the rate of heat transfer from the helium to the fuel.

Try forced convection with 10 SCFM purge rate:

MCO Volume Empty	=	272 gal
MCO Volume Loaded	=	134 gal
Void Volume	=	138 gal

For heat transfer calcs, assume this is annular volume:

$$\text{Cross section rods} = \frac{134 \text{ gal.}}{7.48 \text{ gal}} \text{ft}^3 \ / 160 / 12 \text{ ft} = 1.34 \text{ ft}^2$$

$$\pi r^2 = 1.34 \text{ ft}^2 \quad r = 0.65 \text{ ft} \quad D_1 = 1.31 \text{ ft} \quad D = 24.5 - 1$$

$$= 23.5 / 12$$

$$= 1.96 \text{ ft}$$

$$N_{Re} = \frac{D_{eq} J \rho}{\mu} \quad D_{eq} = \frac{D_2^2 - D_1^2}{D_1} = \frac{1.96^2 - 1.31^2}{1.31} = 1.62 \text{ Ft.} \qquad \text{(Kern, p. 105)}$$

at 170° C mean temp

$$V = 10 \text{ SCM} \ x \ \left(\frac{273 + 170}{273}\right) = 16.2 \text{ ACFM}$$

Natural convection calculations:

$$\text{Properties at mean temp.:} \ = \frac{300 - 40}{2} + 40$$

$$= 170^\circ \text{C}$$

$$= 338^\circ \text{F}$$

$$N_{GR} = \frac{D^3 q \rho^2 \beta \Delta t i}{\mu^2}$$

$D = 2$ ft

$g = 32.17 \, x \, 3600^2 = $ ft / hr^2

$$\rho = \frac{4\#}{359 \text{ ft}^3} \, x \, \frac{492}{798} = 0.0069$$

$$\beta = \frac{1}{T} \text{ (ideal gas)} = \frac{1}{460 + 338} = 0.0013$$

$\Delta t_{max} = 375 - 40 = 335^\circ \text{C} = 603^\circ \text{F (max)}$

$\Delta t_{min} = 375 - 300 = 75^\circ \text{C} = 135^\circ \text{F (min)}$

$\mu \, 338^F = 0.025 \;\; eN = 2.42 \text{ x } 0.25 = 0.0605$ lb / ft - hr (McCabe and Smith)

$$N_{GR} = \frac{(2)^3 \, x \, 32.17 \, x \, 3600^2 \, x \, (0.0069)^2 \, x \, 0.0013 \, x \, 603}{(0.0605)^2}$$

$N_{GR} = 34 x 10^6$

$N_{pr} = 0.761$ (Perry, p. 3 – 247)

170° C

443° K

$k_{He} @ 170^\circ C = 19.3 x 10^{-2}$ watts / meter °K (Perry, p. 3 - 247)

$$k_{He} @ 170^\circ C = 0.193 \frac{\text{watt}}{\text{meter } ^\circ K} \, x \, \frac{3.413 \text{ Btu}}{\text{watt hr}} \, x \, \frac{1 \text{ meter}}{3.281 \text{ ft}} \, x \, \frac{^\circ K}{1.8^\circ \text{F}}$$

$= 0.112$ Btu / hr ft°F

Annular area $= \pi \, (r_2^2 - r^2)$

$$= \pi \left[\left(\frac{1.96}{2} \right)^2 - \left(1.31/2 \right)^2 \right]$$

$= 1.67 \text{ ft}^2$

4/6

$$Vel = \frac{16.2 \text{ ft}^3}{\text{min}} x \frac{1 \text{ min}}{60 \text{ sec}} x \frac{1}{1.67 \text{ ft}^2} = 0.16 \text{ ft / sec.}$$

$$\rho = 0.0069 \text{ \#/ft}^3 \text{(from p. 1)}$$

$$\mu = 0.0605 \text{ \#/ft hr} x \frac{1 \text{ hr.}}{3600 \text{ sec.}} = 1.68x10^{-5} \text{ \#/ft./sec.}$$

$$N_{Re} = \frac{1.62 \text{ ft} x \frac{0.16 \text{ ft}}{\text{sec.}} x \frac{0.0069 \text{ \#}}{\text{ft}^3}}{1.68 x10^{-5} \text{ \#/ft.-sec.}} = 106.4$$

$$N_{NU} = 1.02 \left(N_{Pr}\right)^{0.5} x \left(N_{Re}\right)^{0.45} x \left(\frac{D_{eq}}{L}\right)^{0.4} \left(\frac{D_2}{D_1}\right)^{0.8} \left(\frac{\mu_3}{\mu_1}\right)^{0.14} \left(N_{ER}\right)^{0.05}$$

for heat transfer of laminar flow in annuli (Perry, p. 10 - 15)

$$N_{PR} = 0.761 \quad N_{RE} = 106.4 \quad N_{GR} = 34x10^6$$

$$\frac{D_{eq}}{L} = \frac{1.62}{160/12} = 0.12 \qquad \frac{\mu_3}{\mu_1} = 1$$

$$\frac{D_2}{D_1} = \frac{1.96}{1.31} = 1.50$$

$$N_{NU} = 1.02 \ (0.761)^{.5} \ (106.4)^{0.45} \ (0.12)^{0.4} \ (1.50)^{0.8} \ \left(34x10^6\right)^{0.05}$$

$$= 10.25$$

$$N_{NU} = \frac{h_i L}{k} \qquad k = 0.112 \text{ Btu / hr ft}^\circ F$$

$$L = \text{ distance across annulus } = D_2 - D_1 = 1.96 - 1.31$$

$$= 0.65 \text{ ft.}$$

$$h_i = \frac{(N_u)k}{L} = \frac{10.25x0.112 \text{ Btu}}{0.65 \text{ ft.} \quad \text{hr / ft}^\circ F}$$

$$= 1.77 \text{ Btu / ft}^2 \text{ ht. } ^\circ F$$

Because the interior of the MCO is complex and the helium must travel through fuel holding baskets, then through more than one layer of fuel rods, and because the flow (10 SCFM) upon which the calculation is based on is on the high side, the calculated coefficient of 1.77 is being discounted to 1.0 Btu/ft^2 hr °F. This value will be used in all subsequently derived heating and cooling temperature profiles for the MCO.

Calculation of Outside Film Coefficient for Forced Circulation

It will be assumed that heat will be transferred via cross-flow convection in the annulus. These segmented baffles will be used to reverse flow and force cross flow.

The first iteration will calculate the outside film coefficient (h_o) at an air flow of 250 ACFM.

Assume spacing between the outer wall of the MCO and the inner wall of the heat-transfer plenum of 1 inch

$$J_H = \frac{h_o D_e}{k}\left(\frac{C\mu}{k}\right)^{-1/3}$$

where

$$D_{eq} = 4\ x \text{ hydraulic radius} = \frac{D_2^2 - D_1^2}{D_1} = \frac{26^2 - 24^2}{24}$$

properties
for average of inlet and outlet temp.

C_p = for air at 300°C (572°F) ≈ .26 Btu/# °F
k = 0.0228 Btu - Ft/Ft^2 Hr °F
μ = 0.028 e_p x 2.42 = 0.068 16/Ft.-hr

$$\frac{C_p\mu}{k} = \frac{0.26\ x\ 0.68}{0.0228} = .775$$

$$J_H = \frac{h_o\ x\ 0.33}{0.0228}(0.775)^{-1/3} \quad J_H = 15.8\ h_o$$ (Kern Fig 28, p. 838)

$$N_{Re} = \frac{D_e G_s}{\mu}$$

$$G_s = \frac{250\ x \frac{273}{200+273}\ x \frac{29}{359}\ x\ 60 = 699.35\ \#/hr}{\left(\frac{13}{12}\right)^2 \pi - 1\pi}$$

$$= 1282\ \#/ft^2$$

$$N_{RE} = \frac{0.33\ x\ 1282}{0.068} = 6221$$

J_H = 44 h_o = 44/15.8 = 2.8

Suggest trebling the air rate rather than reducing the annular space

$G_s = 3{,}846\ \#/\text{hr ft}^2$ (750 ACFM)

$$N_{Re} = \frac{0.33 \times 3846}{.0668} = 19{,}000$$

$J_H = 80$

$h_o = 80/15.8 = 5\ \text{BTU}/^\circ\ \text{F hr ft}_2$

By reducing the annular area a factor of 3@250CFM the same h_o may be achieved:

$$\left(\frac{13}{12}\right)^2 \pi - 1\pi = 0.55\ \text{ft}^2$$

$$A_1 = \frac{0.55}{3} = 0.18$$

$$\pi r_2^2 = 0.18 + 1\pi \quad r_2 = 1.03 = 0.34$$

or $\frac{5}{16}$" annular space

This is too small. Use 750 ACFM with 1-inch annular spacing.

Note temperature profiles attached showing the effect of each condition.

MERRICK Engineers & Architects	COMPUTER CALCULATION COVER SHEET PROJECT #30012318	NEW MEXICO OFFICE

CALCULATION TITLE: Determination of MCO Heating Temp Profile

CALCULATION INDEX NO.: HVC - 3

SUBJECT/PURPOSE OF CALCULATION: Determination of MCO Temperature Profile throughout Heating Process

PROGRAM NAME: Quattro Pro → Converted to Excel

PROGRAM REVISION: ~~Dos Version~~ Excel 5.0

INPUT DATA SOURCE: Refer to Calculations

REMARKS:

ATTACHED ARE:

- ☒ PRINTOUT OF INPUT DATA RESULTS
- ☐ PRINTOUT OF SPECIFIC PROGRAMMING OPTIONS AND/OR INSTRUCTIONS
- ☐ DOCUMENTATION OF SOURCES AND/OR DEVELOPMENT OF FORMULA

ORIGINATOR: C B Ames DATE: 5/13/96

INPUT DATA CHECKED BY: D A Munger DATE: 5/13/96

5/3/96

CALCULATION METHODOLOGY FOR DETERMINING MCO HEATING TEMPERATURE PROFILE

The heating profile consists of a series of heat balances on six minute increments which are integrated over time to describe the temperature profiles of interest. The calculation allows for heat from the oven and heat from the nuclear activity of the fuel.

At MCO operating pressures near atmospheric the heat input from external heating of circulating helium is minimal and is not considered in this calculation. As the internal pressure is increased, heat added to the circulating stream can be significant and this calculation would underestimate the rise in temperature for the following reasons:

1. the internal heat transfer coefficient would increase significantly,
2. conduction through the helium would be significant and would add to heat transfer from forced convection, and
3. the mass flow of the helium through an external heat source would provide a significant boost to fuel heating.

The calculations forming the temperature profile are made as follows. All English units are converted to metric in a table which is the basis for the graphical information. Spreadsheet formulas are shown in bold.

<u>Hot air in (°F)</u>
This value is manually set at each hourly increment.

<u>End time (hours)</u>
Time is stepped off in 0.1 hour increments from 0 to 20 hours.

<u>Delta temperature air to MCO (°F)</u>
This is the difference between the *average* hot air temperature and the wall temperature of the MCO.
(hot air temp in + hot air temp out)/2 - MCO wall temp

<u>Net heat into MCO (Btu/hr)</u>
This is the heat into the MCO from the oven less the heat from the MCO to the fuel
external heat transfer coefficient x external surface area of MCO x delta temperature air to MCO - heat from MCO

<u>Hot air temperature out (°F)</u>
This is the hot air into the oven less the temperature resulting from heat transferred to the MCO
***IF*(air temp in -(net heat into MCO + net heat from MCO - nuclear heat) / heat capacity of air x mass flow rate of air) < MCO wall temperature *THEN* MCO wall temperature *ELSE* (net heat in + heat from MCO - nuclear heat) / heat capacity of air x mass flow rate of air)**

<u>MCO wall temperature (°F)</u>
net heat in x (end time this period - end time previous period) / (mass MCO x specific heat MCO) + previous wall temperature

<u>Temperature of fuel rods (°F)</u>
previous temperature of fuel rods + (heat from MCO x (end time this period - end time previous period) / (mass of fuel + specific heat of fuel)

<u>Heat from MCO (Btu/hr)</u>
This is the heat from the MCO to the fuel *plus the heat generated from the nuclear activity of the fuel*
(MCO wall temperature - fuel rod temperature) + nuclear energy from rods

Calculations by Lauren Ames on HANHEAT3.WQ1 5/3/96
reviewed by David Munger

HANHEAT3.WQ1 of 5/7/96 -- FOR CALCULATION OF HEATING TEMP PROFILE							
Santa Fe Engineering, Ltd. - LBA							
h1 (Btu/lb*ft2*F*hr)							
to MCO ou	5		AIR TEMP DATA ENTRY TAKES PLACE				
A1 (ft2) of	92		IN COLUMN N				
h2 (Btu/lb*ft2*F*hr)							
thru MCO	1						
A2 (ft2) of	83						
M*C (air in	397.8	[assumes 750 ACFM]					
m1*c1 (MCO i	471.6						
m2*c2 (fuel	451						
T1 = air tem	programmed as shown						
T2 = air temp out (F)							
t1 = MCO wall temp at							
increment end (F)							
t2 = fuel rod temp at							
increment end (F)							
Q = internal rad heat							
generate	835						
				Hot			
Hot air	End	Delta	Net Heat	air	MCO	Fuel	Heat
in	Time	temp.	into MCO	out	wall	rods	from MCO
(T1)	(hrs)	air/MCO	(Btu/hr)	(T2)	(t1)	(t2)	(Btu/hr)
266	0.0	162			104	104	
266	0.1	65	74,520	104	120	104	4,161
266	0.2	106	25,830	197	125	105	4,539
266	0.3	73	44,281	149	135	106	5,235
266	0.4	86	28,196	188	141	107	5,635
266	0.5	71	34,115	172	148	108	6,132
266	0.6	75	26,581	190	154	110	6,487
266	0.7	67	27,784	186	159	111	6,856
266	0.8	66	23,795	195	164	113	7,149
266	0.9	62	23,319	196	169	114	7,428
392	1.0	123	20,880	201	174	116	7,659
392	1.1	99	48,869	174	184	118	8,378
392	1.2	96	37,036	184	192	119	8,875
392	1.3	92	35,309	192	200	121	9,333
392	1.4	89	33,213	200	207	123	9,746
392	1.5	86	31,283	207	213	126	10,117
392	1.6	83	29,480	213	219	128	10,450
392	1.7	80	27,797	219	225	130	10,747
392	1.8	78	26,227	225	231	133	11,011

Hot air in (T1)	End Time (hrs)	Delta temp. air/MCO	Net Heat into MCO (Btu/hr)	Hot air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from MCO (Btu/hr)
392	1.9	75	24,761	231	236	135	11,244
518	2.0	136	23,391	236	241	138	11,449
518	2.1	128	51,093	241	252	140	12,137
518	2.2	123	46,561	252	262	143	12,733
518	2.3	119	43,915	262	271	146	13,272
518	2.4	115	41,364	271	280	149	13,756
518	2.5	111	38,987	280	288	152	14,189
518	2.6	107	36,769	288	296	155	14,575
518	2.7	104	34,698	296	303	158	14,917
518	2.8	100	32,764	303	310	161	15,219
518	2.9	97	30,959	310	317	165	15,484
617	3.0	144	29,272	317	323	168	15,714
617	3.1	136	50,466	323	334	172	16,313
617	3.2	132	46,372	334	344	175	16,829
617	3.3	127	43,795	344	353	179	17,290
617	3.4	123	41,323	353	362	183	17,699
617	3.5	119	39,020	362	370	187	18,060
617	3.6	116	36,868	370	378	191	18,377
617	3.7	112	34,858	378	385	195	18,652
617	3.8	109	32,981	385	392	199	18,889
617	3.9	106	31,227	392	399	203	19,091
662	4.0	125	29,587	399	405	207	19,261
662	4.1	120	38,405	405	413	212	19,582
662	4.2	117	35,781	413	421	216	19,851
662	4.3	113	33,894	421	428	220	20,082
662	4.4	110	32,102	428	435	225	20,278
662	4.5	107	30,428	435	441	229	20,440
662	4.6	104	28,864	441	447	234	20,572
662	4.7	102	27,400	447	453	238	20,676
662	4.8	99	26,032	453	459	243	20,753
662	4.9	96	24,751	459	464	248	20,807
707	5.0	117	23,553	464	469	252	20,839
707	5.1	112	32,781	469	476	257	21,032
707	5.2	109	30,539	476	482	261	21,182
707	5.3	106	29,008	482	488	266	21,303
707	5.4	103	27,548	488	494	271	21,396
707	5.5	101	26,183	494	500	276	21,463
707	5.6	98	24,905	500	505	280	21,506
707	5.7	96	23,710	505	510	285	21,528
707	5.8	94	22,590	510	515	290	21,529
707	5.9	91	21,542	515	520	295	21,512
707	6.0	89	20,559	520	524	299	21,478
707	6.1	87	19,639	524	528	304	21,428

Hot air in (T1)	End Time (hrs)	Delta temp. air/MCO	Net Heat into MCO (Btu/hr)	Hot air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from MCO (Btu/hr)
707	6.2	86	18,775	528	532	309	21,364
707	6.3	84	17,966	532	536	314	21,287
707	6.4	82	17,206	536	539	318	21,199
707	6.5	80	16,493	539	543	323	21,099
707	6.6	79	15,823	543	546	328	20,989
707	6.7	77	15,194	546	550	332	20,870
707	6.8	76	14,602	550	553	337	20,743
707	6.9	74	14,046	553	556	342	20,608
707	7.0	73	13,523	556	558	346	20,467
707	7.1	71	13,030	558	561	351	20,320
707	7.2	70	12,566	561	564	355	20,167
707	7.3	69	12,129	564	566	360	20,009
707	7.4	68	11,716	566	569	364	19,847
707	7.5	67	11,327	569	571	369	19,681
707	7.6	65	10,959	571	574	373	19,512
707	7.7	64	10,612	574	576	377	19,340
707	7.8	63	10,284	576	578	382	19,165
707	7.9	62	9,973	578	580	386	18,988
707	8.0	61	9,679	580	582	390	18,808
707	8.1	60	9,400	582	584	394	18,628
707	8.2	59	9,136	584	586	398	18,446
707	8.3	59	8,886	586	588	402	18,263
707	8.4	58	8,648	588	590	406	18,079
707	8.5	57	8,421	590	592	410	17,894
707	8.6	56	8,206	592	593	414	17,709
707	8.7	55	8,001	593	595	418	17,524
707	8.8	54	7,806	595	597	422	17,339
707	8.9	53	7,620	597	598	426	17,154
707	9.0	53	7,443	598	600	430	16,969
707	9.1	52	7,273	600	602	434	16,785
707	9.2	51	7,111	602	603	437	16,601
707	9.3	50	6,956	603	605	441	16,418
707	9.4	50	6,807	605	606	445	16,236
707	9.5	49	6,665	606	607	448	16,054
707	9.6	48	6,528	607	609	452	15,874
707	9.7	48	6,397	609	610	455	15,694
707	9.8	47	6,271	610	611	459	15,516
707	9.9	46	6,150	611	613	462	15,339
707	10.0	46	6,033	613	614	466	15,162
707	10.1	45	5,921	614	615	469	14,988
707	10.2	45	5,812	615	617	472	14,814
707	10.3	44	5,708	617	618	476	14,642
707	10.4	43	5,606	618	619	479	14,471

Hot air in (T1)	End Time (hrs)	Delta temp. air/MCO	Net Heat into MCO (Btu/hr)	Hot air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from MCO (Btu/hr)
707	10.5	43	5,509	619	620	482	14,302
707	10.6	42	5,414	620	621	485	14,134
707	10.7	42	5,323	621	622	488	13,967
707	10.8	41	5,234	622	623	492	13,802
707	10.9	41	5,148	623	625	495	13,639
707	11.0	40	5,065	625	626	498	13,477
707	11.1	40	4,983	626	627	501	13,317
707	11.2	39	4,905	627	628	504	13,158
707	11.3	39	4,828	628	629	506	13,001
707	11.4	38	4,754	629	630	509	12,845
707	11.5	38	4,681	630	631	512	12,691
707	11.6	37	4,610	631	632	515	12,539
707	11.7	37	4,541	632	633	518	12,388
707	11.8	36	4,474	633	634	521	12,239
707	11.9	36	4,408	634	635	523	12,091
707	12.0	35	4,344	635	636	526	11,945
707	12.1	35	4,282	636	636	529	11,801
707	12.2	34	4,220	636	637	531	11,658
707	12.3	34	4,160	637	638	534	11,516
707	12.4	34	4,102	638	639	536	11,377
707	12.5	33	4,044	639	640	539	11,238
707	12.6	33	3,988	640	641	541	11,102
707	12.7	32	3,933	641	642	544	10,967
707	12.8	32	3,879	642	642	546	10,833
707	12.9	31	3,826	642	643	549	10,701
707	13.0	31	3,774	643	644	551	10,571
707	13.1	31	3,723	644	645	553	10,442
707	13.2	30	3,673	645	646	556	10,314
707	13.3	30	3,624	646	646	558	10,188
707	13.4	30	3,575	646	647	560	10,063
707	13.5	29	3,528	647	648	562	9,940
707	13.6	29	3,481	648	649	565	9,819
707	13.7	28	3,435	649	649	567	9,698
707	13.8	28	3,390	649	650	569	9,580
707	13.9	28	3,346	650	651	571	9,462
707	14.0	27	3,302	651	651	573	9,346
707	14.1	27	3,260	651	652	575	9,232
707	14.2	27	3,217	652	653	577	9,118
707	14.3	26	3,176	653	654	579	9,006
707	14.4	26	3,135	654	654	581	8,896
707	14.5	26	3,094	654	655	583	8,787
707	14.6	25	3,055	655	656	585	8,679
707	14.7	25	3,016	656	656	587	8,572

Hot air in (T1)	End Time (hrs)	Delta temp. air/MCO	Net Heat into MCO (Btu/hr)	Hot air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from MCO (Btu/hr)
				656	657	589	8,467
707	14.8	25	2,977	657	657	591	8,363
707	14.9	24	2,939	657	658	593	8,260
572	15.0	-43	2,902	658	652	595	7,612
572	15.1	-37	(28,185)	652	647	596	7,038
572	15.2	-35	(24,646)	647	642	598	6,503
572	15.3	-33	(23,043)	642	637	599	6,005
572	15.4	-30	(21,462)	637	633	601	5,543
572	15.5	-28	(19,995)	633	629	602	5,113
572	15.6	-27	(18,629)	629	626	603	4,713
572	15.7	-25	(17,357)	626	622	604	4,342
572	15.8	-23	(16,173)	622	619	605	3,997
572	15.9	-22	(15,071)	619	616	606	3,676
572	16.0	-20	(14,045)	616	613	607	3,378
572	16.1	-19	(13,089)	613	611	608	3,101
572	16.2	-18	(12,199)	611	608	608	2,844
572	16.3	-17	(11,371)	608	606	609	2,605
572	16.4	-16	(10,599)	606	604	609	2,383
572	16.5	-15	(9,881)	604	602	610	2,177
572	16.6	-14	(9,212)	602	600	610	1,986
572	16.7	-13	(8,590)	600	598	611	1,809
572	16.8	-12	(8,010)	598	597	611	1,644
572	16.9	-12	(7,470)	597	595	612	1,491
572	17.0	-11	(6,967)	595	594	612	1,349
572	17.1	-10	(6,499)	594	593	612	1,218
572	17.2	-10	(6,063)	593	591	613	1,096
572	17.3	-9	(5,657)	591	590	613	983
572	17.4	-9	(5,279)	590	589	613	878
572	17.5	-8	(4,927)	589	588	613	781
572	17.6	-8	(4,599)	588	587	613	691
572	17.7	-7	(4,294)	587	586	614	607
572	17.8	-7	(4,009)	586	586	614	530
572	17.9	-6	(3,744)	586	585	614	459
572	18.0	-6	(3,498)	585	584	614	393
572	18.1	-6	(3,268)	584	584	614	332
572	18.2	-5	(3,054)	584	583	614	276
572	18.3	-5	(2,854)	583	582	614	224
572	18.4	-5	(2,668)	582	582	614	176
572	18.5	-5	(2,495)	582	581	614	131
572	18.6	-4	(2,334)	581	581	614	91
572	18.7	-4	(2,184)	581	581	614	53
572	18.8	-4	(2,044)	581	580	614	18
572	18.9	-4	(1,913)	580	580	614	(14)
572	19.0	-4	(1,792)				

Hot air in (T1)	End Time (hrs)	Delta temp. air/MCO	Net Heat into MCO (Btu/hr)	Hot air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from MCO (Btu/hr)
572	19.1	-4	(1,678)	580	579	614	(43)
572	19.2	-3	(1,573)	579	579	614	(70)
572	19.3	-3	(1,474)	579	579	614	(94)
572	19.4	-3	(1,382)	579	578	614	(117)
572	19.5	-3	(1,297)	578	578	614	(138)
572	19.6	-3	(1,217)	578	578	614	(157)
572	19.7	-3	(1,143)	578	578	614	(174)
572	19.8	-3	(1,073)	578	577	614	(190)
572	19.9	-3	(1,009)	577	577	614	(204)
572	20.0	-2	(949)	577	577	614	(217)

MERRICK	COMPUTER CALCULATION COVER SHEET PROJECT #30012318	NEW MEXICO OFFICE

CALCULATION TITLE: Determination of MCO Cooling Temp Profile

CALCULATION INDEX NO.: HSC-4

SUBJECT/PURPOSE OF CALCULATION: Determination of MCO Temperature Profile throughout Cooling Process

PROGRAM NAME: Quattro Pro → converted to Excel

PROGRAM REVISION: ~~Dos Version~~ Excel 5.0

INPUT DATA SOURCE: Refer to Calculations

REMARKS:

ATTACHED ARE:

- [x] PRINTOUT OF INPUT DATA RESULTS
- [ ] PRINTOUT OF SPECIFIC PROGRAMMING OPTIONS AND/OR INSTRUCTIONS
- [ ] DOCUMENTATION OF SOURCES AND/OR DEVELOPMENT OF FORMULA

ORIGINATOR: [signature] DATE: 5/13/96

INPUT DATA CHECKED BY: D H Morgan DATE: 5/13/96

 5/13/96

CALCULATION METHODOLOGY FOR DETERMINING MCO COOLING TEMPERATURE PROFILE

The cooling profile consists of a series of heat balances on six minute increments which are integrated over time to describe the temperature profiles of interest. The calculation allows for heat transfer to the oven from the heat capacity of the MCO and its contents and heat from the nuclear activity of the fuel. The model is the same as for MCO heating except that negative heating rates indicate a reverse direction of heat flow from the MCO system to the cooler air from the oven.

At MCO operating pressures near atmospheric the heat removal from external cooling of circulating helium is minimal and is not considered in this calculation. As the internal pressure is increased, heat removed by the circulating stream can be significant and this calculation would underestimate the rise in temperature for the following reasons:

1. the internal heat transfer coefficient would increase significantly,
2. conduction through the helium would be significant and would add to heat transfer from forced convection, and
3. the mass flow of the helium through an external heat source would provide a significant boost to fuel cooling.

The calculations forming the temperature profile are made as follows. All English units are converted to metric in a table which is the basis for the graphical information. Spreadsheet formulas are shown in bold.

Cool air in (°F)
This value is manually set at each hourly increment.

End time (hours)
Time is stepped off in 0.1 hour increments from 0 to 20 hours.

Delta temperature air to MCO (°F)
This is the difference between the *average* cool air temperature and the wall temperature of the MCO.
(cool air temp in + cool air temp out)/2 - MCO wall temp

Net heat to MCO (Btu/hr)
This is the heat to the MCO to the oven less the heat from the MCO from the fuel. It is a negative value.
external heat transfer coefficient x external surface area of MCO x delta temperature air to MCO - heat from MCO

Cool air temperature out (°F)
This is the cool air into the oven less the temperature resulting from heat transferred from the MCO
***IF*(air temp in - (net heat to MCO + net heat from MCO - nuclear heat) / heat capacity of air x mass flow rate of air) < MCO wall temperature *THEN* (net heat in + heat from MCO - nuclear heat) / heat capacity of air x mass flow rate of air) *ELSE* MCO wall temperature**

MCO wall temperature (°F)
net heat in x (end time this period - end time previous period) / (mass MCO x specific heat MCO) + previous wall temperature

Temperature of fuel rods (°F)
previous temperature of fuel rods + (heat from MCO x (end time this period - end time previous period) / (mass of fuel + specific heat of fuel)

Heat from MCO (Btu/hr)
This is the heat from the MCO to the fuel *plus the heat generated from the nuclear activity of the fuel. It is a negative value.*
(MCO wall temperature - fuel rod temperature) + nuclear energy from rods

calculations by Lauren Ames on HANHEAT4.WQ1 5/3/96 reviewed by David Munger

HANHEAT4.WQ1 of 5/7/96 -- FOR CALCULATION OF COOLING TEMP PROFILE							
Santa Fe Engineering, Ltd. - LBA							
h1 (Btu/lb*ft2*F*hr)							
to MCO o	5		AIR TEMP DATA ENTRY TAKES PLACE				
A1 (ft2) of	92		IN COLUMN N				
h2 (Btu/lb*ft2*F*hr)							
thru MCO	1						
A2 (ft2) of	83						
Cp air (in	562	[assumes 750 ACFM]					
m1*c1 (MCO	471.6						
m2*c2 (fuel	451						
T1 = air te	programmed as shown						
T2 = air temp out (F)							
t1 = MCO wall temp at							
increment end (F)							
t2 = fuel rod temp at							
increment end (F)							
Q = internal rad heat							
generat	835						
				Cold			
Cold air	End	Delta	Heat	air	MCO	Fuel	Heat
in	Time	temp.	from MCO	out	wall	rods	from Fuel
(T1)	(hrs)	air/MCO	(Btu/hr)	(T2)	(t1)	(t2)	(Btu/hr)
410	0.0	-367		0	572	572	
410	0.1	-107	(49,221)	499	562	572	1,984
410	0.2	-94	(51,204)	504	551	572	1,046
410	0.3	-90	(44,077)	493	541	573	251
410	0.4	-83	(41,574)	490	533	573	(485)
410	0.5	-78	(37,505)	484	525	573	(1,137)
410	0.6	-72	(34,595)	480	517	572	(1,724)
410	0.7	-68	(31,583)	475	511	572	(2,249)
410	0.8	-64	(28,996)	472	504	571	(2,718)
410	0.9	-60	(26,566)	468	499	571	(3,135)
284	1.0	-119	(24,381)	465	494	570	(3,506)
284	1.1	-94	(51,353)	494	483	569	(4,346)
284	1.2	-91	(38,855)	483	474	568	(4,950)
284	1.3	-87	(36,966)	474	467	567	(5,509)
284	1.4	-84	(34,695)	467	459	566	(6,018)
284	1.5	-81	(32,605)	459	452	565	(6,481)
284	1.6	-78	(30,654)	452	446	563	(6,902)
284	1.7	-75	(28,834)	446	440	562	(7,282)
284	1.8	-72	(27,136)	440	434	560	(7,626)

Cold air in (T1)	End Time (hrs)	Delta temp. air/MCO	Heat from MCO (Btu/hr)	Cold air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from Fuel (Btu/hr)
284	1.9	-70	(25,551)	434	429	559	(7,935)
104	2.0	-157	(24,073)	429	423	557	(8,213)
104	2.1	-146	(64,094)	423	410	555	(9,190)
104	2.2	-141	(58,039)	410	398	553	(10,042)
104	2.3	-135	(54,651)	398	386	551	(10,819)
104	2.4	-130	(51,374)	386	375	548	(11,524)
104	2.5	-125	(48,323)	375	365	546	(12,162)
104	2.6	-121	(45,477)	365	355	543	(12,739)
104	2.7	-117	(42,821)	355	346	540	(13,258)
104	2.8	-113	(40,343)	346	338	537	(13,724)
104	2.9	-109	(38,031)	338	330	534	(14,141)
104	3.0	-105	(35,872)	330	322	531	(14,512)
104	3.1	-102	(33,857)	322	315	528	(14,841)
104	3.2	-99	(31,975)	315	308	525	(15,130)
104	3.3	-96	(30,218)	308	302	521	(15,384)
104	3.4	-93	(28,576)	302	295	518	(15,604)
104	3.5	-90	(27,043)	295	290	514	(15,792)
104	3.6	-87	(25,610)	290	284	511	(15,952)
104	3.7	-85	(24,271)	284	279	507	(16,086)
104	3.8	-83	(23,019)	279	274	504	(16,195)
104	3.9	-81	(21,848)	274	270	500	(16,282)
68	4.0	-96	(20,753)	270	265	497	(16,347)
68	4.1	-93	(28,009)	265	259	493	(16,539)
68	4.2	-90	(26,097)	259	254	489	(16,694)
68	4.3	-88	(24,762)	254	249	486	(16,823)
68	4.4	-85	(23,491)	249	244	482	(16,927)
68	4.5	-83	(22,304)	244	239	478	(17,008)
68	4.6	-81	(21,193)	239	234	474	(17,068)
68	4.7	-79	(20,154)	234	230	471	(17,108)
68	4.8	-77	(19,181)	230	226	467	(17,131)
68	4.9	-75	(18,270)	226	222	463	(17,137)
68	5.0	-73	(17,417)	222	218	459	(17,128)
68	5.1	-72	(16,618)	218	215	455	(17,106)
68	5.2	-70	(15,869)	215	212	452	(17,070)
68	5.3	-69	(15,167)	212	208	448	(17,023)
68	5.4	-67	(14,509)	208	205	444	(16,965)
68	5.5	-66	(13,892)	205	202	440	(16,897)
68	5.6	-64	(13,312)	202	199	436	(16,821)
68	5.7	-63	(12,768)	199	197	433	(16,736)
68	5.8	-62	(12,256)	197	194	429	(16,643)
68	5.9	-61	(11,776)	194	192	425	(16,544)
68	6.0	-59	(11,324)	192	189	422	(16,439)
68	6.1	-58	(10,899)	189	187	418	(16,329)

Cold air in (T1)	End Time (hrs)	Delta temp. air/MCO	Heat from MCO (Btu/hr)	Cold air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from Fuel (Btu/hr)
68	6.2	-57	(10,499)	187	185	414	(16,213)
68	6.3	-56	(10,122)	185	183	411	(16,093)
68	6.4	-55	(9,767)	183	181	407	(15,968)
68	6.5	-54	(9,432)	181	179	404	(15,840)
68	6.6	-53	(9,116)	179	177	400	(15,709)
68	6.7	-52	(8,818)	177	175	397	(15,575)
68	6.8	-52	(8,537)	175	173	393	(15,439)
68	6.9	-51	(8,271)	173	171	390	(15,300)
68	7.0	-50	(8,019)	171	169	386	(15,160)
68	7.1	-49	(7,780)	169	168	383	(15,018)
68	7.2	-48	(7,555)	168	166	380	(14,875)
68	7.3	-48	(7,341)	166	165	376	(14,730)
68	7.4	-47	(7,138)	165	163	373	(14,584)
68	7.5	-46	(6,945)	163	162	370	(14,438)
68	7.6	-45	(6,762)	162	160	367	(14,292)
68	7.7	-45	(6,588)	160	159	364	(14,145)
68	7.8	-44	(6,422)	159	157	360	(13,997)
68	7.9	-43	(6,264)	157	156	357	(13,850)
167	8.0	7	(6,114)	156	155	354	(13,703)
167	8.1	3	16,800	155	158	351	(13,155)
167	8.2	1	14,315	158	161	348	(12,661)
167	8.3	0	13,244	161	164	345	(12,195)
167	8.4	-1	12,184	164	167	343	(11,756)
167	8.5	-2	11,203	167	169	340	(11,342)
167	8.6	-3	10,291	169	171	338	(10,952)
167	8.7	-4	9,444	171	173	335	(10,585)
167	8.8	-5	8,657	173	175	333	(10,237)
167	8.9	-6	7,926	175	177	331	(9,910)
266	9.0	43	7,247	177	178	328	(9,600)
266	9.1	38	29,387	178	185	326	(8,906)
266	9.2	35	26,180	185	190	324	(8,281)
266	9.3	33	24,435	190	195	322	(7,699)
266	9.4	30	22,746	195	200	321	(7,157)
266	9.5	28	21,177	200	205	319	(6,652)
266	9.6	26	19,716	205	209	318	(6,183)
266	9.7	25	18,356	209	213	316	(5,746)
266	9.8	23	17,091	213	216	315	(5,339)
266	9.9	21	15,912	216	220	314	(4,961)
266	10.0	20	14,815	220	223	313	(4,609)
266	10.1	19	13,794	223	226	312	(4,281)
266	10.2	17	12,844	226	229	311	(3,977)
266	10.3	16	11,959	229	231	310	(3,693)
266	10.4	15	11,135	231	233	309	(3,429)

Cold air in (T1)	End Time (hrs)	Delta temp. air/MCO	Heat from MCO (Btu/hr)	Cold air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from Fuel (Btu/hr)
266	10.5	14	10,368	233	236	308	(3,183)
266	10.6	13	9,654	236	238	308	(2,955)
266	10.7	12	8,990	238	240	307	(2,742)
266	10.8	11	8,371	240	241	306	(2,545)
266	10.9	11	7,795	241	243	306	(2,361)
266	11.0	10	7,259	243	245	305	(2,189)
266	11.1	9	6,760	245	246	305	(2,030)
266	11.2	9	6,296	246	247	304	(1,882)
266	11.3	8	5,863	247	249	304	(1,744)
266	11.4	8	5,460	249	250	304	(1,616)
266	11.5	7	5,086	250	251	303	(1,497)
266	11.6	7	4,737	251	252	303	(1,386)
266	11.7	6	4,412	252	253	303	(1,283)
266	11.8	6	4,109	253	254	302	(1,187)
266	11.9	5	3,828	254	254	302	(1,097)
266	12.0	5	3,565	254	255	302	(1,015)
266	12.1	5	3,321	255	256	302	(937)
266	12.2	4	3,094	256	257	301	(866)
266	12.3	4	2,883	257	257	301	(799)
266	12.4	4	2,686	257	258	301	(737)
266	12.5	4	2,502	258	258	301	(679)
266	12.6	3	2,332	258	259	301	(626)
266	12.7	3	2,173	259	259	301	(576)
266	12.8	3	2,025	259	260	300	(530)
266	12.9	3	1,887	260	260	300	(487)
266	13.0	3	1,759	260	260	300	(447)
266	13.1	2	1,639	260	261	300	(410)
266	13.2	2	1,528	261	261	300	(376)
266	13.3	2	1,425	261	261	300	(344)
266	13.4	2	1,328	261	262	300	(314)
266	13.5	2	1,238	262	262	300	(286)
266	13.6	2	1,155	262	262	300	(261)
266	13.7	2	1,077	262	262	300	(237)
266	13.8	2	1,004	262	263	300	(215)
266	13.9	1	937	263	263	300	(194)
266	14.0	1	874	263	263	299	(175)
266	14.1	1	816	263	263	299	(158)
266	14.2	1	761	263	263	299	(142)
266	14.3	1	710	263	264	299	(126)
266	14.4	1	663	264	264	299	(112)
266	14.5	1	619	264	264	299	(100)
266	14.6	1	578	264	264	299	(88)
266	14.7	1	540	264	264	299	(76)

Cold air in (T1)	End Time (hrs)	Delta temp. air/MCO	Heat from MCO (Btu/hr)	Cold air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from Fuel (Btu/hr)
266	14.8	1	504	264	264	299	(66)
266	14.9	1	471	264	264	299	(57)
266	15.0	1	440	264	264	299	(48)
266	15.1	1	411	264	264	299	(40)
266	15.2	1	385	264	264	299	(32)
266	15.3	1	360	264	265	299	(25)
266	15.4	1	336	265	265	299	(19)
266	15.5	1	315	265	265	299	(13)
266	15.6	1	295	265	265	299	(8)
266	15.7	1	276	265	265	299	(3)
266	15.8	1	258	265	265	299	2
266	15.9	1	242	265	265	299	6
266	16.0	0	227	265	265	299	10
266	16.1	0	213	265	265	299	14
266	16.2	0	199	265	265	299	17
266	16.3	0	187	265	265	299	20
266	16.4	0	175	265	265	299	23
266	16.5	0	165	265	265	299	25
266	16.6	0	155	265	265	299	27
266	16.7	0	145	265	265	299	29
266	16.8	0	137	265	265	299	31
266	16.9	0	129	265	265	299	33
266	17.0	0	121	265	265	299	35
266	17.1	0	114	265	265	299	36
266	17.2	0	107	265	265	299	37
266	17.3	0	101	265	265	299	38
266	17.4	0	96	265	265	299	39
266	17.5	0	90	265	265	299	40
266	17.6	0	85	265	265	299	41
266	17.7	0	81	265	265	299	41
266	17.8	0	76	265	265	299	42
266	17.9	0	72	265	266	299	43
266	18.0	0	68	266	266	299	43
266	18.1	0	65	266	266	299	43
266	18.2	0	61	266	266	299	44
266	18.3	0	58	266	266	299	44
266	18.4	0	55	266	266	299	44
266	18.5	0	53	266	266	299	44
266	18.6	0	50	266	266	299	44
266	18.7	0	48	266	266	299	44
266	18.8	0	45	266	266	299	44
266	18.9	0	43	266	266	299	44
266	19.0	0	41	266	266	299	44

Cold air in (T1)	End Time (hrs)	Delta temp. air/MCO	Heat from MCO (Btu/hr)	Cold air out (T2)	MCO wall (t1)	Fuel rods (t2)	Heat from Fuel (Btu/hr)
266	19.1	0	40	266	266	299	44
266	19.2	0	38	266	266	299	44
266	19.3	0	36	266	266	299	44
266	19.4	0	35	266	266	299	43
266	19.5	0	33	266	266	299	43
266	19.6	0	32	266	266	299	43
266	19.7	0	31	266	266	300	43
266	19.8	0	29	266	266	300	42
266	19.9	0	28	266	266	300	42
266	20.0	0	27	266	266	300	42

MERRICK Engineers & Architects	COMPUTER CALCULATION COVER SHEET PROJECT #30012318	NEW MEXICO OFFICE

CALCULATION TITLE: Material Balance

CALCULATION INDEX NO.: HVC-5

SUBJECT/PURPOSE OF CALCULATION: Determine Stream parameters throughout Hot Conditioning System

PROGRAM NAME: Microsoft Excel

PROGRAM REVISION: 5.0

INPUT DATA SOURCE: Refer to cell definitions

REMARKS:

ATTACHED ARE:

- [x] PRINTOUT OF INPUT DATA RESULTS
- [ ] PRINTOUT OF SPECIFIC PROGRAMMING OPTIONS AND/OR INSTRUCTIONS
- [x] DOCUMENTATION OF SOURCES AND/OR DEVELOPMENT OF FORMULA

ORIGINATOR: CB Amer DATE: 6/12/96

INPUT DATA CHECKED BY: D H M[illegible] DATE: 6/12/96

Material Balance Calculations

The following pages contain printout from the MS Excel spreadsheet used to prepare the material balance. The cell columns and rows are labeled so that they may be referenced to the calculations shown in the following notes section. Some manual calculations on vacuum pumping speed follow the Excel output.

prepared by L.B. Ames 6/12/96

	A	B	C	D	E	F	G	H	I	J
2	Operating Cycle		Ongoing utility				Preparation for heating cycle			
3	Stream Description	MWt	Dewar vacuum draw		MCO area hood vent		Initial vacuum evacuation		Helium filling of MCO	
4	Stream No.		1		2		3		4	
5										
6	Temp. C *(F)*		20-375	*68-707*	20	*68*	40	*104*	20	*68*
7										
8	Press Torr *(psia)*		1.00E-04	*1.93E-06*	760	*14.7*	10	*0.193*	931	*18*
9	Flow rate std l/sec *(scfm)*		nil	*nil*	66	*140*	0.067	*0.142*	5.32	*11.29*
10	Vac rate l/min						350			
11	H_2 kg/hr *(lbs/hr)*	2						-		
12	O_2 kg/hr *(lbs/hr)*	32								
13	N_2 kg/hr *(lbs/hr)*	28								
14	He kg/hr *(lbs/hr)*	4							3.42	*7.55*
15	I^{131} gram/hr *(lbs/hr)*	131								
16	Kr^{86} gram/hr *(lbs/hr)*	86								
17	Cs^{137} gram/hr *(lbs/hr)*	137								
18										
19	Max heat rate kcal/hr *(Btu/hr)*									
20										
21	Process Duration (Note 4)		ongoing		130 hr		6.80	min.	12.95	min.
22	Approx. Total Duration		ongoing		130 hr		15	min.	15	min.
23	Water Removed kg									
24	Hydrogen Removed kg									
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40	MCO volume (liter) =		507.19							
41	External MCO piping (liter) =		60.56							
42	Cyl. gas fill rate (al/m) =		280							
43	Cyl gas fill pressure (psia) =		18							
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =		62.361							
45	System operating pressure (psia)		13							
46	Specific heat of helium (cal/gC)									
47	1 atm (100-300C)		0.519							
48	5 atm (100-300C)		0.519							
49	MCO gas Circulation rate (ACFM)		10							

	A	B	K	L	M	N	O	P	Q	R
2	Operating Cycle								Heating of MCO (40C to 3	
3	Stream Description	MWt	MCO heating air		Helium heating (Heater inlet)		Helium heating (Heater outlet)		Periodic helium purging to 200 C	
4	Stream No.		5		6A		6B		7A	
5										
6	Temp. C *(F)*		375	*707*	102	*216*	325	*617*	200	*392*
7			Note 5							
8	Press Torr *(psia)*		760	*14.7*	688	*13.3*	672	*13*	688	*13.3*
9	Flow rate std l/sec *(scfm)*		149	*316*	1.90	*4.037*	1.90	*4.037*	0.005	*0.011*
10	Vac rate l/min									
11	H_2 kg/hr *(lbs/hr)*	2								
12	O_2 kg/hr *(lbs/hr)*	32								
13	N_2 kg/hr *(lbs/hr)*	28								
14	He kg/hr *(lbs/hr)*	4			1.22	*2.70*	1.22	*2.70*	0.003	*0.007*
15	I^{131} gram/hr *(lbs/hr)*	131								
16	Kr^{86} gram/hr *(lbs/hr)*	86								
17	Cs^{137} gram/hr *(lbs/hr)*	137								
18										
19	Max heat rate kcal/hr *(Btu/hr)*		17,640	*70,000*			142	*562*	0.002	*0.007*
20										
21	Process Duration (Note 4)		13.2 hr (Note 3)		13.2	hr.	13.2	hr.	8	hr.
22	Approx. Total Duration		14	hr.	14	hr.	14	hr.	8	hr.
23	Water Removed kg									
24	Hydrogen Removed kg									
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40	MCO volume (liter) =							g moles @ 40C=		19.54967
41	External MCO piping (liter) =							g moles @ 200C=		12.93667
42	Cyl. gas fill rate (al/m) =							g moles @ 300C=		10.6790
43	Cyl gas fill pressure (psia) =									
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =									
45	System operating pressure (psia)									
46	Specific heat of helium (cal/gC)									
47	1 atm (100-300C)									
48	5 atm (100-300C)									
49	MCO gas Circulation rate (ACFM)									

	A	B	S	T	U	V	W	X
2	Operating Cycle		0+C)					
3	Stream Description	MWt	Helium purging 200 C to 300 C		Helium for purge during heat-up		Purifier Outlet	
4	Stream No.		7B		8		9	
5								
6	Temp. C *(F)*		300	*572*	20	*68*	100	*212*
7								
8	Press Torr *(psia)*		688	13.3	931	*18*		
9	Flow rate std l/sec *(scfm)*		0.003	*0.006*	0.004	*0.009*	1.90	*4.037*
10	Vac rate l/min							
11	H_2 kg/hr *(lbs/hr)*	2						
12	O_2 kg/hr *(lbs/hr)*	32						
13	N_2 kg/hr *(lbs/hr)*	28						
14	He kg/hr *(lbs/hr)*	4	0.002	*0.004*	0.003	*0.006*		
15	I^{131} gram/hr *(lbs/hr)*	131						
16	Kr^{86} gram/hr *(lbs/hr)*	86						
17	Cs^{137} gram/hr *(lbs/hr)*	137						
18								
19	Max heat rate kcal/hr *(Btu/hr)*		0.001	*0.004*				
20								
21	Process Duration (Note 4)		5.3	hr.	13.3	hr.		
22	Approx. Total Duration		6	hr.				
23	Water Removed kg		1.814					
24	Hydrogen Removed kg		0.165					
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40	MCO volume (liter) =							
41	External MCO piping (liter) =							
42	Cyl. gas fill rate (al/m) =							
43	Cyl gas fill pressure (psia) =							
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =							
45	System operating pressure (psia)							
46	Specific heat of helium (cal/gC)							
47	1 atm (100-300C)							
48	5 atm (100-300C)							
49	MCO gas Circulation rate (ACFM)							

	A	B	Y	Z	AA	AB	AC	AD	AE	AF
2	**Operating Cycle**		**Vacuum condition**							**Cooling of**
3	**Stream Description**	MWt	Vacuum draw		Inert gas purge during vacuum		Cooling air		Helium added for cool-down	
4	**Stream No.**		10		11		12		13	
5										
6	**Temp. C** ***(F)***		300	*572*	20	*68*	80	*176*	20	*68*
7							Note 6			
8	**Press Torr** ***(psia)***		5	*0.097*	931	*18*	760	*14.7*	931	*18*
9	**Flow rate std l/sec** ***(scfm)***		0.032	*0.067*	0.030	*0.064*	256	*542*	5.324	*11.288*
10	**Vac rate l/min**		350							
11	**H_2 kg/hr** ***(lbs/hr)***	2	0.0005	*0.001*						
12	**O_2 kg/hr** ***(lbs/hr)***	32								
13	**N_2 kg/hr** ***(lbs/hr)***	28	0.135	*0.298*	0.135	*0.298*				
14	**He kg/hr** ***(lbs/hr)***	4							3.423	*7.547*
15	**I^{131} gram/hr** ***(lbs/hr)***	131								
16	**Kr^{86} gram/hr** ***(lbs/hr)***	86								
17	**Cs^{137} gram/hr** ***(lbs/hr)***	137								
18										
19	**Max heat rate kcal/hr** ***(Btu/hr)***						18,144	*72,000*		
20										
21	**Process Duration (Note 4)**		7.9	min	48	hr.	14	hr.	0.957	min.
22	**Approx. Total Duration**		48	hr.	48	hr.	14.5	hr.	15	min.
23	**Water Removed kg**		0.056							
24	**Hydrogen Removed kg**		0.003999375							
25										
26			Notes:							
27			1. Although hydrogen may be present at concentrations greater than 5%v, it is inherently safe beca							
28										
29			2. Run 23 data assumed to be at MCO operating conditions.							
30										
31			3. Heating rate is determined with an internal heat transfer coefficient of 1 Btu / pound degree F sq. f							
32										
33			4. Mass rate times process duration equals mass. Approximate total duration is for cycle time deter							
34										
35			5. This is the <u>maximum</u> of a programmed temperature schedule							
36										
37			6. This is the <u>minimum</u> of a programmed temperature schedule							
38										
39										
40	MCO volume (liter) =									
41	External MCO piping (liter) =									
42	Cyl. gas fill rate (al/m) =									
43	Cyl gas fill pressure (psia) =									
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =									
45	**System operating pressure (psia)**									
46	Specific heat of helium (cal/gC)									
47	1 atm (100-300C)									
48	5 atm (100-300C)									
49	MCO gas Circulation rate (ACFM)									

	A	B	AG	AH	AI	AJ	AK	AL	AM	AN
2	Operating Cycle					Cooling of				Oxygen passivatio
3	Stream Description	MWt	Helium cooling		Helium cooling		Nitrogen added		Oxygen added	
4	Stream No.		14A		14B		15		16	
5										
6	Temp. C *(F)*		100	*212*	102	*216*	20	*68*	20	*68*
7										
8	Press Torr *(psia)*		672	*13*	688	*13.3*	931	*18*	931	*18*
9	Flow rate std l/sec *(scfm)*		3.053	*6.473*	3.053	*6.473*	3.482	*7.382*	0.071	*0.151*
10	Vac rate l/min									
11	H_2 kg/hr *(lbs/hr)*	2								
12	O_2 kg/hr *(lbs/hr)*	32							0.365	0.806
13	N_2 kg/hr *(lbs/hr)*	28					15.668	34.548		
14	He kg/hr *(lbs/hr)*	4	2.006	*3.143*	2.006	*3.143*				
15	I^{131} gram/hr *(lbs/hr)*	131								
16	Kr^{86} gram/hr *(lbs/hr)*	86								
17	Cs^{137} gram/hr *(lbs/hr)*	137								
18										
19	Max heat rate kcal/hr *(Btu/hr)*									
20										
21	Process Duration (Note 4)		13	hr.	13	hr.	12	hr.	12	hr.
22	Approx. Total Duration		13.5	hr.	13.5	hr.	12	hr.	12	hr.
23	Water Removed kg									
24	Hydrogen Removed kg									
25										
26										
27			e its concentration when diluted would be less than 1%, significantly below its LEL.							
28										
29										
30										
31			. hr and external heat transfer coefficient of 5 Btu / pound degree F sq. ft. hr.							
32										
33			ination only.							
34										
35										
36										
37										
38										
39										
40	MCO volume (liter) =									
41	External MCO piping (liter) =									
42	Cyl. gas fill rate (al/m) =									
43	Cyl gas fill pressure (psia) =									
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =									
45	System operating pressure (psia)									
46	Specific heat of helium (cal/gC)									
47	1 atm (100-300C)									
48	5 atm (100-300C)									
49	MCO gas Circulation rate (ACFM)									

	A	B	AO	AP	AQ	AR	AS	AT
2	**Operating Cycle**				**Inert Gas Packing**			
3	**Stream Description**	MWt	Circulating passivation gas		Oxygen Evacuation		Helium Fill	
4	**Stream No.**		17		18		19	
5								
6	**Temp. C *(F)***		150	*302*	150	*302*	150	*302*
7								
8	**Press Torr *(psia)***		688	*13.3*	5	0.097	1137	*22*
9	**Flow rate std l/sec *(scfm)***		2.576	*5.462*	0.067	*0.142*	4.667	*9.894*
10	**Vac rate l/min**				350			
11	**H_2 kg/hr *(lbs/hr)***	2						
12	**O_2 kg/hr *(lbs/hr)***	32						
13	**N_2 kg/hr *(lbs/hr)***	28						
14	**He kg/hr *(lbs/hr)***	4					3.000	6.615
15	**I^{131} gram/hr *(lbs/hr)***	131						
16	**Kr^{86} gram/hr *(lbs/hr)***	86						
17	**Cs^{137} gram/hr *(lbs/hr)***	137						
18								
19	**Max heat rate kcal/hr *(Btu/hr)***							
20								
21	**Process Duration (Note 4)**		12	hr.	7.90	min.	1.958	min.
22	**Approx. Total Duration**		12	hr.	15	min.	15	min.
23	**Water Removed kg**							
24	**Hydrogen Removed kg**							
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40	MCO volume (liter) =							
41	External MCO piping (liter) =							
42	Cyl. gas fill rate (al/m) =							
43	Cyl gas fill pressure (psia) =							
44	Gas constant (liter * torr * $[K]^{-1}$ * $[gmol]^{-1}$) =							
45	**System operating pressure (psia)**							
46	Specific heat of helium (cal/gC)							
47	1 atm (100-300C)							
48	5 atm (100-300C)							
49	MCO gas Circulation rate (ACFM)							

Cell: C6
Note: Range of allowable heating and cooling temperature

Cell: G6
Note: Assumes receipt at 40 degrees C.

Cell: I6
Note: Assumes ambient temperature at start of filling.

Cell: K6
Note: Set at the maximum permissable temperature for the MCO shell. This temperature is programmed to ramp up to this value. See MCO Heating Temperature Profile for suggesting temperature vs. time for this stream.

Cell: M6
Note: Set based upon blower inlet temperature specifications plus 2 degrees rise for heat of compression.

Cell: W6
Note: Set by inlet temperature restriction to circulation blower.

Cell: Y6
Note: per specification

Cell: C8
Note: Vacuum for effective thermal resistance.

Cell: G8
Note: Set per WHC-S-0460 rev. A of 3/11/96

Cell: I8
Note: Fills to this pressure for maximum internal heat transfer.

Cell: M8
Note: Fills to this pressure for maximum internal heat transfer.

Cell: P8
Note: Assumes 0.5 psi drop across helium heater

Cell: Y8
Note: per specification

Cell: E9
Note: Equivalent to 150 ACFM.
=150*(459.7+32)/((459.7+68)*60*0.0353)

Cell: G9
Note: =G9*(10/760)*(273/(273+40))*(1/60)

Cell: I9
Note: Based upon flow set at 280 liters/min at 120 psia.
=$C$41*($C$42/14.7)*(273/(15+273))/60

Cell: K9
Note: =750*(273/(273+K5))*28.3/60

Cell: M9
Note: =O8

Cell: N9
Note: Maximum internal helium flow based upon Performance Specification WHC-S-0460, rev A

Cell: P9
Note: Maximum internal helium flow based upon Performance Specification WHC-S-0460, rev A
=$C#48*(O7/760)*(273/(273+O5))

Cell: Q9
Note: =($R$41-$R$42)*22.4/(Q20*3600)

Cell: S9
Note: =($R$42+$R$43)*22.4/(S20*3600)

Cell: U9
Note: =(Q8*Q20+S8*S20)/U20

Cell: W9
Note: =M8

Cell: Y9
Note: Set based upon the capacity of the vacuum pump at operating conditions.

Cell: AA9
Note: =AA12*1000*(22.4/B12)/3600

Cell: AE9
Note: Based upon flow set at 280 liters/min at 120 psia.

Cell: AH9
Note: Maximum internal helium flow based upon Performance Specification WHC-S-0460, rev A
=$C$50*(AG7/760)*(273/(273+AG5))

Cell: AI9
Note: =AG8

Cell: AJ9
Note: Maximum internal helium flow based upon Performance Specification WHC-S-0460, rev A

Cell: AK9
Note: Based upon flow set at 280 liters/min at 120 psia.
=AM8*(98/2)

Cell: AM9
Note: =(AM11/3.6)*22.4/$B$11

Cell: AP9
Note: =$C$50*(AP7/14.7)*(460/(460+AP5))

Cell: AQ9
Note: =AQ9*(10/760)*(273/(273+40))*(1/60)

Cell: AS9
Note: =22.4*($AS$7*($C$41+$C$42)/($C$45*($AS$5+273)))/(AS20*60)

Cell: Y11
Note: Five volume percent of nitrogen purge per Run 23.
=Y8*0.05*3600/22.4)*2/1000

Cell: AM12
Note: Based upon 37 kg of UO2 formed over a 12 hour period.

Cell: Y13
Note: =(1.8*60/22.4)*$B$12/1000

Cell: AA13
Note: =Y12

Cell: AK13
Note: Based upon being a 98%v diluent for enough oxygen to produce 37 kg UO2 over 12 hour period.

Cell: I14
Note: =(4/22.4)*I8*3600/1000

Cell: S14
Note: =S8*3600*0.004/22.4

Cell: U14
Note: =(Q13*Q20+S13*S20)/U20

Cell: AE14
Note: =(AE8*3600/22.4)*0.001*B13

Cell: AG14
Note: =AG8*3.68*(B13/22.4)

Cell: AI14
Note: =AG13

Cell: AS14
Note: =0.004*($AS$7*($C$41+$C$42)/($C$45*($AS$5+273)))/(AS20/60)

Cell: L19
Note: This is taken from the temperature profile on spreadsheet HANHEAT3.WQ1

Cell: Q19
Note: =Q13*C48

Cell: S19
Note: =S13*C48

Cell: AC19
Note: Taken from Cooling Temperature Profile spreadsheet HANHEAT4.WQ1

Cell: G21
Note: computed from pumping speed formula from Perry page 5-34 with calcs enclosed in appendix

Cell: I21
Note: =((($C$39+$C$40)*(115/14.7)*(273/(15+273)))/I8)/60

Cell: Q21
Note: Taken from MCO Temperature Profile for heating. Assumes starting heat up at 40C

Cell: S21
Note: Taken from MCO Temperature Profile for heat up.

Cell: Y21
Note: time for vacuum evacuation only

Cell: AA21
Note: per specification

Cell: AE21
Note: =((C41+C42)/(AE8*((273+Y5)/273))*(14.7/C46))/60

Cell: AQ21
Note: from pumping speed formula of Perry

Cell: AS21
Note: =22.4*($AS$7*($C$41+$C$42)/($C$45*($AS$5+273)))/$C$43

Cell: S23
Note: Assumes all hydrate water charged with fuel is removed during heat up between 200C and 300C. The interface listing give no more than 4 lbs of this type of water.

Calculation of MCO Pump Down Time

assume 100 ft (equivalent) 1" sch 40 pipe with 160" ½" sch 40 connected to it. Use method of Perry p 5-32.

Reference pressure = 1 lb/ft^2

$14.7 \times 144 = 2117 \frac{lb}{ft^2}$ per atmosphere

$\frac{2117}{760} = 2.79 \frac{lb}{ft^2 \text{ torr}}$

$1 \frac{lb}{ft^2} = 0.36$ torr

$T_1 = 150°C = 762°R$

$T_2 = 40°C = 564°R$

$\rho_1 = \frac{M}{RT} = \frac{4}{1545 \times 762}$

$\rho_1 = 3.40 \times 10^{-6}$ lb/ft^3

$\rho_2 = 4.59 \times 10^{-6}$ lb/ft^3

w = weight rate of flow

at 0.36 torr pump displacement is 350 l/min

$w_1 = 3.4 \times 10^{-6} \frac{lb}{ft^3} \times 350 \frac{l}{min} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 ft^3}{28.3 l}$

$= 7.00 \times 10^{-7}$ lb/sec

$w_2 = \frac{4.59 \times 10^{-6}}{3.40 \times 10^{-6}} \times 7.00 \times 10^{-7} = 9.45 \times 10^{-7} \frac{lb}{sec}$

$q' = w/\rho$

$q_1' = 7 \times 10^{-7} \frac{lb}{sec} \times \frac{1 \quad ft^3}{3.4 \times 10^{-6} \text{ lb}} = 0.21$ ft^3/sec

$q_2' = 9.45 \times 10^{-7} \frac{lb}{sec} \times \frac{1 \quad ft^3}{4.59 \times 10^{-6} \text{ lb}} = 0.21$ ft^3/sec

Computing pressure drop -

isothermal compressible flow

$$w^2 = \left[\frac{144\, g A^2}{\bar{V}_1\left(\frac{fL}{D} + \ln\frac{P_1'}{P_2'}\right)}\right]\left[\frac{(P_1')^2 - (P_2')^2}{P_1'}\right] \quad \text{(Crane 410 p1-8)}$$

as viscosity of helium is very difficult to obtain, N_{Re} cannot be calculated. f is therefore estimated at 0.6 (see Crane 410 p A-24)

w_1 = #/sec flow = 7×10^{-7} lb/sec

$(w_1)^2 = 4.9 \times 10^{-13}$

$w_2 = 9.45 \times 10^{-7}$ lb/sec

$(w_2)^2 = 8.93 \times 10^{-13}$

for 1" pipe $A = 0.006 \quad A^2 = 3.6 \times 10^{-5}$

for 1/2" $A = 0.00211 \quad A^2 = 4.5 \times 10^{-6}$

$\bar{V}_1 = \frac{ft^3}{lb} = \frac{1}{\rho_1} = \frac{1}{3.4 \times 10^{-6}} = 294{,}118\ ft^3/\#$

$\bar{V}_2 = \frac{1}{4.59 \times 10^{-6}} = 217{,}865\ ft^3/\#$

D 1 inch = 0.0874 $\qquad g = 32.2\ ft/sec^2$

D 1/2 in = 0.0518

L 1 in = 100 ft

L 1/2 in = 160/12 = 13.3 ft

$P_1 = \frac{1}{144}$ Psia = 0.0069 Psfa

P_2 = ?

Try P_2	Calculated w^2	actual w^2
.0001	3.7×10^{-9}	4.9×10^{-13}
.00001	3.1×10^{-7}	$4.9 \cdot 10^{-13}$
.0060	1.1×10^{-10}	4.9×10^{-13}
.0065	6.4×10^{-12}	4.9×10^{-13}
.0067	3.2×10^{-12}	

ΔP for 1" = 0.0001 psfa

ΔP for 1/2

Try P_2	Calculated w^2	Actual w^2
.005	1.63×10^{-11}	4.9×10^{-13}
.006	7.68×10^{-12}	
.0065	3.5×10^{-12}	

ΔP for 1/2" = 0.0001 psfa

$\Sigma \Delta P$ = 0.0002 psfa

Flow rate q is at 1 psf

$$C = q/\Delta P = 0.21/.0002 = 1050\ ft^3/sec$$

$$1/S_o = 1/S_p + 1/C \qquad S_p = 350\ \frac{l}{min} \times \frac{ft}{28.3l} \times \frac{min}{60sec}$$

$$1/S_o = 1/S_p + 1/C = 4.85 \qquad = 0.2061$$

$$S_o = 0.206$$

Pump down time —

$$\Theta = (V_t/S_o)\ ln\left[(P_1 - P_2)/(P_2 - P_0)\right]$$

V_t = 507.19 l + 60.56 l = 567.75 l = 20.06 ft^3

S_o = 0.206 ft^3/sec

P_1 = 13 lb/in² = 1,872 lb/ft²

P_2 = 5 torr = 5/0.36 = 13.9 lb/ft²

P_0 = 6×10^{-3} torr = 6×10^{-3} torr $\times \frac{1\ lb/ft^2}{0.36\ torr}$

= 1.67×10^{-2} lb/ft²

$$\Theta = \frac{20.06}{0.206}\ ln\left[(1872 - 13.9)/(13.9 - 1.67 \times 10^{-2})\right]$$

= 476 sec = 7.9 min to pump from 13 psia to 5 torr to pump to 10 torr

$$\frac{20.06}{0.206} \ln\left[(1872 - 27.8) \Big/ (27.8 - 1.67 \times 10^{-2})\right]$$

$$= 408 \text{ sec} = 6.8 \text{ min}$$

HVC-6
LBA
7/26/96

CALCULATIONS TO DEMONSTRATE THE TEMPERATURE DIFFERENCE ON THE MCO DURING COOL-DOWN

Since issuing the 90 percent CDR, we have received calculations from Q-Metrics which indicate a temperature difference of approximately 150°C across the MCO when taking approximately 24 hours to heat the fuel to a bulk temperature of 300°C. This calculation was performed using finite element analysis. It supersedes the calculation submitted with the 90% CDR.

It should be kept in mind that the MCO can be operated within its 100°C temperature difference specification by changing the temperature profile, taking longer to either heat or cool. We will constrain the profile with both the 50°C rate spec and the 100°C gradient spec in the final MCO temperature patterned profile and intend to coordinate these changes with Q-Matrix through WHC.

Q-Metrics

Q-Metrics, Inc.
P.O. Box 3016
Woodinville, WA 98072-3016
Phone: (206) 915-8590/Fax: (206) 481-5953

FAX TRANSMITTAL & MESSAGE SHEET

Date/Time: 7/2/96 No. of Pages (including cover): 2

Deliver To: Curt Miska/ WHC

Fax Phone: (509) 376-3252 Voice #: 376-7103

Project: Spent Fuel Thermal Support Project #: E014N-KBasin

Subject: MCO Wall Temperature Transient For Heatup/Cool Down

Message:

The attached figure illustrates the estimated wall temperatures along the MCO length during the heat up and cool down cycles of the hot conditioning process. The analysis is based on the following assumptions:

1) Merrick's proposed approach of using 750 cfm of air in a 1-inch annulus around the MCO. Flow proceeds from bottom to top.
2) Five layers of Mark IV fuel baskets with maximum decay heat. No chemical reaction heating is assumed for this analysis.
3) MCO design with the welded head. No special head region heaters employed.

The curves presented on the figure are defined as follows:

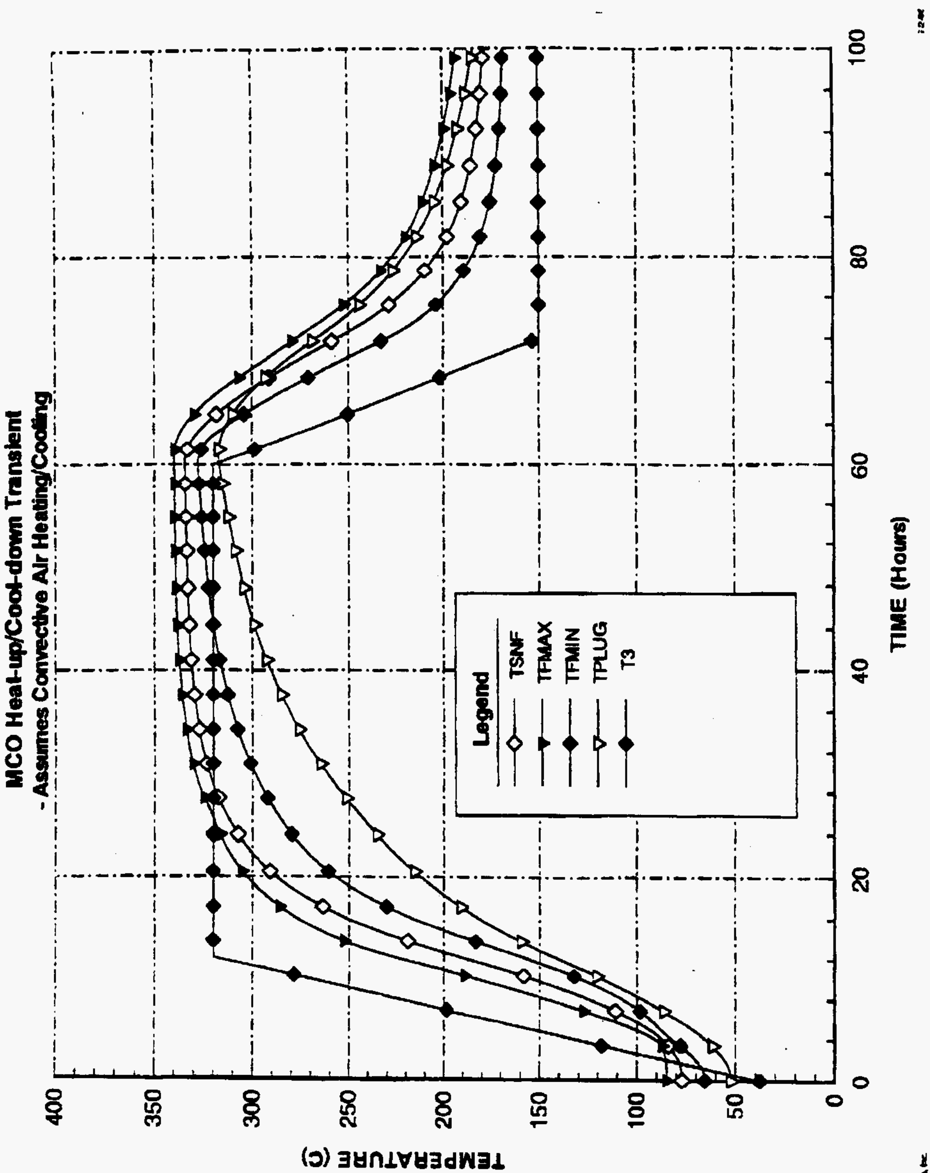
TPLUG	- average temperature of MCO closure plug
T3	- inlet air temperature
TA270	- temperature of MCO sidewall at bottom
TB70	- " " " " approximately 17 inches above the bottom
TC70	- " " " " " 45 " " "
TD70	- " " " " " 73 " " "
TE70	- " " " " " 101 " " "
TF70	- " " " " " 129 " " "
TG70	- " " " " " 132 " " "
TG74	- " " " " " 145 " " "

As seen from the figure, the MCO wall temperature gradient is expected to be relatively low except in the head region. Without some sort of supplemental heating or cooling, the closure plug will lag the average MCO wall temperature by up to 100°C during heat up and 75°C during cool down.

Let me know if you have any questions.

From: Gregory J. Banken, P.E.

Attachment: Transient plot


MCO Heat-up/Cool-down Transient
- Assumes Convective Air Heating/Cooling
TEMPERATURE (C)
TIME (Hours)
Legend
TSNF
TFMAX
TFMIN
TPLUG
T3
0
50
100
150
200
250
300
350
400
20
40
60
80
100

Q-Metrics

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FAX TRANSMITTAL & MESSAGE SHEET

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Fax Phone:	(509) 376-3252	Voice #:	376-7103
Project:	Spent Fuel Thermal Support	Project #:	E014N-KBasin
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1) Merrick's proposed approach of using 750 cfm of air in a 1-inch annulus around the MCO. Flow proceeds from bottom to top.
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TPLUG	- average temperature of MCO closure plug									
T3	- inlet air temperature									
TA270	- temperature of MCO sidewall at bottom									
TB70	-	"	"	"	"	approximately 17 inches above the bottom				
TC70	-	"	"	"	"	"	45	"	"	"
TD70	-	"	"	"	"	"	73	"	"	"
TE70	-	"	"	"	"	"	101	"	"	"
TF70	-	"	"	"	"	"	129	"	"	"
TG70	-	"	"	"	"	"	132	"	"	"
TG74	-	"	"	"	"	"	145	"	"	"

As seen from the figure, the MCO wall temperature gradient is expected to be relatively low except in the head region. Without some sort of supplemental heating or cooling, the closure plug will lag the average MCO wall temperature by up to 100°C during heat up and 75°C during cool down.

Let me know if you have any questions.

From: Gregory J. Banken, P.E.

Attachment: Transient plot

Q-Metrics

Q-Metrics, Inc.
P.O. Box 3016
Woodinville, WA 98072-3016
Phone: (206) 915-8590/Fax: (206) 481-5953

FAX TRANSMITTAL & MESSAGE SHEET

Date/Time: 7/8/96 No. of Pages (including cover): 2

Deliver To: Curt Miska/ WHC

Fax Phone: (509) 376-3252 Voice #: 376-7103

Project: Spent Fuel Thermal Support Project #: E014N-KBasin

Subject: Mark IV Fuel Temp. Transient For Heatup/Cool Down

Message:

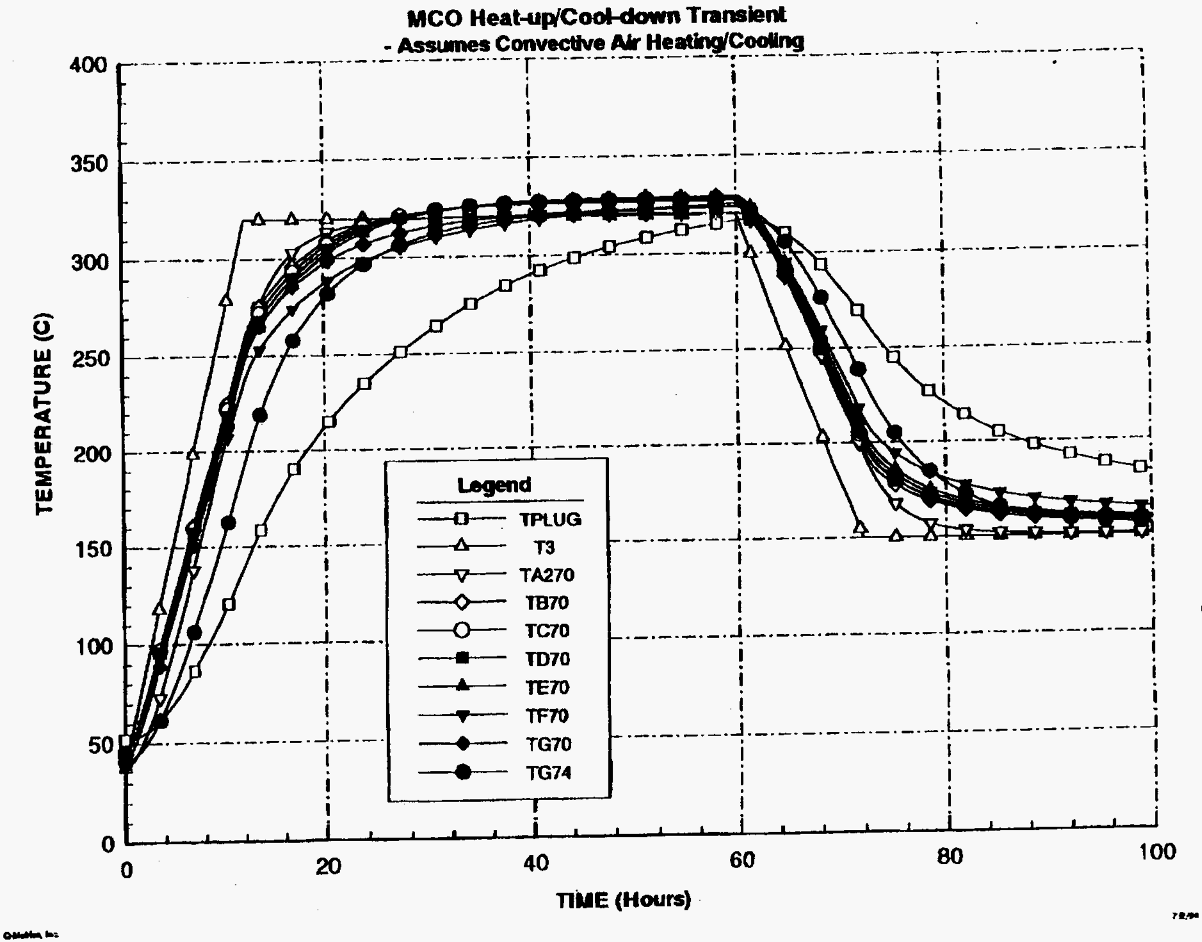
The attached figure illustrates the estimated average (TSNF), maximum (TFMAX), and minimum (TFMIN) fuel element temperatures during the heat up and cool down cycles of the hot conditioning process. The plot is a companion to the plot faxed to you on 7/2. In addition to the analysis assumptions described in that fax, the following pertinent facts need to be added:

1) no credit is taken for heating and cooling via the feed gases.
2) Only "clean" Mark IV fuel is assumed. A thermal model with sludge coated fuel and the latest fuel basket design is being created and checked out.

Let me know if you have any questions.

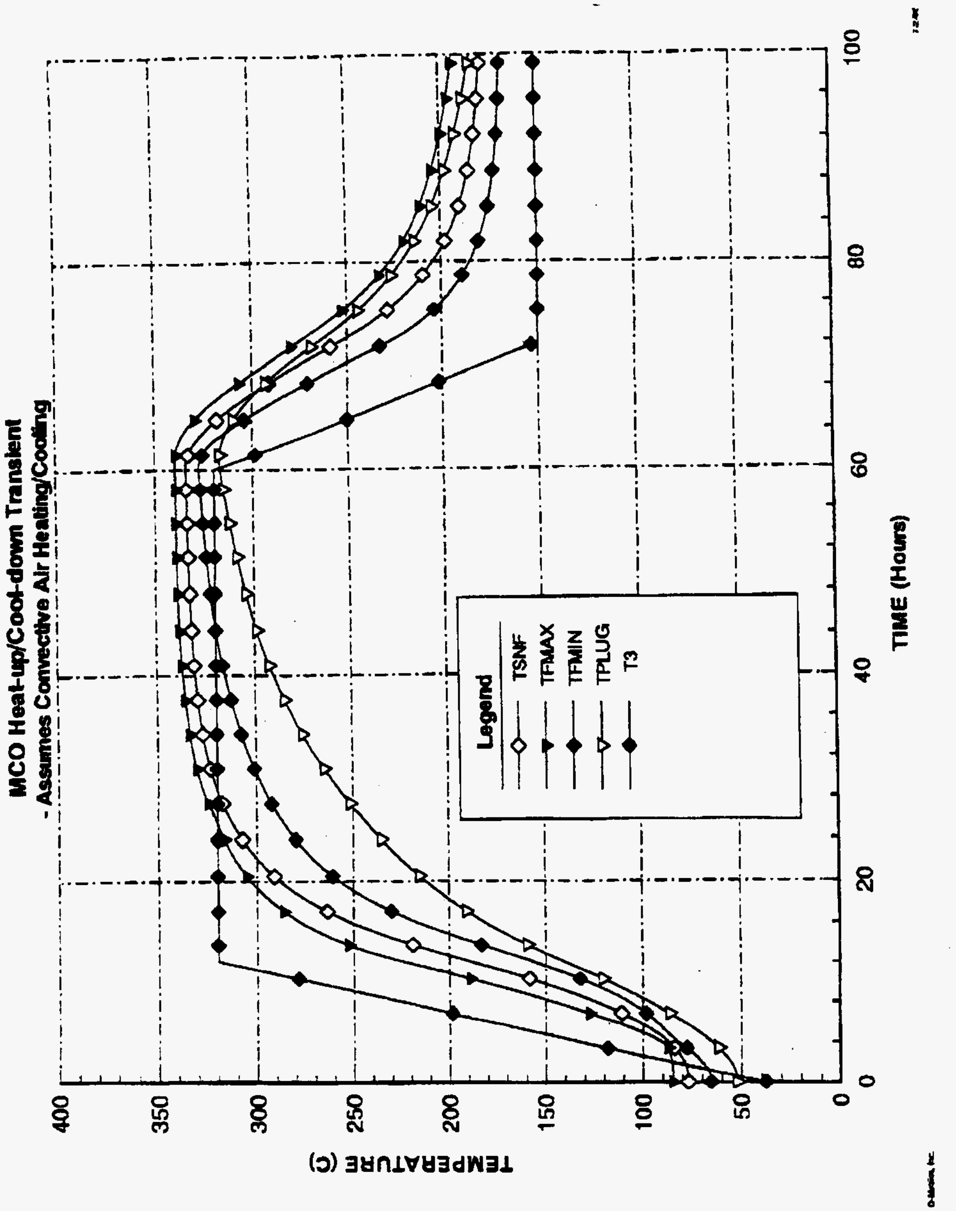
From: Greg
Gregory J. Banken, P.E.

Attachment: Transient plot



WHC-SD-SNF-CDR-007, REV. 0

G-45


MCO Heat-up/Cool-down Transient
- Assumes Convective Air Heating/Cooling
TEMPERATURE (C)
0
50
100
150
200
250
300
350
400
TIME (Hours)
0
20
40
60
80
100
Legend
TSNF
TFMAX
TFMIN
TPLUG
T3

MERRICK	COMPUTER CALCULATION COVER SHEET PROJECT #30012318	NEW MEXICO OFFICE

CALCULATION TITLE: HEAT EXCHANGER DUTY

CALCULATION INDEX NO.: HVC-7

SUBJECT/PURPOSE OF CALCULATION: Determine Duties for VPS-PFR-1101, VPS-CLR-1103, MCS-CLR-1153

PROGRAM NAME: MS WORD V6.0

PROGRAM REVISION:

INPUT DATA SOURCE: Material Balance

REMARKS:

ATTACHED ARE:

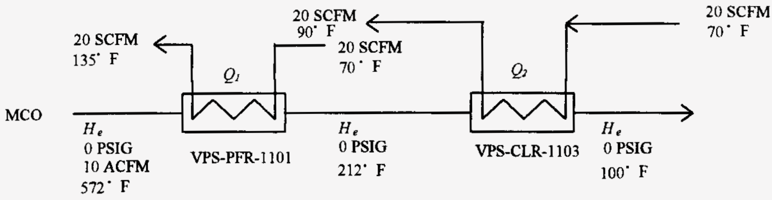
- ☒ PRINTOUT OF INPUT DATA RESULTS
- ☐ PRINTOUT OF SPECIFIC PROGRAMMING OPTIONS AND/OR INSTRUCTIONS
- ☐ DOCUMENTATION OF SOURCES AND/OR DEVELOPMENT OF FORMULA

ORIGINATOR: DH Meyer DATE: 7/20/96

INPUT DATA CHECKED BY: LB Ames DATE: 7/20/96

Vacuum Pumping System Coolers

C_p Air @ Ambient Conditions = 0.0181 BTU/Ft^3



Mass Flow H_e

$$\frac{10\,\text{Ft}^3}{\text{Min}} X \frac{68\;460}{572\,460}\;\frac{0.0103\#}{\text{Ft}^3} = 0.0527\,\#/\text{Min}\,H_e$$

H_e Heat Load Q_1

$$\frac{0.0527\,\#/H_e}{\text{Min}}\;\frac{60\,\text{Min}}{\text{Hr}} X \frac{1.25\,\text{BTU}}{\#\,^\circ F} X \frac{(212-572)^\circ F}{} = -1423\,\text{BTU}/\text{Hr}$$

H_e Heat Load Q_2

$$\frac{0.0527\,\#/H_e}{\text{Min}} X \frac{60\,\text{Min}}{\text{Hr}} X \frac{1.25\,\text{BTU}}{\#\;^\circ F} X \frac{(100-212)^\circ F}{} - 443\,\text{BTU}/\text{Hr}$$

20 SCFM each for Air Cool in

$$\frac{0.0181\ \text{BTU}}{\text{Ft}^3\ ^\circ F} X \frac{20\,\text{Ft}^3}{\text{Min}} X \frac{60\ \text{Min}}{\text{Hr}} = 21.72\ \text{BTU}/\text{Hr}\ ^\circ F$$

$$Q_1\ \text{Load}\ \frac{1423\ \text{BTU}}{\text{Hr}} X \frac{\text{Hr}\ ^\circ F}{2172\ \text{BTU}} = 69^\circ F\,\text{Temp. Rise}$$

$$Q_2\ \text{Load}\ \frac{443\ \text{BTU}}{\text{Hr}} X \frac{\text{Hr}\ ^\circ F}{2172\ \text{BTU}} = 20.4^\circ F\,\text{Temp. Rise}$$

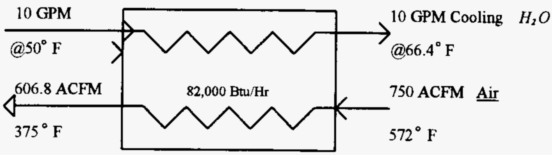
MCO Cooling System Cooler
MCS-CLR-1153

Assume 82,000 Btu/hr max duty which is the rate of heat transfer for an MCO temperature change of 50° C per hour.

CASE #1: <u>High Temp Case</u> 572° F Air @ 750 ACFM

$$\frac{750\ Ft^3}{m}\ \frac{(68 \times 460)}{(572\ +\ 460)}\ \frac{0.075\ ^{\#}}{Ft^3}\ \frac{60\ m}{Hr} = 1726\ \#/Hr$$

$$\frac{82{,}000\ Btu}{Hr}\ \frac{Hr}{1{,}726\ \#}\ \frac{\#\ ^\circ F}{.241\ Btu} = 197^\circ\ F$$



$$\Delta T\ H_2O\ = \frac{82{,}000\ BTU}{Hr}\ \frac{\#\ ^\circ F}{1\ BTU} X \frac{}{10\,GPM} X \frac{GPM}{500\ \#/Hr} = 16.4^\circ\ F$$

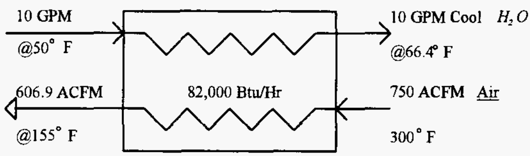
$$750\ ACFM\ \frac{375+460}{572+460} = 606.8\ ACFM@375^\circ\ F$$

CASE #2: Low Temp Case 300° F Air@750 ACFM

$$\frac{750\ \text{Ft}^3}{m}\ \frac{68+460}{300+400}\ \frac{0.075^{\#}}{\text{Ft}^3}\ \frac{60\ \text{m}}{\text{Hr}} = 2{,}345\ \#/\text{Hr}$$

$$\frac{82{,}000\ \text{Btu}}{\text{Hr}}\ \frac{\text{Hr}}{2{,}345^{\#}}\ \frac{\#\ {}^\circ\text{F}}{0.241\ \text{Btu}} = 145^\circ\ \text{F}$$

$$\frac{750\ \text{Ft}^3}{n}\ \frac{155+460}{300+460} = 606\ \text{ACFM@}155^\circ\ \text{F}$$



MERRICK Engineers & Architects	COMPUTER CALCULATION COVER SHEET PROJECT #30012318	NEW MEXICO OFFICE

CALCULATION TITLE: Process Time Simulation

CALCULATION INDEX NO.: HVC - 8

SUBJECT/PURPOSE OF CALCULATION: To calculate the approximate processtime for 10 casks through the HCS Process

PROGRAM NAME: Witness

PROGRAM REVISION: Release 7.0

INPUT DATA SOURCE: DWG SK-2-300411 Block Flow Diagram

REMARKS:

ATTACHED ARE:

- [X] PRINTOUT OF INPUT DATA RESULTS
- [ ] PRINTOUT OF SPECIFIC PROGRAMMING OPTIONS AND/OR INSTRUCTIONS
- [ ] DOCUMENTATION OF SOURCES AND/OR DEVELOPMENT OF FORMULA

ORIGINATOR: [signature] DATE: 7/25/96

INPUT DATA CHECKED BY: [signature] DATE: 7/25/96

INTRODUCTION:

The following report summarizes results taken from a simulated run of a model created in WITNESS Release 7.0. WITNESS can simulate real events through random number generation and will create reports documenting inputs into the model as well as results from the actual run. The following statistics report details the activity of each block during the simulated run. The following summary report describes the characteristics of each block and thus how they behaved in the model. Any questions regarding report interpretation should be directed at Merrick.

PURPOSE:

The purpose of this model is to calculate the approximate process time for 10 casks through a hot conditioning process.

ASSUMPTIONS:

1. All information for the model, except for shift times, was supplied by the block flow diagram, Figure 2.1-1, Hot Conditioning Model Operating Sequence. This included identification of each process, order of processes, process times, decision blocks, and percentages on yes/no decisions.
2. Decision blocks that did not indicate a percentage were assigned a 50/50 chance yes or no.
3. Only one item could be processed for each cycle.
4. Shift times were input to the model. It was assumed seven days on, no days off. Each day on consisted of three 8 hour shifts.
5. No statistical or deterministic breakdowns were included in the model.
6. The model had an infinite amount of labor available, i.e. tasks were not resource constrained.
7. Ten (10) complete operations would be modeled.
8. An allowance of 24 hours was placed in the model between cycle completion and restart to allow for any clean up or preparatory activities.

CONCLUSION:

The model determined it would take approximately 115.52 hours to process each cask through the entire process. To process ten casks consecutively, approximately 1,410.30 hours would be required; this is roughly 59 days, or 8.5 weeks. Of course, these results are largely based on the above assumptions. Consideration should be given that these assumptions are valid.

STATISTICS REPORT:

HCSE_1 Report — Time: 1410.30

PART STATISTICS — REPORTED BY ON-SHIFT TIME

Name	Number Entered	Number Shipped	Number Scrapped	Number Assembled	Number Rejected	W.I.P	Av. W.I.P	Av. Time
puck	21	0	0	20	0	1	1.44	96.48

BUFFER STATISTICS — REPORTED BY ON-SHIFT TIME

Name	Total in	Total out	Now in	Max	Min	Average Size	Average Time	Av. after Delay No.	Av. after Delay Time
holdpuck	10	10	0	1	0	0.00	0.00		

MACHINE STATISTICS — REPORTED BY ON-SHIFT TIME

Name	Number of Ops.	%Idle	%Cycle		%Stopped		%Waiting	
sel_oven	10	99.94	Busy :	0.06	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
move_MHM	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
lowr_MCO	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
remv_MHM	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
mov_cell	10	99.82	Busy :	0.18	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
con_cell	10	99.94	Busy :	0.06	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
opn_valt	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
plac_cvr	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
att_covr	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
remv_cvr	10	99.82	Busy :	0.18	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
inst_cvr	10	99.94	Busy :	0.06	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
inst_val	10	99.88	Busy :	0.12	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00
					Down :	0.00	Repair :	0.00
opn_valv	10	99.82	Busy :	0.18	Blocked :	0.00	Setup :	0.00
					Setup :	0.00	Cycle :	0.00

Name	Number of Ops.	%Idle	%Cycle	%Stopped		%Waiting	
				Down :	0.00	Repair :	0.00
evac_MCO	10	99.76	Busy : 0.24	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
fill_MCO	10	99.94	Busy : 0.06	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
leak_chk	12	99.79	Busy : 0.21	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
passleak	12	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
cls_valv	2	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
disc_vlv	2	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
cln_port	2	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
inst_vlv	2	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
insl_cvr	10	99.94	Busy : 0.06	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
cls_valt	10	99.94	Busy : 0.06	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
het_cycl	10	91.49	Busy : 8.51	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
surv_cel	10	99.65	Busy : 0.35	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
discproc	10	99.94	Busy : 0.06	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
remvproc	10	99.82	Busy : 0.18	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
purg_vac	10	65.96	Busy : 34.04	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
perftest	11	98.44	Busy : 1.56	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
accept	11	99.99	Busy : 0.01	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
add_purg	1	98.30	Busy : 1.70	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
coolpass	10	91.49	Busy : 8.51	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00

Name	Number of Ops.	%Idle	%Cycle	%Stopped	%Waiting
				Down : 0.00	Repair : 0.00
evacMCO	10	99.76	Busy : 0.24	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
pass_gas	10	99.94	Busy : 0.06	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
pass_per	10	91.49	Busy : 8.51	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
cooldown	10	92.91	Busy : 7.09	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
evacMCO2	10	99.76	Busy : 0.24	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
fill_He	10	99.94	Busy : 0.06	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
move_in	10	99.82	Busy : 0.18	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
conn_cel	10	99.94	Busy : 0.06	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
openvalt	10	99.88	Busy : 0.12	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
remvcovr	10	99.94	Busy : 0.06	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
clos_MCO	10	99.82	Busy : 0.18	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
weldcovr	10	99.88	Busy : 0.12	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
instweld	10	99.76	Busy : 0.24	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
weldroot	10	99.65	Busy : 0.35	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
vis_insp	14	99.83	Busy : 0.17	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
clenweld	14	99.83	Busy : 0.17	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
accept2	14	99.98	Busy : 0.02	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
grind	4	99.93	Busy : 0.07	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
rep_weld	4	99.93	Busy : 0.07	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00

Name	Number of Ops.	%Idle	%Cycle		%Stopped		%Waiting	
					Down	0.00	Repair	0.00
soak	15	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
aply_die	15	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
remv_die	15	99.73	Busy	0.27	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
aply_dev	15	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
bleed	15	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
inspect	15	99.91	Busy	0.09	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
cleen	15	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
accept3	15	99.98	Busy	0.02	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
grind2	5	99.91	Busy	0.09	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
reprweld	5	99.91	Busy	0.09	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
makecovr	10	99.65	Busy	0.35	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
visinsp2	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
accept4	10	99.99	Busy	0.01	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
covrpass	10	99.65	Busy	0.35	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
grind3	0	100.00	Busy	0.00	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
repweld	0	100.00	Busy	0.00	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
visinsp3	11	99.87	Busy	0.13	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
accept5	11	99.99	Busy	0.01	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
grind4	1	99.98	Busy	0.02	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00

Name	Number of Ops.	%Idle	%Cycle	%Stopped	%Waiting
				Down : 0.00	Repair : 0.00
repaweld	1	99.98	Busy : 0.02	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
corpass2	10	99.65	Busy : 0.35	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
visinsp4	10	99.88	Busy : 0.12	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
accept6	10	99.99	Busy : 0.01	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
grind5	0	100.00	Busy : 0.00	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
reparwld	0	100.00	Busy : 0.00	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
cvrpass3	10	99.65	Busy : 0.35	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
visinsp5	13	99.85	Busy : 0.15	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
accept7	13	99.98	Busy : 0.02	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
grind6	3	99.95	Busy : 0.05	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
repr_wd	3	99.95	Busy : 0.05	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
cvrpass4	10	99.65	Busy : 0.35	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
visinsp6	10	99.88	Busy : 0.12	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
accept8	10	99.99	Busy : 0.01	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
grind7	0	100.00	Busy : 0.00	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
repr_wld	0	100.00	Busy : 0.00	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
apply_di	12	99.86	Busy : 0.14	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
soke	12	99.86	Busy : 0.14	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00
				Down : 0.00	Repair : 0.00
remov_di	12	99.79	Busy : 0.21	Blocked : 0.00	Setup : 0.00
				Setup : 0.00	Cycle : 0.00

Name	Number of Ops.	%Idle	%Cycle		%Stopped		%Waiting	
					Down	0.00	Repair	0.00
aplydevl	12	99.86	Busy	0.14	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
bleed2	12	99.86	Busy	0.14	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
inspect2	12	99.93	Busy	0.07	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
cleen2	12	99.86	Busy	0.14	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
accept9	12	99.99	Busy	0.01	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
grind8	2	99.96	Busy	0.04	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
repr_wel	2	99.96	Busy	0.04	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
remvtrap	10	99.29	Busy	0.71	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
new_trap	10	99.29	Busy	0.71	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
wastdrum	10	99.65	Busy	0.35	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
remvshed	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
hot_trap	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
topshiel	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
tie_bag	10	99.82	Busy	0.18	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
closdrum	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
undocovr	10	99.88	Busy	0.12	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
rem_covr	10	99.94	Busy	0.06	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
closvalt	10	99.94	Busy	0.06	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00
					Down	0.00	Repair	0.00
survcell	10	99.65	Busy	0.35	Blocked	0.00	Setup	0.00
					Setup	0.00	Cycle	0.00

Name	Number of Ops.	%Idle	%Cycle	%Stopped		%Waiting	
				Down :	0.00	Repair :	0.00
disccell	10	99.94	Busy : 0.06	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
remvcell	10	99.82	Busy : 0.18	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
movinMHM	10	99.88	Busy : 0.12	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
pull_MCO	10	99.88	Busy : 0.12	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
removMHM	10	99.88	Busy : 0.12	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
next_MCO	10	97.87	Busy : 2.13	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00
regroup	9	84.68	Busy : 15.32	Blocked :	0.00	Setup :	0.00
				Setup :	0.00	Cycle :	0.00
				Down :	0.00	Repair :	0.00

VARIABLE STATISTICS REPORTED BY ON-SHIFT TIME

Name	Indices	<--------------- Value(s) ----------------->
counter		10

SHIFT STATISTICS REPORTED BY ON-SHIFT TIME

Name	On-Shift	Off-Shift	Completed Shifts
worktime	100.00	0.00	8

SUMMARY REPORT:

HCSE_1 Report Time: 1410.30

PART SUMMARY

Name	Maximum arrivals	Attribute type	Group	Output rule	Actions C	Actions L	Part route	Contains fluids	Rep
puck	1	Variable	1	Push	N	N	No	No	Yes

BUFFER SUMMARY

Name	Qty	Delay	Capacity	Input	Output Dirn.	Output Rule	<-Actions-> I	O	Min	Max	Rep
holdpuck	1	None	1000	Rear	Front	First	N	N	N	N	I

MACHINE SUMMARY

Name	Qty	Type	Lab R	Lab C	Down	Input rule	Output rule	Actions S	Actions F	Actions B	Actions R	Fluid rules F	Fluid rules E	Rep
sel_oven	1	Single	N	N	N	Pull	Push	N	N	N	N	N	N	I
move_MHM	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
lowr_MCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remv_MHM	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
mov_cell	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
con_cell	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
opn_valt	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
plac_cvr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
att_covr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remv_cvr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
inst_cvr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
inst_val	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
opn_valv	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
evac_MCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
fill_MCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
leak_chk	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
passleak	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
cls_valv	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
disc_vlv	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cln_port	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
inst_vlv	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
insl_cvr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cls_valt	1	Production	N	N	N	Wait	Sequence	N	N	N	N	N	N	I
het_cycl	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
surv_cel	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
discproc	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remvproc	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
purg_vac	1	Assembly	N	N	N	Wait	Push	N	N	N	N	N	N	I
perftest	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
add_purg	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
coolpass	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
evacMCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
pass_gas	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
pass_per	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cooldown	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
evacMCO2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
fill_He	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
move_in	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
conn_cel	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
openvalt	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remvcovr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
clos_MCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
weldcovr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
instweld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
weldroot	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
vis_insp	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
clenweld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept2	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
rep_weld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
soak	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
aply_die	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remv_die	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
aply_dev	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
bleed	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I

Lab Name	Input Qty	Type	Output R	C	Actions Down	Fluid rules rule	rule	S	F	B	R	F	E	Rep
inspect	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cleen	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept3	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
reprweld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
makecovr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
visinsp2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept4	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
covrpass	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
grind3	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
repweld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
visinsp3	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept5	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind4	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
repaweld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
corpass2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
visinsp4	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept6	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind5	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
reparwld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cvrpass3	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
visinsp5	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept7	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind6	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
repr_wd	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cvrpass4	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
visinsp6	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept8	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind7	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
repr_wld	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
apply_di	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
soke	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remov_di	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
aplydevl	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
bleed2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
inspect2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
cleen2	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
accept9	1	Single	N	N	N	Wait	Percent	N	N	N	N	N	N	I
grind8	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
repr_wel	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remvtrap	1	Production	N	N	N	Wait	Sequence	N	N	N	N	N	N	I
new_trap	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
wastdrum	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remvshed	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
hot_trap	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
topshiel	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
tie_bag	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
closdrum	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
undocovr	1	Assembly	N	N	N	Wait	Push	N	N	N	N	N	N	I
rem_covr	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
closvalt	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
survcell	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
disccell	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
remvcell	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
movinMHM	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
pull_MCO	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I
removMHM	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I

Lab Name	Input Qty	Output Type	Actions R	C	Down	Fluid rules rule	rule	S	F	B	R	F	E	Rep
next_MCO	1	Single	N	N	N	Wait	Push	Y	Y	N	N	N	N	I
regroup	1	Single	N	N	N	Wait	Push	N	N	N	N	N	N	I

VARIABLE SUMMARY

Name	Quantity	Type
counter	1	Integer

SHIFT SUMMARY

Name	Type	Periods	Total	Work Time	Overtime	Actions S	E	Rep
worktime	Main	7	168.00	168.00	0.00	N	N	Yes

APPENDIX H

VENDOR CUT SHEETS

APPENDIX H - VENDOR CUT SHEETS

1.0 STACK MONITORING

A-1000	Beta/Gamma Particulate Monitor (1)
A-2000	Beta/Gamma Particulate Monitor (1)
A-3000	Alpha/Beta Particulate Monitor (1)
A-3001	Tritium Monitor (1)
A-4000	Alpha/Beta Particulate Monitor (1)
A-4001	Tritium Monitor (1)
A-5000	Record Air Sampler (1)
A-6000	Record Air Sampler (1)

2.0 CHILLED WATER SYSTEM

CHW-ACC-2021	Expansion Tank (1)
CHW-CH-2026	Chiller (1)
CHW-P-2022	Chilled Water Circulation Pump (1)
CHW-P-2023	Chilled Water Circulation Pump (1)

3.0 COOLING WATER SYSTEM

CW-ACC-2011	Expansion Tank (1)
CW-HX-2014	Glycol/Cooling Water Exchanger (1)
CW-P-2012	Cooling Water Pump (1)
CW-P-2013	Cooling Water Pump (1)

4.0 MCO COOLING SYSTEM

MCS-CLR-1X53	MCO Chiller Exchanger (6)

5.0 PROCESS ENCLOSURE

Remote Manipulator (1)
Weld Head (1)

6.0 PROCESS HEATING SYSTEM

PHS-BLO-1X51	Heat/Cool Blower (6)
PHS-HCL-1X52	MCO Heating Element (6)

APPENDIX H - VENDOR CUT SHEETS

7.0 PROCESS VENT

PV-BLO-2043	Vent Blower (1)
PV-BLO-2046	Vent Blower (1)
PV-F-1X71	MCO Vault Filter (6)
PV-F-2041	Main Vent HEPA - First Stage (1)
PV-F-2042	Main Vent HEPA - Second Stage (1)
PV-F-2044	Main Vent HEPA - First Stage (1)
PV-F-2045	Main Vent HEPA - Second Stage (1)

8.0 VACUUM SYSTEM

VAC-VAC-3041	Main Dewar Vacuum Pump (1)
VAC-VAC-3042	Main Dewar Boost Pump (1)

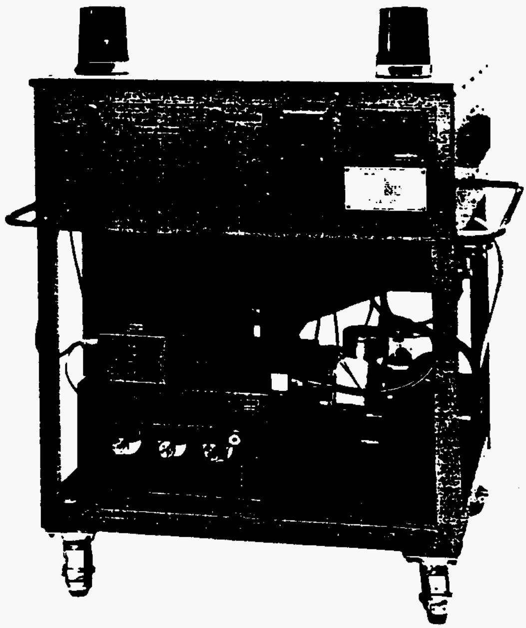
9.0 VACUUM PUMPING SYSTEM

VPS-BLO-1X06	He Recirculation Blower (6)
VPS-CLR-1X03	MCO Vent Cooler (6)
VPS-F-1X02	MCO Vent HEPA (6)
VPS-F-1X07	MCO Vent HEPA (6)
VPS-HCL-1X05	MCO Vent Heater (6)
VPS-VAC-1X04	MCO Vent Vacuum/Circulation Pump (6)

STACK A-1000
A-2000

Particulate, Iodine and Noble Gas Monitor

Model PING-3B



- SELF-CONTAINED MICROCOMPUTER-BASED UNIT FOR MONITORING STACK EFFLUENTS AND WORK AREAS
- FEATURES INCLUDE: DIGITAL DISPLAYS, BACKGROUND SUBTRACTION, HIGH ACCURACY AND SENSITIVITY, SIMPLE TO OPERATE AND MAINTAIN

Eberline

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$54,700 ea

PING-3

MNC 22

Model PING-3B
Particulate, Iodine and Noble Gas Air Monitoring System

GENERAL DESCRIPTION

The Model PING-3B is a microcomputer-based, cart-mounted monitor designed to measure the airborne concentration or stack emission rates of radioactive particulates, iodine, and noble gas. The PING-3B is simple to operate and maintain, containing all of the necessary hardware and programming (software) to be a complete, stand-alone system. A simple, easy-to-understand keyboard allows the operator to input operating parameters and request current or historical data for hard-copy output. The microcomputer monitors the operation of the detectors and pumping system, does all of the calculations, and communicates with the keyboard, printer, digital displays and alarm system. Eberline's data acquisition methods and background subtraction features yield the lowest possible minimum detectable concentration from a given detector configuration. The PING-3B is ideal for backfitting at existing nuclear power plants that have analog systems.

SPECIFICATIONS

MICROCOMPUTER

The microcomputer handles eight channels: one each for particulate and iodine, two for noble gas, and four for background subtraction.

It accumulates count data from each detector, then computes count rates and subtracts user specified background factors.

It determines, annunciates and logs status changes to the printer for each channel and controls the alarm lights and check sources. The microcomputer computes and retains the average net count rate in history files for each channel. The PING-3B automatically prints (logs) the one-hour history files for any or all channels at a user-specified time each day and can optionally log the ten-minute files every four hours. Files are maintained for the past 24 one-minute, ten-minute, one-hour and one-day averages.

History file information can be averaged, integrated or differentiated. In addition, the microcomputer can calculate the average release rate for a history file based on discharge rate when the PING-3B is used as a stack or duct monitor.

Battery-backed random access memory enables the PING-3B to retain channel parameter files in the event of a complete loss of power to the system.

Continuous flow and pressure inputs from a new solid-state flow sensor combined with new programming enables the PING-3B to perform derived concentration calculations on fixed filter channels resulting in readouts in units of $\mu Ci/cm^3$. Absolute pressure measurements made by the flow sensor allow the microcomputer to correct the noble gas readings for variations in chamber pressures.

SECURITY

Two key-locked switches provide security against unauthorized operation or modification of channel parameter files. The first key is necessary to allow operator commands such as "pump on" and "check source". The second, and highest priority key, is necessary to alter data base parameters such as alarm setpoints.

DISPLAY

The Eberline Display III is a LED (light emitting diode) display module used to display current channel readings. The format of the data display is three significant mantissa digits with a 1½-digit exponent ($10^{\pm 19}$ maximum). An array of six lights display the current status of the selected channel. The channel to be displayed is selected by a thumbwheel switch located on the display panel.

PRINTER

The printer assembly consists of a new and highly reliable 40 column, 7 × 7 dot matrix printer. This printer has been used worldwide in retail, financial and industrial terminals, and has a mean printhead life expectancy of 1.5×10^8 characters. The new printer is one of the most significant improvements incorporated into the PING-3B. As part of Eberline's continuing effort to support current PING-3 users, the new printer is now available in a PING-3 printer upgrade kit.

KEYBOARD

The keyboard is the communication point from man to machine and has two subgroups. One group is the instruction pad, and the second group is the data pad. All commands begin with a single entry via the instruction pad, followed by an entry or entries via the data pad, and are terminated with the *ENTER* key. Numerical data (calibration constants, etc.) are entered in fixed decimal point scientific notation. The instruction and data pads are color-keyed according to function.

SAMPLER AND DETECTOR SUBSYSTEM

An Eberline Model SA-13 sampler assembly contains sample chambers for particulate, iodine, and noble gas in one compact, 4π lead-shielded assembly (3 inches of lead shielding with 1 inch of lead between detectors).

PARTICULATE

Fixed Filter: 47-mm-diameter, Millipore SM is recommended. (Part No. FIFP1/9)

Detector: Eberline Model RDA-3A, beta scintillation detector with the Model RDS-1 solid-state alpha detector for radon background subtraction.

Nominal Sensitivity (at flow rates of 60 L/min):
^{137}Cs = 5 cpm/h for 1 × 10^{-11} μCi/cm^3,
$^{90}Sr - ^{90}Y$ = 8.8 cpm/h for 1 × 10^{-11} μCi/cm^3,
^{99}Tc = 3.8 cpm/h for 1 × 10^{-11} μCi/cm^3.

Range: Approximately 10^{-11} to 10^{-6} μCi/cm^3.

Background: Approximately 25 cpm (depending on geographic location) plus 10 cpm per mR/h of external ^{137}Cs field. Both fixed and "live" background sources may be specified for background subtraction. A solid-state alpha detector provides a means of subtracting out the build-up of radon daughters on the filter, and the area monitor provides a means of subtracting gamma background. The noble gas effect can be subtracted via a portion of the low-range gas channel data.

IODINE

Cartridge: 2-inch-diameter x ¾-inch-thick metal-cased cartridge containing TEDA impregnated charcoal (Part No. FIFC1/4). Silver zeolite cartridges are available upon request.

Detector: Eberline Model RDA-2A 2-inch-diameter x 2-inch-thick NaI(Tl) crystal with a ^{241}Am seed embedded for automatic gain stabilization for drift-free pulse-height analysis.

Nominal Sensitivity: ^{131}I = 3.5 cpm/h for 1 × 10^{-11} μCi/cm^3 at a flow rate of 60 L/min.

Range: Approximately 10^{-11} to 10^{-6} μCi/cm^3.

Background: Approximately 45 cpm (depending on geographic location) plus 15 cpm per mR/h of external ^{137}Cs gamma which is subtracted via the adjacent energy window.

NOBLE GAS (LOW RANGE)

Volume: 2.65 inches in diameter × 3 inches deep (270 cm^3 volume). Approximately 35 cm^3 of the volume is taken up by the noble gas detector.

Detector: Eberline Model RDA-3A beta scintillation detector, 2-inch-diameter × 0.010-inch-thick plastic with 1.6 mg/cm^2 aluminized Mylar® window.

Nominal Sensitivity:
^{133}Xe = 28 cpm for 1 × 10^{-6} μCi/cm^3 at 14.7 psia;
^{85}Kr = 41 cpm for 1 × 10^{-6} μCi/cm^3 at 14.7 psia.

Range: Approximately 10^{-7} to 10^{-2} μCi/cm^3 ^{133}Xe equivalent.

Background: Approximately 25 cpm (depending on geographic location) plus 10 cpm per mR/h of external ^{137}Cs field. An empirically determined fraction of the background channel is subtracted to correct for gamma background.

NOBLE GAS (INTERMEDIATE RANGE)

Volume: 2.65 inches in diameter × 3 inches deep (270 cm^3 volume). This is the same volume viewed by the low range noble gas detector. (Approximately 35 cm^3 of the volume is taken up by the noble gas detector.)

Detector: Eberline energy-compensated Geiger-Mueller (G-M) tube.

Nominal Sensitivity:
^{133}Xe = 0.41 cpm for 1 γBq MeV/cm^3 (5.99 × 10^{-4} μCi/cm^3) at 14.7 psia,
^{85}Kr = 0.61 cpm for 1 γBq MeV/cm^3 (0.01 μCi/cm^3) at 14.7 psia.

Range: Approximately 10^{-3} to 10^{2} μCi/cm^3 ^{133}Xe equivalent (1 to 10^{6} γBq MeV/cm^3).

Background: Approximately 0.5 cpm (depending on geographic location) plus 1 cpm per mR/h of external ^{60}Co field. An empirically determined fraction of the background channel (identical detector in the lead shield) is subtracted for background compensation.

AREA MONITOR

A gamma-detecting area radiation monitor which has a range of 0.01 to 100 mR/h is included.

MISCELLANEOUS SPECIFICATIONS

Electronics: Eberline Interface Boxes, Models IB-2, IB-3C and IB-4A, which contain the detector high voltage, signal amplifier and line driver, and provide the function of interfacing the detectors to the microcomputer.

Battery Backup: The PING-3B contains a battery which powers the electronics for 8 hours in the event of a loss of external power. This insures against information being lost from the microcomputer's memory.

Check Source: There is a motor-driven check source assembly for each of the monitoring channels, except the intermediate range noble gas. Installed sources include a 30 μCi ^{137}Cs for particulate and low range noble gas, a 0.5 μCi ^{133}Ba for iodine, and a 0.3 μCi ^{90}Sr – ^{90}Y for area monitor (NRC license required). The check source is completely shielded from the detector in a retracted position, and it is actuated either individually or as a group by keyboard request.

Analog Signal Input: The acquisition of an analog signal may be desirable in the event the PING-3B is used as a stack monitor. A signal can be acquired which is representative of the stack flow rate and used in computations of radioactive effluent release rates. Six channels of analog input are standard with the PING-3B. Two of the channels are used for input of absolute and differential pressure from the installed transducers with four channels of input available for other signals.

PUMP AND FLOW INDICATION SYSTEM

Pump: Eberline Model RAP-3 with adjustable, regulated flow to a maximum flow of 110 L/min. Recommended sample flow rate is 60 L/min.

Flow Indicator: The flow measurement system consists of absolute and differential pressure transducers which pass information to the microcomputer. This information is then used to calculate the mass flow rate of the monitored air stream. The current sample flow rate in liters per minute may be viewed at any time by selecting Channel 15 on the digital display. Channel 14 displays the sample pressure. This solid-state flow transducer system is used to correct problems defined by NRC Notice 82-49.

MECHANICAL SPECIFICATIONS

Size: 36.4 inches wide (44.5 inches with handles) × 31.75 inches deep × 50.1 inches high (0.92 m × 0.81 m × 1.27 m) with casters.

Weight: Approximately 1500 pounds (682 kg).

Operating Temperature: 32 °F to 122 °F (0 °C to 50 °C).

Power Requirements: 115 Vac, 60 Hz at 15 A maximum (typically 7 A running). (220 Vac, 50 Hz optional.)

Inlet and Outlet Connections: 1-inch-o.d. (2.54 cm) tube-compression fittings.

OPTIONS

High Range Noble Gas Detector

An Eberline Model SA-9 detector assembly providing 3 inches (7.6 cm) of lead shielding in a 4π configuration.

Detector: Energy-compensated G-M tube with 0.7 μCi ^{90}Sr – ^{90}Y check source which views a portion of a 1-inch stainless-steel pipe running through the SA-9.

Nominal Sensitivity: 0.01 cpm per γBq MeV/cm^3 at 14.7 psia

Range: 1 to 10^6 μCi/cm^3 ^{133}Xe equivalent.

Background: Background compensation is accomplished by automatically subtracting a portion of the signal from the G-M detector imbedded in the SA-13 lead block.

Analog Signal Output Option

Occasionally it is desirable to output a signal which is representative of the radiation level sensed by a particular detector in the PING-3B. This is made possible by the analog output option which is a 4 to 20 mA current loop. Any or all of the measurement channels may have this option except Channel 2 (alpha particulate).

Manual Purge/Grab Sample Option

This option provides the necessary valves and plumbing to allow purging the PING-3B and to allow grab sampling. All valves included in this option are manually-operated, stainless-steel valves.

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Santa Fe, New Mexico 87504-2108
(505) 471-3232 TWX: 910-985-0678

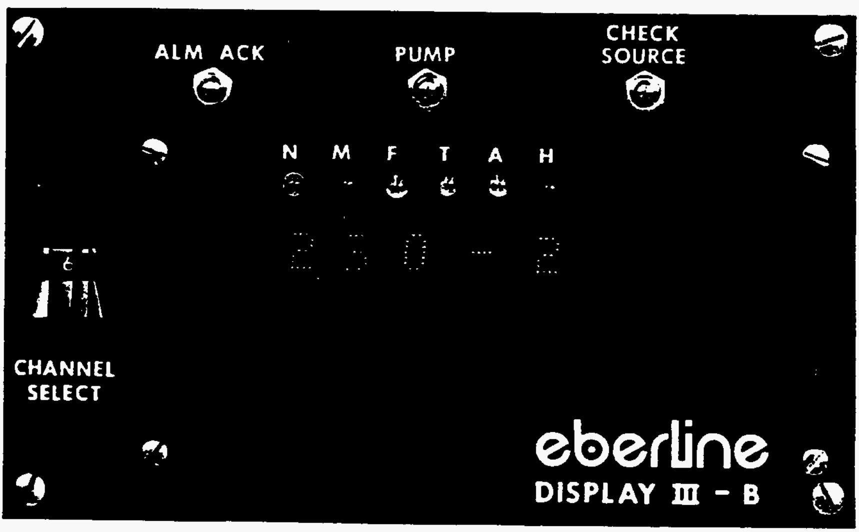
Model PING-3
Particulate, Iodine, and Noble Gas Air Monitoring System

```
   02-03 NORMAL
01 IODINE
02 CPM
03 CAL.CONSTANT   +1.00E+00
04 BKG#1 CH#       0
05 BKG#1 FACTOR   +0.00E+00
06 BKG#2 CH#       0
07 BKG#2 FACTOR   +0.00E+00
08 FIX.BKG.SUB.   +0.00E+00
09 HI ALM SET     +1.00E+06
10 ALT ALM SET    +1.00E+06
11 TN ALM (%/M)   +1.00E+06
16 LOGGED? NO
19 SAM.FLO.CH.    00
20 FLOW (CC/M)    +0.00E+00
21 REL.FLO.CH.    00
22 REL.FLO.FAC.   +0.00E+00
```

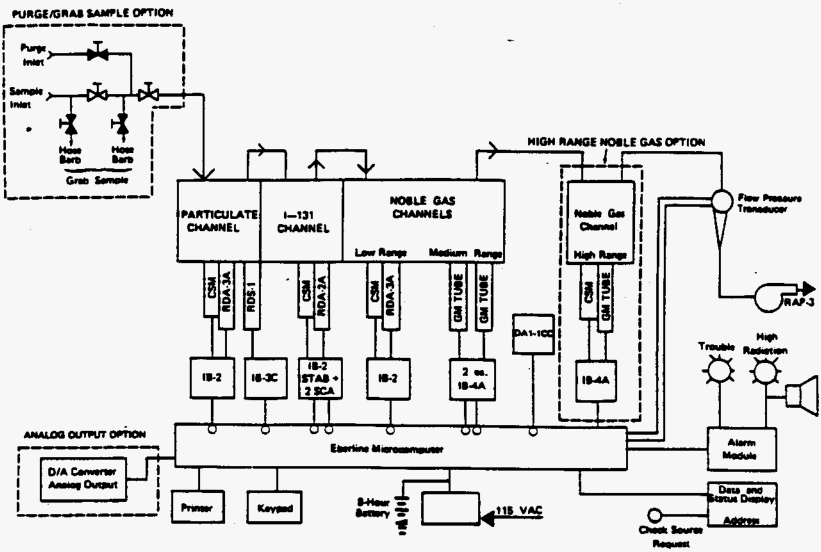
Iodine Channel Parameter File (shown before edit)

```
   02-03 NORMAL
01 IODINE
02 UCI
03 CAL.CONSTANT   +2.00E-05
04 BKG#1 CH#       4
05 BKG#1 FACTOR   +0.00E+00
06 BKG#2 CH#       0
07 BKG#2 FACTOR   +0.00E+00
08 FIX.BKG.SUB.   +0.00E+00
09 HI ALM SET     +4.00E+04
10 ALT ALM SET    +1.00E+04
11 TN ALM (%/M)   +1.00E+06
16 LOGGED? NO
19 SAM.FLO.CH.    15
20 SAM.FLO.FAC.   +1.00E+00
21 REL.FLO.CH.    00
22 REL.FLO.FAC.   +0.00E+00
```

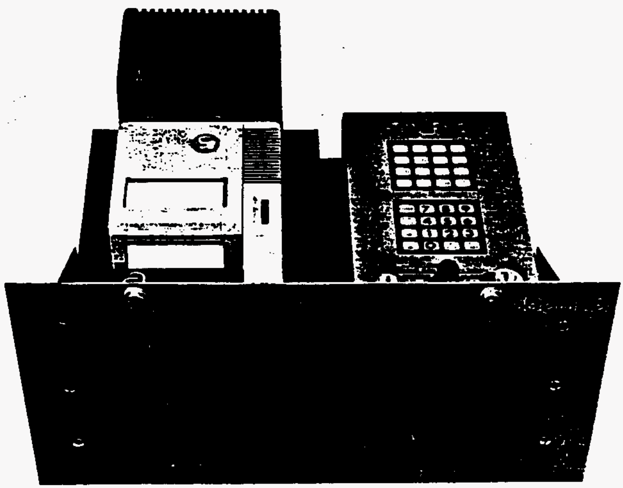
Iodine Channel Parameter File (shown after edit)



Visual Display



PING-3B Functional Diagram

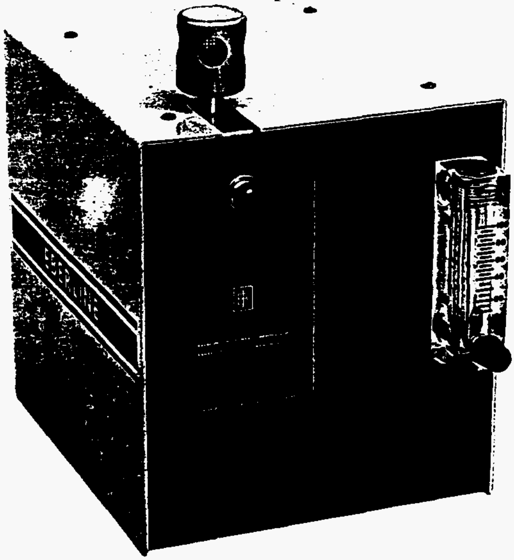


PING-3B Printer and Keyboard

STACK A-3000
A-4000

Alpha Particulate Sampler Assembly

Model SA-4A



- COLLECTS AND MEASURES AIRBORNE ALPHA PARTICULATE
- SOLID-STATE DETECTOR
- MAY BE USED TO MEASURE SPECIFIC ALPHA EMITTERS (for example ^{239}Pu, ^{230}Th, ^{234}U, or ^{235}U) WITH RADON DAUGHTER BACKGROUND SUBTRACTION
- MAY BE USED TO MEASURE RADON DAUGHTERS INDIVIDUALLY OR AS A GROSS MEASUREMENT
- DESIGNED TO INTERFACE WITH DIGITAL OR ANALOG SYSTEMS

$3,000 ea

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SA-4A

MNC 23

Model SA-4A, Alpha Particulate Sampler Assembly

GENERAL DESCRIPTION

The Model SA-4A Sampler Assembly utilizes a particulate filter for sample collection and a solid-state alpha detector for determination of the alpha activity on that filter. The detector is followed by an amplifier and up to three pulse-height-analyzer (PHA) modules. The PHA modules provide the SA-4A with the capability of monitoring for specific alpha-emitting isotopes as well as performing the functions of signal processing and line driving for interfacing the SA-4A to a digital or analog system.

The filter is 47 mm in diameter and is easily accessible through the front door of the unit. A flowmeter (10 to 100 L/min) is provided. The SA-4A is also available with a wall-mounting bracket.

SPECIFICATIONS

Detector: Silicon-diffused junction type (cleanable) with 490 mm^2 area.

Filter: 47-mm-diameter; Millipore SM or equivalent recommended.

Counting Efficiency: Approximately 20 percent of 2π from a plated 47-mm-diameter ^{239}Pu source in the filter holder.

Amplifier: Charge-sensitive input allowing very high input sensitivity with excellent noise rejection followed by a dc-coupled amplifier fed back for stability and control. Overall sensitivity is adjustable by an internal gain control.

Pulse-Height Analysis (PHA): Normally supplied with two, but will accept three pulse-height analyzer modules. Each pulse-height analyzer contains adjustable threshold and window levels. A window switch may be selected "out" for gross counting. Output process line signal drivers are capable of driving 2000 feet of twisted-pair cable.

Power Requirement: 12 Vdc at 150 mA (add 50 mA for each additional PHA card); mating power connector is Amphenol No. 165-14.

Temperature: Operational from +20°F to +130°F (−7°C to +55°C); total change in system gain is less than ±5 percent.

Size: 6.2 inches wide x 10 inches deep x 8.1 inches high (15.6 cm x 25.4 cm x 20.6 cm).

Weight: 8.8 pounds (4 kg).

The intake has a screen-protected cap with four ports for approximately 1 in^2 total open area. The cap is easily removed for attachment of a .5-inch-i.d. hose for remote sampling. The outlet has a hose barb for 5/16-inch-i.d. hose.

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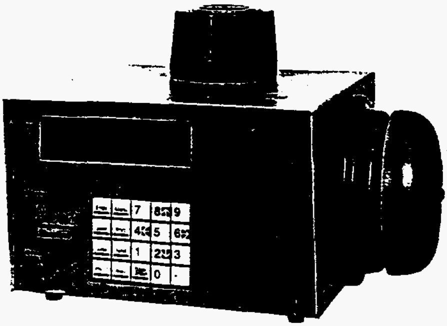
3-87

STACK

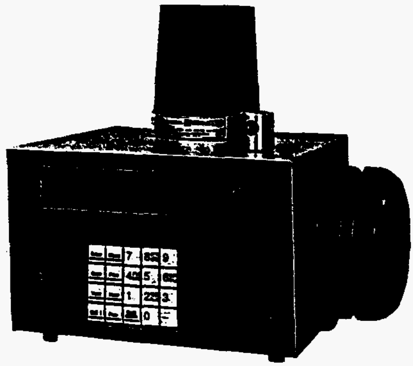
Alpha Air Monitor

ALPHA6 Product Family

~~ISO-KINETIC SAMPLING HEAD~~



ALPHA6A-1



ALPHA6-1

- CONTINUOUS AIRBORNE ALPHA MONITOR
- USER CONFIGURABLE FOR SPECIFIC ISOTOPE IDENTIFICATION
- 256 CHANNEL ANALYZER FOR RADON-THORON DISCRIMINATION
- TWO RS-232C COMMUNICATION PORTS FOR HARDCOPY PRINTOUT AND COMMUNICATION WITH PERIPHERAL DEVICES
- A VARIETY OF CONFIGURATIONS INCLUDING STANDALONE, REMOTE DETECTOR HEAD, INLINE DETECTOR HEAD, AND NETWORKED SYSTEMS.

$5,000 ea

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ALPHA6

MNC 26

ALPHA6 Product Family

GENERAL DESCRIPTION

The ALPHA6 product family utilizes a solid-state detector and a 256 channel analyzer to measure alpha particles of specific energies while minimizing interference from radon-thoron alpha emitters. This increases the sensitivity over conventional one or two channel pulse height analyzer techniques so that 4 DAC hours of ^{239}Pu may be detected in a typical radon-thoron background.

The instrument incorporates micro-computer technology which greatly enhances the measurement and data storage capabilities. Multiple historical files are maintained so that the most information possible may be obtained from the data.

A mass air flow measuring system provides flow and flowrate information which is used in computing the concentration level. The combination of the mass flow system and the 256 channel analyzer ensures that the best measurement at the highest possible sensitivity can be made.

Two RS-232C communication ports are provided so that data and information may be output to a printer for hardcopy data retention or so that a communication link may be made between the ALPHA6 and a terminal or other computer. Information and setup parameters may be transferred bi-directionally.

A local keypad is included so that calibration parameters and alarm settings may be input at the unit.

Both visual and audible alarms are actuated when the user adjustable alarm setpoints are exceeded. Alarm relay contacts are located on the back panel of the instrument and the alarm status is transmitted over communication lines if a printer or other peripheral is connected.

A failure warning is given if a major fault is detected, such as loss of the detector signal, loss of the air flow or failure of the real time clock. A local visual and audible alarm is activated and a normally activated relay drops out to provide an external alarm. In addition the alarm condition is transmitted over the communication lines to a printer or other peripheral.

The instrument is designed to be used with either an external air pump, such as the Eberline Model RAP-1, or with a house vacuum system.

CONFIGURATIONS

The ALPHA6 family of alpha air monitors include a variety of configurations to help meet user specific system requirements. The ALPHA6 family includes:

ALPHA6-1 — Alpha air monitor utilizing the traditional top entry air intake stack identical to the ALPHA-5A and AMS-3A.

ALPHA6A-1 — Alpha air monitor utilizing the radial entry head. The radial entry head is designed to maximize particulate collection efficiency, meeting the requirements of DOE Order 5480.11.

ACS-1 — Alpha cam system features a centralized electronics mounted in 19" instrument racks and utilizing remote detector heads located in the work place. A central computer is used for all display and control functions. Each rack unit will hold up to six alpha cam channels.

ALPHA6A OPT1 — Remote detector using the radial entry head.

ALPHA6A OPT4 — Remote detector using an inline configuration for stack and duct monitoring applications.

SPECIFICATIONS

Detector: Diffused junction, solid state, 490 sq. mm (25 mm dia) active area. The gross efficiency is approximately 25% (4π). The efficiency to ^{239}Pu is approximately 17% (4π).

Filter: 47 mm Millipore SM or Fluoropore FS. Deposition area is restricted to center one inch diameter.

Readout: The readout is a dot matrix liquid crystal display system. Various forms of information are presented, including time and date, air flow rate, energy spectra, and the measured values (cpm, concentration, etc.) and the alarm points. A strip chart recorder type of presentation is also available with selectable time units of seconds, minutes, hours and days. The display provides prompts to guide the user through the menus and historical data files.

Equation Specification: Five user definable variables are available for configuration of the ALPHA6 to a specific application. Default equations are defined for measurement of ^{239}Pu but may be changed by the user to configure the instrument for the measurement of different isotopes.

Alarm Determination: Up to six comparisons on the user variables may be made to determine alarms and/or failures. Default settings determine ^{239}Pu alarms but these settings may be changed to reflect changes in equation definitions.

Clock: A real time clock is provided so that all alarms and data can be time stamped.

High Alarm: The computer in the ALPHA6 provides optimum high alarm determinations. Slow, possibly statistical, count rate increases are examined at length while faster increases give an immediate alarm.

Alarm Outputs: High alarm and failure alarm outputs are available. Relay contacts rated for 1A, 115 Vac are supplied. The failure alarm is normally energized. Locally, a strobe light and bell are provided.

Air Flow Alarm: Provides an alert if the flow rate deviates from the nominal range.

Computer Output: Dual RS-232C communication ports are provided so that the information may be transferred to a printer and so that communications may be established with other peripherals. ALPHA6 OPT2 provides an RS-232/RS-485 converter for networking a group of alpha air monitors to a central computer.

Historical Files: Included are files on energy regions, air flow volume, computed values of counts per minute, total computed counts, concentration, etc. Each file kept includes the most recent 64 seconds, 64 minutes, 64 hours and 64 days.

Battery Backup: Used to maintain the real time clock, operational configuration, and historical files in case of a power failure.

Local Keyboard: For local entry of calibration and alarm parameters and for the selection of information to be displayed. A security code entry is required before operational parameters can be changed.

Subtraction Function: Provides automatic background subtraction. The amount of subtraction is determined by the percentage of the RaA and ThC peaks which scatters into the region of the isotope of interest. This percentage varies due to the changing amount of dust loading on the filter medium. The equation automatically corrects for this changing percentage of scatter.

Air Flow System: The air flow system incorporates a mass flow measurement. Flow data is incorporated in the concentration calculations.

Sensitivity: 4 DAC-hours of ^{239}Pu can be detected with an average radon-thoron background.

Max. Count Rate: Approximately 500,000 cpm

Max. Channel Counts: Greater than 4,000,000 counts per channel

Temperature: Operation from 32°F to 104°F (0°C to 40°C)

Power: 120 or 240 Vac, 50/60 Hz, at 0.5 A. RFI filter incorporated for line noise rejection.

Size: ALPHA6-1	Approximately 13.75 inches high × 12.5 inches deep × 15 inches wide (35 cm × 32 cm × 38 cm)
ALPHA6A-1	10.5 inches high × 15 inches wide × 12.5 inches deep (27 cm × 38 cm × 32 cm)

Weight:

ALPHA6-1	15.4 pounds (7 kg)
ALPHA6A-1	14.6 pounds (6.6 kg)

Software Options: Alternate programs are available which default to measure uranium isotopes, thorium and radon daughter products. Contact the factory for current list of alternate programs available.

CENTRAL COMPUTER SOFTWARE

Central computer software is available for systems using either individual alpha cams such as the ALPHA6A-1 or the ACS-1 Alpha Cam System. This software provides the operator with centralized data acquisition and control over all alpha cams connected to the central PC. The central computer software utilizes a pull down menu system and provides the following functions:

Edit Allows the user to display and modify the configuration of all alpha cams in the system. The operator may modify alarm setpoints, variable equations and regions of interest.

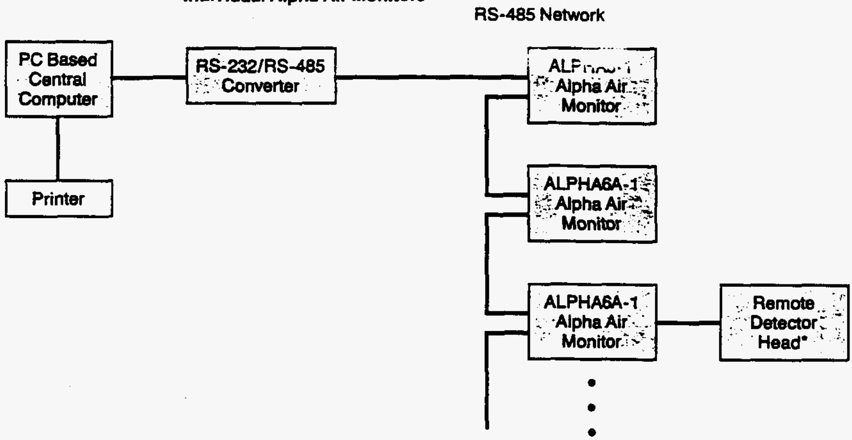
Readings Provides floor plans and group displays which are configured by the user.

Data This menu item allows the operator to display historical and current data. History files are displayed in either tabular or graphical modes. A graph of the current alpha spectrum can also be displayed.

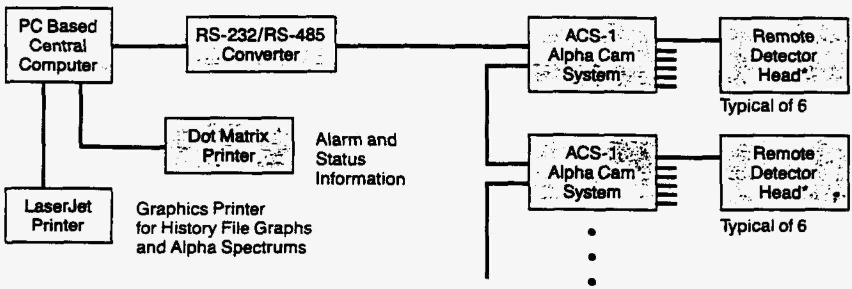
Utilities Counter control provides stop, start and reset commands. A clock set function is also provided.

TYPICAL SYSTEM CONFIGURATIONS

Individual Alpha Air Monitors



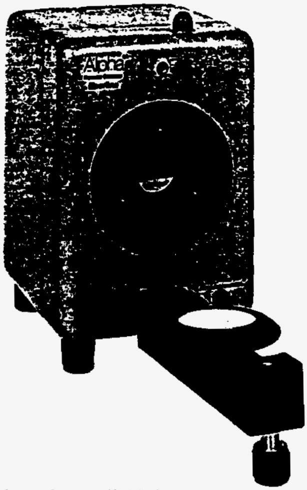
ACS-1 Alpha Cam



*Either Remote Detector Head Style May Be Used.

REMOTE DETECTORS

ALPHA6A OPT1
Remote Radial Entry Detector Head



Head: Radial Entry Style

Application: Workplace monitoring

Temperature: Operational from 32°F to 122°F (0°C to 50°C)

Humidity: 0-100% relative humidity

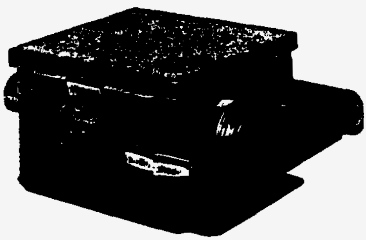
Size: 8.3 inches high × 7.9 inches deep × 5.5 inches wide (21 cm × 20 cm × 14 cm)

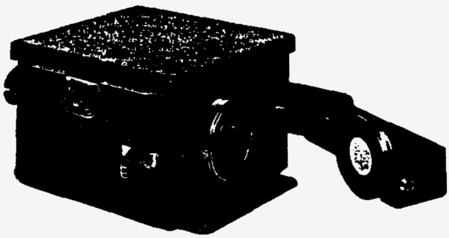
Weight: 6.5 lbs. (2.9 kg)

Distance from Electronics: Up to 500 cable feet (152.4 m)

Seal: Dust tight

ALPHA6A OPT4
Remote Inline Detector Head





Head: Inline Entry Style

Application: Duct and Stack Monitoring

Temperature: Operational from 32°F to 122°F (0°C to 50°C)

Humidity: 0-100% relative humidity

Size: 7.5 inches high × 4.4 inches deep × 10.25 inches wide

Weight: 11.25 lbs. (5.1 kg)

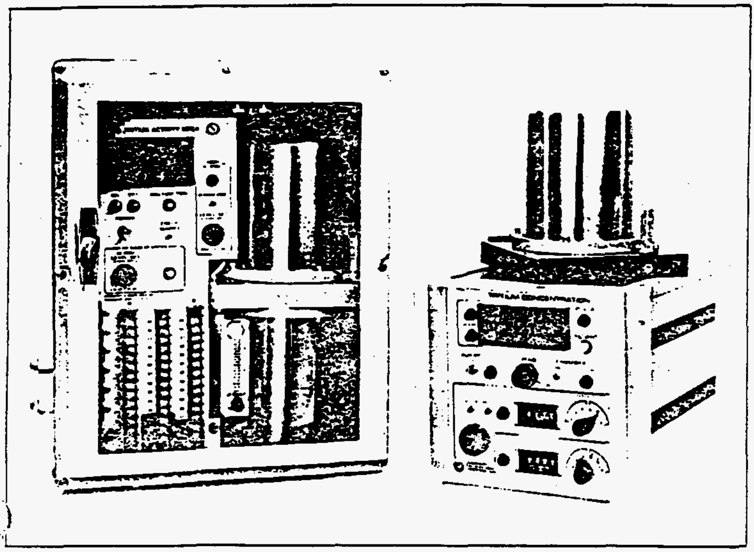
Distance from Electronics: Up to 500 cable feet (152.4 m)

Seal: Dust tight

FIXED MONITORS 300 AND 400 SERIES FEATURES

OVERHOFF TECHNOLOGY CORPORATION

STACK A-3001
A-4001



FIXED, RACKMOUNT AND BENCHTOP MONITORS

These are line powered, and continuously operating monitors. They can be built with a large number of combinations of FEATURES and OPTIONS, to suit the end user's particular needs. They are designed around three primary product FEATURES:

- RANGE OF MEASUREMENT
- IONIZATION CHAMBERS
- PANEL METERS.

Each feature is designated by an alpha/numerical code.

Fixed monitors are classified into four basic groups.

31X series — single range, with single ionization chamber
32X series — single range, with dual ionization chamber $6,000 each "TRITIUM MONITOR"
41X series — multi range, with single ionization chamber
42X series — multi range, with dual ionization chamber

P.O. Box 182
1160 U.S. ROUTE 50
MILFORD, OHIO 45150-9705
(513) 248-2400

MNC 24

FEATURES

RANGE OF MEASUREMENT

Instruments are available in both single and multi range versions.

The single range instruments are lower in cost, and are recommended when a very wide range of measurement is not required.

Single Range (3XX)

Applications which require a limited range of measurement can be met by a single range instrument, designated as "three hundred" series. Range of measurement can extend from three decades to five or even six decades.

Multi Range (4XX)

Multi range instruments are used for applications where a much wider range of measurement is required. These instruments are designated as "four hundred" series, either automatically (AR) or manually (MR) ranged versions. The most common are instruments with five ranges, however, any range from three to seven can be supplied. For example, to obtain a measurement span of eight decades, a four hundred series tritium monitor equipped with a three digit panel meter has to be provided with five automatically switched ranges.

PANEL METERS

Instruments can be supplied with either digital or analog displays. Either linear or logarithmic scales can be supplied for analog meter faces.

Digital Panel Meters (DP)

These meters are available in 3½ and 4½ digit versions. Single range monitors (300 series) can be equipped with either type of meter, depending upon the measurement range required. Multiranging monitors (400 series) are normally equipped with 3½ digit panel meters, since the overall measurement range is determined equally by the number of automatically switched ranges as by the digit range of the panel meter itself.

Analog Panel Meters (AP)

Analog panel meters are available with either logarithmic (LOG) or linear (LIN) scales. A logarithmic scale can cover up to six decades for a 300 series instrument, or up to nine or even ten decades for the 400 series instruments.

IONIZATION CHAMBERS

Monitors are available with either single or dual chambers. The chambers can be mounted inside the electronics cabinet (ICI), or they can be located remotely (ICR).

Ionization chambers are available in a large number of sizes and configurations, each specifically designed for a paticular purpose. A more general description of the nature and design of ionization chambers is found on a separate sheet.

Single Ionization Chamber (X1X)

Dual Ionization Chamber (X2X)

The middle number in the alpha/numeric code designation for the description of the basic features of an instrument refer to the number of the ionization chambers to form part of the tritium monitor.

Monitors are generally supplied with either single chambers, or with dual chambers, although there are occasional applications where clusters of three or more chambers can be used.

Mounting of Ionization Chambers

Internal Ionization Chambers (ICI)

Remote Ionization Chambers (ICR)

Mounting of the ionization chamber assembly can be internal to the main electronics cabinet. This ionization chamber assembly can also be mounted remotely at distances up to several hundred feet from the main electronics cabinet.

Chamber mounting must be selected at the time of specifying the instrument.

TECHNICAL SPECIFICATIONS

mation provided here is of a general nature, and serves to provide an overview of some of the key rmance characteristics to be found in OVERHOFF TECHNOLOGY CORPORATION tritium monitors.

MEASUREMENT

Tritium monitors with ionization chambers are capable of an extremely wide range of measurement. Some OTC tritium monitors are capable of measuring activities as low as 0.01 μCi/m³, other versions of the instruments are designed for high level measurements, approaching pure streams of tritium.

RADON (ALPHA) PULSE SUPPRESSION (APS)

OTC tritium monitors can be supplied with proprietary circuitry which suppresses response to naturally occurring spurious background, thereby extending low level tritium measurement well below environmental radon or cosmic ray background.

STABILITY AND NOISE

The zero stability of an instrument is guaranteed to be equal or better than the smallest required increment of measurement. For those instruments which are furnished with a digital panel meter, the short term drift or noise is equal to, or less than, the least significant digit of the meter.

DRIFT, ENVIRONMENTAL (AZ)

Longterm drift can be caused by tritium plate-out, as well as by changes in the electronics. Auto zeroing circuitry can be incorporated in order to eliminate all longterm electronic drift. Special chamber configuration such as heated or gridded chambers are recommended for prevention of effects from tritium plate-out.

RESPONSE RATE

measurement signal level and the rate (time constant) are inherently interrelated. High surement levels demand fast response, whereas low measurement levels demand long time constants, in order to smooth out noise and to provide a stable display. To accommodate this contradictory requirement, three distinct time constants have been incorporated into the instruments.

2 second for measurement above 1000 μCi/m3
5 to 10 second time constant for measurement of 80-1000 μCi/m3
20 seconds or more for measurement below 80 μCi/m3

Time constants usually switch automatically, although manual switching as well as different break points are available.

ALARM SYSTEM, SIGNAL

Dual independent alarms are standard. Single, triple and quadruple independent alarm systems can be provided.

SET POINT

Setting the level at which the alarm is activated is accomplished with the use of front panel mounted potentiometers. Multi-ranging models also include front panel mounted rotary RANGE selector switches, thereby permitting set point adjustment over the entire range of operation of the instrument.

MODE SELECT, CONFIGURATIONS

Front panel switch for operator selection of several alarm modes

Non-latching
Alarm active above set point; ceases below set point

Latching
Alarm triggered above set point; remains active until reset. Can only be reset after the measurement receded below the set point value.

nowledge
n alarm which continues active once tripped, but which can be deactivated by means of a push button at any time, regardless of set point level status

INDICATORS AND ACTUATORS

Incandescent or solid state lamps for alarm status and ac power status. Piezoelectric acoustic signallers with steady or pulsating tones.

INTERFACE

24 pin receptacle, located on the rear of the cabinet for interface connections for remote display, control and alarms, process controls or for interconnection to digital computer systems.

ENVIRONMENTAL

Temperature
operating 0°c to +50°c
storage -40°c to +70°c

Humidity
0-95% RH

Shock
5 G, all directions

PHYSICAL

Power
115/230 V ac, 50/60 Hz

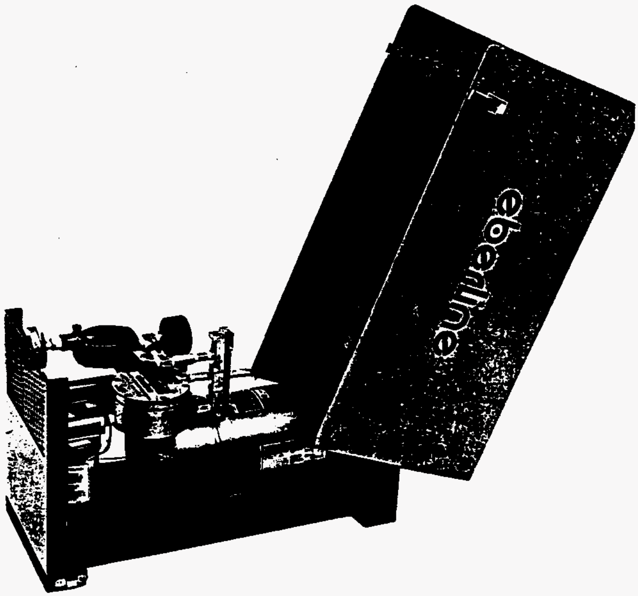
Enclosure
19" rack mounting
13" deep
heights from 5.25" to 10.50"
other cabinets available

Weights
cabinets—under 10 kg
ionization chambers 10 to 50 kg, depending on number, size and shielding.

STACK A-5000
A-6000

Environmental Air Sampler

Model RAS-2



- WEATHERPROOF HOUSING
- OPTIONAL IODINE CARTRIDGE HOLDER
- FLOWMETER AND VACUUM GAUGE
- 47-mm FILTER HOLDER

Eberline

A DIVISION OF Thermo Electron CORPORATION

$1,250 ea

RAS-2

MNL 25

Model RAS-2, Environmental Air Sampler

GENERAL DESCRIPTION

The Model RAS-2 is a weatherproof air particulate sampler containing an oil-free vacuum pump, motor, airflow regulator, flowmeter, vacuum gauge, and filter holder. The system is mounted in a weatherproof enclosure (WPH-1) permitting exterior use. The pump and motor provide enough heat to prevent winter freeze-up, and an exhaust fan provides summer cooling.

The Eberline airflow regulator is designed to maintain a constant pressure drop across an in-line orifice by controlling a variable bypass valve into the pump. The orifice is adjustable, permitting flow rate adjustment from near zero up to the maximum pump flow capacity.

This flow control system permits the pump to operate at a minimum pressure drop at all times, which provides cooler pump operation to extend the lifetime.

It should be noted that when pressure varies, the flow through an orifice with a constant pressure drop will vary as the square root of the ratio of the absolute pressure. Therefore, if filter loading creates a pressure drop of 50 percent of the original pressure, the flow referenced to atmosphere will decrease by 30 percent.

SPECIFICATIONS

Pump Type: Oil-free, carbon vane

Motor: ¼ HP, 115 V, 60 Hz, 5 A (220 V, 50 Hz optional)

Vacuum: 26 inches Hg at sea level

Flow Rates: See figure

Filter Holder: Model FH-1, 47-mm

Flowmeter: 0 to 100 L/min (0 to 3.5 ft³/min)

Vacuum Gauge: 0 to 30 inches Hg (0 to 760 mm Hg)

Size: 23 inches long x 9.25 inches wide x 13 inches high (58 cm x 23.5 cm x 33 cm).

Weight: 60 pounds (27 kg)

AVAILABLE ACCESSORIES

Iodine Cartridge Holder: Model ICH-1

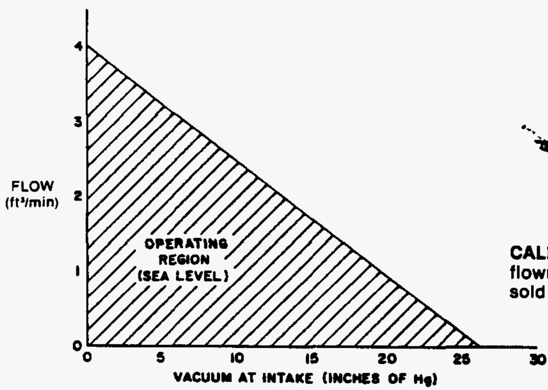
Iodine Cartridge: Part No. IC-1

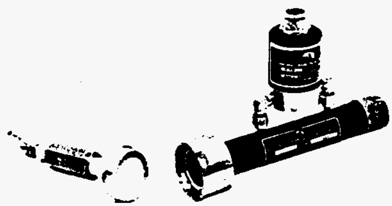
Calibration Adapter: Model ZP10758009 (Mates FH-1 to 1-inch NPT)

Filter Paper: Part No. FIFP8, 47-mm

Calibration

The unit is supplied with a three-point flow calibration using a mass flowmeter.

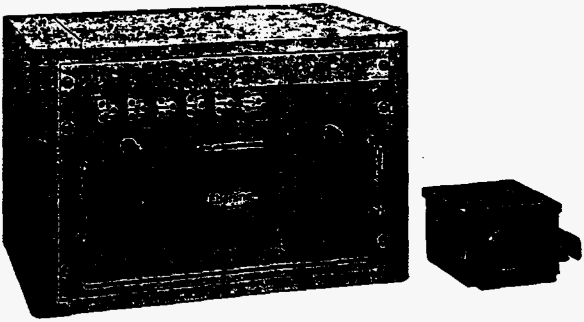




CALIBRATION ADAPTER (Shown with mass flowmeter attached) mass flowmeters are not sold by Eberline.

Eberline
A DIVISION OF Thermo Electron CORPORATION
P.O. Box 2108
Santa Fe, New Mexico 87504-2108
(505) 471-3232 TWX: 910-985-0678

ACS-1 ALPHA CAM SYSTEM



ACS-1 Alpha Cam System

The Alpha Cam System (ACS-1) is based on the Eberline Model Alpha6 Alpha Air Monitor, with appropriate design changes to create the most efficient system configuration. The most significant difference is the use of rack mounted electronics modules. Up to six Alpha6 electronics modules can be placed in one 19" rack. The electronics module is the heart of the Alpha6 monitor and includes the pulse processing electronics, MCA (multi channel analyzer) and the microprocessor based computer system used to analyze the spectral data and control the monitor. In order to conserve valuable floor space, improve the man-machine interface and cut the costs of multiple individual displays, a PC based system controller for readout and control of the monitoring system is used. The individual displays, typical on the individual Alpha6 cams, have been removed and the PC will provide this function for the whole system. The PC also provides data archiving/report generation capability. The electronics modules perform the monitoring and alarm functions independent of the central computer. Therefore, a loss of the central computer does not compromise the safety function of the ACS-1.

The ACS-1 is comprised of two modules: the electronics module and the remote detector head assembly. These modules are connected by a single multi-conductor cable. The detector head assembly may be located up to 500 ft away from the electronics module. Either the radial entry or inline versions of the remote detector head can be used.

Electronics Module

The electronics modules are contained within the 19" rack mount enclosure which is capable of holding up to six electronics modules. The electronics module is the standard computer board used in the Alpha6 Alpha Air Monitor. In this configuration the liquid crystal display and keypad typical to each monitor are removed in favor of a single PC based display/control system for all monitors. The display and keypad is not necessary on each monitor when all the monitors and the display/control computer system are all located together. The display/control computer system provides an enhanced operator interface by displaying the current status and reading of all monitors in the system on one display.

Contained within the electronics modules are the power supply, the multi-channel analyzer and electronic subsystems to support the flowmeter, communications and various alarms. Each electronics module has an RS-232/RS-485 converter for communications to the system display/control computer. Two relay outputs are provided for each module. One relay is provided for alarm and a second relay for failure conditions. Each relay has a set of DPDT contacts.

The rack unit has indicating LEDs for each channel. The LEDs provide indication of normal, alarm and failure status for each channel. Each channel also includes a connector for a portable terminal accessible just behind the hinged front of the panel. The portable terminal allows the operator to take a given channel out of the system for periodic maintenance and calibration.

Eberline
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Santa Fe, New Mexico 87554-2108
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Pages H-21 through H-28 have been removed from the document due to copyright and/or trademark restrictions. The information on these pages can be obtained from the project manager.

TRANE

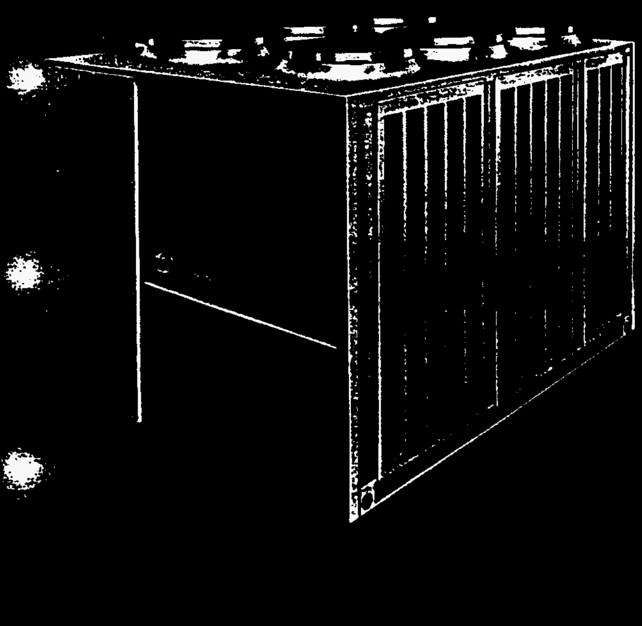
S/S-DS-1 MNC4
May 1989
First Printing

Split System Air Conditioners

20 through 120 Ton

~~CHW-CH 2023~~

#Δ to CHW-CH -2026 6/28/96

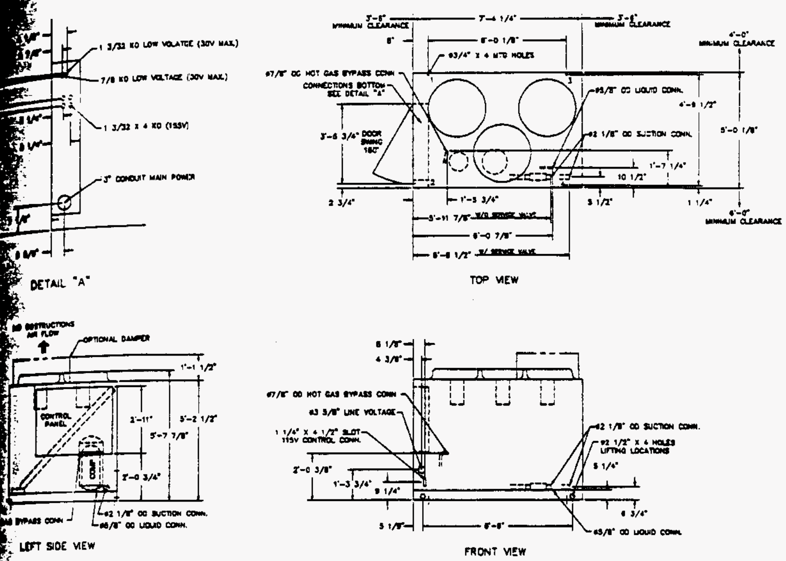


Performance Data

Capacity Data — Condensing Unit With Evaporator Chiller

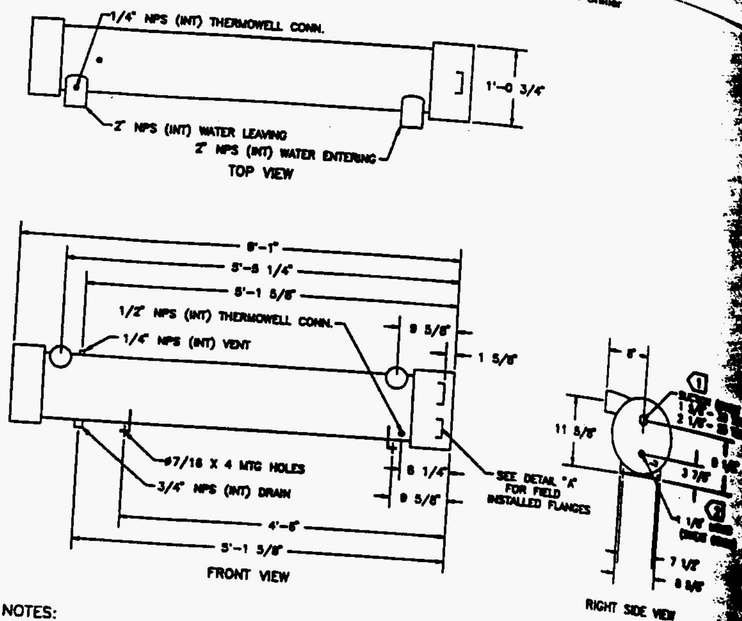
Outside Ambient Temperature Entering Condenser (F)							
85		95		105		115	
Tons	Kw	Tons	Kw	Tons	Kw	Tons	Kw
16.1	17.4	15.3	19.4	14.4	21.6	13.5	24.1
16.6	17.5	15.8	19.5	14.9	21.8	14.0	24.2
17.4	17.8	16.6	19.8	15.7	22.0	14.7	24.5
18.3	18.0	17.4	20.0	16.4	22.3	15.4	24.8
18.8	18.1	17.9	20.2	16.9	22.5	15.9	25.0
16.7	17.6	15.9	19.5	15.0	21.8	14.0	24.3
17.3	17.7	16.4	19.7	15.5	22.0	14.5	24.5
18.1	18.0	17.2	20.0	16.2	22.2	15.2	24.7
19.0	18.2	18.0	20.2	17.0	22.5	16.0	25.1
19.5	18.3	18.6	20.4	17.5	22.7	16.5	25.3
21.0	22.2	20.0	24.6	18.9	27.4	17.7	30.5
21.7	22.4	20.6	24.8	19.5	27.6	18.3	30.7
22.7	22.7	21.6	25.1	20.4	27.9	19.2	31.0
23.8	23.0	22.6	25.5	21.4	28.3	20.2	31.4
24.5	23.2	23.3	25.7	22.1	28.5	20.8	31.6
[illegible]	22.4	20.6	24.8	19.4	27.6	18.2	30.7
22.4	22.6	21.2	25.0	20.1	27.8	18.8	30.9
23.4	22.9	22.3	25.4	21.1	28.1	19.8	31.3
24.5	23.2	23.3	25.7	22.1	28.5	20.8	31.6
25.3	23.4	24.0	25.9	22.8	28.7	21.4	31.9
24.9	26.2	23.7	29.1	22.5	32.4	21.2	35.9
25.7	26.5	24.5	29.4	23.2	32.6	21.9	36.2
26.9	26.8	25.7	29.8	24.4	33.1	23.0	36.6
28.2	27.2	26.9	30.2	25.5	33.5	24.1	37.1
29.1	27.4	27.7	30.5	26.3	33.8	24.9	37.4
33.9	34.8	32.2	38.8	30.4	43.2	28.5	48.2
35.0	35.1	33.3	39.1	31.4	43.6	29.4	48.6
36.7	35.5	34.9	39.6	32.9	44.1	30.9	49.2
38.5	36.0	36.5	40.1	34.5	44.7	32.5	49.8
[illegible]	36.3	37.7	40.4	35.6	45.0	33.5	50.2
34.9	35.0	33.1	39.0	31.2	43.5	29.2	48.5
36.0	35.3	34.2	39.3	32.2	43.9	30.2	48.9
37.7	35.8	35.8	39.8	33.8	44.4	31.8	49.5
39.5	36.2	37.5	40.3	35.5	45.0	33.3	50.1
40.7	36.5	38.7	40.7	36.6	45.3	34.4	50.5
41.4	44.6	39.3	49.5	37.2	55.0	34.9	61.2
42.7	45.0	40.6	49.9	38.4	55.5	36.1	61.7
44.7	45.6	42.5	50.6	40.3	56.2	37.8	62.4
46.8	46.2	44.5	51.2	42.2	56.8	39.7	63.1
48.2	46.6	45.9	51.6	43.5	57.3	40.9	63.6
42.7	45.0	40.6	49.9	38.3	55.5	36.0	61.7
44.1	45.4	41.9	50.3	39.6	55.9	37.2	62.1
46.2	46.0	43.9	51.0	41.5	56.6	39.0	62.9
[illegible]	46.6	46.0	51.7	43.5	57.3	40.9	63.6
[illegible]	47.0	47.4	52.1	44.9	57.8	42.2	64.1
49.0	52.6	46.8	58.5	44.3	65.0	41.7	72.1
50.6	53.0	48.3	59.0	45.8	65.5	43.1	72.7
53.0	53.7	50.6	59.7	48.0	66.3	45.2	73.6
55.5	54.5	52.9	60.5	50.2	67.2	47.4	74.5
57.2	55.0	54.6	61.0	51.8	67.8	48.9	75.1
53.7	54.0	51.0	59.9	48.2	66.4	45.1	73.6
55.5	54.5	52.8	60.5	49.8	67.0	46.7	74.2
58.3	55.3	55.4	61.3	52.4	68.0	49.2	75.2
61.1	56.1	58.1	62.2	55.0	68.9	51.7	76.2
63.1	56.6	60.0	62.8	56.8	69.6	53.4	76.9

Figure 29-1 — Air-Cooled Condensing Unit — RAUC 25 Ton



Dimensional Data

Figure 36-1 — 20 and 25-Ton Evaporator Chiller



NOTES:

1. DIMENSIONAL TOLERANCE IS ±1/8".
2. ALLOW 6'-1" TUBE REMOVAL CLEARANCE EITHER END OF EVAPORATOR.

Evaporator Flange Connection.
Flange adapter and O-ring supplied by Trane.

H-32

300

END SUCTION

ENGINEERING SPECIFICATIONS AND DIMENSIONS

CHW-P-2022, CHW-P-2023

The contractor shall furnish (and install in location as shown on the plan) an Aurora Type (321 horizontal) (323 flange mounted) (324A horizontal) Centrifugal Pump size ...... (bronze fitted) (all bronze) (all iron) construction. Each pump shall have a capacity of ...... G.P.M. at ...... ft. total head and ...... specific gravity. The pump is to be furnished with case wearing ring and a mechanical seal, with all metal parts to be 316 stainless steel, "Buna-N" bellows, Ni-resist seat, and carbon washer.

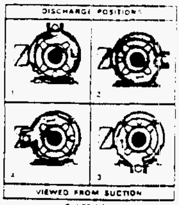
310

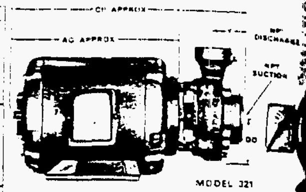
FLEXIBLE COUPLED PUMPS — MODEL 324A

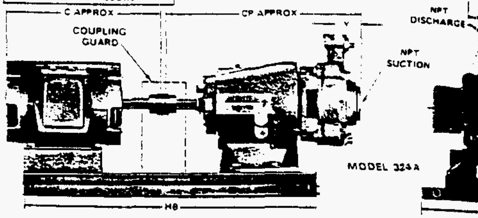
The pump shaft is to be stainless steel with (grease lubricated) (oil lubricated) ball bearings. The pump is to be flexible coupled to a standard horizontal NEMA motor of ...... H.P., ... phase, ... Hertz, ... voltage, ... R.P.M. (drip proof) (totally enclosed) (explosion proof) enclosure. The pump shall be mounted on a (fabricated steel drip rim) (steel) base plate. Pump and motor alignment must be checked according to the Standards of Hydraulic Institute after the pump has been installed.

→ CLOSE-COUPLED PUMPS — MODEL 321-323

The pump is to be close-coupled to a NEMA motor of ..1/2.. H.P., SINGLE phase, ..60.. Hertz, ..120.. voltage, ..1750 R.P.M., (drip proof) (totally enclosed) enclosure, with stainless steel motor shaft. The motor shall be designed to Aurora Pump specifications as to vibration limits.







Pump Size			Pump Weight (Lbs.)							
Disch.	Suction	Case Bore	321	323	324	X	Y	DC	DD	DE
3/4	1	6A	25	30	55	5 1/4	1 3/4	3 9/16	3 7/16	3 7/8
→ 3/4	1	7	35	40	65	6 1/4	1 7/8	3 13/16	4	4 7/16
1	1 1/4	4	21	26	51	4 1/2	1 11/16	2 5/8	2 3/8	2 7/16
1	1 1/4	5	27	32	57	5	2	2 13/16	2 7/8	3
1	1 1/4	6	29	34	59	5 1/2	1 15/16	3 5/16	3 3/8	3 7/8
1 1/4	1 1/2	5	27	32	57	5	1 15/16	2 7/8	2 15/16	3 7/16
1 1/4	1 1/2	7A	37	42	67	6 1/4	2	4	4 7/16	4 1/2
1 1/4	1 1/2	7B	37	42	67	6 1/4	2 7/16	4	4 7/8	4 5/8
1 1/4	1 1/2	9	52	57	82	8	2 1/4	5 13/16	5 5/16	5 13/16
1 1/2	2	4	24	29	54	5	2 1/8	2 1/2	3	2 3/4
1 1/2	2	7	38	43	68	7	2 1/4	4 7/16	4 1/4	4 7/8
2	2 1/2	4	28	33	58	5	3 1/16	2 1/2	3	2 13/16
2	2 1/2	5	31	36	61	6	2 11/16	3	3 3/16	3 7/16
2	2 1/2	6	36	41	66	6	2 3/4	3 1/2	3 11/16	4 5/8
2	2 1/2	7	43	48	73	7	2 15/16	4 1/16	4 9/16	4 7/8
3	3	6	48	53	78	8	3 5/8	3 1/8	4 7/16	5 7/8

MODELS 321-323

Frame	Horsepower 3500 RPM	Horsepower 1750 RPM	Motor Weight (Lbs.)	A	D	AG	CP 321	CP 323
56	1/3	1/3	29	6 3/4	3 1/2	11	17 1/2	20
	1/2	1/2	46					
	3/4	3/4	56					
	1	1	56					
	1 1/2	1 1/2**	65					
	2	NA	80					
145T		1 1/2*	42	7	3 1/2	11	17 1/2	20
	3**	2**	48					
182T	3*	2*	65	9	4 1/2	11	17 1/2	20
	5**	3**	69					
184T	7 1/2**	3*	79	9	4 1/2	12	18 1/2	21
		5**	83					

MODELS 324A

Frame	Horsepower 3500 RPM	Horsepower 1750 RPM	Motor Weight in Lbs.	[illegible]
48	1/3-1/2	1/3	30	100
56	3/4-1	1/2-3/4	50	100
143T	1 1/2	1	34	100
145T	2-3	1 1/2-2	42	[illegible]
182T	5	3	65	[illegible]
184T	7 1/2	5	79	100
213T	10	7 1/2	185	100

NOTES

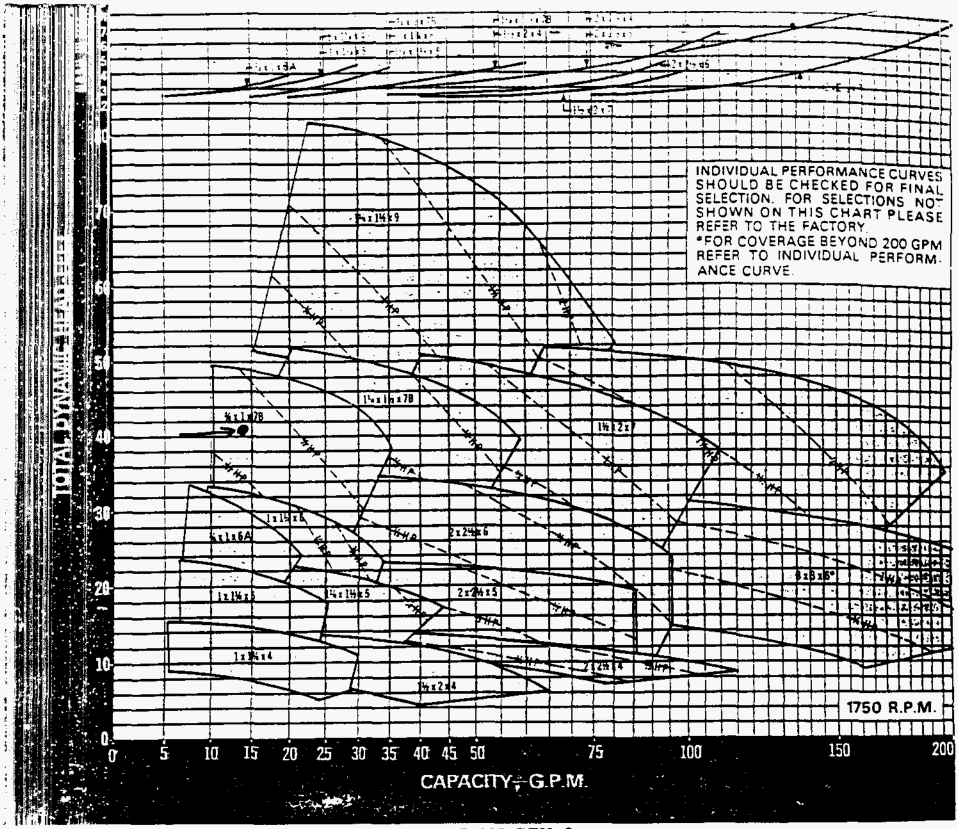
1. Dimensions and weights are approximate
2. All dimensions are in inches and may vary ± [illegible]
3. Frame sizes "C" & "AG" dimension and motor weight are for open drip proof motors only
4. Conduit box is shown in approximate position. Dimensions are not specified as they vary with each motor manufacturer
5. Add pump, base and motor weight for unit weight
6. Not for construction purposes unless certified
7. Discharge position No. 3 is not available on Model 323 and 324A. Position No. 1 is furnished as standard unless otherwise specified
8. Model 323 not available in all bronze construction
9. Aurora Pump reserves the right to make revisions to its products and their specifications and to this bulletin and related information without notice

* Single phase only ** Three phase only

MWL7

H-33

AURORA PU[MP]
A UNIT OF GENERAL S[IGNAL]
800 AIRPORT ROAD • NORTH AURORA, ILL[INOIS]
SALES OFFICES IN ALL MAJOR CITIES AND COU[NTRIES]
Refer to "Pumps" in the yellow pages of your phone [directory]
MAIN OFFICE AND MANUFACTURING FACILI[TIES]
LOCATED IN NORTH AURORA, ILLINOIS (GREATER CH[ICAGO])



WHC-SD-SNF-CDR-007, REV. 0

DESIGN DETAILS

	DESCRIPTION	DIM.
	Pipe Connections — Thread N.P.S.F	Var.
	Rotation — Facing Suction	CCW
PUMP SHAFT	Diameter at Impeller	19/32
	Diameter at Seal	3/4
	Diameter Between Bearings	1-3/8
	Diameter at Coupling End	7/8
	Coupling Keyway	1-3/8 Lg. x 3/32 Dp.
	Max. Deflection at Seal Face	.002
BALL BEARINGS	Bearing (Inboard Radial)	206K
	Bearing (Outboard Thrust)	206 KG.
	Bearing Centers	5-11/16
	Bearing Type	Ball
	Min. B_{10} Bearing Life Under Max. Rec. Load	2 Yrs.

MATERIAL OF CONST.

PUMP PART	BRONZE FITTED	ALL IRON	† ALL BRONZE See Note 8.
Casing	Cast Iron ASTM A48	Cast Iron ASTM A48	Bronze ASTM B62
Case Wearing Ring	Bronze ASTM B62	Cast Iron ASTM A48	Bronze ASTM B62
Impeller	Bronze ASTM B584	Cast Iron ASTM A48	Bronze ASTM B584
Motor Bracket	Cast Iron ASTM A48	Cast Iron ASTM A48	Bronze ASTM B62
Shaft	Stain. Steel AISI 416	Stain. Steel AISI 416	Stain. Steel AISI 316
Power Frame 324A	Cast Iron ASTM A48	Cast Iron ASTM A48	Cast Iron ASTM A48
Mechanical Seal	Stainless steel metal parts. "Buna-N" elastomer parts. Ni-resist seat and carbon washer. †All bronze has Viton elastomer parts and ceramic seat.		

LIMITATIONS

MAX. BASED ON STD. MATL'S & WATER		
Speed — rpm		3500
Horsepower		7-1/2
Temperature — °F	Close Coupled	225
	Frame Mounted	225
Hydrostatic Test — P.S.I.		220
Case Working Press — P.S.I.		175
Suction Press — P.S.I.		175

4

Pages H-35 through H-42 have been removed from the document due to copyright and/or trademark restrictions. The information on these pages can be obtained from the project manager.

PENTAD ASSOCIATES, INC.

7950 S. Lincoln, Suite 102
Littleton, CO 80122-2713

303 794-4802
303 794-2345 FAX

FAX TRANSMITTAL

CW-HX-2014

DATE: June 14, 1996

TO: Santa Fe Engineering

ATTN: Dave Munger

FAX #: 505-983-5608

FROM: Pam Standley

RE: Heat Exchanger ~~CW-HX-2013~~
Plate & Frame / MaxChanger Sizings

Total pages (including cover): 6

MESSAGE:

Dave, please find the following sizings, per our conversation.

QUOTATION

tranter®

PLATECOIL®
SUPERCHANGER®
MAXCHANGER®

DAVE MUNGER

DATE 06/12/96 PAGE 1

YOUR REFERENCE:

OUR REFERENCE: MC 013343-18A R00 MAT

Thank you for your inquiry. We appreciate the opportunity to propose the following :

QTY	DESCRIPTION	AMOUNT
4	MAXCHANGER Model MX-39-0424-HP-072/.048 Plate Material 316LSS Unit Price $ 2443.00	$ 9772.00

Tranter, inc. warrants the products sold by it to the buyer to be free from defects in material or workmanship under normal use and conditions for a period of 18 months from date of shipment by Tranter or 1 year from start-up, whichever occurs first. Tranter's liability to the buyer under this warranty shall be limited at Tranter's choice to replacement at its factory of any part or parts thereof which Tranter determines to be defective after inspection thereof at its factory or to refund of the purchase price. In no event shall Tranter be liable for consequential or special damages, or for any expense incurred as a result of use of its product, irrespective of whether same may be proven defective under the warranty. Tranter's liability shall in no event exceed the purchase price of the goods and/or services furnished by Tranter.

Because MAXCHANGER units are used in corrosive environments and small variations in operating conditions can significantly affect the corrosion rates of MAXCHANGER units, Tranter, inc. assumes no responsibility for corrosion resistance or life span of MAXCHANGER units in any application. Tranter, inc. warrants the products sold to be free from defects in material or workmanship under normal use and conditions for a period of one year from date of shipment by Tranter, inc.

The shipping estimate quoted excludes our scheduled plant shutdown from June 21, 1996 through July 8, 1996.

Continued ...

ORIGINAL

tranter

TRANTER, Inc. • Texas Division • P.O. Box 2289 • Wichita Falls, Texas 76307
Telephone (817) 723-7125 • FAX (817) 723-5131

PLATECOIL®
SUPERCHANGER®
MAXCHANGER®

QUOTATION

DAVE MUNGER

DATE: 06/12/96 PAGE 2

YOUR REFERENCE:

OUR REFERENCE: MC 613343-18A R66 MAT

ITEM	QTY	DESCRIPTION	AMOUNT
		ENCLOSURES: Specification Sheets.	

SHOULD AN ORDER RESULT FROM THIS QUOTATION, PLEASE ADDRESS YOUR PURCHASE ORDER TO TRANTER, inc. OR TRANTER, inc. C/O SALES REPRESENTATIVE. PLEASE DO NOT ADDRESS THE PURCHASE ORDER SOLELY TO TRANTER'S SALES REPRESENTATIVE.

Our shipping estimate is 4-6 Weeks A.R.O.
This estimate is based upon "after receipt of order" and "after final drawing approvals" as required. However, day to day changes do occur that may change delivery time. Please contact us if earlier shipment is required.
Our shipping terms are F.O.B. Wichita Falls, Texas . Freight: [illegible].

Prices are firm for sixty days and subject to change without notice thereafter.
Our payment terms are Net thirty days. No provision is made for Federal,State,or Municipal taxes.
All orders are subject to credit approval and acceptance by Tranter, inc. The terms of this agreement [illegible] side of this page.

Your Tranter Representative is:
PENTAD Associates, Inc.
7350 E. Lincoln, Suite 102
Littleton, CO 80122
(303) 794-4802

Your Order Will Receive Our Prompt Attention
Tranter, inc. - Texas Division

Kimberly L. Servia, Technical Specialist

ORIGINAL

06. 12. 96 08:24AM *TRANTER INC DEX 2500 P03

TRANTER, INC.
MAXCHANGER SPECIFICATION SHEET

Date : 06/11/96
Customer : DAVE MUNGER

Reference : 013343-18A R00
Item Number: A

Run Number: 3243
Model : MX-39-0424-HP-072 / 0.048

Technician : KLS
Pass Arrangement: 1 x 1

Total Units :4
Units in Parallel :4
Units in Series :N/A

Flow Dir: Counter Flow
Total Heat Transfer Area: 156.7 SQ FT

	Hot Side		Cold Side	
Fluid Circulated	WATER		50% PROP GLY	
Total Flow Rate	63.0000	GPM	45.0000	GPM
Unit Flow Rate	15.7500	GPM	11.2500	GPM
Specific Heat	1.0000	BTU/(LB DEG F)	0.8420	BTU/(LB DEG F)
Specific Gravity	0.9995		1.0450	
Thermal Conductivity	0.3374	BTU/(HR FT DEG F)	0.2245	BTU/(HR FT DEG F)
Viscosity	1.2335	CP AT AVG TEMP	13.6068	CP AT AVG TEMP
Inlet Temperature	57.6000	DEG F	40.0000	DEG F
Outlet Temperature	50.0000	DEG F	52.0865	DEG F
Pressure Drop	0.8661	PSI Total	2.2824	PSI Total
Operating Pressure	60.0000	PSIG	60.0000	PSIG

Heat Exchanged 239631.6 BTU/HR TOTAL

* CONSTRUCTION
  - ASME code stamp : No
  - Design Pressure : 150 PSIG
  - Test Pressure : 225 PSIG
  - Design Temperature: 384 DEG F
  - Unit Net Weight : 95.0 LBS

* UNIT DIMENSIONS
  - Width : 6.00"
  - Length : 24.00"
  - Height : 6.56"
  - Nozzles : 1.50" / 1.50"

* MATERIALS
  - Plates and Fittings : 316L SS

* REMARKS

Your Tranter Representative is:

PENTAD Associates, Inc.
7950 S. Lincoln, Suite 102
Littleton, CO 80122

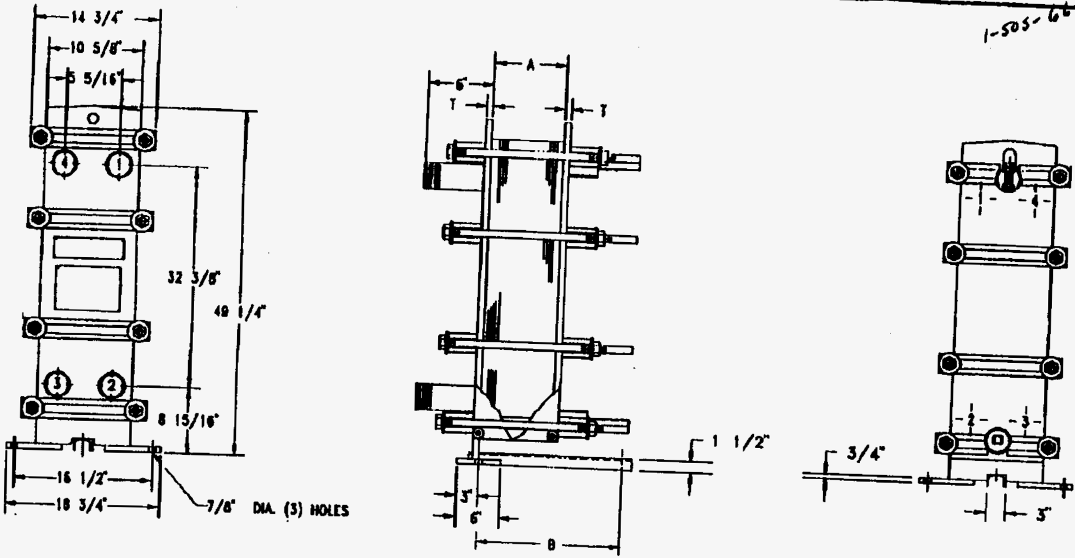
(303) 794-4802

*The MAXCHANGER performance guarantee is based on the accuracy of the data presented above, and the customers ability to supply product and operating conditions in conformance with the above.

06.12.96 08:24AM *TRANTER INC DEX 2900 P04

Carla Gustat
1-505-662-3851

TOTAL P.01



H-47

NOTES:
(1) ALL DIMENSIONS ARE APPROXIMATE, NOT TO BE USED FOR CONSTRUCTION PURPOSES.
(2) REFER TO THE ATTACHED COMPUTER SPECIFICATION SHEET FOR MATERIALS OF CONSTRUCTION AND SURFACE AREA.

TRANTER, Inc. - TEXAS DIVISION

Wichita Falls, Texas, U.S.A.

UFX-18-1 THREADED (4)

REV. 12-2-95

CW-P-2012
CW-P-2013

QUOTATION FROM

FALCON PUMP & SUPPLY

P.O. BOX 3180 • CASPER, WY 82602 • 307/265-1207

STORE LOCATION WHERE THIS QUOTE ORIGINATED				
	☐	BOX 3180	PHONE 307-265-1207	CASPER, WYOMING 82602
	☐	BOX 1317	307-382-3893	ROCK SPRINGS, WYOMING 82902
	☒	1424 WEST CEDAR	303-698-2500	DENVER, COLORADO 80223
	☐	BOX 1351	701-572-8012	WILLISTON, NORTH DAKOTA 58801

Date: 2-26-96

TO: Merrick

CUSTOMER INQUIRY NO:

REQUESTED BY Tony Goveas

Quotation No. 411796

All bids and contracts made by us are made subject to the following conditions: (1) Falcon Pump & Supply shall not be liable for any delay in the completion of any contract caused by strike or any other labor difficulties, or by fire, flood, act of God, or act of the public enemy, or by any cause whatsoever beyond its control; (2) liability, if any, of Falcon Pump & Supply for any defect in workmanship or material is limited strictly to the extent that new material will be supplied for any part proven defective, but no claim for labor will be allowed for damages resulting from defect in workmanship or material.

QUANTITY	DESCRIPTION	PRICE
1	Goulds ICS 1x1½-5, 3 ~~phase~~ HP, 3450 RPM, single phase, TEFC close coupled centrifugal pump	
	Total Unit Price	$1582.00 ASSUME
1	Goulds ICS 1x1½-5, 3 HP, 3450 RPM, 3 phase, TEFC close coupled centrifugal pump	
	Total Unit Price	$1646.00
	Conditions: 50 GPM @ 115' TDH Pumpage: De-mineralized water	

Sincerely,

Dave Miller/Tom McGinn
Denver

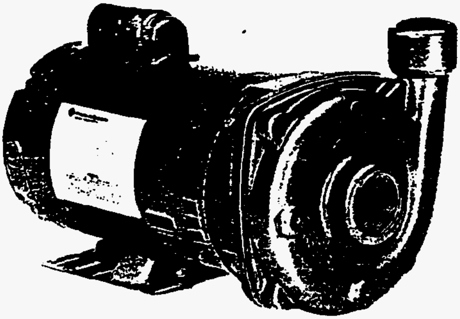
Terms Net 30

F.O.B. Point Factory

Delivery 3-4 Weeks ARO (After Receipt of Order)

MNC 28

FEB 26 '96 14:19 FROM FALCON PUMP PAGE.05



G&L
STAINLESS STEEL
Close-Coupled Centrifugal Pump

MODEL

ICS

FEATURES

Superior Materials of Construction: Precision investment casting for liquid-end components are all type 316 stainless steel.

Compact Design: Close-coupled, save space and simplifies maintenance and installation.

High Efficiency Impeller: 316 cast stainless impeller of open design for efficient operation and fast clean-up.

Casing Features: Stainless steel construction with NPT threaded connections, optional drain and vent with stainless steel plugs.

Mechanical Seal: Standard John Crane Type 21 with carbon versus ceramic faces, Viton elastomers, and 316 S.S. metal parts. Optional high temperature and mild abrasives seals available.

Motor: NEMA standard open drip-proof or totally enclosed fan cooled enclosures. Rugged ball bearing design for continuous duty.

APPLICATIONS

Designed for ultra pure water, chemical and general services. Specific uses are for:

- Washer Equipment
- Ultra pure water systems
- Scrubbers
- Chemical Transfer
- Water reclamation and treatment
- Beverage processing
- Pharmaceutical service
- Machine tool coolant

SPECIFICATIONS

Capacities to:
56 GPM (13m³/h) at 1750 RPM
103 GPM (24m³/h) at 3500 RPM

Heads to:
33 feet (10m) at 1750 RPM
129 feet (40m) at 3500 RPM

Working Pressures to:
175 PSIG (12 bars)

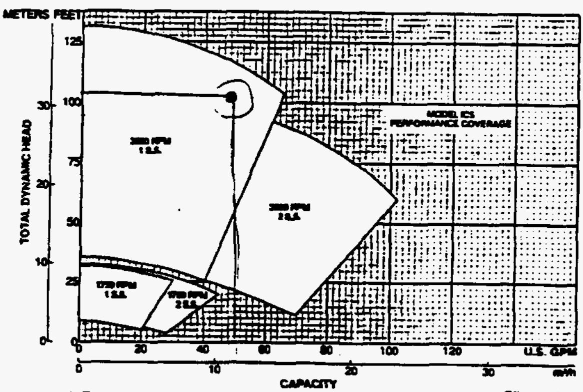
Maximum Temperature to:
212°F (100°C) with standard seal or 250°F (121°C) with optional hig temperature version.

Rotation clockwise when viewed from motor end.

MOTORS

NEMA standard design:
1750 RPM ½ HP or 3500 RPM ½ through 3 HP ratings, 56J frame. Open drip-proof or totally enclosed fan-cooled enclosures. Ball bearing design stainless steel shaft.

- Single phase voltage 115/230 ODP and TEFC. (3HP model 230 volt only) Built in overload with autorese provided.
- Three phase voltage 208-230/460 ODP and TEFC. Starter and heaters must be ordered separately



H-49

Effective May, 1991
BGL ICS

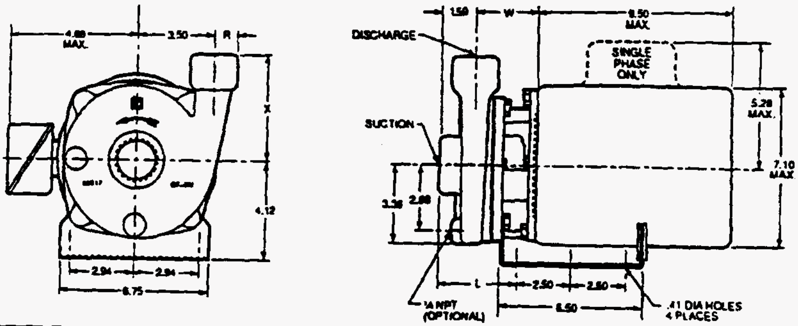
G&L
A GOULDS PUMPS COMPANY

Dimension Print
SECTION 1
MODEL ICS
Effective May, 1991

Stainless Steel Close-Coupled Centrifugal Pumps 1750 RPM

ENGINEERING DATA

Clockwise Rotation Viewed from Drive End	Installation Drawing No. 119-64	Certified for construction purposes ☐ For Approval ☐ For Record By Signature Date



WEIGHTS & DIMENSIONS – DETERMINED BY PUMP

Pump	Suct. NPT	Disch. NPT	L	R	W	X	*Wt. Max.
1 x 1¼-5	1¼	1	3.75	.94	3.01	4.62	17
1¼ x 1½-5	1½	1¼	3.62	1.06	2.88	4.56	17

NOTES:
1. Pumps will be shipped with top vertical discharge as standard, for other orientations, remove casing bolts, rotate to desired position, and tighten ⅜" bolts to 24 lbs.-ft.
2. Dimensions in inches, weight in pounds.
3. Not to be used for construction purposes unless certified.
4. Motor dimensions may vary with motor manufacturers.

* Weight is liquid end only. For complete pump, add weight of applicable motor shown below.

AVAILABLE MOTOR WEIGHTS

HP	Motor Weights in Pounds			
	1 Phase		3 Phase	
	ODP	TEFC	ODP	TEFC
½	19	20	19	20

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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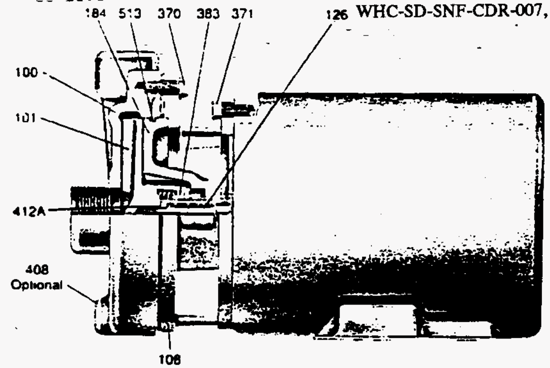
DGL1750C

FEB 26 '96 14:21 FROM FALCON PUMP



MATERIALS OF CONSTRUCTION

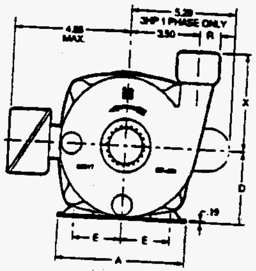
Item No.	Description	Materials
100	Casing	AISI 316 S.S.
101	Impeller	
108	Motor Adapter	Cast Iron
126	Shaft Sleeve	AISI 316 S.S.
184	Seal Housing	
330*	Shim Pack	Plastic
370	H.H. Screw, Adapter to Casing	AISI 304 S.S
370H*	H.H. Screw, Adapter to Seal Hsg.	
371	H.H. Screw, Adapter to Motor	
383	Mechanical Seal	**see chart
408	Drain Plug, Casing (Optional)	AISI 316 S.S
412A	O-Ring, Impeller	Viton
513	O-Ring, Casing	

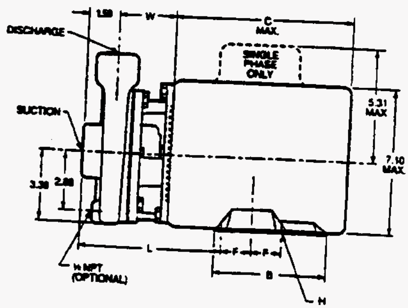
*Not shown

**Mechanical Seals-Item 383

Part No.	Service	Rotary	Stationary	Elastomers	Metal Parts	Crane Type
10K38	Mild Chemical	Carbon	Ceramic	Viton	316 S.S.	21
10K39	Hot Water up to 250° F		Ni-Resist	EPR		
10K40	Mild Abrasives		Tungsten-Carbide	Viton		

PUMP DIMENSIONS & WEIGHTS





Note: Pumps will be shipped with top vertical discharge as standard. For other orientations, remove casing bolts, rotate to desired position and tighten ¼" bolts to 24 ft. lb. torque.
All dimensions are in inches, weights are in pounds.
Not to be used for construction purposes.

Drawing illustrates 3500 RPM configuration.
Motor feet will vary with 1750 RPM motor design.

Motor Weight and Length

HP	RPM	1ø Phase ODP	1ø Phase TEFC	3ø Phase ODP	3ø Phase TEFC	C Max.
½	1750	19	20	19	20	9.5
	3500	19	—	20	—	10.34
¾	3500	22	24	22	21	10.34
1	3500	25	26	24	23	10.77
1 ½	3500	31	35	27	28	11.21
2	3500	36	39	39	33	11.72
3	3500	40	45	42	37	13.34

Model Size	Suction	Discharge	R	W	X	A (3500 RPM)	B (3500 RPM)	D (3500 RPM)	E (3500 RPM)	F (3500 RPM)	L (3500 RPM)	H (3500 RPM)	A (1750 RPM)	B (1750 RPM)	D (1750 RPM)	E (1750 RPM)	F (1750 RPM)	L (1750 RPM)	H (1750 RPM)	Wt.
x 1 ¼ – 5	1 ¼	1	.94	3.01	4.62	6.50	5.88	3.50	2.44	1.50	7.35	.34x.88	6.75	6.5	4.12	2.94	2.5	3.75	.41	17
x 1 ½ – 5	1 ½	1 ¼	1.06	2.88	4.56	6.50	5.88	3.50	2.44	1.50	7.22	Slot	6.75	6.5	4.12	2.94	2.5	3.62	Holes	17

PUMPS COMPANY

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PRINTED IN U.S.A.

H-51

G&L
A GOULDS PUMPS COMPANY

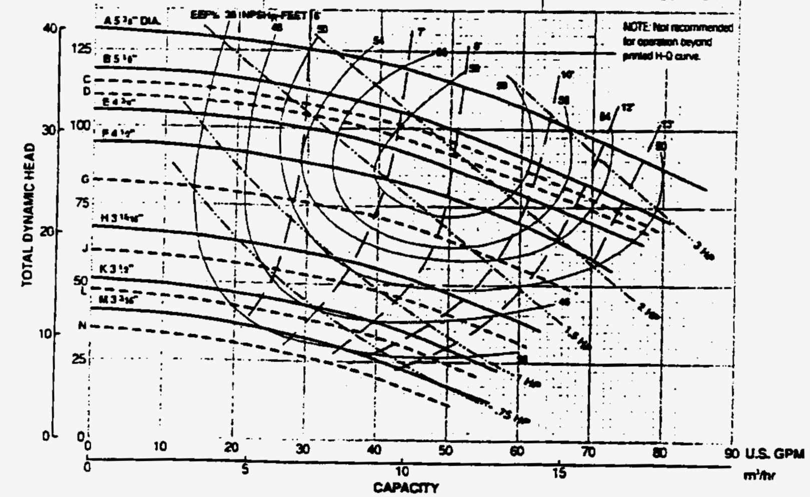
Close-Coupled

WHC-SD-SNF-CDR-007, REV. 0

Performance Curve – SECTION
Model ICS 1 x 1 ¼ – 5

Page 1

G&L | Model/Size ICS 1 x 1¼ – 5 IMP. DWG No. 119-56 | RPM 3500 Curve No. CN284R01



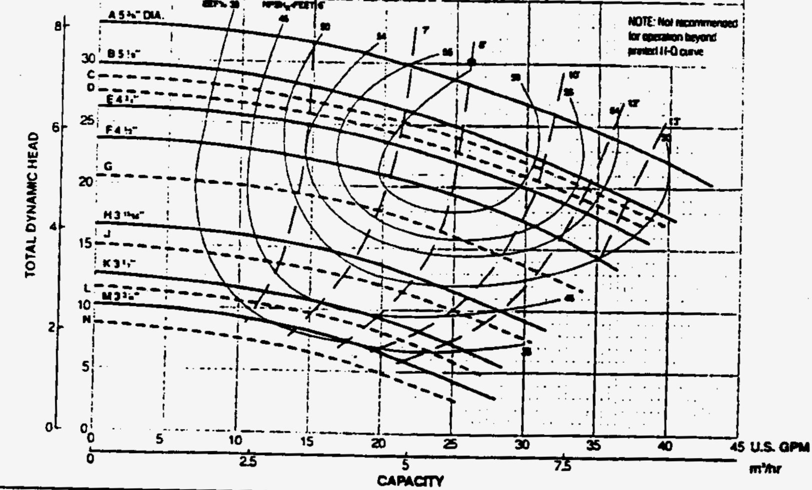
Optional Impel	
Ordering Code	Diame
A	5 ⅜"
B	5 ⅛"
C	5"
D	4 ⅞"
E	4 ¾"
F	4 ½"
G	4 ¼"
H	3 15/16"
J	3 ¾"
K	3 ½"
L	3 ⅜"
M	3 3/16"
N	3"

Note: Pump will pass a sphere to ¼" Diameter.

"O" = Pre. engineered unit rating. See pump price sheet.

For ordering optional impeller see price sheet: option page.

G&L | Model/Size ICS 1 x 1¼ – 5 IMP. DWG No. 119-56 | RPM 1750 Curve No. CN287R01



Optional Impeller	
Ordering Code	Diameter
A	5 ⅜"
B	5 ¼"
C	5"
D	4 ⅞"
E	4 ¾"
F	4 ½"
G	4 ¼"
H	3 15/16"
J	3 ¾"
K	3 ½"
L	3 ⅜"
M	3 3/16"
N	3"

Note: Pump will pass a sphere to ¼" Diameter.

"O" = Pre. engineered unit rating. See pump price sheet.

For ordering optional impeller see price sheet option page.

Customer ______ Pump Item ______	Condition of Service Imp. Dia. ______ ______ GPM ______ TDH ______ EFF%	Certified for: By ______ Date ______	Approval ☐ Record ☐

H-52

Effective April, 1991
CGL ICSC

MCS-CLR-1153

MARLO COIL P.O. BOX 171 HIGH RIDGE, MISSOURI 63049 PHONE 314-677-6600

Date: 6.14.96

Marlo

FAX TO	
Attn:	David Mueller
Firm:	Santa Fe Eng
Fax #:	1 505 983 5608

FROM	
Name:	Chris Lohmann
Phone:	(314) 677-7731 ext. 38
FAX:	(314) 677-1203

Page 1 of 4

♦ ♦ Call back immediately if you do not receive all pages ♦ ♦

REFERENCE:

MESSAGE:

Chris Lohmann
Coil Sales

MNC 19

MARLO COIL P.O. BOX 171 HIGH RIDGE, MISSOURI 63049 PHONE 314-677-6600

Marlo

June 14, 1996

Subject: Santa Fe Engineering
Marlo Q# 96230370

Dear Mr. Munger,

Marlo is pleased to provide budget pricing per your request:

Qty.	Description	Net Each	Extended Net
(1)	Airtight Housing w/ Transitions and (1)8W8-12-5611F-1-H-.5-R-W	$5,073	$5,073

All pricing is F.O.B. High Ridge, MO, freight collect.

Materials of construction:

Fins:	.010" thk. 304 stainless steel
Tubes:	.049" wall, .625" O.D. 304 stainless steel
Headers:	Sch10 304 stainless steel pipe
Connections:	1" Class 150 304 stainless steel pipe flanges
Casing:	min. 16 ga. 304 stainless steel
Insulation:	TBD

Assembly consists of an airtight coil assembly with upstream and downstream transitions from square coil face to round pipe flanges. Entire assembly will be covered with insulation.

Coil connections will be same end.

If you have any questions, please call me at (314)677-7731 ext.38.

Thank you for the opportunity.

Best Regards,

Chris Lohmann

Chris Lohmann

MARLO (R), P.O. BOX 171, HIGH RIDGE, MO. 63049-0171

`EPRESENTED BY
.arlo (314) 677-6600
P.O. Box 171
High Ridge, Missouri 63049-0171

ENTRY DATE = 06-14-1996
CUSTOMER ID = SANTA FE ENGINERING
TAG NUMBER =
PROGRAM ID = WATER COIL RATING / VERSION 3.8
APPLICATION = COOLING

DESCRIPTION	RATING	COIL DESCRIPTION	
Air flow (ACFM)	750	FIN HEIGHT	= 12.375
Ent. air DB / WB (F)	● 302.0 / 0.0	FINNED LENGTH	= 12.000
Lvg. air DB / WB (F)	134.9 / 0.0	FACE AREA	= 1.0
Total capacity (BTUH)	93,838	TUBE MATERIAL	= SS304
Sens. capacity (BTUH)	93,838	TUBE THICKNESS	= .049
Ent / Lvg water (F)	50.0 / 73.4	FIN MATERIAL	= SS
Water flow (GAL/MIN)	8.0	FIN THICKNESS	= .01
Water velocity(FT/SEC)	2.7	TURBULATORS	= N
Water pres. drop (FT)	4.2	INSIDE FOULING	= 0
Face velocity(FT/MIN)	727.3	OUTSIDE FOULING	= 0
Std. air P.D. (IN.WG)	0.61	FLUID TYPE = WATER	
Altitude (FEET)	440	GLY CONCENTRATION 0 %	

/ARLO MODEL#: SW 8- 12.0-5611F- 1.0-H/V-0.50-R/L B/W

COIL RATED IN ACCORDANCE WITH CURRENT EDITION OF ARI STANDARD 410.
● DENOTES VARIABLE(S) OUTSIDE THE CERTIFICATION RANGE.

MARLO (R), P.O. BOX 171, HIGH RIDGE, MO. 63049-0171

REPRESENTED BY
Marlo (314) 677-6600
P.O. Box 171
High Ridge, Missouri 63049-0171

ENTRY DATE = 06-14-1996
CUSTOMER ID = SANTA FE ENGINERING
TAG NUMBER =
PROGRAM ID = WATER COIL RATING / VERSION 3.8
APPLICATION = COOLING

DESCRIPTION	RATING	COIL DESCRIPTION	
Air flow (ACFM)	750	FIN HEIGHT	= 12.375
Ent. air DB / WB (F)	● 572.0 / 0.0	FINNED LENGTH	= 12.000
Lvg. air DB / WB (F)	182.9 / 0.0	FACE AREA	= 1.0
Total capacity (BTUH)	161,312	TUBE MATERIAL	= SS304
Sens. capacity (BTUH)	161,312	TUBE THICKNESS	= .049
Ent / Lvg water (F)	50.0 / 90.3	FIN MATERIAL	= SS
Water flow (GAL/MIN)	8.0	FIN THICKNESS	= .01
Water velocity(FT/SEC)	2.7	TURBULATORS	= N
Water pres. drop (FT)	4.2	INSIDE FOULING	= 0
Face velocity(FT/MIN)	727.3	OUTSIDE FOULING	= 0
Std. air P.D. (IN.WG)	0.37	FLUID TYPE	= WATER
Altitude (FEET)	440	GLY CONCENTRATION	0 %

MARLO MODEL#: SW 8- 12.0-5611F- 1.0-H/V-0.50-R/L B/W

COIL RATED IN ACCORDANCE WITH CURRENT EDITION OF ARI STANDARD 410.
● DENOTES VARIABLE(S) OUTSIDE THE CERTIFICATION RANGE.

Titan III

The TITAN III is a dexterous and powerful telerobotic manipulator system that is available in a variety of configurations for use in extreme environments.

▼ TITAN III S

Ideally suited for applications using remotely operated vehicles and manned submersibles at depths to 21,000 fsw (6,500 m).

▼ TITAN III T

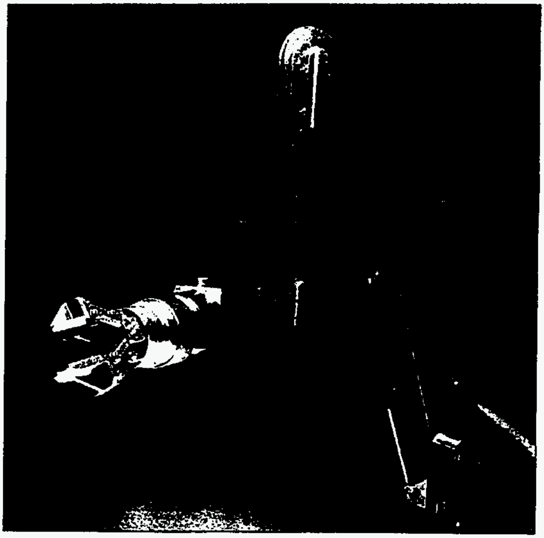
Designed for nuclear inspection and maintenance, environmental restoration, sorting and characterization, disassembly and dismantlement, and explosive ordnance disposal.

▼ TITAN III VME

For customers developing applications in the VME environment, this system provides a shared memory interface to the user's VME control system.

GEC ALSTHOM

SCHILLING ROBOTIC SYSTEMS

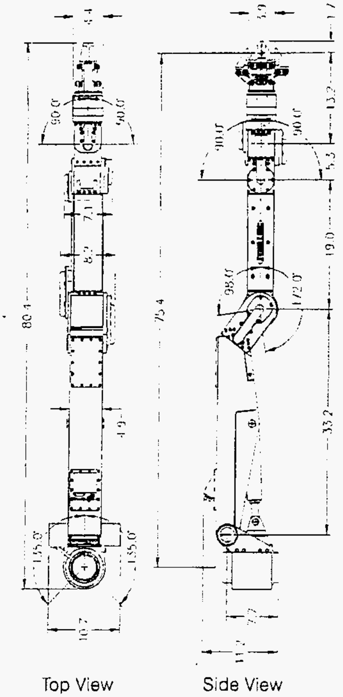


To meet the critical demands of remote manipulation in hostile environments, Schilling Robotic Systems, Inc. (SRS) offers the TITAN III, a dexterous, servo-hydraulic, telerobotic manipulator system with six degrees of freedom. The TITAN, now in its third generation, has a proven track record of reliability and unequaled performance in some of the most demanding environments in the world. SRS's six-degree-of-freedom miniature replica master arm ensures comfortable and intuitive manipulator operation. Constructed primarily of 6-4 titanium, the TITAN III is capable of lifting 250 lb (113.4 kg) at its full reach of 75.4 inches (191.5 cm).

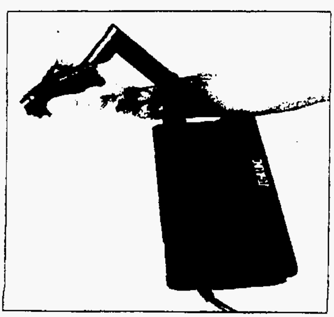
The variety of possible remote work tasks requires the manipulator to be highly reliable, field maintainable, and adaptable. SRS's experience in designing and manufacturing telerobotic manipulators for extreme environments has resulted in a range of standard configurations and options to meet a variety of requirements.

SRS offers the Titan III S for manipulative tasks that require high dexterity and a large payload capacity, and that must be performed in hostile subsea environments of up to 21,000 fsw (6,500 m). The TITAN III S is ideally suited for use on remotely operated vehicles (ROVs) and manned submersibles. It comes equipped with everything necessary for installation on hydraulically powered vehicles, including a slave arm, compact master controller with

Titan III



TITAN III slave arm dimensions (inches)



TITAN III compact master controller with replica master arm

replica master arm, control electronics, slave controller with submersible enclosure, electrical interface cables, and hydraulic compensator. Available options include software for robotic control and Cartesian control.

The TITAN III T offers the same performance and dexterity as the TITAN III S, but is designed for land-based applications or shallow water applications up to a depth of 100 feet (30.5 m). Typical applications include commercial nuclear inspection and maintenance, environmental restoration, hazardous material sorting and characterization, disassembly and dismantlement, and explosive ordnance disposal. With the addition of a user-supplied hydraulic power unit, the TITAN III T is shipped ready for operation, with a slave arm, compact master controller with replica master arm, control electronics, slave controller with enclosure, and electrical interface cables. Available options include radiation hardening (for applications exceeding $1x10^3$ rad gamma cumulative dosage), tool interchange, Cartesian control, and robotic control.

For customers developing applications in the VME environment, SRS offers the TITAN III VME, which provides a VME interface to the user's host control system. This configuration provides a shared memory interface to the user's VME control environment. The system includes a slave arm, electrical interface cables, slave arm data acquisition electronics, and a VME interface card. Options include a force/torque sensor, tool interchange, and Magellan (a 3-D, graphics-based, integrated telerobotic controller that simplifies remote operation in both structured and unstructured environments).

GENERAL DESCRIPTION

Mode of operation .... Closed-loop position control
Input device .... Six-degree-of-freedom replica master arm
Degrees of freedom .... Six plus grip

SLAVE ARM SPECIFICATIONS

Maximum reach .... 75.4 in. (191.5 cm)
Weight in air .... 223 lb (101.2 kg)
Weight in sea water.. 168 lb (76.2 kg)
Maximum lift capacity at full reach .... 250 lb (113.4 kg)
Maximum grip opening (standard gripper) .... 3.9 in. (10 cm)
Maximum grip force .... 1,000 lb (4,448 N)
Maximum wrist torque .... 1,200 in-lb (135.5 N-m)
Wrist rotate, slaved .... 360 degrees
Wrist rotate, continuous .... 0-35 rpm

MASTER CONTROLLER DIMENSIONS

Length .... 19.1 in. (48.5 cm)
Width .... 6.0 in. (15.25 cm)
Height... 2.7 in. (6.9 cm)
Weight .... 9.5 lb (4.3 kg)

SLAVE ARM FUNCTIONS

Function	Actuator Type	Torque or Force @ 3000 psi	Mechanical Range
Azimuth	Rotary	18,000 in-lb (2,032 N-m)	270°
Shoulder pitch	Linear	21,400 in-lb (2,416 N-m)	120°
Elbow pitch	Rotary	9,200 in-lb (1,038 N-m)	270°
Wrist pitch	Rotary	4,000 in-lb (451.6 N-m)	180°
Wrist yaw	Rotary	4,000 in-lb (451.6 N-m)	180°
Wrist rotate	Gerotor	1,200 in-lb (135.5 N-m)	360°
Jaw	Linear	1,000 lb (4,448 N)	3.9 in. (10 cm)

HYDRAULIC REQUIREMENTS

Fluid type: Petroleum-based or water/glycol-based hydraulic fluid (non-corrosive)

Viscosity .... 10-200 cSt
Flow .... 1.5-5.0 gpm (5.7-19.0 l/min)
Pressure .... 3,000 psi (200 bar)

ELECTRICAL AND TELEMETRY REQUIREMENTS

100-240 VAC 50/60 Hz standard. Consult SRS for other power options.

Standard with RS-422/485 half-duplex, optional RS-422/485 full-duplex or RS-232 communication protocol.

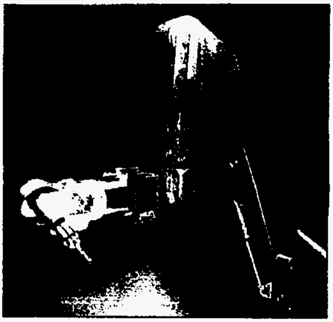
Consult SRS for other telemetry options.

OPTIONS

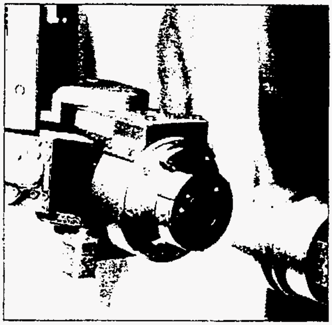
	Titan III S	Titan III T	Titan III VME
Robotic software	▼	▼	▼*
Radiation hardening (up to 1x10^7 rad gamma)		▼	▼
Tool interchange		▼	▼
Magellan			▼
Force/torque sensor			▼
Extended depth rating to 21,000 fsw (6,500 m)	▼**		

* The TITAN III VME uses Magellan robotic software.
** The TITAN III S standard depth rating is up to 5,000 fsw (1,524 m).

Magellan is a 3-D, graphics-based, integrated telerobotic controller. Magellan simplifies complex tasks by providing computer-aided teleoperation through modeling, motion planning, and manipulator control. With features such as simple and efficient trajectory specification, real-time graphical display, and collision-free path planning, Magellan provides a cost-effective solution to complex remote manipulation problems.



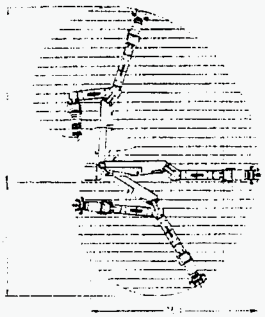
TITAN III T shown with interchangeable rotary power tool, 90° drill head



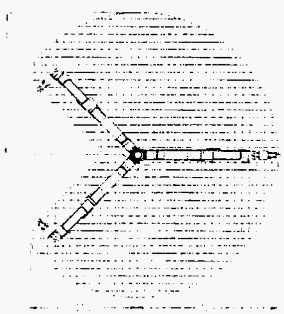
TITAN III tool interchange coupling

Examples of interchangeable electric and hydraulic tools

Titan III



Elevation View (1 square = 4 inches)



Plan View (1 square = 4 inches)

TITAN III range of motion (inches)

TITAN III FEATURES

- Corrosion-resistant titanium construction
- Miniature replica master arm
- Wide range of motion
- High payload-to-weight ratio
- Rugged and reliable

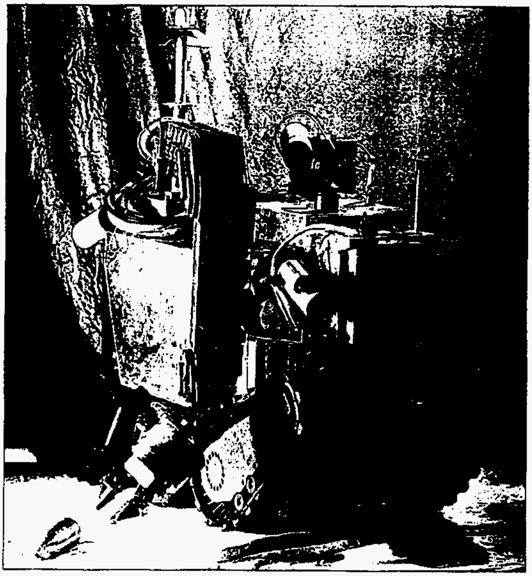
GEC ALSTHOM
SCHILLING ROBOTIC SYSTEMS
1632 Da Vinci Court
Davis, California 95616, USA
Phone: (916) 753-6718
Fax: (916) 753-8092

ACCESSORIES

- Hydraulic power unit (TITAN III T/VME only)
- Interchangeable tools (consult SRS for specifications)
- Hydraulic hose kits
- Spares kits
- Mounting pedestal

FOR MORE INFORMATION

Contact SRS for configuration detail sheets and technical application guides for the TITAN III S, T, and VME.



Developed by Battelle, the Remote Ordnance Neutralization System (RONS) is a stair-climbing, off-road vehicle with robotic control, fiber optic communication system, remote operator control system, and a TITAN telerobotic manipulator system

DIMETRICS, INC. | Jalley Industries

Attachment 3

Model 'F' GTAW Weld Head

P/N 282-1100-103

Process Enclosu Weld Head

Features

- Precision electromechanical servos for Travel, AVC, Wire Feed and Oscillator.
- Patented, zero backlash traction drive travel carriage. No expensive gear drive travel mechanisms.
- Fast mounting to all Dimetrics circular and flat track without latch roller change-out.
- Weld head mounted jog and sequence controls.
- Optional front-end/wire manipulator configurations for most any application.
  - 'A' single wire, one direction
  - 'C' dual wire, bi-directional
  - 'D' deep groove, bi-directional
- Optional remote video viewing front-ends with mechanized torch tilt and wire manipulation.

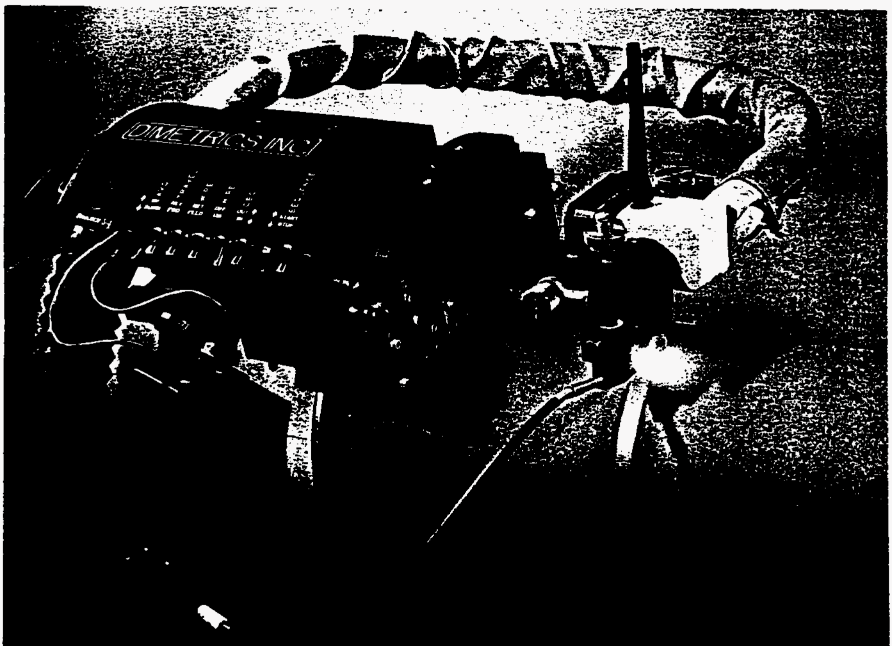
Specifications

Travel Speed:	0 - 20 IPM
Jog Speed:	40 IPM
Oscillation Travel:	2.00" *
Arc Voltage Control Stroke:	1.50" **
Wire Size:	.030" to .063" diameter
Wire Spool Weight/Size:	2 lbs., 4" diameter std.
Wire Feed Rate:	0 - 99 IPM
Wire Positioning:	Up/Down +/- 3/8" In/Out +/- 15°
Welding Torch Rating:	300 AMPS, 100% duty cycle
Axial Clearance:	17.75" (minimum)
Radial Clearance:	4.75" (minimum)
Head Weight:	20 lbs. (less cable)
Cable Length/Weight:	35', 40 lbs.

* 1.00" Cross-Seam with 1.00" Oscillation Stroke plus 1.00" Slide Travel

** 2.25" Vertical Slide Adjustment

Model 'F' Weld Head pictured with 'C' Front-End



August 1993

PHS-BLO-1151

Industrial Fans

Blowers

Exhausters

Since 1892

ROBINSON INDUSTRIES, INC.

P.O. Box 100
Zelienople, PA 16063-0100
Phone: (412) 452-6121
Fax: (412) 452-0388

QUO #: H80346-1   Customer Inquiry: VERBAL 5-29-96   31-MAY-1996

Customer: MERRICK & COMPANY
195 EAST ROAD
LOS ALAMOS NA 87544

Attention: CARLA GUSTAFASON (FAX:505-662-3851)(PHONE:505-662-0606 EXT.3143)

Fan Application: I. D. FAN

Quantity 1 , Size 33 X 1/2" , Type RB1806-5 , Arr. #8. Class IV , Inlet SWSI

FAN PERFORMANCE

R.P.M.	C.F.M.	S.P.	DENSITY	TEMP.	ELEV.	B.H.P.
1,780	750	17.860"	0.07430	70 F	440	3.70
1,780	750	8.000"	0.03340	710 F	440	1.60

Note: Evase required to meet performance.

Price complete with checked Accessories $10,551 Ea. Fan

OPTIONAL EQUIPMENT FOR EACH FAN

#90 FALK GRID COUPLING, MAX BORE	$498 Ea. Fan
5HP 1800RPM 3/60/460 TEFC STD.MOTOR	$232 Ea. Fan

NOTE :THE ABOVE REVISED QUOTE IS BASED ON THE VERBAL INFORMATION OF 5/29/96. IF YOU REQUIRE ADDITIONAL INFORMATION, PLEASE ADVISE.

ACCESSORIES	
Flanged Inlet	X
Flanged Outlet	X
Inspection Door	
Casing Drain	X
Split Housing	
Shaft Seal	
Heat Flinger	
Inlet Screen	
Coupling Guard	X
Shaft Guard	X
V-belt Dr. Grd.	
Insulation Clips	
Evase by Others	X
STD.PRIMER	X

MATERIAL	
Hsg.	1/4" MILD STEEL
Wheel	MILD STEEL MATERIAL
Shaft	ALLOY MATERIAL
1 PR.	2-7/16" SPHER.RLR.BRG
Weight	1,462 lbs.
WR2	53 lbs./ft2

$750 \frac{ft^3}{min} \cdot 28.32 \frac{L}{ft^3} = 21,237 \frac{L}{min}$

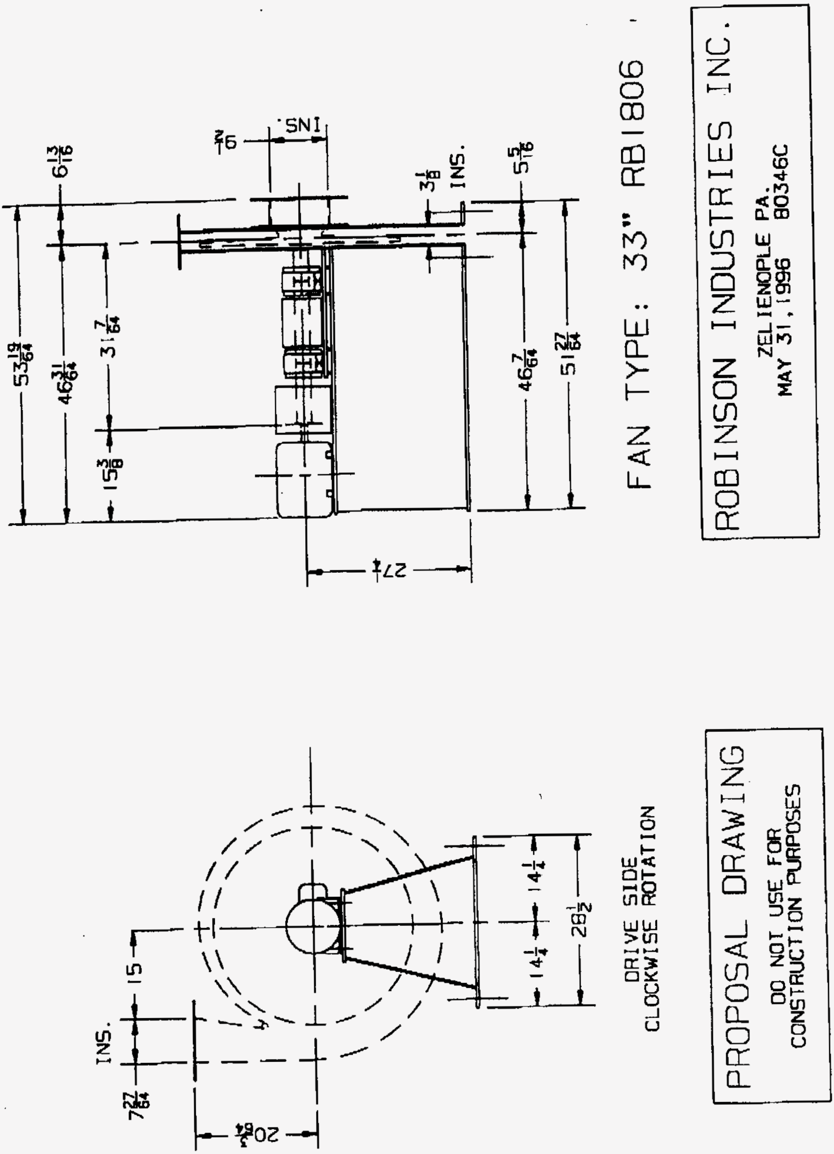
FE Ref Man p2.

CLOSEST TO 21,000 LPM SPEC ON HCS_101, SO ENTERED FOR PHS-BLO-1151

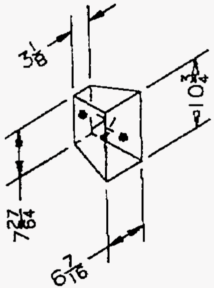
MNC 10

H-60

Guarantee: The above material fully guaranteed for a period of one year from date of shipment, free from defects in design, materials and workmanship; any part or parts becoming defective within this time to be replaced free of charge, f.o.b. factory.


FAN TYPE: 33" RB1806
ROBINSON INDUSTRIES INC.
ZELIENOPLE PA.
MAY 31, 1996 80346C
PROPOSAL DRAWING
DO NOT USE FOR CONSTRUCTION PURPOSES
DRIVE SIDE CLOCKWISE ROTATION
INS.

OUTLET EVASE REQUIRED
AS PART OF FAN DESIGN



SUPPLIED BY OTHERS

33 X 1/2" RB1806-5, ARR #8, SWSI

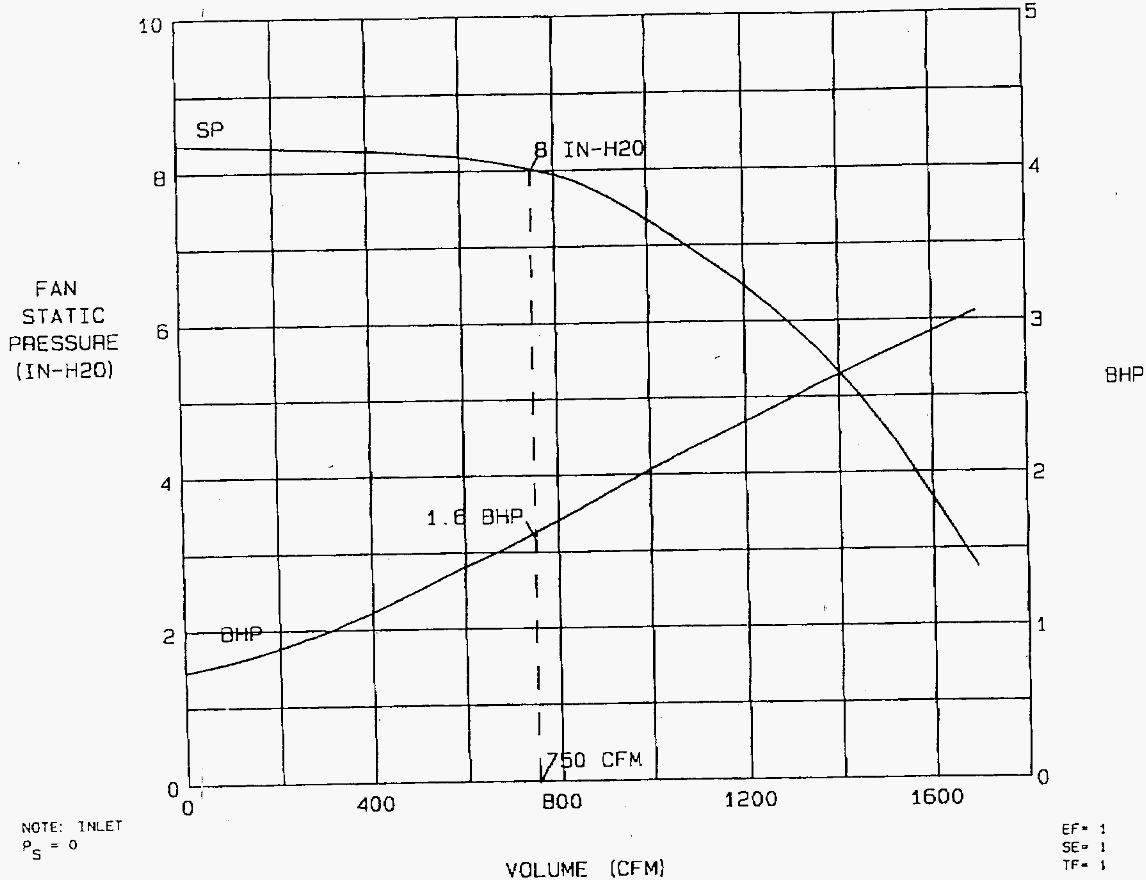
ROBINSON INDUSTRIES INC.

QUOTE NUMBER: HB0346-1
ZELIENOPLE PA.
MAY 31, 1996

ROBINSON INDUSTRIES INC.
FAN: 33 X 0.5 RB1806-5 SWSI
FOR: MERRICK & COMPANY

SPEED: 1780 RPM
TEMP: 710 DEG. F
DENSITY: 0.0334 #/FT3

DATE: 5-30-199'
QUOTE #: H80346-1



NOTE: INLET
$P_S = 0$

EF= 1
SE= 1
TF= 1

ROBINSON INDUSTRIES, INC. DATE: 05/31/1996

SOUND PROGRAM OUTPUT

QUOTE # :H80346-1 DATE: FRI MAY 31 1996
CUSTOMER :MERRICK & CO.
DESIGN :RB1806-5 DIAMETER: 33.00000 INCH RPM: 1780.00 WIDTH: SWSI
CFM : 750.00 PS-INCHES H20: 8.00000 BLADES: 18

NEAR FIELD APPROXIMATELY 3 FEET

SOUND POWER LEVEL RATINGS SHOWN ARE DECIBELS REFERRED TO 10-12 WATT AND OBTAINED IN ACCORDANCE WITH AMCA STANDARD 300.
RELATED AIR PERFORMANCE RATINGS PER AMCA STANDARD 210.
PWL FOR EACH BAND AND DBA ARE CALCULATED PER AMCA STANDARD 301.
LEVELS SHOWN DO NOT INCLUDE MOTOR OR OTHER AUXILIARY EQUIPMENT.

OPERATING CONDITIONS OTHER THAN THE ABOVE STATED VALUES CAN RESULT IN SIGNIFICANTLY DIFFERENT SOUND LEVELS.

DATA IS FOR USE BY A SYSTEM ACOUSTICAL DESIGN ENGINEER FOR EVALUATION OF THE FAN SINGULARLY AND WITHIN A SYSTEM. BECAUSE OF THE INFINITE VARIATIONS IN SYSTEM ARRANGEMENTS AND THE MANY FACTORS WHICH AFFECT SOUND PRESSURE LEVELS, IT IS THE DESIGNERS RESPONSIBILITY TO PROPERLY APPLY THIS DATA BASED ON HIS KNOWLEDGE OF THE SYSTEM. SOME GUIDELINES FOR USE OF THIS DATA ARE: FOR "NEAR FIELD" COMPUTER DATA TO APPLY TO DUCTED INLET AND OUTLET INSTALLATIONS, ANY OPENING IN THE DUCT MUST BE A MINIMUM OF 100 FEET REMOTE OF THE FAN. OPENINGS WITHIN THIS RANGE ARE ASSUMED TO EMIT A SOUND PRESSURE EQUAL TO THE SOUND POWER LEVEL. THIS ALSO APPLIES TO UNTREATED INLET & OUTLET EXPANSION JOINTS. NOTE THAT FOR DUCTED INLET/OUTLET THE DUCTWORK THICKNESS AND DENSITY MUST EQUAL THAT OF THE FAN HOUSING TO ACHIEVE THE SOUND LEVELS NOTED.

NEAR FIELD--A HEMISPHERICAL SPACE WHERE SOUND PRESSURE WAVES FROM ONE RADIATING SURFACE TEND TO INTERFERE WITH WAVES GENERATED BY OTHER SURFACES. NEAR FIELD BOUNDARY, DISTANCE FROM RADIATING SURFACE, IS RELATED TO THE WAVELENGTH OF THE LOWEST FREQUENCY AND OVERALL SIZE OF SOURCE.

FREE FIELD--AREA BEYOND NEAR FIELD, WITH NO OBSTRUCTIONS, WHERE SOUND PRESSURE LEVELS DECAY 6 DB FOR EACH DOUBLING OF DISTANCE FROM NEAR FIELD.

*********** LEVELS SHOWN DO NOT INCLUDE MOTOR OR OTHER AUX EQUIPMENT ***********

	OCTAVE BAND LEVELS								
BAND NO.	1	2	3	4	5	6	7	8	DBA
MID FREQ	63	125	250	500	1000	2000	4000	8000	
SOUND POWER LEVELS AT ACOUSTIC CENTER OF FAN									
PWL+/-2dB	83	86	89	80	79	76	71	68	85
FOR DUCTED INLET AND OUTLET INSTALLATION — ESTIMATED SOUND PRESSURE LEVEL FOR NEAR FIELD WITH 0.25000 INCH CASING LOSS									
SPL+/-2dB	70	68	68	57	52	47	38	32	61
ESTIMATED SOUND PRESSURE LEVEL AT 0.00000 FEET BEYOND NEAR FIELD OF CASING									
SPL+/-2dB	70	68	68	57	52	47	38	32	61

WHC-SD-SNF-CDR-007, Rev. 0

WATLOW HEATERS

PHS-HCL-[illegible]

Tubular and Process Assemblies

Circulation Heaters

6" Flange

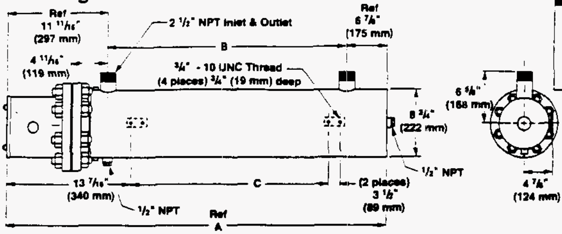


Fig. No.	A Dimension in	(mm)	B Dimension in	(mm)	C Dimension in	(mm)
6.1	39 1/16	(991)	20 1/2	(521)	17	(432)
6.2	49 9/16	(1259)	31	(787)	27 1/2	(699)
6.3	70 9/16	(1792)	52	(1321)	48 1/2	(1232)
6.4	91 9/16	(2326)	73	(1854)	69 1/2	(1765)

6" 150 lb ANSI Flange—WATROD Element

WATROD Description	kW	Fig. No.	Code No. 240VAC 1-Phase	No. of Circuits	240VAC 3-Phase	No. of Circuits	480VAC 1-Phase	No. of Circuits	480VAC 3-Phase	No. of Circuits	Est. Ship. Weight lbs	(kg)
Application: Clean Water												
60 W/in²	24	6.1	**CFPC715G10**	2	**CFPC715G3**	2	**CFPC715G11**	1	**CFPC715G5**	1	212	(97)
Steel Tank	36	6.1	**CFPC721G10**	3	**CFPC721G3**	2	**CFPC721G11**	2	**CFPC721G5**	1	217	(99)
12-Copper	48	6.2			**CFPC726R3**	4	**CFPC726R11**	2	**CFPC726R5**	2	222	(101)
(9.3 W/cm²)	60	6.2			**CFPC732G3**	4	**CFPC732G11**	2	**CFPC732G5**	2	226	(103)
	72	6.3			**CFPC737R3**	4			**CFPC737R5**	2	290	(132)
	100	6.3							**CFPC750R5**	2	298	(136)
	120	6.4							**CFPC760G5**	4	360	(164)
60 W/in²	30	6.1	**CFPC715G10X**	3	**CFPC715G3X**	5	**CFPC715G11X**	3	**CFPC715G5X**	1	215	(98)
Steel Tank	45	6.1	**CFPC721G10X**	5	**CFPC721G3X**	5	**CFPC721G11X**	3	**CFPC721G5X**	5	223	(102)
15-Copper	60	6.2			**CFPC726R3X**	5	**CFPC726R11X**	3	**CFPC726R5X**	5	226	(103)
(9.3 W/cm²)	75	6.2			**CFPC732G3X**	5	**CFPC732G11X**	5	**CFPC732G5X**	5	288	(131)
	90	6.3			**CFPC737R3X**	5			**CFPC737R5X**	5	296	(134)
	125	6.3							**CFPC750R5X**	5	306	(139)
	150	6.4							**CFPC760G5X**②	5	370	(168)
Application: Deionized Water, Demineralized Water												
60 W/in²	24	6.1	**CFPR715N10**	3	**CFPR715N3**	2	**CFPR715N11**	2	**CFPR715N5**	1	212	(97)
316 SS Tank	36	6.1	**CFPR721N10**	3	**CFPR721N3**	2	**CFPR721N11**	3	**CFPR721N5**	1	217	(99)
12-316 SS	48	6.2			**CFPR727E3**	4	**CFPR727E11**	3	**CFPR727E5**	2	222	(101)
(9.3 W/cm²)	60	6.2			**CFPR732N3**	4	**CFPR732N11**	3	**CFPR732N5**	2	226	(103)
Passivated	72	6.3			**CFPR738E3**	4			**CFPR738E5**	2	290	(132)
	100	6.3							**CFPR751E5**	2	298	(136)
	120	6.4							**CFPR760N5**	4	360	(164)
60 W/in²	30	6.1	**CFPR715N10X**	3	**CFPR715N3X**	5	**CFPR715N11X**	3	**CFPR715N5X**	1	215	(98)
316 SS Tank	45	6.1	**CFPR721N10X**	5	**CFPR721N3X**	5	**CFPR721N11X**	3	**CFPR721N5X**	5	223	(102)
15-316 SS	60	6.2			**CFPR727E3X**	5	**CFPR727E11X**	3	**CFPR727E5X**	5	226	(103)
(9.3 W/cm²)	75	6.2			**CFPR732N3X**	5	**CFPR732N11X**	5	**CFPR732N5X**	5	288	(131)
Passivated	90	6.3			**CFPR738E3X**	5			**CFPR738E5X**	5	296	(135)
	125	6.3							**CFPR751E5X**	5	306	(139)
	150	6.4							**CFPR760N5X**	5	370	(168)

CONTINUED

All circulation heaters are Assembly Stock unless otherwise noted.

② Standard

Availability
Assembly Stock: 5-7 working days.
Standard: 10 working days.

MNC 30

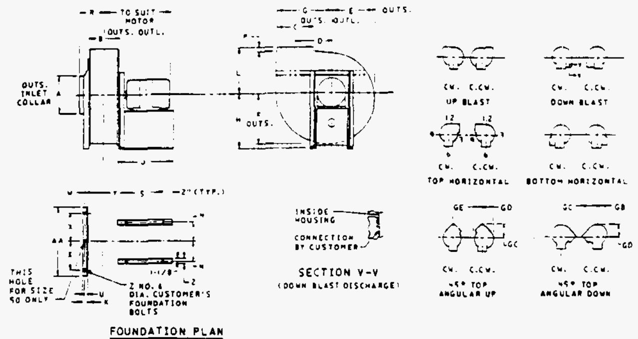
H-65

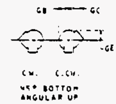
EV-BLO-2043, 2046

INDUSTRIAL EXHAUSTERS

DIMENSIONAL DATA

ARRANGEMENT 4





NOTES:

1. DRAWING SHOWS CLOCKWISE ROTATION AND UP BLAST DISCHARGE. FAN IS FURNISHED AS REQUIRED PER ORDER.
2. WHEN ACCESS DOOR IS REQUIRED, SPECIFY DOOR ℄ BY THE HANDS OF THE CLOCK FROM THE DRIVE SIDE. (REFER TOP HORIZONTAL DISCHARGE KEY SKETCH.)
3. FOR DUCT CONNECTION ON DOWN BLAST DISCHARGE SEE SECTION V-V.

	MOTORS									H																			
Size	Min	Max	A	B	C	D	E	F	G	UB, DB, TH, TAU, TAD	BAU	BH	J	K	L	N	P	R	S	U	W	X	Y	Z	AA	GB	GC	GD	GE
17	56	184T	7 1/2	6	7 3/4	7 5/16	8 3/4	9 3/4	10 13/16	14	14	14	15 13/16	2	9 3/4	7 1/4	1 1/2	6 1/16	11 13/16	1 1/4	4 1/8	7 1/4	5	6 1/2	16 3/4	9 5/16	14 7/16	10 1/2	8 3/4
21	56	215T	9	7 1/4	8 3/4	8 11/16	10 1/2	11 11/16	13	16 1/2	16 1/2	16 1/2	15 13/16	2	11 3/16	7 1/4	1 1/2	6 3/4	11 13/16	1 1/4	4 3/4	7 1/4	5 3/4	6 1/2	19 3/4	11 1/8	17 1/8	12 7/16	10 5/16
25	56	215T	10 3/4	8 3/4	10 1/4	10 3/4	12 3/4	13 13/16	15 7/16	16 1/2	16 1/2	19	15 13/16	2	12 13/16	7 1/4	1 1/2	7 3/4	11 13/16	1 1/4	5 5/16	7 1/4	6 1/16	6 1/2	22 3/4	13 1/8	20 1/16	14 11/16	11 1/8
30	182T	215T	12 1/4	10 1/4	12 1/8	12 7/16	14 3/4	16 3/4	18 1/2	18	18	20 1/2	17 7/16	2	15 3/4	8 3/4	1 1/2	8 1/4	13 7/16	1 1/4	6 5/16	8 3/4	7 1/16	6 1/2	26 3/4	15 11/16	23 13/16	17 11/16	14 3/16
35	182T	215T	14 3/4	11 3/4	14 1/4	14 1/2	17 1/4	19 5/16	21 5/16	21 3/4	21 3/4	24 1/4	17 7/16	2	18	8 3/4	1 1/2	9 1/16	13 7/16	1 1/4	7	8 3/4	7 1/2	6 1/2	30	18 5/16	28	20 5/16	16 7/16
40	182T	254T	17	13 3/4	16 1/4	16 5/16	19 1/2	22	24 3/4	24	24	27	19 5/16	2 1/2	20 1/2	9 3/4	1 1/2	10 3/4	15 3/16	1 3/4	8 5/16	9 3/4	8 11/16	6 3/4	33 3/4	20 11/16	31 11/16	23 7/16	18 3/4
45	254T	254T	19 3/4	15	18 1/4	18 3/4	21 1/2	24 11/16	27 3/4	26 1/4	30 1/4	30 3/4	19 5/16	2 1/2	23	9 3/4	2	11 1/4	15 5/16	1 3/4	8 3/4	9 3/4	9 1/2	6 3/4	37 3/4	23 1/4	35 11/16	26 1/4	[illegible]
50	284T	326T	21 3/4	16 3/4	20 1/4	20 3/4	24 1/4	27 1/4	30 13/16	30 1/2	30 1/2	34 1/2	22 13/16	2 1/2	25 3/4	9 3/4	2	12 5/16	18 11/16	1 3/4	9 11/16	18 3/4	10 5/16	7 3/4	41 3/4	25 3/4	39 11/16	29 3/4	23 1/4

MAXIMUM MOTOR FRAME	FAN SIZE	17	21	25	30	35	40	45	50	55	60	70	80	90
Arr. 9 Pivot Base	O.D.P.	184	184	215	215	215	286	286	326	326	326	445	445	445
Arr. 9 Pivot Base	T.E.F.C.	184	184	215	215	215	256	256	286	286	286	405	445	445
Arr. 9 Channel Base	O.D.P.	256	284	284	324	364	364	365	404	405	444	—	—	—
Arr. 9 Channel Base	T.E.F.C.	256	284	284	324	364	364	365	404	405	444	—	—	—
Arr. 10	O.D.P. AND T.E.F.C.	145	145	145	145	215	215	256	286	286	286	—	—	—

SIZE	ARR. No. 1	ARR. No. 4	ARR. No. 8	ARR. No. 9	ARR. No. 10	ARR. No. 9 CHANNEL
17	130	125	180	155	155	215
21	200	190	250	225	225	285
25	250	225	275	275	275	335
30	385	345	425	405	405	535
35	550	500	600	575	575	700
40	700	630	770	725	725	880
45	910	820	1000	935	935	1090
50	1100	1000	1200	1130	1130	1350
55	1350	1200	1500	1380	1380	1600
60	1500	—	1650	1530	1530	1860
70	2500	—	2700	2540	—	3150
80	3300	—	3500	3345	—	—
90	3700	—	4000	3750	—	—
100	4400	—	—	—	—	—
110	5000	—	—	—	—	—
120	6000	—	—	—	—	—

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MNC 12

SIZE 21 AW

Wheel dia. 15¾"
Outlet Area .403 ft.²
Inlet Area .445 ft.²

CAP. CFM	OUTLET VELOCITY FPM	1" S.P. RPM	1" S.P. BHP	1½" S.P. RPM	1½" S.P. BHP	2" S.P. RPM	2" S.P. BHP	2½" S.P. RPM	2½" S.P. BHP	3" S.P. RPM	3" S.P. BHP	3½" S.P. RPM	3½" S.P. BHP	4" S.P. RPM	4" S.P. BHP	4½" S.P. RPM	4½" S.P. BHP	5" S.P. RPM	5" S.P. BHP
400	993	893	0.11	1071	0.16	1226	0.22	1366	0.29	1495	0.36	1614	0.43	1725	0.51	1830	0.59	1930	0.67
490	1216	926	0.13	1093	.020	1242	0.27	1377	0.34	1502	0.41	1618	0.49	1727	0.57	1831	0.66	1929	0.75
580	1439	966	0.16	1125	0.24	1267	0.31	1396	0.39	1517	0.47	1630	0.56	1736	0.65	1837	0.74	1933	0.83
670	1663	1013	0.20	1164	0.28	1300	0.36	1424	0.45	1539	0.54	1649	0.63	1752	0.73	1850	0.83	1944	0.93
760	1886	1065	0.24	1209	0.33	1338	0.42	1457	0.52	1569	0.61	1674	0.71	1773	0.82	1870	0.92	1961	1.03
850	2109	1120	0.29	1257	0.38	1381	0.49	1496	0.59	1604	0.70	1705	0.80	1802	0.91	1894	1.03	1982	1.14
940	2333	1178	0.34	1310	0.45	1429	0.56	1539	0.67	1643	0.78	1741	0.90	1835	1.02	1925	1.14	2011	1.26
1030	2556	1239	0.41	1365	0.52	1480	0.64	1586	0.76	1686	0.88	1781	1.00	1872	1.13	1959	1.26	2043	1.39
1120	2779	1301	0.48	1422	0.60	1533	0.72	1636	0.85	1733	0.98	1825	1.12	1913	1.25	1998	1.39	2080	1.53
1210	3002	1365	0.56	1482	0.69	1589	0.82	1689	0.96	1783	1.10	1872	1.24	1958	1.38	2040	1.53	2119	1.68
1300	3226	1431	0.66	1544	0.79	1647	0.93	1743	1.08	1835	1.22	1921	1.37	2005	1.53	2085	1.68	2162	1.84
1390	3449	1498	0.76	1607	0.91	1707	1.05	1800	1.20	1889	1.36	1973	1.52	2054	1.68	2132	1.84	2208	2.01
1480	3672	1566	0.88	1671	1.03	1768	1.19	1859	1.35	1945	1.51	2027	1.67	2106	1.84	2182	2.01	2256	2.19
1570	3896	1635	1.01	1736	1.17	1830	1.33	1919	1.50	2003	1.67	2083	1.84	2160	2.02	2234	2.20	2306	2.38
1660	4119	1705	1.16	1803	1.32	1894	1.49	1980	1.67	2062	1.85	2140	2.03	2215	2.21	2287	2.40	2358	2.59
1750	4342	1776	1.32	1870	1.49	1959	1.67	2043	1.85	2122	2.04	2199	2.23	2272	2.42	2343	2.61	2411	2.81
1840	4566	1847	1.50	1939	1.68	2025	1.86	2106	2.05	2184	2.24	2258	2.44	2330	2.64	2399	2.84	2467	3.05
1930	4789	1919	1.69	2008	1.88	2092	2.07	2171	2.27	2247	2.47	2320	2.67	2390	2.88	2457	3.09	2523	3.30
2020	5012	1992	1.90	2078	2.10	2159	2.30	2237	2.50	2311	2.71	2382	2.92	2450	3.13	2516	3.35	2581	3.57
2110	5236	2065	2.13	2148	2.33	2228	2.54	2303	2.75	2375	2.97	2445	3.19	2512	3.41	2577	3.63	2640	3.86
2200	5459	2138	2.37	2220	2.59	2297	2.80	2370	3.02	2441	3.25	2509	3.47	2574	3.70	2638	3.93	2700	4.17
2290	5682	2212	2.64	2291	2.86	2366	3.09	2438	3.31	2507	3.55	2573	3.78	2638	4.02	2700	4.25	2761	4.50
2380	5906	2287	2.92	2363	3.16	2436	3.39	2507	3.63	2574	3.86	2639	4.11	2702	4.35	2763	4.60	2823	4.85
2470	6129	2361	3.23	2436	3.47	2507	3.72	2576	3.96	2642	4.20	2705	4.45	2767	4.70	2827	4.96	2885	5.22
2560	6352	2436	3.56	2509	3.81	2579	4.06	2645	4.31	2710	4.57	2772	4.82	2833	5.08	2892	5.34	2949	5.61

CAP. CFM	OUTLET VELOCITY FPM	5½" S.P. RPM	5½" S.P. BHP	6" S.P. RPM	6" S.P. BHP	6½" S.P. RPM	6½" S.P. BHP	7" S.P. RPM	7" S.P. BHP	7½" S.P. RPM	7½" S.P. BHP	8" S.P. RPM	8" S.P. BHP	9" S.P. RPM	9" S.P. BHP	10" S.P. RPM	10" S.P. BHP	11" S.P. RPM	11" S.P. BHP
400	993	2026	0.76	2117	0.85	2204	0.94	2289	1.03	2371	1.13	2450	1.23	2601	1.44	2744	1.65	2880	1.88
490	1216	2023	0.84	2113	0.93	2200	1.03	2283	1.13	2364	1.23	2442	1.34	2592	1.56	2735	1.78	2870	2.02
580	1439	2026	0.93	2114	1.03	2200	1.13	2282	1.24	2362	1.35	2440	1.46	2588	1.69	2729	1.92	2864	2.17
670	1663	2035	1.03	2121	1.14	2205	1.25	2286	1.36	2365	1.47	2441	1.59	2588	1.83	2727	2.07	2861	2.33
760	1886	2049	1.14	2134	1.25	2216	1.37	2296	1.49	2373	1.61	2448	1.73	2593	1.98	2730	2.24	2862	2.51
850	2109	2067	1.26	2152	1.38	2233	1.50	2310	1.63	2386	1.75	2460	1.88	2602	2.14	2737	2.42	2867	2.70
940	2333	2094	1.39	2174	1.51	2252	1.64	2330	1.78	2404	1.91	2476	2.04	2615	2.32	2749	2.61	2876	2.90
→ 1030	2556	2124	1.52	2203	1.66	2279	1.80	2353	1.93	2425	2.07	2495	2.22	2633	2.51	2764	2.81	2890	3.11
1120	2779	2159	1.67	2235	1.81	2309	1.96	2382	2.11	2452	2.25	2521	2.40	2654	2.71	2784	3.02	2907	3.34
1210	3002	2196	1.83	2271	1.98	2344	2.13	2414	2.29	2483	2.44	2551	2.60	2681	2.92	2806	3.25	2926	3.58
1300	3226	2237	1.99	2311	2.16	2381	2.32	2450	2.48	2518	2.64	2583	2.81	2711	3.15	2834	3.49	2952	3.84
1390	3449	2281	2.17	2352	2.34	2421	2.51	2487	2.68	2555	2.86	2619	3.03	2744	3.38	2865	3.74	2981	4.10
1480	3672	2327	2.36	2397	2.54	2464	2.72	2530	2.90	2595	3.08	2656	3.25	2781	3.63	2899	4.01	3013	4.39
1570	3896	2376	2.56	2443	2.75	2510	2.94	2574	3.12	2637	3.31	2699	3.51	2817	3.88	2935	4.28	3047	4.68
1660	4119	2426	2.78	2492	2.97	2557	3.17	2620	3.36	2682	3.56	2743	3.76	2861	4.17	2972	4.57	3084	4.99
1750	4342	2478	3.01	2543	3.21	2606	3.41	2668	3.62	2729	3.83	2788	4.03	2904	4.45	3015	4.88	3123	5.31
1840	4566	2532	3.25	2595	3.46	2658	3.67	2718	3.89	2778	4.10	2836	4.32	2949	4.76	3059	5.20	3165	5.65
1930	4789	2587	3.52	2649	3.73	2710	3.95	2770	4.17	2828	4.40	2885	4.62	2996	5.08	3104	5.53	3208	6.00
2020	5012	2644	3.79	2705	4.02	2764	4.25	2823	4.48	2880	4.71	2936	4.94	3045	5.41	3151	5.89	3253	6.37
2110	5236	2701	4.09	2761	4.32	2820	4.56	2877	4.80	2933	5.03	2988	5.28	3096	5.76	3199	6.25	3300	6.75
2200	5459	2760	4.41	2819	4.65	2876	4.89	2933	5.13	2988	5.38	3042	5.63	3147	6.13	3249	6.64	3348	7.16
2290	5682	2820	4.74	2878	4.99	2934	5.24	2989	5.49	3044	5.75	3097	6.00	3200	6.52	3301	7.05	3398	7.58
2380	5906	2881	5.10	2937	5.35	2993	5.61	3047	5.87	3100	6.13	3153	6.40	3255	6.93	3353	7.47	3449	8.02
2470	6129	2942	5.48	2998	5.74	3053	6.00	3106	6.27	3158	6.54	3210	6.81	3310	7.36	3407	7.92	3502	8.48
2560	6352	3005	5.88	3060	6.15	3113	6.42	3166	6.70	3217	6.97	3268	7.25	3366	7.82	3462	8.39	3555	8.97

CAP. CFM	OUTLET VELOCITY FPM	12" S.P. RPM	12" S.P. BHP	13" S.P. RPM	13" S.P. BHP	14" S.P. RPM	14" S.P. BHP	15" S.P. RPM	15" S.P. BHP	16" S.P. RPM	16" S.P. BHP	17" S.P. RPM	17" S.P. BHP	18" S.P. RPM	18" S.P. BHP	19" S.P. RPM	19" S.P. BHP	20" S.P. RPM	20" S.P. BHP
850	2109	2992	2.98	3112	3.28	3228	3.58	3341	3.89	3450	4.21	3556	4.53	3660	4.86	3760	5.19	3859	5.54
940	2333	2999	3.20	3118	3.50	3233	3.82	3344	4.14	3452	4.47	3557	4.80	3660	5.14	3760	5.49	3857	5.84
1030	2556	3011	3.43	3128	3.75	3241	4.07	3351	4.40	3458	4.74	3562	5.09	3663	5.44	3762	5.80	3859	6.16
1120	2779	3026	3.67	3142	4.00	3253	4.34	3362	4.69	3467	5.04	3570	5.40	3670	5.76	3768	6.13	3864	6.51
1210	3002	3046	3.93	3159	4.27	3269	4.62	3376	4.98	3480	5.35	3581	5.72	3680	6.10	3777	6.48	3872	6.87
1300	3226	3066	4.19	3177	4.55	3288	4.92	3393	5.30	3496	5.67	3596	6.06	3694	6.45	3789	6.84	3883	7.24
1390	3449	3093	4.47	3202	4.85	3308	5.23	3414	5.62	3515	6.02	3614	6.41	3710	6.82	3804	7.23	3897	7.64
1480	3672	3123	4.77	3230	5.16	3334	5.56	3436	5.96	3535	6.36	3635	6.79	3730	7.20	3823	7.63	3914	8.05
1570	3896	3156	5.08	3261	5.49	3364	5.90	3463	6.32	3561	6.74	3656	7.16	3749	7.59	3844	8.04	3934	8.49
1660	4119	3191	5.41	3294	5.83	3395	6.26	3494	6.69	3590	7.13	3683	7.57	3775	8.01	3865	8.46	3953	8.92
1750	4342	3228	5.75	3330	6.19	3429	6.63	3526	7.08	3621	7.53	3713	7.99	3804	8.45	3893	8.92	3979	9.39
1840	4566	3269	6.10	3368	6.56	3466	7.02	3561	7.48	3654	7.95	3745	8.43	3835	8.91	3922	9.39	4008	9.87
1930	4789	3309	6.47	3411	6.96	3504	7.42	3598	7.90	3690	8.39	3780	8.88	3868	9.38	3954	9.87	4039	10.40
2020	5012	3353	6.85	3450	7.35	3544	7.84	3637	8.34	3727	8.84	3816	9.35	3903	9.86	3988	10.40		
2110	5236	3398	7.26	3493	7.76	3587	8.28	3678	8.79	3766	9.31	3854	9.84	3940	10.40	4024	10.90		
2200	5459	3445	7.68	3539	8.20	3630	8.73	3720	9.26	3808	9.80	3897	10.40	3978	10.90				
2290	5682	3493	8.12	3586	8.66	3676	9.20	3764	9.75	3851	10.30	3936	10.90	4019	11.40				
2380	5906	3543	8.57	3634	9.13	3723	9.69	3810	10.30	3895	10.80	3979	11.40						
2470	6129	3594	9.05	3683	9.63	3771	10.20	3857	10.80	3941	11.40	4023	12.00						
2560	6352	3646	9.55	3734	10.10	3821	10.70	3905	11.30	3988	11.90								

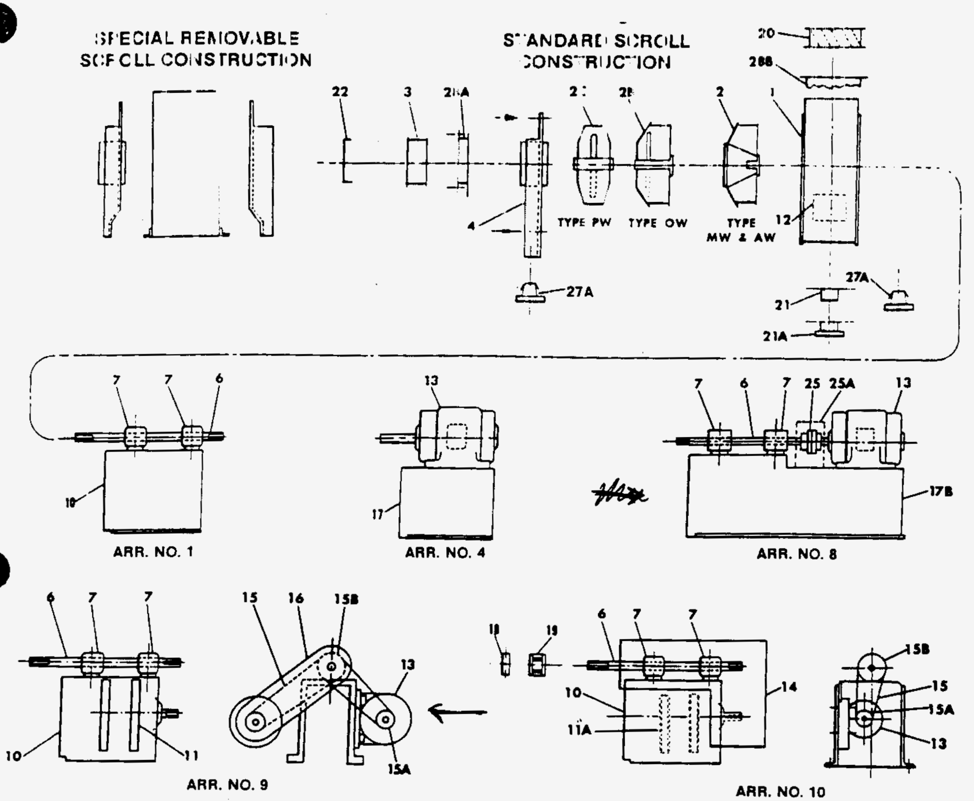
Ratings are at 70°F and 29.92" barometer.
BHP does not include drive losses.
The performance shown is for standard MW, AW and OW fans with inlet and outlet duc

High speed ratings may require special construction. Contact Buffalo Forge Company.

H-67

TYPES MW, AW & OW SINGLE INLET

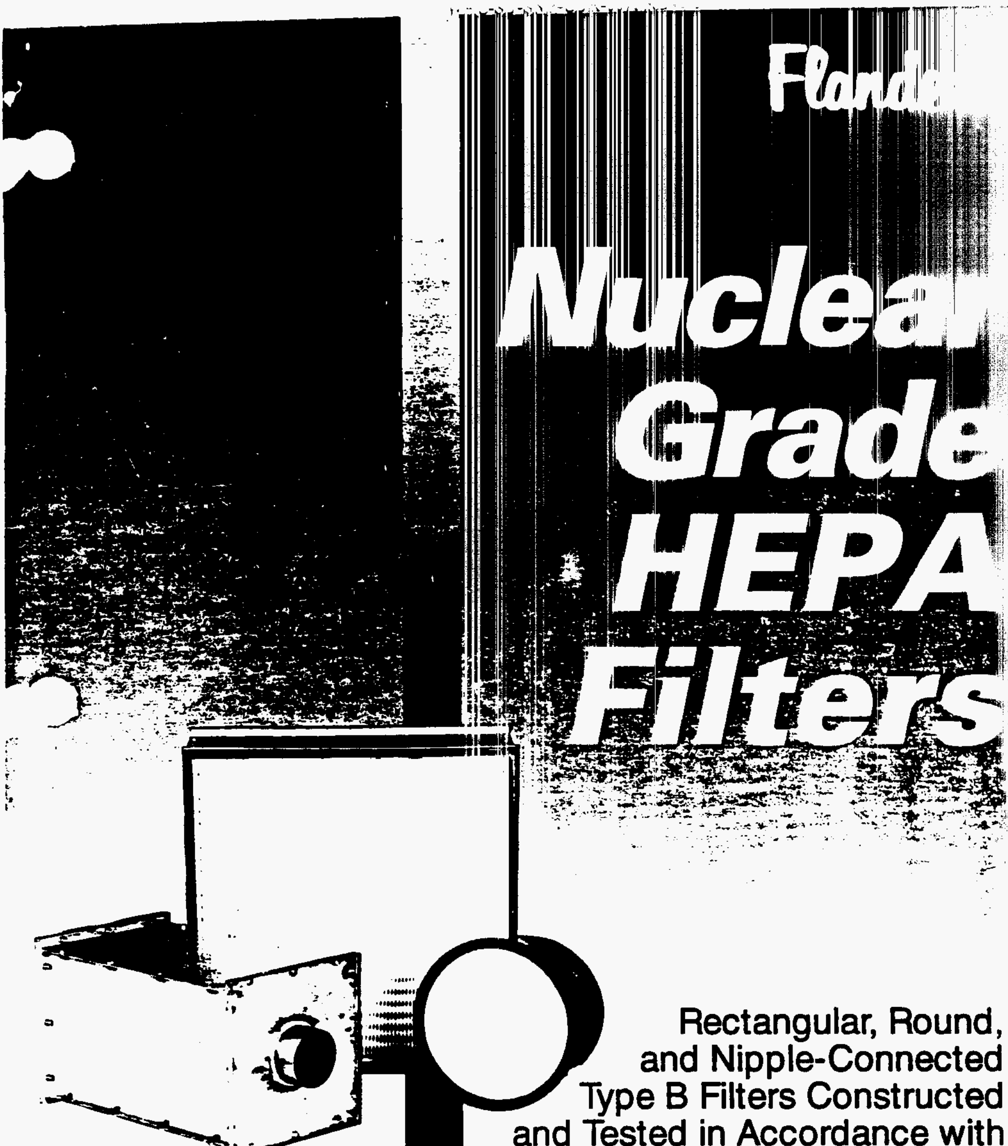
WEC-SD-SNF-CDR-0??, REV 0



FAN PARTS LIST

- 1 - Housing
- 2 - Backplate and Flange Wheel
- 2B - Open Wheel
- 2C - Paddle (Blast) Wheel
- 3 - Inlet Cone
- 4 - Inlet Stand
- 6 - Shaft
- 7 - Pillow Block Bearing
- 10 - Bearing Base
- 11 - Arr. 9 Motor Slide Rails
- 11A - Arr. 10 Motor Slide Rails
- 12 - Standard or Raised Access Door
- 13 - Motor
- 14 - Combination All-Weather Cover and Belt Guard
- 15 - V-Belts
- 15A - Motor Sheave
- 15B - Fan Sheave
- 16 - Belt Guard
- 17 - Arr. 4 Motor Base
- 17B - Arr. 8 Motor and Bearing Base
- 18 - Shaft Seal
- 19 - Heat Slinger
- 20 - Outlet Damper
- 21 - Standard Drain, ½ Tapped Pipe Coupling
- 21A - Flanged Type Drain
- 22 - Inlet Screen
- 25 - Coupling
- 25A - Coupling Guard
- 27A - Rail Type Vibration Isolators
- 28A - Inlet Flange
- 28B - Outlet Flange

H-68



Nuclear Grade HEPA Filters

Rectangular, Round, and Nipple-Connected Type B Filters Constructed and Tested in Accordance with

- MIL-STD-282
- IES-RP-CC-001.3

Bulletin No. 936

PV-F-1171 MNC

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Filter Design and Construction

Filter Media

The filter media in Flanders' Nuclear Grade filter elements is all glass (boron silicate microfiber) and contains a waterproofing binder which adds strength under both wet and dry conditions. Flanders manufactures its own filter media to meet or exceed the requirements of MIL-F-51079 (latest issue). Flanders '007' media is currently listed on the U.S. Army Qualified Products List QPL 51079. QPL-approved media which have been treated for resistance to airborne acids are also available; consult the factory.

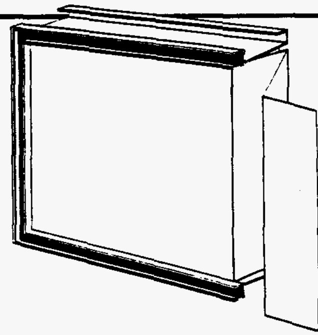
Sealants

Fire-retardant urethanes are used to bond the filter element to its integral frame. PUREFORM™ filters are made using solid urethane whereas separator-type filters are made with either polyurethane foam or solid urethane.

Frame Material

Plywood — Fire-retardant plywood frames are ideal for many applications, and are easier to incinerate or breakdown for disposal than are metal frame filters. However, they are not recommended for use in systems having high-moisture content, since they may warp or support biological growth. Stainless steel frame materials should be used in moisture-laden applications.

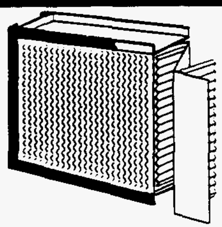
Stainless Steel — Type 409 and Type 304 stainless steel frames are also available. The 14-gauge Type 409 stainless steel is used in place of the cadmium-plated and chromized steel that was used in the past. However, since the Type 409 material has a low resistance to caustic atmospheres, the Type 304 stainless steel is recommended for those applications.



Flanders PUREFORM™ filters use a formed, corrugated element that is self-supporting.

The Separatorless PUREFORM™ Filter

Flanders has developed unique processes for the production of self-supporting, self-separating *PUREFORM™* filter elements, which offer higher dust-holding capacity, and thus longer service life, than separator-type filters. The higher capacity of separatorless filters is due not only to greater surface area, but also to the thickness of the medium - a fact often overlooked. *(See chart, below right.)*



Separator-type filters use paper or aluminum foil to separate the folds of the filter element.

Filter Type	Avg. Media Thickness	Sq. Ft. Media
Competitor X	15 Mils	210-220
Flanders Separator	20.5 Mils	220
8" PUREFORM	28 Mils	250
11" PUREFORM	28 Mils	295

Filter media made by specialty paper manufacturers is used by all Flanders competitors, and has an average thickness of 13-17 mils. (15 mils is required for nuclear service). Flanders' *media are consistently better than* these, ranging from 18-28 mils and averaging 20 mils.

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Frame Style

The technique that will be used to seal the filter in service determines the selection of the filter frame style. (See illustrations below.)

Fluid Seal — Metal frame fluid seal filters have a fabricated channel (3/4" wide x 3/4" deep) located on one face. Wood frame filters have a routed channel (3/8" wide x 3/4" deep) on one face.

Gasket Seal — Metal frame gasketed filters are provided with one or two flanges for the placement of the gasket as specificed by the customer. On wooden frames, the gasket is simply applied to the edge of the frame.

Fluid or Gasket Seal

Fluid Seal — BLU-JEL® Seal was developed by Flanders' and is the standard fluid seal material. Service temperatures are to 392°F. *For complete information on* BLU-JEL® Seal, *see Data Sheet 8601B.*

Gasket Seal — Gasketed filters for normal service are supplied with either closed cell sponge neoprene or Cohrlastic silicone sponge gaskets (1/4" x 3/4"). High-temperature filters require the special sealants described on page 8. *Specify upstream, downstream, or both for the location of the gasket or fluid seal in the model number.*

Faceguards

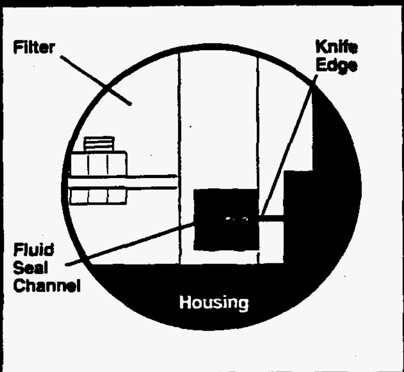
The standard faceguard is 4 x 4 mesh, 23-gauge, welded and galvanized dipped steel. Type 304 stainless steel faceguards (4 x 4 mesh, 17-gauge woven wire per ASTM A276) are also available for highly-corrosive atmospheres. Faceguards protect the media, but are not a guarantee against damage due to mishandling. *Specify faceguard location as upstream, downstream or both.*

Underwriters Laboratory, UL 586

To be listed under UL 586, filters must be submitted to Underwriters Laboratories for extensive testing including spot flame, and environmental exposure to heated air. A UL 586 listing is accepted by the DOE as meeting the Heated Air requirement for Nuclear Grade filters.

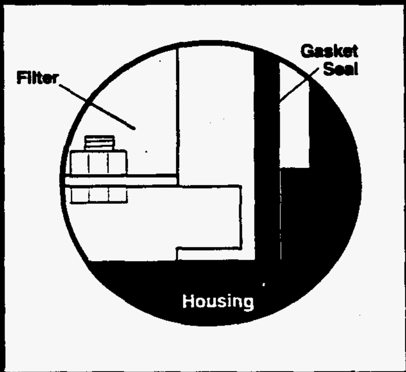
UL labels are optional. Some high-temperature filters, and filters larger than 24" x 30" x 11½", are not eligible for UL 586.

The Fluid Seal



A knife edge in the filter housing mates into a fluid-filled channel provided on the filter. Flanders invented the fluid seal in response to requirements for an absolute seal in the most critial applications. *In most cases, fluid seal filters are also easier and quicker to change out than gasketed filters.*

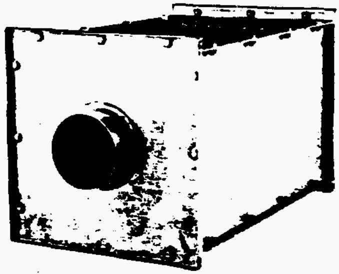
The Gasket Seal



A filter clamping mechanism is typically used to maintain sealing pressure on gasketed filters. Gasket seals have a tendency to develop bypass leaks, primarily because of compression set.

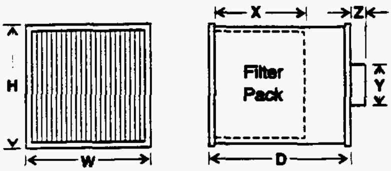
Nipple-Connected Filters

Nipple-Connected Nuclear Grade filters are available with one (N1) or two (N2) pipe connections, and with separatorless PUREFORM™ or separator-type filter elements. Frame materials are Type 304 or Type 409 stainless steel and 3/4" fire-retardant plywood. Only gasket seals are available. High temperature models are also available (see page 8 for information on sealants). Nipple-Connected filters are made of the same materials specified in MIL-F-51068 but are not tested for rough handling, wet over-pressure, or heated air as called out by that specification. Flanders performs acceptance testing of penetration and resistance only.



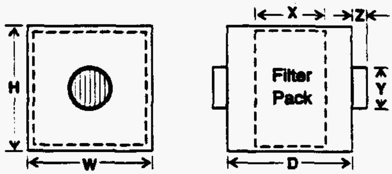
N1 Filters

TYPICAL METAL FRAME FILTER ILLUSTRATED



N2 Filters

TYPICAL WOOD FRAME FILTER ILLUSTRATED



N1 or N2 Filters with PUREFORM™ Filter Elements

SIZE DESIGNATOR	DIMENSIONS H	W	D	X	Y	Z	NOMINAL RATED CAPACITY	MAXIMUM INITIAL RESISTANCE
BB-D	8"	8"	10"	4"	3"	1½"	35	
CC-D	12"	12"	12"	4"	4"	1½"	100	
CC-F	12"	12"	16"	8"	4"	1½"	160	1.0" w.g.
GG-D	24"	24"	12"	4"	12"	4"	500	
GG-F	24"	24"	16"	8"	12"	4"	1000	

N1 or N2 Filters with Separator-Type Filter Elements

SIZE DESIGNATOR	DIMENSIONS H	W	D	X	Y	Z	NOMINAL RATED CAPACITY	MAXIMUM INITIAL RESISTANCE
BB-A	8"	8"	8"	3 1/16"	2"	1½"	20	
BB-D	8"	8"	10"	5 7/8"	3"	1½"	35	
CC-D	12"	12"	12"	5 7/8"	4"	1½"	100	1.0" w.g.
CC-F	12"	12"	16"	11½"	4"	1½"	160	
GG-D	24"	24"	12"	5 7/8"	12"	4"	500	
GG-F	24"	24"	16"	11½"	12"	4"	1000	

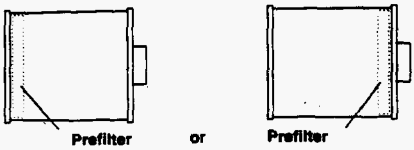
NOTE:

When ordering an N1 Filter, the customer must specify the location of the nipple (i.e. upstream or downstream).

When ordering N1 or N2 filters, the customer should specify the size of the nipple connections if Flanders' standard sizes (see the 'Y' dimensions) are not appropriate.

Roughing Prefilter

The frames of N1 filters may be extended 2" in depth to accomodate a roughing prefilter. *Indicate the 'P' prefix in the model number to specify this option. Also requires a special size designator. Contact the factory for details.*

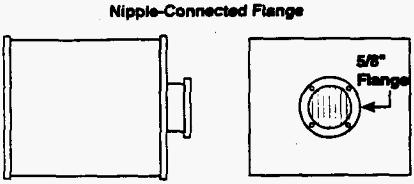


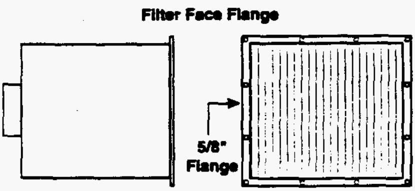
Gasket Seal (N1 Filters Only)

Gaskets are made from 1/4" x 3/4" closed cell neoprene material. *Specify location of the gasket as upstream, downstream, or both, in the filter model number.*

Drilled Flanges (N1 Filters Only)

Standard flanges may be located on the filter face or on the nipple connection. These flanges may be drilled in a standard pattern or according to customer specifications. Flanders' standard patterns are as follows: 5/16" diameter holes equally spaced and centered on the filter face flange; or 5/16" diameter holes equally spaced and centered on the nipple-connected flange.

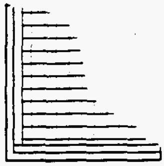




Slip-On Flanges

Optional 150 pound slip-on flanges for pipe-nipple connections shall be available in carbon steel or Type 304 stainless steel, and in any standard IPS size. *Other sizes and types of flanges are available per customer specifications.*

Faceguards (N1 and N2 Filters)



Standard faceguard material is 4x4 mesh, 23-gauge, welded and galvanized dipped steel. Type 304 stainless steel faceguards (4x4 mesh, 17-gauge woven wire per ASTM-A276) are also available for highly corrosive atmospheres. *Specify faceguard location as upstream, downstream, or both.*

UL 586 (N1 and N2 Filters)

To be listed under UL586, filters must be submitted to Underwriters Laboratories for extensive testing including spot flame and exposure to heated air. A UL586 listing is accepted by the DOE as meeting the Heated Air Requirement for Nuclear Grade filters. *UL labels are optional and are applied only if specified by the buyer.*

NOTE: High-temperature sealants are not eligible for UL586.

Model Numbers and Specification

To write a specification for Nipple-Connected Filters, use the Designating Chart on Page 15 to determine the model number. Fill in the numbered locations in the Suggested Specification Text on Page 16 with the model number and other appropriate selections from the listing at the bottom of the page.

Containment Housings With In-Place Test

In-place testing of hepa filters and adsorbers is required for nuclear systems and should be considered for any HVAC system where toxic particulates or gases are present in the effluent airstream. The testing of adsorbers usually presents no problem since the freon that is used to challenge the system passes through particulate filters. Hepa filter banks require distance both up and downstream of the bank to successfully introduce and disperse challenge aerosol on the upstream side and to mix potential leakage into the airstream (i.e. for an efficiency test) on the downstream side. This is not always a practical solution in complex filter trains. Flanders offers a complete built-in test system that can be installed between successive filter banks. Regardless of the number of filters in parallel or in series, the maximum distance between successive banks utiliized by test apparatus is 28". (See below) (Refer to Flanders Bulletin No. 381C for further information.)

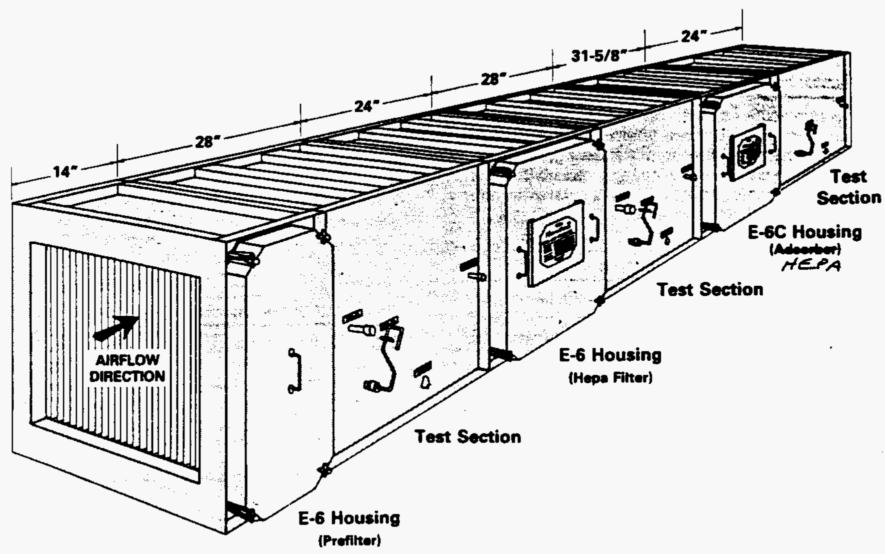


Fig. 6 — E-6 Filter Housings with In-Place Test Sections JC MNC 13

E-6 (Hepa Filter) Housing Component and Designating Code

Housing Model Number	Housing Size Designator (Filters High x Wide)	Height A	Width B	Depth C: Standard Filters Only (Size GG-F)	Depth C: Standard Filters With 2", 4", or 6" Prefilters	Housing Material	Left or Right-Hand Access	Type of Housing
	1 x 1		27-¼"					
	1 x 2	30"	51-¼"					
	1 x 3		75-¼"					
	2 x 1 (Stacked →)		27-¼"					
	2 x 2	60"	51-¼"					
	2 x 3		75-¼"					
E-6	3 x 1		27-¼"	24" Specify **GG-F**	36-½" Specify **GG-F2**, **GG-F4** or **GG-F6**	Standard Type **304** or Type **304L** Stainless Steel (Type **316** or Type **316L** Stainless Steel Optional	**L / R**	**Type 1** or **Type 3**
	3 x 2	90"	51-¼"					
	3 x 3		75-¼"					
	4 x 1		27-¼"					
	4 x 2	120"	51-¼"					
	4 x 3		75-¼"					

How to Order

Example: E-6 2x2 GG-F2 (304) L Type 1

Housing Size Designator (Filters High x Wide)	Nominal Capacity (CFM): 1000 CFM Per Filter	1200 CFM Per Filter	1500 CFM Per Filter	Approximate Weight (in lbs.): GG-F Housing	GG-F2 Housing
1 x 1	1000	1200	1500	180	300
1 x 2	2000	2400	3000	270	375
1 x 3	3000	3600	4500	335	480
2 x 1	2000	2400	3000	360	600
2 x 2	4000	4800	6000	540	750
2 x 3	6000	7200	9000	670	960
3 x 1	3000	3600	4500	540	900
3 x 2	6000	7200	9000	810	1125
3 x 3	9000	10800	13500	1005	1400
4 x 1	4000	4800	6000	720	1200
4 x 2	8000	9600	12000	1080	1500
4 x 3	12000	14400	18000	1340	1920

Table title: **Additional E-6 Information**

Type of Door Arrangement

Type 1 Housing: The standard E-6 Housing has an access door on one side and a flanged plate on the other. The owner must specify left or right-hand access.

Type 3 Housing: This housing consists of two side-by-side housings in parallel. Access to the filters and operation of the filter removal rod is from both sides of the parallel housings (see page 8.)

Special E-6 Housings are available upon special request.

SAIC ACCEPTANCE TEST PROCEDURE		
Project No.: 9277-01 (486.1)	Cust./P.O.: LESAT/950460	EGS-TR-927701-104 Revision Orig
Item Description: Bubbletight Damper Model/Part No.: BTR-92 and BTO-92	OEM: Ruskin Dwg./Spec.: 50-001162-01D thru -13D	Attachment: 1 Part: 2 Page 1 of 1
Safety Function: Maintain structural integrity and operability before, during and after a seismic event		Prep. by: [signature] Date: 1-3-96 Rev'd by: [signature] Date: 1-10-96

1. **Product Identification**

   a) Manufacturer
   Verify the manufacturer to be Ruskin. Record tag information and attach to the data sheet.

   b) Model Number
   Verify the model number to be as specified on Figures 1-1 through 1-13.

2. **Physical Attributes**

   a) Dimensions
   Verify dimensions are per the customer-approved drawing (Reference Figures 1-1 through 1-13) by review of the Ruskin Final Inspection Reports.

   b) Configuration
   Verify the damper is free from damage and is of the configuration depicted in Figures 1-1 through 1-13 or the customer-approved drawings. Record the customer-approved drawing number, including revision, on the data sheet.

3. **Mechanical Attributes**

   a) Material
   Verify the material used for construction of the dampers has been independently tested and accepted by SAIC/EGS. The following materials shall be verified:

Frame	Blade Stiffeners
Flange	Actuator Bracket
Blade	Weld Wire

   Verify all welders performing welding on the damper are certified to ASME Section IX.

4. **Electrical Attributes**

   Verified per Paragraph 5.

5. **Operability**

   a) Proper Operation
   Verify each damper operates as required by Ruskin Procedures Nos. 092395 and 092295.

LOC 980

(6 EACH) BTR92 MOTORIZED " SIZE
&
(6 EACH) BTR92 MOTORIZED 12" SIZE

RUSKIN BUBBLE TIGHT SEISMIC DAMPERS W/ MOTORIZED OPERATORS
& POSITION SWITCHES

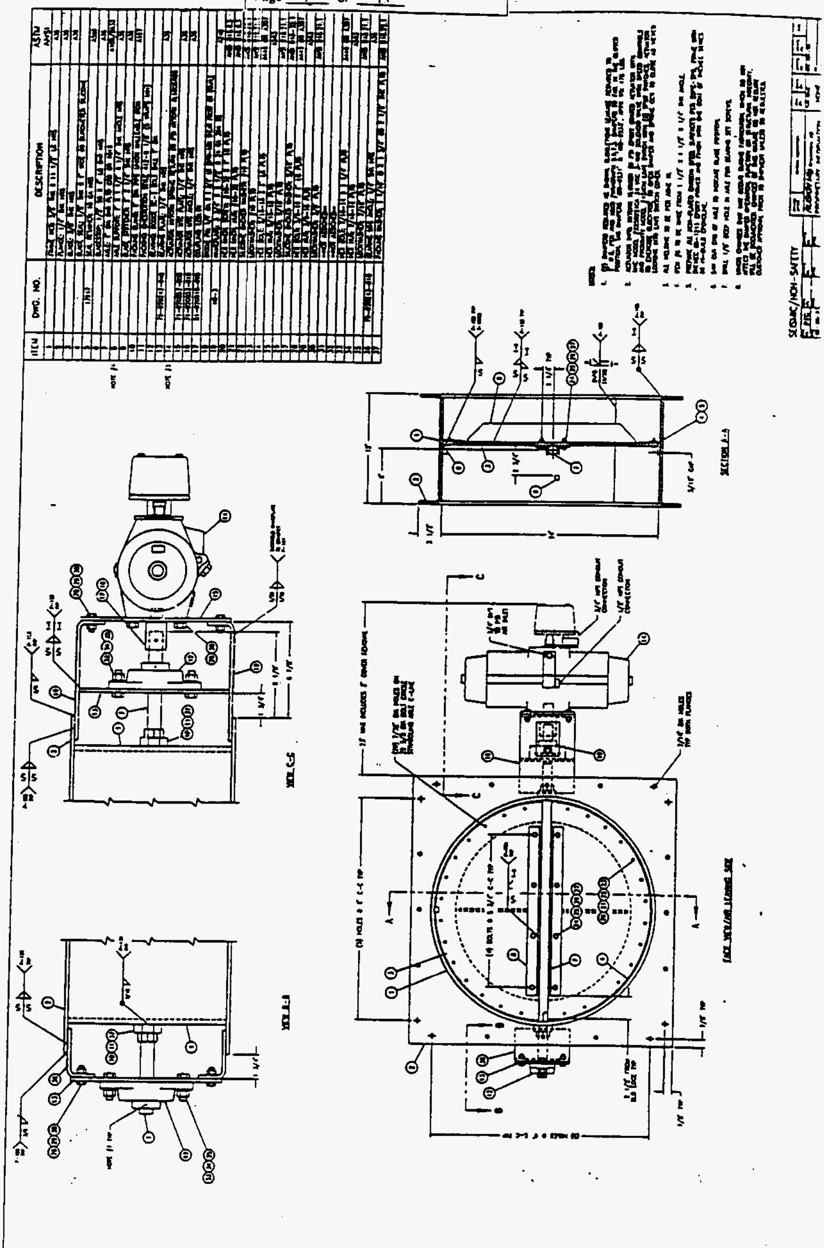


Figure 1-5

VAC-VAC-5041

PRICE LIST

How to order your Turbo Mini or Turbo Cart Pumping Station

Ordering a Varian Turbo Mini Pumping Station or Turbo Cart Pumping Station is quick and easy. Please use the enclosed Order Form and this Price List to configure and price your turbo pumping system.

For product information about a system component, refer to the accompanying supplements for Turbo Pumps and Controllers, Vacuum Gauges and Controls, Mechanical Pumps, and Valves. Part numbers and prices for all basic system configurations and customer-selectable options and accessories are located in this Price List. If what you want is not here, please call us at 1-800-882-7426 to discuss how we can build it for you.

Turbo Pumps

		Turbo Cart Pumping Station			Turbo Mini Pumping Station		
PUMP SIZE	DESCRIPTION	ORDER NO. 120V/60HZ	ORDER NO. 220V/50HZ	LIST PRICE	ORDER NO. 120V/60HZ	ORDER NO. 220V/50HZ	LIST PRICE
V70 Turbo Pump *	ISO-63 Inlet	3344-MSP-9357	3344-MSP-8357	$5,760.00	3344-MSP-7357	3344-MSP-6357	$4,670.00
	4-½" CFF Inlet	3344-MSP-9358	3344-MSP-8358	5,885.00	3344-MSP-7358	3344-MSP-6358	4,795.00
V70D Turbo Pump *	ISO-63 Inlet	3344-MSP-9361	3344-MSP-8361	6,060.00	3344-MSP-7361	3344-MSP-6361	4,975.00
	4-½" CFF Inlet	3344-MSP-9362	3344-MSP-8362	6,185.00	3344-MSP-7362	3344-MSP-6362	5,100.00
V70LP Turbo Pump *	ISO-63 Inlet	3344-MSP-9365	3344-MSP-8365	6,395.00	3344-MSP-5365	3344-MSP-4365	5,325.00
	4-½" CFF Inlet	3344-MSP-9366	3344-MSP-8366	6,520.00	3344-MSP-5366	3344-MSP-4364	5,450.00
V250 Turbo Pump *	ISO-100 Inlet	3344-MSP-8607	3344-MSP-8507	8,495.00	3344-MSP-2501	3344-MSP-2502	7,695.00
	6" CFF Inlet	3344-MSP-8608	3344-MSP-8508	8,645.00	3344-MSP-2500	3344-MSP-2503	7,845.00
V300HT Turbo Pump *	ISO-160 Inlet	3344-MSP-9039	3344-MSP-9139	9,795.00	N/A	N/A	N/A
	8" CFF Inlet	3344-MSP-9040	3344-MSP-9140	9,970.00	N/A	N/A	N/A
550 Turbo Pump *	ISO-160 Inlet	3344-MSP-9049	3344-MSP-9149	14,350.00	N/A	N/A	N/A
	8" CFF Inlet	3344-MSP-9050	3344-MSP-9150	14,525.00	N/A	N/A	N/A
V700HT Turbo Pump *	ISO-200 Inlet	3344-MSP-9057	3344-MSP-9157	16,700.00	N/A	N/A	N/A
	10" CFF Inlet	3344-MSP-9058	3344-MSP-9158	16,900.00	N/A	N/A	N/A
V1000A Turbo Pump *	ISO-200 Inlet	3344-MSP-9053	3344-MSP-9153	22,550.00	N/A	N/A	N/A
	10" CFF Inlet	3344-MSP-9054	3344-MSP-9154	22,750.00	N/A	N/A	N/A

* Basic configuration includes turbomolecular pump, inlet screen, pump controller, [illegible] and [illegible] for single-switch operation

Options and Accessories for Turbo Cart and Turbo Mini Pumping Stations

DESCRIPTION	ORDER NO.	LIST PRICE	ORDER NO.	LIST PRICE
■ 1.4 cfm Diaphragm Pump * †	3344-MSP-0200	$2,380.00	3344-MSP-0099	$2,380.00
■ 2.3 cfm Diaphragm Pump ** †	3344-MSP-0201	3,290.00	3344-MSP-0100	3,290.00
■ 21 cfm Dry Scroll Pump	3344-MSP-0202	7,000.00	N/A	N/A
■ SD-40 Mechanical Pump ***	3344-MSP-0203	1,160.00	3344-MSP-0097	1,160.00
■ SD-90 Mechanical Pump ***	3344-MSP-0204	1,500.00	3344-MSP-0098	1,500.00
■ SD-200 Mechanical Pump ***	3344-MSP-0205	1,680.00	N/A	N/A
■ SD-300 Mechanical Pump ***	3344-MSP-0206	1,900.00	N/A	N/A
■ SD-450 Mechanical Pump ***	3344-MSP-0207	2,370.00	N/A	N/A
■ SD-700 Mechanical Pump ***	3344-MSP-0208	[illegible]	N/A	N/A

* [illegible] V70LP and V250 [illegible] Pumps only
** [illegible] V70LP, V250, [illegible] and V700HT [illegible]
*** Mist [illegible] included with pump
† [illegible]

Varian vacuum products

ISO 9001

H-78

Varian Vacuum Products
121 Hartwell Avenue
Lexington, MA 02173-3133, USA

Tel: 1-800-8-VARIAN (1-800-882-7426) USA only (617) 861-7200
1-800-663-2727 (Canada)
Fax: (617) 860-5437

Gauge Controller Options	Turbo Cart Pumping Station		Turbo Mini Pumping Station	
DESCRIPTION	ORDER NO.	LIST PRICE	ORDER NO.	LIST PRICE
DV100 Diaphragm Manometer Control *	3344-MSP-0209	$357.00	3344-MSP-0101	$357.00
DV100-2 Diaphragm Manometer Control (2 set points) *	3344-MSP-0210	557.00	3344-MSP-0102	557.00
Transducer, SST, ¼" NPT	3344-MSP-0211	357.00	3344-MSP-0103	357.00
Transducer, Silicon, ¼" NPT	3344-MSP-0212	227.00	3344-MSP-0104	227.00
Transducer, KF-16 Flange	3344-MSP-0213	264.00	3344-MSP-0105	264.00
801 Thermocouple Gauge Control **	3344-MSP-0214	215.00	3344-MSP-0106	215.00
810 Thermocouple Gauge Control **	3344-MSP-0215	415.00	3344-MSP-0107	415.00
810-2 Thermocouple Gauge Control **	3344-MSP-0216	545.00	3344-MSP-0108	545.00
531 Thermocouple Gauge, NW-10 Flange	3344-MSP-5311	86.00	3344-MSP-5311	86.00
531 Thermocouple Gauge, NW-16 Flange	3344-MSP-5312	87.00	3344-MSP-5312	87.00
531 Thermocouple Gauge, NW-25 Flange	3344-MSP-5313	89.00	3344-MSP-5313	89.00
531 Thermocouple Gauge, NW-40 Flange	3344-MSP-5314	93.00	3344-MSP-5314	93.00
531 Thermocouple Gauge, 1⅓" CF Flange	3344-MSP-5315	93.00	3344-MSP-5315	93.00
531 Thermocouple Gauge, 2¾" CF Flange	3344-MSP-5316	96.00	3344-MSP-5316	96.00
ConvecTorr Gauge Control ***	3344-MSP-0217	475.00	3344-MSP-0109	475.00
ConvecTorr Gauge Control (2 set points) ***	3344-MSP-0218	685.00	3344-MSP-0110	685.00
WV100-2 Gauge Control (2 set points) *	3344-MSP-0219	738.00	3344-MSP-0111	738.00
Transducer, Silicon, ¼" NPT	3344-MSP-0220	512.00	3344-MSP-0112	512.00
Transducer, Silicon, KF-16 Flange	3344-MSP-0221	558.00	3344-MSP-0113	558.00
Transducer, SST, ¼" NPT	3344-MSP-0222	646.00	3344-MSP-0114	646.00
Transducer, SST, KF-16 Flange	3344-MSP-0223	687.00	3344-MSP-0115	687.00
HV100 Pirani Gauge Control *	3344-MSP-0224	583.00	3344-MSP-0116	583.00
HV100-2 Pirani Gauge Control (2 set points) *	3344-MSP-0225	738.00	3344-MSP-0117	738.00
Transducer, ¼" Tubulation	3344-MSP-0226	99.00	3344-MSP-0118	99.00
Transducer, KF-16 Flange	3344-MSP-0227	134.00	3344-MSP-0119	134.00
860 Cold Cathode Gauge Control *	3344-MSP-0228	675.00	3344-MSP-0120	675.00
860-2 Cold Cathode Gauge Control (2 set points) *	3344-MSP-0229	975.00	3344-MSP-0121	975.00
524-2 Cold Cathode Gauge, 1" Tubulation	3344-MSP-0230	385.00	3344-MSP-0122	385.00
524-2 Cold Cathode Gauge, NW-25 Flange	3344-MSP-0231	415.00	3344-MSP-0123	415.00
524-2 Cold Cathode Gauge, 2¾" CF Flange	3344-MSP-0232	425.00	3344-MSP-0124	425.00
525 Cold Cathode Gauge, 1" Tubulation	3344-MSP-5251	325.00	3344-MSP-5251	325.00
525 Cold Cathode Gauge, NW-25 Flange	3344-MSP-5252	355.00	3344-MSP-5252	355.00
525 Cold Cathode Gauge, NW-40 Flange	3344-MSP-5253	355.00	3344-MSP-5253	355.00
Multi-Gauge (basic unit, gauging card req.)	3344-MSP-0233	770.00	3344-MSP-0125	770.00
T/C Card *	3344-MSP-0234	470.00	3344-MSP-0126	470.00
UHV Card *	3344-MSP-0235	780.00	3344-MSP-0127	780.00
C/C Card *	3344-MSP-0236	620.00	3344-MSP-0128	620.00
B/A Card *	3344-MSP-0237	690.00	3344-MSP-0129	690.00
Set Point Card	3344-MSP-0238	195.00	3344-MSP-0130	195.00
Convectron Card *	3344-MSP-0239	545.00	3344-MSP-0131	545.00
CDG Card *	3344-MSP-6491	620.00	3344-MSP-6491	620.00
RS-232 Computer Interface	3344-MSP-6439	150.00	3344-MSP-6439	150.00
RS-485/422 Computer Interface	3344-MSP-8940	125.00	3344-MSP-8940	125.00
senTorr Basic Unit, (2) T/C's and (1) B/A †	3344-MSP-L9120	1,165.00	3344-MSP-L9120	1,165.00
senTorr Basic Unit, (2) T/C's and (1) C/C *	3344-MSP-L9121	1,165.00	3344-MSP-L9121	1,165.00
senTorr Basic Unit, (1) B/A †	3344-MSP-L9122	715.00	3344-MSP-L9122	715.00
senTorr Basic Unit, (1) C/C	3344-MSP-L9112	685.00	3344-MSP-L9112	685.00
senTorr Set Point	3344-MSP-L9132	60.00	3344-MSP-L9132	60.00
senTorr RS-485/422	3344-MSP-L9143	150.00	3344-MSP-L9143	150.00
senTorr RS-232	3344-MSP-L6450	150.00	3344-MSP-L6450	150.00
senTorr Resistive Degas	3344-MSP-L9135	85.00	3344-MSP-L9135	85.00
571 Gauge Tube, 1" Glass Tubulation	3344-MSP-24711	105.00	3344-MSP-24711	105.00
571 Gauge Tube, 1" Kovar Tubulation	3344-MSP-24712	115.00	3344-MSP-24712	115.00
571 Gauge Tube, 2¾" CF	3344-MSP-24713	145.00	3344-MSP-24713	145.00
571 Gauge Tube, NW-25 Flange	3344-MSP-24717	122.00	3344-MSP-24717	122.00
572 Gauge Tube, NW-40 Flange	3344-MSP-24714	125.00	3344-MSP-24714	125.00
572 Gauge Tube, 1" Glass Tubulation	3344-MSP-24715	95.00	3344-MSP-24715	95.00

[illegible] configurations and pricing available [illegible]

Varian Vacuum Products – Turbo Pumping Systems – Order Form

Shaded areas on the Price List and this Order Form are applicable only to Turbo Cart Pumping Stations
Non-shaded areas on the Price List and this Order Form are applicable only to Turbo Mini Pumping Stations

WHC-SD-SNF-CDR-007, REV. 0	Turbo Cart Pumping Station	Turbo Mini Pumping Station	Qty	Price
Turbo Cart Pumping Station	3344-MSP-			
Turbo Mini Pumping Station		3344-MSP-		
Mechanical Pump (select one)	3344-MSP-	3344-MSP-		
Vacuum Gauge Controllers (select one Multi-Gauge or up to 2 separate gauge controllers)				
Multi-Gauge Controller: Basic Unit (select gauging card(s) below)	3344-MSP-	3344-MSP-		
Thermocouple Gauge Card	3344-MSP-	3344-MSP-		
Bayard-Alpert Gauge Card	3344-MSP-	3344-MSP-		
Cold Cathode Gauge Card	3344-MSP-	3344-MSP-		
UHV Gauge Card	3344-MSP-	3344-MSP-		
Convectron Gauge Card	3344-MSP-	3344-MSP-		
Set-Point Card	3344-MSP-	3344-MSP-		
RS-232 Interface	3344-MSP-	3344-MSP-		
RS-485/422 Interface	3344-MSP-	3344-MSP-		
or				
Vacuum Gauge Controller # 1	3344-MSP-	3344-MSP-		
Vacuum Gauge Controller # 2	3344-MSP-	3344-MSP-		
Vacuum Gauge Controller Options (e.g., RS-interfaces, Degas)	3344-MSP-	3344-MSP-		
Vacuum Gauge Tubes/Transducers	3344-MSP-	3344-MSP-		
DV-100 Transducer	3344-MSP-	3344-MSP-		
531 Thermocouple Gauge Tube (801, 810, senTorr, Multi-Gauge)	3344-MSP-	3344-MSP-		
ConvecTorr Gauge Tube	3344-MSP-	3344-MSP-		
Convectron Gauge Tube (Multi-Gauge)	3344-MSP-	3344-MSP-		
WV100-2 Transducer	3344-MSP-	3344-MSP-		
HV-100 Transducer	3344-MSP-	3344-MSP-		
524-2, 525 Cold Cathode Gauge Tube (860, senTorr, Multi-Gauge)	3344-MSP-	3344-MSP-		
571, 563, 564 Bayard-Alpert Gauge Tube (senTorr, Multi-Gauge)	3344-MSP-	3344-MSP-		
580 Nude Gauge Tube (senTorr, Multi-Gauge)	3344-MSP-	3344-MSP-		
UHV-24 Nude Gauge Tube (Multi-Gauge)	3344-MSP-	3344-MSP-		
Turbo Pump Venting Devices (select one)	3344-MSP-	3344-MSP-		
Turbo Pump Air Cooling Kits (select one)	3344-MSP-	3344-MSP-		
Turbo Pump Water Cooling Kits (select one)	3344-MSP-	3344-MSP-		
Turbo Pump Heater Bands (select one)	3344-MSP-	3344-MSP-		
ISO Turbo Inlet Spools (select one)	3344-MSP-	3344-MSP-		
ConFlat® Flange Turbo Inlet Spools (select one)	3344-MSP-	3344-MSP-		
Turbo Pump Inlet Valves (select one)				
V70, V70D, and V70LP (for Cart or Mini Station)	3344-MSP-	3344-MSP-		
V250 (for Cart or Mini Station)	3344-MSP-	3344-MSP-		
V300HT and V550 (for Cart Station only)	3344-MSP-	N/A		
V700HT and V1000A (for Cart Station only)	3344-MSP-	N/A		
Turbo Pump Foreline Valves (select one)				
V70/V70D/V70LP and V250 (for Cart and Mini Station)	3344-MSP-	3344-MSP-		
V300HT, V550, V700HT and V1000A (for Cart Station only)	3344-MSP-	N/A		
Turbo Inlet Adapters (select one)	3344-MSP-	3344-MSP-		
Miscellaneous Accessories				
Caster set for Turbo Mini Pumping Stations	N/A	3344-MSP-		
			Total	$

Fax your order to (617) 860-5437, or call 1-800-8-VARIAN (1-800-882-7426) USA only
(617) 861-7200 1-800-663-2727 (Canada)

Name ____________

Company ____________

Address ____________

City ______ State ______ Zip ______

Phone ______ Fax ______

varian
vacuum products

Varian Vacuum Products
121 Hartwell Avenue
Lexington, MA 02173-3133, USA

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Gauge Controller Options (continued)

DESCRIPTION	Turbo Cart Pumping Station ORDER NO.	Turbo Cart Pumping Station LIST PRICE	Turbo-Mini Pumping Station ORDER NO.	Turbo-Mini Pumping Station LIST PRICE
563 Gauge Tube, 1" Glass Tubulation	3344-MSP-24661	$125.00	3344-MSP-24661	$125.00
563 Gauge Tube, 1" Kovar Tubulation	3344-MSP-24662	135.00	3344-MSP-24662	135.00
563 Gauge Tube, 2¾" CFF	3344-MSP-24663	165.00	3344-MSP-24663	165.00
563 Gauge Tube, NW-25 Flange	3344-MSP-24664	142.00	3344-MSP-24664	142.00
563 Gauge Tube, NW-40 Flange	3344-MSP-24665	155.00	3344-MSP-24665	155.00
564 Gauge Tube, 1" Glass Tubulation	3344-MSP-25001	185.00	3344-MSP-25001	185.00
564 Gauge Tube, 1" Kovar Tubulation	3344-MSP-25002	195.00	3344-MSP-25002	195.00
564 Gauge Tube, 2¾" CFF	3344-MSP-25003	225.00	3344-MSP-25003	225.00
564 Gauge Tube, NW-25 Flange	3344-MSP-25004	208.00	3344-MSP-25004	208.00
564 Gauge Tube, NW-40 Flange	3344-MSP-25005	215.00	3344-MSP-25005	215.00
580 Nude Gauge, Thoria, 2¾" CFF	3344-MSP-51502	345.00	3344-MSP-51502	345.00
580 Nude Gauge, Tungsten, KF-40 Flange	3344-MSP-51505	275.00	3344-MSP-51505	275.00
UHV-24 Nude Gauge, Tungsten, 2¾" CFF	3344-MSP-5008	345.00	3344-MSP-5008	345.00
UHV-24 Nude Gauge, Thoria, 2¾" CFF	3344-MSP-5007	360.00	3344-MSP-5007	360.00
UHV-24 Nude Gauge, Tungsten, KF-40 Flange	3344-MSP-66511	410.00	3344-MSP-66511	410.00
UHV-24 Nude Gauge, Thoria, KF-40 Flange	3344-MSP-66512	440.00	3344-MSP-66512	440.00

Includes cabling

Includes cabling and 531 gauge (⅛" NPT)

Includes cabling and ConvecTorr gauge (⅛" NPT)

† Includes cabling, excludes UHV-24 gauge operation

Turbo Pump Accessories

DESCRIPTION	Turbo Cart ORDER NO.	Turbo Cart LIST PRICE	Turbo-Mini ORDER NO.	Turbo-Mini LIST PRICE
Venting Devices				
■ Emergency Vent	3344-MSP-0240	$145.00	3344-MSP-0132	$145.00
■ Four-Second Delayed Vent	3344-MSP-0241	605.00	3344-MSP-0133	605.00
■ Adjustable Vent	3344-MSP-0242	1,150.00	3344-MSP-0134	1,150.00
Air Cooling				
Hi-Flow Forced Air for V70, V70D, V70LP, V250, V300HT *	3344-MSP-0243	280.00	3344-MSP-0135	280.00
■ Forced Air for V70, V70D, V70LP, V250, V300HT	3344-MSP-0244	220.00	3344-MSP-0136	220.00
■ Forced Air for V550, V700HT	3344-MSP-0245	295.00	N/A	N/A
■ Forced Air for V1000A	3344-MSP-0246	385.00	N/A	N/A
Water Cooling				
■ V70, V70D, V70LP Turbo Pumps	3344-MSP-0247	75.00	3344-MSP-0137	75.00
■ V250, V300HT Turbo Pumps	3344-MSP-0248	75.00	3344-MSP-0138	75.00
■ V550, V700HT Turbo Pumps	3344-MSP-9318	75.00	N/A	N/A
Heater Bands				
■ V70, V70D, V70LP Turbo Pumps	3344-MSP-0249	165.00	3344-MSP-0139	165.00
■ V250, V300HT Turbo Pumps	3344-MSP-0250	250.00	3344-MSP-0140	250.00
■ V550, V700HT Turbo Pumps	3344-MSP-0251	295.00	N/A	N/A
■ V1000A Turbo Pump	3344-MSP-0252	325.00	N/A	N/A
ISO Turbo Inlet Spools				
■ V70, V70D, V70LP ISO-63	3344-MSP-0253	545.00	3344-MSP-0141	545.00
■ V250 ISO-100	3344-MSP-0254	645.00	3344-MSP-0143	645.00
■ V300HT, V550 ISO-160	3344-MSP-0255	750.00	N/A	N/A
■ V700HT, V1000A ISO-200	3344-MSP-0256	955.00	N/A	N/A
ConFlat® Flange Turbo Inlet Spools				
■ V70, V70D, V70LP 4[illegible] CFF	3344-MSP-0257	545.00	3344-MSP-0142	545.00
■ V250 [illegible] CFF	3344-MSP-0258	645.00	3344-MSP-0144	645.00
■ V550 [illegible] CFF	3344-MSP-0259	750.00	N/A	N/A
■ V1000A 10[illegible] CFF	3344-MSP-0260	955.00	N/A	N/A
Turbo Inlet Adapters				
■ ISO-[illegible] to NW-40	3344-MSP-0307	245.00	[illegible]	245.00
■ [illegible] to 2[illegible] CFF	3344-MSP-0308	195.00	[illegible]	195.00
Other configurations available upon request				
Miscellaneous Accessories				
■ [illegible] Turbo-Mini Pumping Station	N/A	N/A	[illegible]	160.00

[illegible] ordered with [illegible]

[illegible] NW-[illegible]

[illegible] CFF [illegible]

	Turbo Cart Pumping Station™		Turbo Mini Pumping Station	
Valves				
DESCRIPTION	**ORDER NO.**	**LIST PRICE**	**ORDER NO.**	**LIST PRICE**
[illegible]bo Inlet Valves				
[illegible]or V70, V70D, V70LP Cart and Mini Stations				
■ 2½" CFF H/O Linear Gate Valve	3344-MSP-0261	$1,425.00	3344-MSP-0145	$1,425.00
■ ISO-63 H/O Linear Gate Valves	3344-MSP-0262	1,200.00	3344-MSP-0146	1,200.00
■ 2½" A/O Linear Gate Valve	3344-MSP-0263	1,525.00	3344-MSP-0147	1,525.00
■ ISO-63 A/O Linear Gate Valve	3344-MSP-0264	1,300.00	3344-MSP-0148	1,300.00
■ NW-40 Electromagnetic Block Valve *	3344-MSP-0265	815.00	3344-MSP-0149	815.00
■ NW-40 H/O Block Valve *	3344-MSP-0266	265.00	3344-MSP-0150	265.00
■ NW-40 A/O Block Valve *	3344-MSP-0267	345.00	3344-MSP-0151	345.00
■ 1½" H/O S/S Right Angle 2¾ CFF *	3344-MSP-0268	415.00	3344-MSP-0152	415.00
■ 1½" H/O S/S Right Angle NW-40 Flange *	3344-MSP-0269	305.00	3344-MSP-0153	305.00
■ 1½" A/O S/S Right Angle 2¾" CFF *	3344-MSP-0270	475.00	3344-MSP-0154	475.00
■ 1½" A/O S/S Right Angle KF-40 Flange *	3344-MSP-0271	400.00	3344-MSP-0155	400.00
For V250 Cart and Mini Stations				
■ 4" H/O Swing Gate Valve 6" CFF	3344-MSP-0272	1,650.00	3344-MSP-0272	1,650.00
■ 4" A/O Swing Gate Valve 6" CFF	3344-MSP-0273	1,775.00	3344-MSP-0273	1,775.00
■ 4" H/O Swing Gate Valve ISO-100 Flange	3344-MSP-0274	1,850.00	3344-MSP-0274	1,850.00
■ 4" A/O Swing Gate Valve ISO-100 Flange	3344-MSP-0275	1975.00	3344-MSP-0275	1975.00
■ NW-40 Electromagnetic Block Valve *	3344-MSP-0276	815.00	3344-MSP-0276	815.00
■ NW-40 H/O Block Valve *	3344-MSP-0277	265.00	3344-MSP-0277	265.00
■ NW-40 A/O Block Valve *	3344-MSP-0278	345.00	3344-MSP-0278	345.00
■ 1½" H/O S/S Right Angle 2¾" CFF *	3344-MSP-0279	415.00	3344-MSP-0279	415.00
■ 1½" H/O S/S Right Angle NW-40 Flange *	3344-MSP-0280	305.00	3344-MSP-0280	305.00
■ 1½" A/O S/S Right Angle 2¾" CFF *	3344-MSP-0281	475.00	3344-MSP-0281	475.00
■ 1½" A/O S/S Right Angle KF-40 Flange *	3344-MSP-0282	400.00	3344-MSP-0282	400.00
[illegible]or V300HT, V550 Cart Stations				
6" H/O Swing Gate Valve 8" CFF	3344-MSP-0283	2,100.00	N/A	N/A
■ 6" A/O Swing Gate Valve 8" CFF	3344-MSP-0284	2,275.00	N/A	N/A
■ 6" H/O Swing Gate Valve ISO-160 Flange	3344-MSP-0285	2,300.00	N/A	N/A
■ 6" A/O Swing Gate Valve ISO-160 Flange	3344-MSP-0286	2,475.00	N/A	N/A
■ NW-40 Electromagnetic Block Valve *	3344-MSP-0287	1,015.00	N/A	N/A
■ NW-40 H/O Block Valve *	3344-MSP-0288	465.00	N/A	N/A
■ NW-40 A/O Block Valve *	3344-MSP-0289	545.00	N/A	N/A
■ 1½" H/O S/S Right Angle 2¾" CFF *	3344-MSP-0290	615.00	N/A	N/A
■ 1½" H/O S/S Right Angle NW-40 Flange *	3344-MSP-0291	503.00	N/A	N/A
■ 1½" A/O S/S Right Angle 2¾" CFF *	3344-MSP-0292	675.00	N/A	N/A
■ 1½" A/O S/S Right Angle KF-40 Flange *	3344-MSP-0293	600.00	N/A	N/A
For V700HT, V1000A Cart Stations				
■ 8" H/O Swing Gate Valve 10" CFF	3344-MSP-0294	2,850.00	N/A	N/A
■ 8" A/O Swing Gate Valve 10" CFF	3344-MSP-0295	3,025.00	N/A	N/A
■ 8" H/O Swing Gate Valve ISO-200 Flange	3344-MSP-0296	3,050.00	N/A	N/A
■ 8" A/O Swing Gate Valve ISO-200 Flange	3344-MSP-0297	3,225.00	N/A	N/A
Foreline Valves				
For V70, V70D, V70LP, V250 Cart and Mini Stations				
NW-16 Electromagnetic Block Valve	3344-MSP-0298	755.00	3344-MSP-0156	755.00
NW-25 Electromagnetic Block Valve	3344-MSP-0299	775.00	N/A	N/A
NW-16 H/O Block Valve	3344-MSP-0300	215.00	3344-MSP-0157	215.00
NW-25 H/O Block Valve	3344-MSP-0301	[illegible]	N/A	N/A
NW-16 A/O Block Valve	3344-MSP-0302	315.00	3344-MSP-0158	315.00
NW-25 A/O Block Valve	3344-MSP-0303	225.00	N/A	N/A
For V300HT, V550, V700HT, and V1000A Cart Stations				
NW-40 Electromagnetic Block Valve	3344-MSP-0304	815.00	N/A	N/A
NW-40 H/O Block Valve	3344-MSP-0305	265.00	N/A	N/A
NW-40 A/O Block Valve	3344-MSP-0306	345.00	N/A	N/A

[illegible] mounting hardware

BEST AVAILABLE COPY

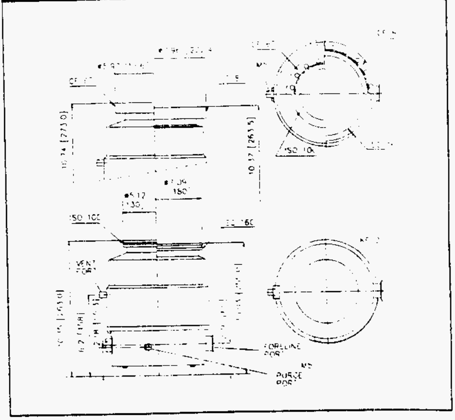
[illegible]

WHC-SD-SNF-CDR-007, REV. 0

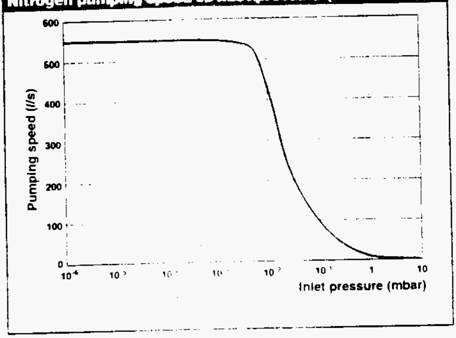
Turbo-V550

NEW

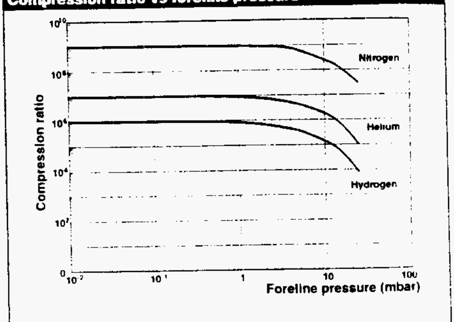
Outline Drawing inches (mm)



Nitrogen pumping speed vs inlet pressure (DN 160 only)



Compression ratio vs foreline pressure



Features

- MacroTorr stages
- Excellent reliability
- High compression ra... ...ight gases
- Standard gas purge ...
- Operation with dr... ...pumps
- Installation in an...
- Ceramic bearings
- Maintenance-fre...

Common Applications

- HV and UHV technology
- Semiconductor process technology
- Physics/research/accelerators
- Electron microscopy
- Industrial applications
- Mass spectrometry

MNL 14

BEST AVAILABLE COPY

H-83

VARIAN

To order, call 1-800-882-7426

Technical Specifications

Pumping speed l/s	N_2 550 He 600 H_2 510
Compression ratio	N_2 > 1 x 10^9 He 1 x 10^7 H_2 1 x 10^6
Base pressure	With recommended mechanical pump < 1 x 10^{-10} mbar (< 1 x 10^{-10} Torr) With recommended diaphragm pump 2 x 10^{-9} mbar (1 x 10^{-9} Torr)
Inlet flange	DN 160 ISO DN 160 CFF (8" OD) DN 100 ISO DN 100 CFF (6" OD)
Foreline flange	NW25 KF
Rotational speed	42,000 RPM
Startup time	5 min
Recommended forepump	Two-stage rotary pump SD 30; Diaphragm pump MD 60
Operating position	Any
Cooling requirements	Forced air Water optional
Bakeout temperature	120°C at inlet flange (CFF version)
Vibration level (displacement)	< 0.01 μm at inlet flange
Operating ambient temperature	+5°C to +35°C
Weight lbs (kg)	ISO: 30.8 (14); CFF: 43 (19.5)

Ordering Information

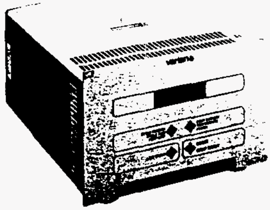
Description	Part Number	Price	Shipping Weight lbs (kg)
Pumps			
Turbo-V550 Pump with ISO 160 inlet flange	969-9049	$11,285 DCM assume	35 (16.0)
Turbo-V550 Pump with 8" CF inlet flange	969-9050	$11,285	48 (21.5)
Turbo-V550 Pump with ISO 100 inlet flange	969-9047	$10,265	35 (16.0)
Turbo-V550 Pump with 6" CF inlet flange	969-9048	$10,265	48 (21.5)
Controllers			
Turbo-V550 standard controller, 220 V	969-9444	$2,590	35 (15.7)
Turbo-V550 standard controller, 120 V	969-9544	$2,590	35 (15.7)
Accessories			
Inlet screen, DN 100	969-9302	$85	1 (0.5)
Inlet screen, DN 160	969-9304	$113	1 (0.5)
Heater band, 120 V	969-9808	$295	2 (1.0)
Heater band, 220 V	969-9807	$295	2 (1.0)
Water cooling kit	969-9318	$75	1 (0.5)
Air cooling kit	969-9314	$330	7 (3.0)
Vibration isolator, ISO 100	969-9342	$1,375	7 (3.0)
Vibration isolator, CF 6"	969-9332	$1,640	7 (3.0)
Vibration isolator, ISO 160	969-9343	$1,985	9 (4.0)
Vibration isolator, CF 8"	969-9333	$2,290	9 (4.0)
Vent flange, NW 10 KF	969-9109	$30	1 (0.5)
Vent device with adjustable delay time	969-9831	$1,150	5 (2.2)
Vent valve with fixed delay time	969-9833	$605	4 (2.0)

Turbo Pumps

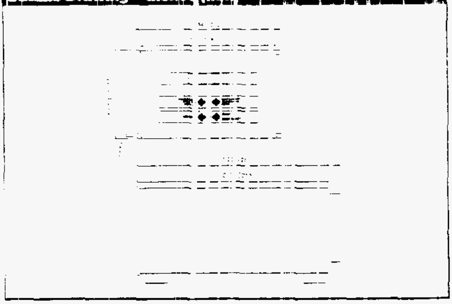
H-84

Standard Controllers for V300HT, V550, and V700HT Pump Series

WHC-SD-SNF-CDR-007, REV. 0



Outline Drawing inches (mm)



These Turbo-V controllers are microprocessor-controlled frequency converters with self diagnostic and protection features that ensure the highest degree of reliability. The compact, ½ rack unit has a multifunction alphanumeric display for pump status and error code diagnostics. The front panel display is a two-line dot matrix LCD display with back lighting. It displays rotational speed as the pump starts up and indicates when full speed is reached. At any time during the operation of the pump, the speed, current, power, and bearing temperature can be displayed. Additionally, the microprocessor acts as a pump cycle log, and can display the number of vacuum cycles, the cycle time for the current cycle, and the total operating hours on the pump. Remote operation can be accomplished with logic level contact closures, and with optional computer interfaces.

PCB controllers are available on request.

Technical Specifications

	V300HT	V550	V700HT
Input	100/120/220/240 V 1 ph, 50/60 Hz	100/120/220/240 V 1 ph, 50/60 Hz	100/120/220/240 V 1 ph, 50/60 Hz
Maximum input power	350 VA	600 VA	600 VA
Output voltage	90 VAC, 3 ph	56 VAC, 3 ph	56 VAC, 3 ph
Output frequency	933 Hz	700 Hz	700 Hz
Maximum output power	250 W	325 W	350 W
Startup power	170 W	420 W	420 W
Operating temperature	0°C to +40°C	0°C to +40°C	0°C to +40°C
Storage temperature	–20°C to +70°C	–20°C to +70°C	–20°C to +70°C

Ordering Information

Description	Part Number	Price	Shipping Weight lbs (kg)
Controllers			
Standard controller for Turbo-V300HT pump, 120 V	969-9524	$2,260	35 (15.7)
Standard controller for Turbo-V300HT pump, 220 V	969-9424	$2,260	35 (15.7)
Standard controller for Turbo-V550 pump, 120 V	969-9544	$2,590	35 (15.7)
Standard controller for Turbo-V550 pump, 220 V	969-9444	$2,590	35 (15.7)
Standard controller for Turbo-V700HT pump, 120 V	969-9545	$2,860	35 (15.7)
Standard controller for Turbo-V700HT pump, 220 V	969-9445	$2,860	35 (15.7)
Accessories			
Output mating connector (input included with controller)	969-9852	$30	1 (0.5)
RS-232 computer communication kit	969-9850	$130	1 (0.5)
RS-422 computer communication kit	969-9849	$130	1 (0.5)
RS-485 computer communication kit	969-9848	$130	1 (0.5)
Extension cable (controller to pump) for V300HT	969-9950L○○○○	$245	7 (3.0)
Extension cable (controller to pump) for V550 and V700HT	969-9951L○○○○	$275	7 (3.0)

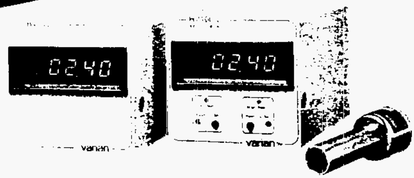
○○○○ Insert the length in centimeters (example: cable 1.5 m long is 969-9950L0150). If the two connectors only are required, order 969-9950L0000 or 969-9951L0000.

H-85

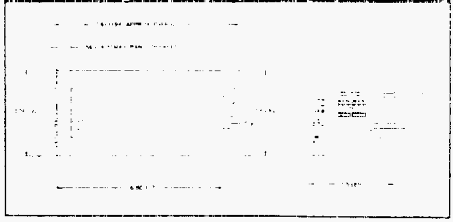
WHC-SD-SNF-CDR-007, REV. 0

High-Vacuum Pirani Gauge

NEW



Outline Drawing Inches (mm)



The Varian HV100 and HV100-2 High-Vacuum Pirani Gauges measure pressure from 0.01 mTorr to 100 mTorr (10^{-5} mbar to 0.1 mbar) and offer precision and high resolution digital electronics. These compact instruments use a newly-developed Pirani sensor which incorporates an upscale trim to improve tracking ability. The extremely rugged sensor is constructed with a solid, inert, noble metal that maintains its calibration over long periods.

Lower operating temperatures in the Pirani-type gauge tube (half that of thermopile gauges) enhances stability as does a unique temperature compensation network. The gauge tubes are matched so they can be replaced without recalibration.

The Varian HV100-2 dual set point controller operates two independently-set control relays. Set point values are easily adjusted from the front panel and displayed on the meter. Push-to-set switches simplify display of the set point pressures, without interrupting the pressure measurement circuit. Relays have 3-ampere, Form C contacts. Screw terminals for the relay outputs are provided on the rear panel.

Both the indicator and the controller instruments feature simple, single-hole installation. The new panel mounting system makes panel mounting as easy as turning a screw. Gauge tubes have ¾ inch O.D. tubulation that fits standard quick connects.

Features	Benefits
• Linear analog output 0 to 1.0 VDC	• Ideal for analytical as well as industrial uses
• Optional dual set points	• Process control with ± 0.02 mTorr (± 2 x 10^{-5} mbar) set point reliability
• 115 VAC, 50/60 Hz; 230 VAC	• Meets all power requirements at no additional cost
• Line regulation	• Change in line voltage produces less than 1% change in reading
• Temperature compensation	• Changes in ambient temperature between 0°C and 50°C change the reading less than 0.004 mTorr (5 x 10^{-6} mbar) per °C at hard vacuum
• Digital LED display	• Crisp, clear, and sharp pressure reading

Gauge Controllers

MNC 15

H-86

VARIAN

[illegible] CD [illegible] R[illegible]

Technical Specifications

[illegible]ge

0.01 mTorr to 100 mTorr
(10^{-5} mbar to 0.1 mbar)

Resolution

± 0.01 mTorr (± 10^{-5} mbar) resolution over [illegible] range

Accuracy

Better than 5% of value or ± 0.03 mTorr (± [illegible] 10^{-5} mbar), whichever is larger

Set Point Range

Adjustable over 100% of range

Set Point Repeatability

± 0.02 mTorr
(± 2 x 10^{-5} mbar)

Recorder Output

0 to 1.000 VDC

G[illegible]e C[illegible]

10 [illegible] attached

L[illegible]

3[illegible]ch (1[illegible] mm) attached

Mounting

P[illegible]ting hardware included

Power Consumption

Approximately 1 watt for indicator
Approximately 2 watts for controller

Net Weight

Indicator 1 lb. 2 oz (0.5 kg)
Controller 1 lb. 6 oz (0.75 kg)

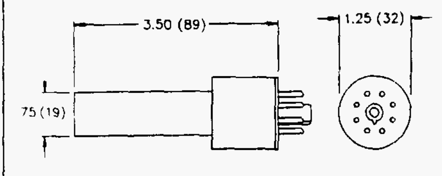
Relays

1 SPDT relay for each set point;
3 amperes at 115 VAC, non-inductive

Calibration

For accurate and easy calibration, an optional vacuum gauge calibrator is available. See Ordering Information for part numbers.

Transducer Dimensions inches (mm)



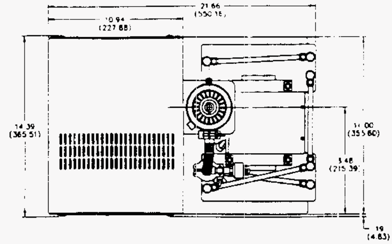
Ordering Information

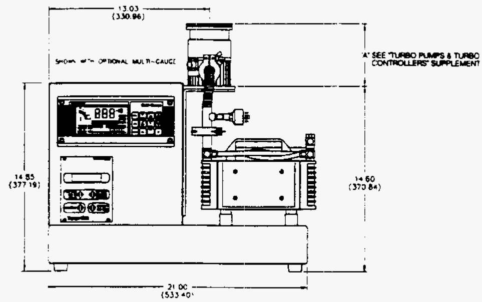
Description	Part Number	Price	Model	Voltage	Shipping Weight lbs (kg)
HV100	6522-08-415	$563	No set points (Torr)	(115 V)	1.0 (0.5)
HV100-2	6522-08-420	$718	Two set points (Torr)	(115 V)	1.5 (0.8)
HV100	6522-08-440	$563	No set points (Torr)	(230 V)	1.0 (0.5)
HV100-2	6522-08-445	$718	Two set points (Torr)	(230 V)	1.5 (0.8)
HV100	6522-08-515	$202	No set points (mbar)	(115 V)	1.0 (0.5)
HV100-2	6522-08-505	$718	Two set points (mbar)	(115 V)	1.0 (0.8)
HV100	6522-08-520	$563	No set points (mbar)	(230 V)	1.0 (0.5)
HV100-2	6522-08-510	$718	Two set points (mbar)	(230 V)	1.5 (0.8)
Calibrator	6528-30-010	$202	(Torr)	–	1.0 (1.5)
Calibrator	6528-30-030	$202	(mbar)	–	1.0 (1.5)
Transducer	6543-25-025	$99	¾" Tubulation	–	1.0 (1.5)
Transducer	6543-25-026	$130	SST, Mini-CF, non-rotatable	–	1.0 (1.5)
Transducer	6543-25-027	$140	SST, Cajon 8 VCR (female)	–	1.0 (1.5)
Transducer	6543-25-028	$140	SST, Cajon 8 VCO (female)	–	1.0 (1.5)
Transducer	6543-25-030	$134	KF16 Flange	–	1.0 (1.5)
Transducer	6543-25-029	$130	SST, KF25 Flange	–	1.0 (1.5)

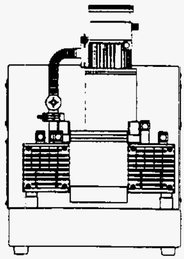
NOTE • Special-length cable quotations are available upon request.

H-87

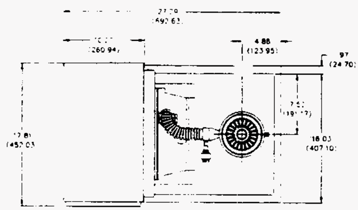
Turbo Pump Mini Station

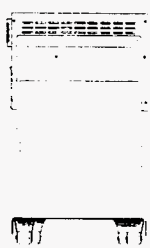






Turbo Cart Pumping Station





Varian 600DS Dry Scroll Pump

VAC-VAC-3042

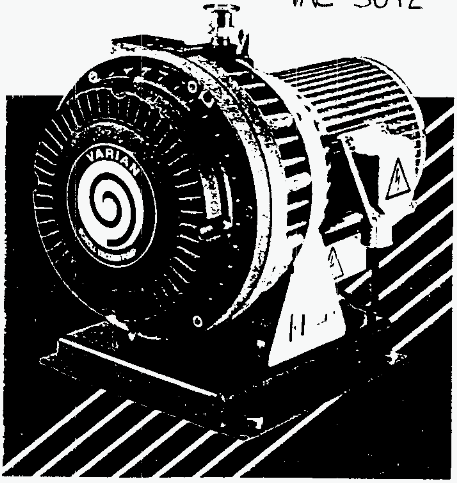
Varian's New 600DS Dry Scroll Pump incorporates a technology that produces clean, cost effective, and reliable vacuum pumping performance.

Unlike many other types of dry pumps, the 600DS has both a low ultimate pressure and high pumping speed. With a base pressure in the 10^{-3} Torr range and superior pumping efficiency, it is suitable for applications where oil-sealed mechanical pumps have typically been used.

In the oil-free scroll pump, crescent-shaped pockets are formed and bounded by the meshed scrolls. As the orbiting scroll moves within the fixed scroll, these pockets progressively decrease in volume as they move the pumped gases in the spiral path from inlet to discharge. Sealing is accomplished with PTFE seals against anodized aluminum walls eliminating the need for oil sealing.

Because the scroll pump is intrinsically clean, there is no risk of contaminating your vacuum system. Conventional oil sealed mechanical pumps require costly accessories (traps and baffles) to achieve only marginal levels of cleanliness. Since no oils are required, the costs of purchasing and disposal of them are eliminated. Few moving parts and carefully chosen materials of construction minimize pump failures, with typical maintenance intervals of twelve to eighteen months. All these factors contribute to low cost of ownership and maximum uptime.

Varian's 600DS Dry Scroll pump is the preferred choice for your clean high vacuum requirements.



Applications

- Turbo, Ion, or Cryo Pumped Systems
- Load Lock Chambers
- Leak Detection Systems
- Optics
- Research
- Any application where the presence of hydrocarbons is detrimental to your process

Features	Benefits
Scroll Design	Low ultimate pressure High speed Compact size Quiet, low vibration operation Two moving parts Long service life
Oil Free	No risk of oil contamination No expensive traps or filters No costs of buying and disposing of oil
Carefully chosen construction materials	Long life operation Low maintenance Low cost of ownership

MNC 16

Free Air Displacement
60 Hz 600 l/m (21 cfm)
50 Hz 500 l/m (17.5 cfm)

Pumping Speed
60 Hz 500 l/m (17.5 cfm)
50 Hz 420 l/m (15 cfm)

Ultimate Total Pressure
$<10^{-2}$ Torr (mbar)

Inlet Connection
NW-40

Outlet Connection
NW-25

Motor Rating
0.8 hp (0.6 kW)

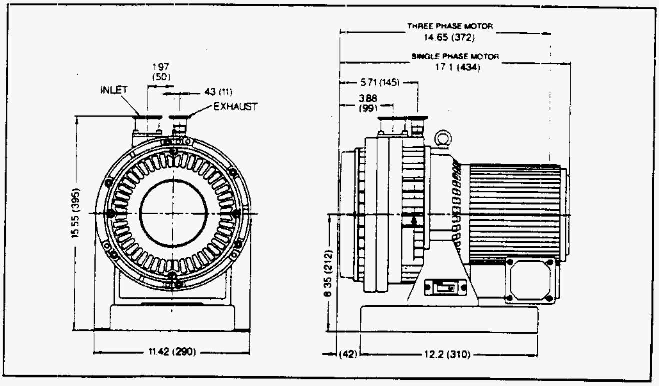
Electrical Supply
1 Phase/60 Hz/120V
3 Phase/60 Hz/208V

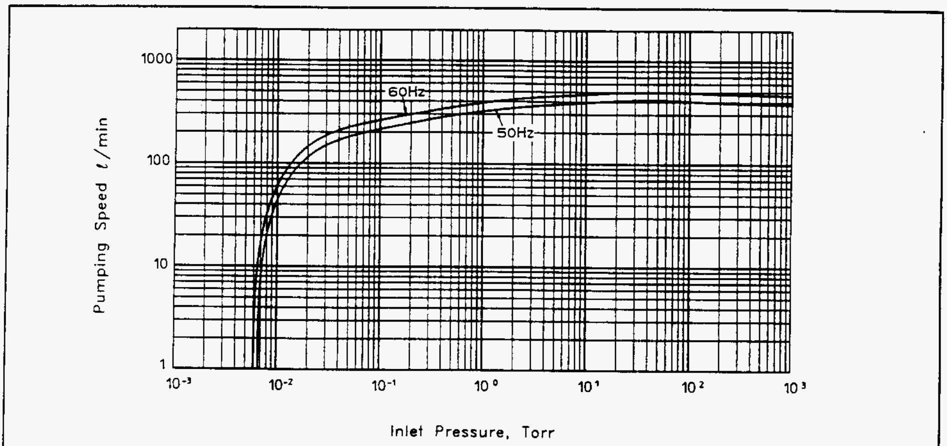
Noise Level at 1 meter
60 dBA

Operating Range
40°F to 105°F (5°C to 40°C)

Weight
88.2 lb (40.0 kg)

Varian Part No.	Description
600DS-16120	Model 600DS with base, hour meter, and direct drive motor (1 ph/60 Hz/120V)
600DS-36208	Model 600DS with base, hour meter, and direct drive motor (3 ph/60 Hz/208V)
600DS-KMI	Minor Maintenance Kit
600DS-KMA	Major Maintenance Kit

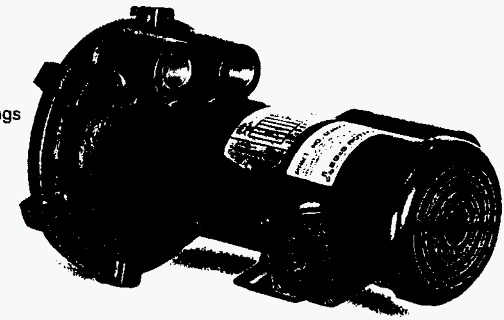




VPS-BLO-1106
$24,068
MNC 36

MD 101
Magnetic-Drive Regenerative Blower

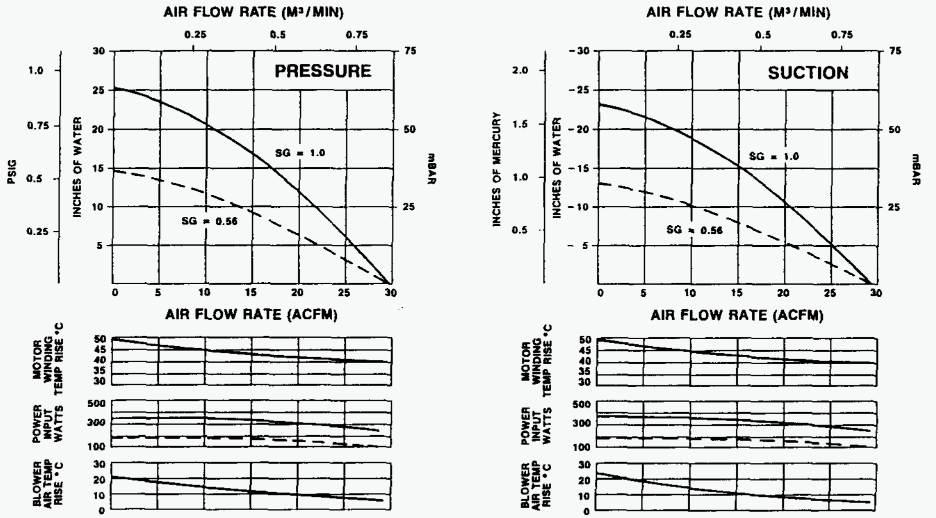
FEATURES
- Hermetically designed seal-less blower
- Continuous operation
- Manufactured in the USA
- Maximum flow: 29 SCFM
- Maximum pressure: 25" WG
- Maximum vacuum: 23" WG
- 0.25 HP TEFC motor standard
- Disconnect motor without disassembling from piping
- Blower construction — cast aluminum housing, impeller and flanges; permanently sealed ball bearings in housing
- Motor construction — permanently sealed ball bearings
- Quiet operation within OSHA standards



OPTIONS
- Explosion-proof motors
- 50 Hz motor
- International voltages
- Corrosion resistant surface treatments

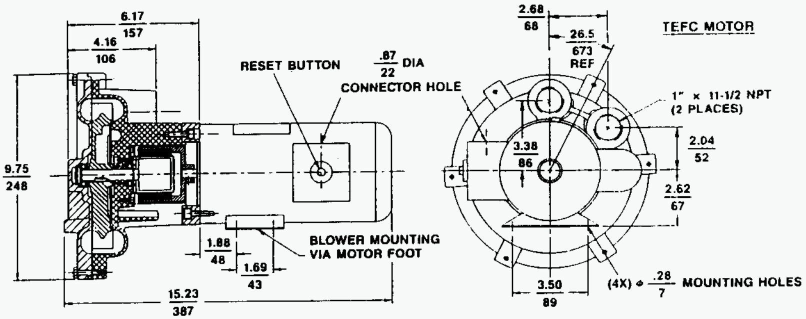
ACCESSORIES
- Moisture separators
- Explosion-proof motor starters
- Inline & inlet filters
- Vacuum & pressure gauges
- Relief valves
- External mufflers

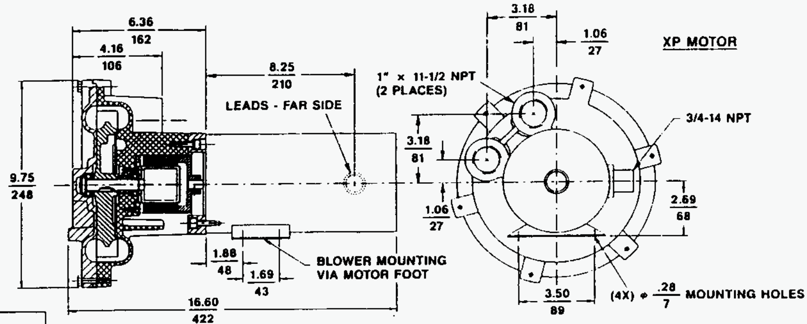
BLOWER PERFORMANCE



EG&G ROTRON

MD 101
Magnetic-Drive Regenerative Blower





DIMENSIONS: IN / MM
TOLERANCES: .XX ± .08 / 2
(UNLESS OTHERWISE NOTED)

A ▷ 0.87 DIAM ON TEFC MOTOR, 0.75" NPT ON XP MOTOR

SPECIFICATIONS

MODEL	MD101CB4	MD101CC4
Part No.	038014	038271
Motor Enclosure Type	TEFC	XP
Horsepower	0.25	0.25
Phase — Frequency	Single - 60 Hz	Single - 60 Hz
Voltage	115	115
Motor Nameplate Amps	2.0	2.6
Maximum Blower Amps	2.2	2.2
Inrush Amps	7.2	7.2
Starter Size	00	00
Service Factor	1.0	1.0
Thermal Protection	Automatic, Manual Reset	Automatic
Bearing Type	Sealed, Ball	Sealed, Ball
Shipping Weight lbs (kg)	40 (18)	40 (18)

Specifications subject to change without notice. Please contact factory for specification updates.

EG&G ROTRON, SAUGERTIES, N.Y. 12477 • 914/246-3401 • FAX 914/246-3802

VPS-CLR-1103

TRANTER, INC.
MAXCHANGER SPECIFICATION SHEET

Date : 06/19/96
Customer : PENTAD ASSOCIATES, INC.

Reference : 013312-18A R00
Item Number: A

Run Number: 3263
Model : MX-03-0412-HP-012 / 0.060

Technician : KLS
Pass Arrangement: 1 x 1

Total Units :1
Units in Parallel :N/A
Units in Series :N/A

Flow Dir: Counter Flow
Total Heat Transfer Area: 2.8 SQ FT

	Hot Side		Cold Side	
Fluid Circulated	HELIUM		WATER	
Total Flow Rate	43.5000	GPM	1.0000	GPM
Unit Flow Rate	43.5000	GPM	1.0000	GPM
Specific Heat	1.2400	BTU/(LB DEG F)	1.0006	BTU/(LB DEG F)
Specific Gravity	0.0001		0.9997	
Thermal Conductivity	0.0900	BTU/(HR FT DEG F)	0.3355	BTU/(HR FT DEG F)
Viscosity	0.0223	CP AT AVG TEMP	1.2970	CP AT AVG TEMP
Inlet Temperature	212.0000	DEG F	50.0000	DEG F
Outlet Temperature	68.0000	DEG F	51.1366	DEG F
Pressure Drop	0.0042	PSI Total	0.0524	PSI Total
Operating Pressure	14.7000	PSIG	60.0000	PSIG

Heat Exchanged 560.2 BTU/HR TOTAL

* CONSTRUCTION
  - ASME code stamp : No
  - Design Pressure : 150 PSIG
  - Test Pressure : 225 PSIG
  - Design Temperature : 350 DEG F
  - Unit Net Weight : 13.0 LBS

Note: This is a hot gas run

* UNIT DIMENSIONS
  - Width : 4.00"
  - Length : 12.00"
  - Height : 1.70"
  - Nozzles : 0.75" / 0.75"

* MATERIALS
  - Plates and Fittings : 316L SS

* REMARKS

Case 1 (modified per 6/12 fax)

Your Tranter Representative is:

PENTAD Associates, Inc.
7950 S. Lincoln, Suite 102
Littleton, CO 80122

(303) 794-4802

$677.00 each + $675. Mass Spec.

*The MAXCHANGER performance guarantee is based on the accuracy of the data presented above, and the customers ability to supply product and operating conditions in conformance with the above.

* single wall construction

PROPOSAL

Pall Advanced Separations Systems™

July 25, 1996

Santa Fe Engineering
2204 Brothers Road
Santa Fe, NM 87505

Attention: Dave Munger

Reference: Pall Proposal Number BP7ACDR96-129PDI

Dear Mr. Munger:

Thank you for your continued interest in ***Pall Advanced Separations Systems*** and our products. I am pleased to offer you this budgetary quotation for an UltraMet™ cleanable, Metal HEPA rated filter.

Operating Conditions:

The filter is designed for the following conditions:

Fluid:	Nitrogen or Helium
Flow:	20 ACFM
Temperature:	0 - 575°F
Pressure:	5 TOR → 10 PSIG

Equipment Description:

The Pall UltraMet™ Air Filter Assembly consists of one (1) 8" diameter, 304 SST filter housing and one (1) 6" diameter x 16" long stainless steel UltraMet™ filter element.

The filter assembly is a completely closed canister that is welded permanently shut. The canister is a cylindrical filter vessel with weld cap ends and 1" 150# ANSI flanged inlet and outlet connections located on the center line of the vessel.

2200 Northern Boulevard • East Hills, NY 11548 • USA • Phone 516-484-5400 • Fax 516-484-5228

PROPOSAL

Pall Advanced Separations Systems™

Pricing:

Prices for the Pall UltraMet™ Air Filter Assembly as described herein are:

Price for one (1) assembly: ....

Price each for three (3) assemblies: ....

Delivery:

Estimated delivery time is 12 - 16 weeks after receipt of a purchase order.

Features & Benefits:

The UltraMet™ Air Assembly offers Santa Fe Engineering advantages:

High Strength:

All stainless steel, fully welded construction.

Cleanable:

The filters can be cleaned using a variety of mechanical methods.

High Temperature Capability:

Sustained operation at 750°F with intermittent temperature excursion to 1100°F.

Safety:

The strength and durability of UltraMet™ Air filters provide maximum protection to people and the environment.

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PROPOSAL

Pall Advanced Separations Systems

Conclusion:

Pall Corporation is a 900+ million dollar, multi-national company and the world's largest producer of fine porous media filters. In order to succeed, it is essential that we provide better value to our customers. We are dedicated to this policy, which is why Pall's filter sales are four to five times that of our nearest competitor. We look forward to the opportunity of working with you to provide a cleanable, high efficiency metal filter system. If you have any questions, or require further assistance, please do not hesitate to contact me directly at (607) 753-6041 Ext. 1680 or Teree Rush of Kyser Company, Inc.

Very truly yours,

Pall Advanced Separations Systems

Paul Dittman
Senior Applications Engineer

CC: Kyser Company, Inc.
5821 Midway Park Blvd. Ne/Suite K
Albuquerque, NM 87109
Contact: Teree Rush
Phone: (505) 343-9355
Fax: (505) 345-0885

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ULTRAMET AIR FILTER GRADES AND THEIR CHARACTERISTICS

VPS-F-1102
VPS-F-1107

Pall Ultramet Air Filter.

Pleated

	GRADE	
	HEPA-1	ULPA-1
PENETRATION		
[illegible]		[illegible]
[illegible] at 0.3 μm [illegible]	[illegible]	
PRESSURE DROP (in w.g./mbar)*		
at 1.5 ft./min / 0.76 cm/s	0.8 in. / 2 mbar	[illegible]
at 2.8 ft./min / 1.4 cm/s	3.5 in. / 8.7 mbar	
at 5.0 ft./min / 2.5 cm/s	5.0 in. / 12.4 mbar	
at 6.5 ft./min / 3.3 cm/s	6.5 in. / 16.2 mbar	

*As measured with standard UltraMet air filter, 6-inch O.D. x 48 inches long.

TABLE 2. FILTER MODULES

GRADE	CAPACITY (ACFM/m³/h) 1000/1700	[illegible]	[illegible]	[illegible]
VESSEL O.D. (in./cm)				
HEPA-1	16/41	38/97	48/122	[illegible]
VESSEL INLET/OUTLET (in./cm)				
HEPA-1	6/15	14/36	20/51	[illegible]
VESSEL MATERIAL OF CONSTRUCTION (stainless steel)				
HEPA-1	304	304	304	304
VESSEL WEIGHT (lb./kg — with filters)				
HEPA-1	850/386	4200/1,909	7,200/3,273	9,200/[illegible]
PRESSURE DROP (in w.g./mbar)* (initial — with filters)				
HEPA-1	3/7.5	3/7.5	3/7.5	3/7.5

SPECIFICATIONS

Filter Medium

Wet Tensile Strength: 25 lb./in. width, minimum, after 15-minute soak in water.

Tensile Strength After Radiation: 25 lb./in. width, minimum, after exposure to an integrated gamma radiation dose of 6.4 x 10⁷ RAD.

Water Repellency: Zero penetration under 30 inches of water per MIL-STD-282.

Water Repellency After Radiation: Zero penetration under 6 inches of water after exposure to 6.4 x 10⁷ RAD.

Filter Elements

Resistance to Heated Air: Resistant to air at 750°F for 48 hours or at 1000°F for 5 minutes per UL-586 and MIL-F51068.

Spot Flame Resistance: No sustained flame on downstream side and no transmittal of flame to outside surfaces per ANSIB132.1.

Resistance to Moisture and Overpressure: No permanent damage after 10 psi water differential for 1 hour.

Resistance to Rough Handling: No damage per MIL-STD-282, method 105.9.

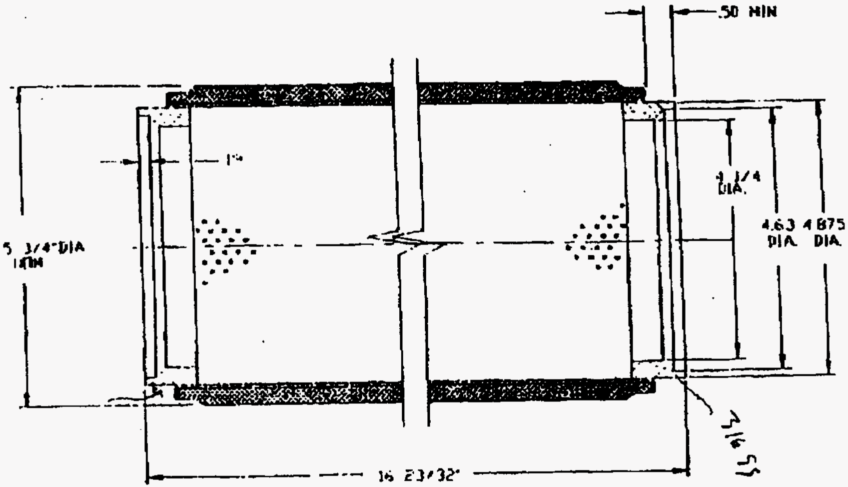
Quality Assurance: To ASME-NQA-1-1989 and in accordance with MIL-F-51079. Certified to ISO9001.

Dust Capacity: 29 gm/ft.² per ASHRAE 52-76.

MNC 31

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 1

To RALPH MANSK	From PAUL DITTMAN
Co. RUST GEO	Co. PALL
Dept.	Phone # 607-753-6041
Fax # 970-248-6090	Fax # 607-858-5747



PALL

PROCESS EQUIPMENT DEVELOPMENT

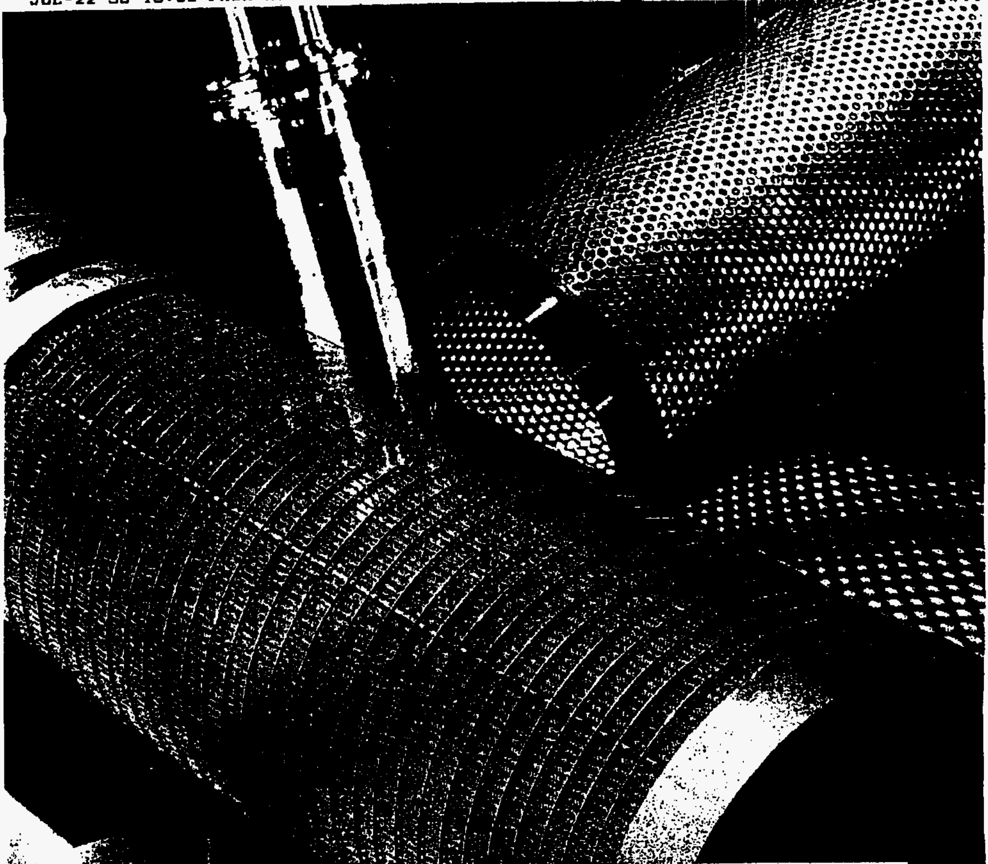
SEMI-FINISHED [redacted]
ULPA MODULE ENVELOPE

	NAME	DATE
	MBV	

PED | 81349 | - | 100 | N/C

HOLD

H-98



Pall Advanced Separations Systems

Pall Corporation
Pall Advanced Separations Systems
2200 Northern Boulevard
East Hills, New York 11548-1289
(516) 484-5400 • 1 (800) 645-6532
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Distributed By:

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AGT11937.5M

PHS-HCL-H52

Small capacity/low flow gas heaters

Stainless steel
0.5 to 3 kW
120 and 240V, 1 phase
Incoloy® sheath (50 W/in²)
Type GCHIS-C

Application

For heating gases, especially efficient for low flow rate/high temperature applications. (Outlet temperatures to 600°F)

Features

Compact, rugged design permits easy installation.

Overtemperature protection. Type K thermocouple located inside heating element sheath.

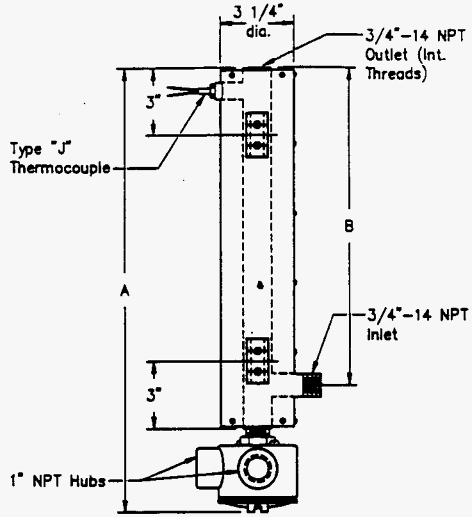
Accurate process control by means of Type J thermocouple installed in the heater outlet.

Controls — ordered separately. Consult Controls Section of this catalog.

High temperature insulation and insulation jacket.

304 Stainless steel construction of all wetted parts except Incoloy® sheath.

Special voltage and wattage ratings available. Contact your local Chromalox representative.



Heater is shown with E-2 construction.

				E-1 Gen. purpose enclosure						E-2 Moisture tight/explosion-resistant encl.					
kW	Volts	Circ.	Phase	Catalog No.	Status	PCN	Dim. In. A	Dim. In. B	Wt. lbs.	Catalog No.	Status	PCN	Dim. In. A	Dim. In. B	Wt. lbs.
Stainless steel vessel construction/Incoloy sheath element (50 W/in²)															
0.5	120	1	1	GCHIS-C05	NS	024483	14	8	3	GCHIS-C05E2	NS	024555	14	8	3
0.5	240	1	1	GCHIS-C05	NS	024491	14	8	3	GCHIS-C05E2	NS	024563	14	8	3
→1.0	120	1	1	GCHIS-C10	NS	024504	20	14	4	GCHIS-C10E2	NS	024571	20	14	4
1.0	240	1	1	GCHIS-C10	NS	024512	20	14	4	GCHIS-C10E2	NS	024580	20	14	4
2.0	120	1	1	GCHIS-C20	NS	024520	32	26	5	GCHIS-C20E2	NS	024598	32	26	5
2.0	240	1	1	GCHIS-C20	NS	024539	32	26	5	GCHIS-C20E2	NS	024600	32	26	5
3.0	240	1	1	GCHIS-C30	NS	024547	44	38	6	GCHIS-C30E2	NS	024619	44	38	6

$6765.00

MNC 29

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VPS-VAC-1104

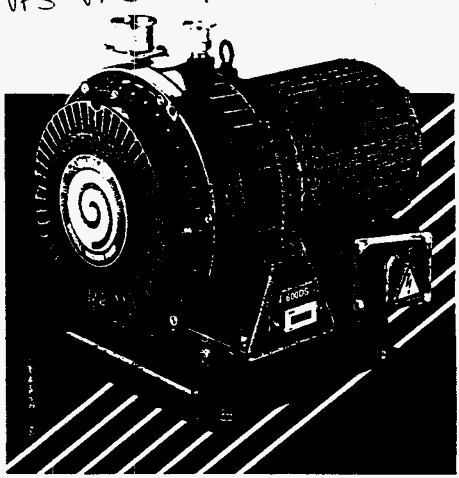
Varian's New 600DS Dry Scroll Pump incorporates a technology that produces clean, cost effective, and reliable vacuum pumping performance.

Unlike many other types of dry pumps, the 600DS has both a low ultimate pressure and high pumping speed. With a base pressure in the 10^{-3} Torr range and superior pumping efficiency, it is suitable for applications where oil-sealed mechanical pumps have typically been used.

In the oil-free scroll pump, crescent-shaped pockets are formed and bounded by the meshed scrolls. As the orbiting scroll moves within the fixed scroll, these pockets progressively decrease in volume as they move the pumped gases in the spiral path from inlet to discharge. Sealing is accomplished with PTFE seals against anodized aluminum walls eliminating the need for oil sealing.

Because the scroll pump is intrinsically clean, there is no risk of contaminating your vacuum system. Conventional oil sealed mechanical pumps require costly accessories (traps and baffles) to achieve only marginal levels of cleanliness. Since no oils are required, the costs of purchasing and disposal of them are eliminated. Few moving parts and carefully chosen materials of construction minimize pump failures, with typical maintenance intervals of twelve to eighteen months. All these factors contribute to low cost of ownership and maximum uptime.

Varian's 600DS Dry Scroll pump is the preferred choice for your clean high vacuum requirements.



- Turbo, Ion, or Cryo Pumped Systems
- Load Lock Chambers
- Leak Detection Systems
- Optics
- Research
- Any application where the presence of hydrocarbons is detrimental to your process

■ Scroll Design	■ Low ultimate pressure ■ High speed ■ Compact size ■ Quiet, low vibration operation ■ Two moving parts ■ Long service life
■ Oil Free	■ No risk of oil contamination ■ No expensive traps or filters ■ No costs of buying and disposing of oil
■ Carefully chosen construction materials	■ Long life operation ■ Low maintenance ■ Low cost of ownership

H-101

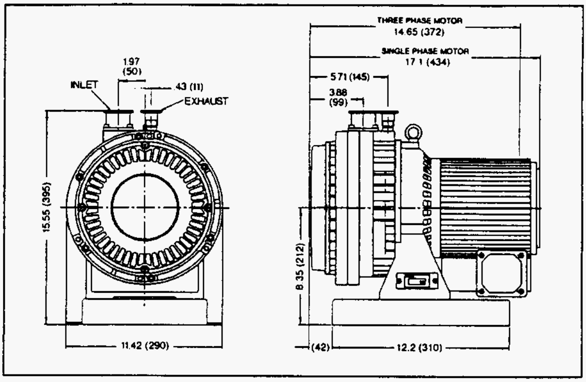
MNL 16

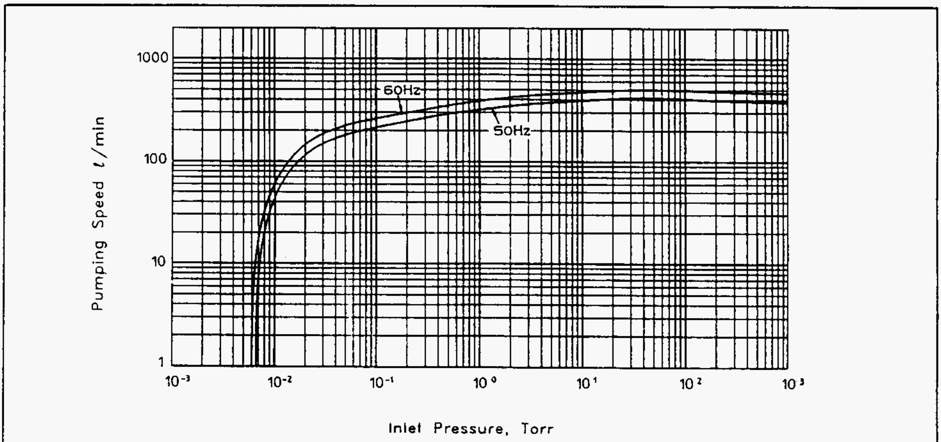
DC

WHC-SD-SNF-CDR-007, REV. 0

- **Free Air Displacement**
60 Hz 600 l/m (21 cfm)
50 Hz 500 l/m (17.5 cfm)
- **Pumping Speed**
60 Hz 500 l/m (17.5 cfm)
50 Hz 420 l/m (15 cfm)
- **Ultimate Total Pressure**
<10^{-2} Torr (mbar)
- **Inlet Connection**
NW-40
- **Outlet Connection**
NW-25
- **Motor Rating**
0.8 hp (0.6 kW)
- **Electrical Supply**
1 Phase, 50/60 Hz, 100/115/200/230 V
3 Phase, 50/60 Hz, 200/208/230/380/415/460 V
- **Noise Level at 1 meter**
60 dBA
- **Operating Range**
40°F to 105°F (5°C to 40°C)
- **Weight**
88.2 lb (40.0 kg) 1 Phase
100 lb (45.0 kg) 3 Phase

Varian Part No.	Description
600DS-1UNIV	Model 600DS with base, hour meter, and direct drive, 1 phase motor
600DS-3UNIV	Model 600DS with base, hour meter, and direct drive, 3 phase motor
600DS-KMI	Minor Maintenance Kit
600DS-KMA	Factory Rebuild Service





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APPENDIX I

CRITERIA EVALUATION

CRITERIA EVALUATION
for the
HOT CONDITIONING SYSTEM EQUIPMENT
of the
K-BASIN SPENT NUCLEAR FUEL STORAGE PROJECT

1.0 INTRODUCTION

Spent Nuclear Fuel (SNF) is to be conditioned by heating it in an inert (helium) environment, by holding the heated SNF under vacuum until the outgassing rate diminishes, and by controlled oxidation of exposed uranium surfaces. The process will be accomplished by placing a container full of SNF, called the Multiple Canister Overpack (MCO), into an oven where it will be connected to a process system that can circulate gas through the MCO and that can draw a vacuum within the MCO while the oven heats the MCO. The hot conditioning process development and the hot conditioning process equipment design, fabrication, and installation are the scope of the Hot Conditioning System Equipment (HCSE) project.

The HCSE is to be housed in an addition to the Canister Storage Building (CSB) called the Hot Conditioning System Annex (HCSA). The HCSA is to be coupled to the CSB such that it is completely open to the storage area of the CSB. This arrangement allows the MCO Handling Machine (MHM) to perform transactions of MCOs between storage tubes that are below the CSB floor and the HCSE ovens that must also be in tubes below the floor for proper MHM interfacing. The HCSA is a separate project from the HCSE being performed through an addition of scope to the CSB project.

The interface of the HCSE/HCSA/CSB projects determines many of the criteria for the HCSE. The CSB utilizes work performed previously as part of the Hanford Waste Vitrification Project (HWVP). The building foundation was completed previously and the final design of the CSB building has been issued for review in preparation of an immediate construction start. Therefore, the structural and nuclear material release confinement criteria have been selected and implemented for the CSB. Since there will be no wall between the HCSA and the CSB, the same criteria must also apply to the HCSA.

The CSB facility design is based on the fact that the MCO will always be secondarily contained within very rigid/protected structures (below ground storage holes with thick concrete plug caps or within the MHM) that will be qualified to perform the confinement functions required during and after credible Design Basis Accidents (DBAs). Therefore, the CSB design does not include a building shell and ventilation system designed to perform nuclear material confinement. It follows that the HCSA will not have a building shell or ventilation system designed to perform nuclear material confinement.

Given that the HCSE does have the potential of accidentally releasing radioactive material through a variety of scenarios caused by a variety of initiators, the responsibility of providing nuclear material confinement systems to adequately protect site workers and the off-site public lies with the HCSE project. This fact is fundamental to the selection and interpretation of appropriate criteria given below.

2.0 FACILITY CLASSIFICATION CRITERIA

2.1 DOE STD -1027 "Hazard Categorization"

The design of a nuclear facility necessarily requires iteration between design concept development, hazards analysis, and criteria definition in order to arrive at a consistent package of criteria and designs. This is because the hazard classification (HC), which is key to the criteria selection and design characteristics of the facility can be controlled to some extent by controlling the amount and form of the radioactive materials that will be present in the process systems and facility. The performance categorization (PC) of structures, systems, and components (SSCs) that are subjected to postulated Design Basis Accidents (DBAs) is dependent on the HC. And, the determination of whether an SSC is "safety class" or "safety significant" is determined by the off-site consequences (safety class) or on-site consequences (safety significant) of releases that might occur as a result of DBAs. However, calculation of consequences requires some model of the facility and the processes that it contains. PC and safety class determinations imply certain structural loads and analysis, as well as special design features to assure that there are no single point failure modes for an SSC.

DOE Order 5480.23, "Nuclear Safety Analysis Reports", requires that a Hazard Categorization (HC) be performed for planned nuclear facilities for the purpose of establishing a graded approach to safety analysis. Ratings range from HC-1 for the most hazardous rating to HC-4 for non-nuclear facilities. The methodology for assessing the Hazard Category is given in DOE STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports".

APPENDIX I - CRITERIA EVALUATION

In a general sense DOE STD - 1027 defines HC's as follows:

- HC-3: Hazard analysis shows potential for only significant localized consequences. Facilities with quantities of radioactive materials in excess of the Table A-1 values which would yield a does of 10 Rem in 24 hrs at 30 m using the calculation method given in Attachment 1.
- HC-2: Hazard analysis shows potential for significant on-site consequences. The facility has potential for nuclear criticality events or has quantities of material at risk and energy sources to effect a release that would exceed 1 Rem exposure at a distance of 100 m. using the calculation method given in Attachment 1, or would require on-site emergency planning activities.
- HC-1: Hazard analysis shows the potential for significant off-site consequences. Category A reactors (> 20 MW) and facilities designated by PSO.

The STD - 1027 methodology is based on comparing the radiological inventory of a facility to HC Threshold Quantities (TQ) provided in Attachment 1. The Standard recognizes that large quantities of radioactive materials may be present in a facility, but in a containment vessel, distribution, or a form that precludes release, and which need not be counted in the inventory when making the HC determination.

- "The concept of independent facility segments should be applied where facility features preclude bringing material together or causing harmful interaction among from a common severe phenomena. .... It is not desirable to estimate the potential consequences from an inventory of hazardous materials when facility features would preclude bringing this material together. Therefore, the standard permits the concept of facility segmentation provided the hazardous material in one segment could not interact with hazardous materials in other segments."
- "Additionally, material contained in DOT Type B shipping containers (with or without overpack) may also be excluded from summation of a facilities radioactive inventory."
- "Alternatively, for facilities initially classified as Hazard Category 2, if release fractions can be shown to be significantly different than these values based on physical and chemical form and available dispersive energy sources, the threshold inventory values for Category 2 in Table A-1 may be divided by the ratio of the maximum potential release fraction to that found on Page A-9. All

assumptions which are used to reduce the inventory at risk should be supported in the Hazards Analysis."

Facilities that have radioactive material inventories in excess of the HC-2 may be derated to HC-3 by demonstrating that hazardous material is not part of the at-risk inventory and by scaling the threshold values according to the ratio of realistic facility specific release fractions to the release fractions that were assumed when the thresholds were established. A discussion of the TQ assumptions and calculations is given in Attachment 1 of the standard.

At this time, the Hazards Analysis for the HCSE/HCSA is being performed. Preliminary results suggest that the MCO package will limit the postulated releases to levels that will not exceed the site boundary (public exposure) limitation. The hazard category rating for the HCSE/HCSA facility and process support systems that confine releases will be HC-2 (the same as the CSB) .The HCSA and HCSE will not have any safety class SSCs. The consequences for onsite workers are expected to exceed the limits that are allowed without mitigating SSCs. Therefore, the HCSA/HCSE projects will provide safety significant SSCs to confine releases.

Given that the CSB/HCSA structures are not designed to confine releases and the CSB/HCSA facilities do not include HEPA filtered exhaust, the HCSE must provide the safety significant SSCs.

2.2 DOE STD - 1021 "Performance Categorization"

DOE Order 5480.28, "Natural Phenomena Hazards Mitigation" establishes a graded approach for determining the Performance Categorization PC of a Structure, System, and Component (SSC) when subjected to Natural Phenomena Hazards based on the probability that SSC response will exceed a safety limitation. Guidance for PC determination is given in DOE STD 1021-93, "Natural Phenomena Hazards Performance Categorization Criteria for Structures, Systems, and Components". Figure 1-1 of STD 1021 summarizes the guidance. It can be seen from the table that SSCs that perform a safety significant function in an HC-2 facility will be rated PC-2.

PC-2 rating does not require dynamic finite element analysis. The critical facility static analysis methodology given in UBC may be applied to HCSE safety significant SSCs such as the process piping, HEPA filters, and so forth.

2.3 DOE 6430.1A "Facility Type Categorization"

The HCSA will be a "Nuclear Facility" as defined in the glossary of terms (page 21). Therefore, it will be a "Special Facility" as defined by paragraph 1300-1.1. The criteria given in Division 13 "Special Facilities" are the basic guidance for the design of the HCSA and HCSE. Application of Division 13 requirements involves the general requirements given in Section 1300 as well as the requirements given in the applicable facility type section. In addition, the special facilities specific paragraphs labeled - 99.0 in the Discipline Divisions apply.

The HCSA will be classified as an Irradiated Fissile Material Storage Facility (IFMSF) because it is an extension of the CSB. As discussed above, the HCSE is an active process that could have accidental releases with a higher frequency than a passive SNF storage facility and some amount of radioactivity may be withdrawn from the MCO as a normal process practice. The inclusion of this HCSE process within the IFMSF does not alter the CSB criteria so long as the HCSE includes its own confinement SSCs.

2.4 10 CFR Part 72 "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel And High Level Radioactive Waste"

The DOE has stated that it generally desires to comply with the requirements of the CFRs except for the licensing requirements, except for those instances and facility types that are not specifically addressed by the CFRs, and except for those instances where the DOE policies are more conservative than the requirements of the CFRs.

The CSB will comply with the requirements of 10 CFR Part 72 because it is an SNF Storage Facility. The HCSA, as an extension of the CSB will also be considered to be an Independent Spent Fuel Storage Installation. This classification is dependent upon designing the HCSE so that it confines nuclear releases without reliance on the facility structure and systems.

3.0 DESIGN CRITERIA

3.1 DOE Orders & Standards

Table 3.1 contains a list of DOE Orders and DOE Technical Standards that contain provisions that will effect features of the design of the HCSE/HCSA or that may effect the contents of the engineering/design documentation of the HCSE/HCSA.

APPENDIX I - CRITERIA EVALUATION

A brief description of each of the entries is as follows:

5400.1 General Environmental Protection Program -This order states that environmental notification and reporting requirements are to be determined on a facility case by case basis. It requires an annual environmental report which is essentially an emissions summary. It requires that an environmental protection plan and an environmental monitoring plan be developed and approved. These should be approved before authorization to initiate operations is given. The HCSE design will have to include appropriate monitoring capability.

APPENDIX I - CRITERIA EVALUATION

DOE ORDERS SUMMARY

ORDER/ STANDARD	TITLE
5400.1	General Environmental Protection Program
5400.3	Hazardous and Radioactive Mixed Waste Program
5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements
5400.5	Radiation Protection of the Public and the Environment
5440.1E	National Environmental Policy Act Compliance Program
5480.1B	Environment, Safety, and Health Program
5480.4	Environmental Protection, Safety and Health Protection Standards
N5480.6	DOE RadCon Manual
5480.7A	Fire Protection
5480.9	Construction Safety and Health Program
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports
5480.28	Natural Phenomena Hazards Mitigation
5481.31	Start-Up and Restart of Nuclear Facilities
5483.1A	Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities
5700.6C	Quality Assurance
5820.2A	Radioactive Waste Management
6430.1A	General Design Criteria
STD-0101	Compilation of Nuclear Safety Criteria for Potential Application to DOE Non-Reactor Nuclear Facilities
STD-1020	Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities
STD-1021	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
STD-1022	Natural Phenomena Hazards Site Characterization

APPENDIX I - CRITERIA EVALUATION

DOE ORDERS SUMMARY
(Continued)

ORDER/ STANDARD	TITLE
STD-1024	Guidelines for Use of Probabilistic Seismic Hazard Curves at DOE Sites
10CFR835	Radiation Exposure
STD-1027	Guidance For Preliminary Hazard Classification and Accident Analysis Techniques for Compliance With DOE Order 5480.23, Safety Analysis Reports
STD-1044	Guide To Good Practices for Equipment and Piping Labeling
STD-3003	Backup Power Sources for DOE Facilities
STD-3006	Planning and Conduct of Operations Readiness Reviews
STD-3009	Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports
STD-3011	Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans
40CFR61	National Standards for Hazardous Air Pollutants

5400.3 Hazardous and Radioactive Mixed Waste Program - This order implements RCRA in the DOE. The HCSE will generate radioactive waste that is regulated by RCRA.

5400.4 CERCLA Requirements -This order implements CERCLA in the DOE.

5400.5 Radiation Protection of the Public and the Environment -Sets limits on public doses from normal operations. Defines Derived Air Concentrations and implements ICRP recommendations.

5440.1E NEPA Compliance Program - This order implements the National Environmental Protection Act in the DOE.

5480.1B Environment, Safety, and Health Program - This document is the master document for the 5480 series of orders.

5480.4 Environmental Protection, Safety, and Health Protection Standards - This order implements a list of regulations that apply to private organizations but which are not automatically applied to the DOE. The order is a useful reference list.

APPENDIX I - CRITERIA EVALUATION

N5480.6 DOE RadCon Manual - This notice sets policy regarding radiation exposure limits, radiation area practices, and ALARA considerations. A design program is required to achieve the ALARA goal. The guideline also contains criteria governing the design of change rooms and other radiation/radioactive material control procedures. One key criteria is the ALARA design guideline of 500 mR per year for an individual radiation exposure.

5480.7A Fire Protection - This order relates to nuclear facility safety issues such as fire protection of safety class equipment, fire hazards analysis for the design basis fire to be included in the SAR, seismic criteria for the fire protection system, and life safety codes. It sets forth provisions that address loss limitation for government owned facilities.

5480.9 Construction Safety and Health Program -This order implements requirements found in the OSHA regulations regarding construction safety. Construction specifications should reference appropriate requirements.

10CFR835 Radiation Protection for Occupational Workers - This document sets the requirements for radiation exposure protection and As Low As Reasonably Achievable (ALARA) policy.

5480.19 Conduct of Operations Requirements for DOE Facilities - Safety of workers and protection of the public requires that nuclear facilities be formally managed by operations program that meets high standards of discipline. In the nuclear power, NRC, arena the conduct of operations requirements are specified by the ICRP. This order implements similar requirements for facilities regulated by the DOE. It addresses operations procedures, shift changes, operator training, and so forth. The design team will write a draft Conduct of Operations Plan.

5480.21 Unresolved Safety Questions - Is analogous to 10CFR50.59. Establishes a process for changing the operating basis of the facility. Allows the operator the freedom to perform experiments and investigate safety issues that may arise while conducting day-to-day operations.

5480.22 Technical Safety Requirements - This order requires that safety limits for the operating parameters of the facility be established, that procedures for assuring that these limits are not exceeded be established, that these parameters be monitored, and that response actions for conditions outside the safety limits be determined.

5480.23 Nuclear Safety Analysis Reports - This order applies in its entirety because it is the document that defines the requirements for safety analysis and SARs, which are the means of demonstrating that the public/environment and workers are adequately protected. The major impacts on the project are:

- A preliminary hazards analysis is to be performed and published. Guidance is given by DOE STD - 1027.
- A Preliminary Safety Analysis Report (PSAR) is to be developed. The PSAR is developed simultaneously with design. There is iteration between safety analysis and design. The PSAR analysis demonstrates that the design adequately mitigates the consequences of the hazards presented in the hazards analysis.
- A Final Safety Analysis Report is to be developed. This report updates the PSAR to reflect the as-built facilities and incorporates the operating procedures for the facilities.

5480.28 Natural Phenomena Hazards Mitigation - Establishes requirements for response of facilities to natural phenomena such as earthquakes and high winds.

5480.31 Start-up and Restart of Nuclear Facilities - Sets out requirements for authorization to initiate operations utilizing nuclear materials. Essentially this document establishes the DOE "licensing" criteria. The Operating Readiness Plan should be written by the design team. Th plan should follow the guidance of DOE-STD-3006.

5483.1A Occupational Safety and Health Program for DOE Contractor Employees at Government Owned Contractor Operated Facilities - This order implements OSHA within the DOE.

5700.6C Quality Assurance - The document is analogous to ASME NQA-1 which is a nuclear facilities quality assurance guideline required by DOE 6430.1A.

5820.2A Radioactive Waste Management - This order requires a waste management plan, has D&D requirements, and sets waste characterization standards, as well as establishing numerous other requirements that affect both the design and operations of the CVDS.

6430.1A General Design Criteria - This order sets forth design criteria for all engineering disciplines as well as special facility and special equipment criteria. Facility type classification and safety class SSC requirements are discussed in Section 2..3 above.

Key confinement system ventilation requirements are referred to ERDA 76-21 and to the 1550-99 paragraphs of the order. The key statement comes from 1550-99.0.1 "General Ventilation and Off-Gas Criteria", "These criteria cover ventilation and off-gas systems, or portions of them, that are identified as safety class items in accordance with Section 1300-3.2, Safety Class Items". Strictly speaking, this means that the HCSE will not be governed by these requirements. None-the-less the principles stated in 1550-99.0.2 "Confinement Ventilation Systems" should be followed as a matter of good engineering practice (except where specific references to the safety class characteristics of the system are made). The basic design concepts for exhaust filtration performance and stack design should be derived from safety analysis that analyzes the consequences of credible release scenarios.

Section 1300-12 "Human Factors Engineering" requires that a human factors program plan be written. The level of detail of the plan is to be determined by the complexity or safety issues associated with human activities. The subsections also set out extensive human factors requirements for human factors engineering. The HCSE should write and implement a plan given that the radiation exposure during operations can severely restrict the staff planning.

STD-0101 Compilation of Nuclear Safety Criteria For Potential Application to DOE Non-Reactor Nuclear Facilities - This STD contains a listing of references.

STD-1020 Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities - This standard gives guidance regarding the selection of design criteria to be applied to nuclear facilities structural design.

STD-1021 Natural Phenomena Hazards Performance Categorization Guidelines For Structures, Systems and Components - See discussion in Section 2.2.

STD - 1022 Natural Phenomena Hazards Site Characterization - The site NPHs have been characterized by the CSB project.

STD - 1024 Guidelines For Use of Probabilistic Seismic Hazard Curves at DOE Sites - Seismic hazards risks have been established for the HCSA/HCSE by the CSB project.

STD-1027 Guidance for Preliminary Hazard Classification and Accident Analysis Techniques for Compliance With DOE Order 5480.23, Safety Analysis Reports - See discussion in Section 2.1.

STD - 1044 Guide To Good Practices For Equipment and Pipe Labeling - Sets forth guidelines for labeling equipment and piping.

STD -3003 Backup Power Sources For DOE Facilities - There is no safety requirement for backup power in the CVDS. The guidance in the is guideline will be followed if backup power is included for other reasons.

STD-3006 Planning and Conduct of Operations Readiness Reviews - ORR planning will be addressed by the design team in order to assure that the necessary engineering documentation is ready for the ORR.

STD-3009 Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports - See discussion in Section 2.1.

STD-3011 Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans - These plans will be drafted as part of the design process.

40CFR61 National Standards for Hazardous Air Pollutants - This sets forth restrictions on the release amount of those materials considered by this standard to be hazardous air pollutants.

3.2 NRC Equivalency

Report WHC-SD-SNF-DB-003 Rev.1, December, 1995, "Spent Nuclear Fuel Project Path Forward Additional NRC Requirements" addresses implementation of the U.S. DOE K Basin Spent Nuclear Fuel Regulatory Policy (August 4, 1995) to achieve "nuclear safety equivalency" to comparable U.S. Nuclear Regulatory Commission (NRC) licensed facilities. This report addresses the project as a whole. Each of the components of the project is required to look at application for the specific features of the components. This section addresses application of each of the 29 items in WHC-SD-SNF-DB-003 to the HCSE as follows:

1. Fire Protection - Assure that DOE 5480.7A and DOE 6480.1A are equivalent to 10 CFR50, Appendix R. There are significant hazards associated with the event that a hot MCO undergoing conditioning might be suddenly flooded with fire water. A Fire Hazards Analysis will be performed to determine appropriate fire protection system features.

2. Response to Natural Phenomena Hazards. The key difference is that NRC includes a Design Basis Tornado and missile analysis. The CSB and HCSA will not be designed to perform nuclear release confinement in the event that they are struck by a tornado. The HCSE will contain appropriate tornado resistant features (such as oven installation in

covered pits) and will also rely on probabilistic arguments for specific targets.

3. In the event that safety class 1 electrical equipment may be required and may be exposed to harsh environments ..... The HCSE will not have any safety class 1 SSCs requiring power to function.

4. SAR should include a loss of power accident analysis. The HCSE will be designed to shut down safely to a passive condition in the event of a (Loss Of operating Power) LOOP incident. LOOP analysis is standard practice in DOE 5480.23 safety analysis as prepared according to DOE-STD-3009.

5. Incorporate the requirements of IEEE Std 484-1987 into the design and installation of safety class 1 batteries. The HCSE will not have safety class 1 batteries.

6. Incorporate the requirements of IEEE Std 535-1986 into the design and installation of safety class 1 batteries. The HCSE will not have safety class 1 batteries

7. Incorporate the requirements of IEEE Std 603-1991 into the design of safety class 1 instrumentation and control systems. The HCSE will not have any safety class 1 instrumentation and control systems.

8. Incorporate the requirements of ANSI/ANS 8.3 1986 for criticality alarm systems. The HCSE will not have a criticality alarm system because criticality cannot occur in the process.

9. Human factors planning and engineering. See discussion about the DOE 6430.1A human factors engineering requirements in Section 3.1 above.

10. Use Regulatory Guide 1.26 to assist in assigning appropriate code class to ASME Section III systems and components. The HCSE will not contain any ASME Section III systems or components.

11. Regulatory Guides 1.84 and 1.85 regarding application of ASME Section III requirements to safety class 1 systems. The HCSE will not have any safety class 1 systems.

APPENDIX I - CRITERIA EVALUATION

12. Ensure that the requirements of ANSI/ANS 509 and ANSI/ANS 510 are incorporated into HEPA filter design. The NRC and DOE 6430.1A requirements are the same. HEPA filter systems will be designed and specified according to these standards.

13. Incorporate the requirements of ANSI/ANS 57.1 and 57.2. Does not apply to the HCSE since there will be no cranes.

14. Incorporate the applicable design requirements of Generic Letters 88-14, 89-10, and 89-13 into safety class 1 ..... The HCSE will not have safety class 1 SSCs.

15. 10 CFR Part 21 requires that manufacturers of procured items report defects in items or services for safety class 1 SSC procurement. Standard clause in WHC procurement terms and conditions. The HCSE will not have any safety class 1 SSCs.

16. 10 CFR 830.120 Quality Assurance program requirements. The normal DOE requirements for compliance with DOE 5700.6c exceeds this requirement. The HCSE will follow the DOE requirements.

17. 10 CFR 50.55 requires reporting of unusual occurrences during construction. This is covered by WHC-CM-1-5. The HCSE will observe this requirement.

18. 10 CFR 50, Appendix B Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants. The normal DOE requirements for compliance with DOE 5700.6c exceeds this requirement. The HCSE will follow the DOE requirements.

19. Institute a process to identify safety class 1 equipment that has been identified in the commercial nuclear power industry via IE Bulletins and Notices as being potentially defective. The HCSE will not have safety class 1 SSCs.

20. 10 CFR Part 20 - incorporate control devices for access to high radiation areas that conform to the requirements of Section 20.161. The requirement will be met by means of installing shielding and by use of a process enclosure that prevents access to the high radiation area above an oven when the top is open.

APPENDIX I - CRITERIA EVALUATION

21. Apply the radiological exposure criteria of Section 72.104 .... The criteria will be met.

22. Use a deterministic value of 5 Rem in safety analyses for the onsite worker at the boundary of the controlled area (100 m from the CVDS release point) for design basis accidents to assist in determining safety class 2 and 3 SSCs (refs. 10 CFR 72.106, .100, .126). 10 CFR Part 72 requirements do not apply to the CVDS. The DOE orders and STDs do not address safety class 2 and 3 specifically. Equivalently they discuss SSCs that are safety significant to encompass those systems that protect on site workers and plant workers. The DOE criteria is 1 Rem at 100 m., which is more restrictive than the referenced NRC requirement.

23. Implementation of RG 8.8, *Information Relative to Ensuring That Occupational Radiation exposures at Nuclear Power Stations Will Be As Low As Reasonably Achievable, Rev. 3*, DOE requirements from DOE N 5480.6 are more restrictive than RG 8.8. The design process will include a thorough ALARA analysis that estimates exposure considering source trems, work sequences, and anticipated repair requirements.

24. Implementation of RG 3.26, *Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants* or RG 3.48 *Standard Format and Content of Safety Analysis Reports for an Independent Spent Fuel Storage Installation (Dry Storage)*. The safety analysis methodology established for the CSB will be implemented. The HCSE project will assume that the CSB project has complied with this requirement.

25. Review the monitoring requirements of 10 CFR 20, 10 CFR 70.59, 10 CFR50, Appendix A. These are analogous to DOE 6430.1A 1589-99.0.1. which is a project requirement stated above in DOE 6430.1A review in Section 3.1.

26. The 10 CFR 50, Appendix 50 general design criteria are adequately covered by the application of the criteria in this report.

27. Incorporate a criticality safety value of keff = 0.95. The CVDS cannot achieve a critical condition. Criticality analysis for the configuration of the SNF inside the MCO will be the responsibility of the MCO design team. No criticality analysis will performed as part of the HCSE project.

28. Review ANSI/ANS 57.9 and RG 3.60 which set forth ISFSI design criteria. These criteria affect the CSB and HCSA projects but do not effect the HCSE project.

29. Identify items that are "important to safety" in accordance with 10 CFR 72.3 and impose safety class 1 requirements. Items that are important to safety will be identified and treated as safety significant items.

4.0 NUCLEAR SAFETY PROGRAM CRITERIA

Key nuclear facility safety documents that define public safety aspects of the HCSE/HCSA criteria are discussed in Sections 2.1 through 2.4 above. The key DOE Orders are the DOE 5480 series and the DOE 5400 and 5500 series.

Worker radiation exposure safety within the plant is defined by 10 CFR 835 and DOE N5480.6. Of these the DOE N5480.6 is the most comprehensive and restrictive document. A program to achieve radiation exposure As Low As Reasonably Achievable with an administrative control limitation of 500 mrem per year per person is the stated whole body exposure criteria in DOE N 5480.6. 10 CFR 835 defines the DOE ALARA design target as 1.0 Rem per year. The HCSE design criteria will the DOE N 5480.6 value (500 mrem) unless features required to achieve this value prove to be unreasonable (in which case the 10 CFR 835 of 1.0 rem will be observed).

5.0 OPERATIONS PREPARATIONS CRITERIA

The transition from the end of the HCSE construction project to operations will be an Operations Readiness Review. This review will be conducted according to the requirements of DOE 5480. 31. The ORR will determine that the facility is complete, that the safety analysis is complete, that TSRs (DOE 5480.22 and DOE STD -3011, 1082) are complete, that appropriate design criteria have been established and met, that systems operations tests are complete, that personnel training has been completed (DOE STD 1005, 1007, 1008, 1009, 1011, 1056, 1060, 1070, 1074, 1078) that safety programs are operational (DOE STD - 1082), that an appropriate conduct of operations program (DOE 5480.19 and DOE STD - 1032, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1045, 1051, 1054, 1055) is in place, that emergency preparedness programs are appropriate. In order to activate the transition and ORR plan is required per DOE STD-3006. This plan should be developed in parallel with the detailed design.

APPENDIX I - CRITERIA EVALUATION

Addendum 1 - Listing of Reference Criteria Documents

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
DOE DIRECTIVES					
DOE 1300.2A Technical Standards Program				X	No Design Impact
DOE 1324.5B Records Management		X		X	No Design Impact
DOE 1332.1A Uniform Reporting System	X			X	WACs also apply No Design Impact
DOE 1360.2B Records Management Program				X	No Design Impact
DOE 1540.1A Materials Transport & Traffic Management				X	No Design Impact
DOE 1540.2 Hazardous Material Packaging				X	WACs also apply No Design Impact
DOE 1540.3A RM Transportation Packaging				X	No Design Impact
DOE 4330.4B Maintenance Management				X	No Design Impact
DOE 4700.1 Project Management	X		X	X	No Design Impact
DOE N 4700.5 Project Control Guidelines	X				Expired a/21/94
RLID 4900.1			X		Has been cancelled
DOE 5000.3B Occurrence Reporting				X	
RLID 5000.3B Occurrence Reporting				X	Use DOE 5000.3B
RLID 5000.12			X		Has been cancelled
DOE 5300.1C Telecommunications		X		X	No Design Impact
DOE 5400.1 Environmental Protection				X	WACs also apply
DOE 5400.2A Environmental Compliance Issue Coord				X	
DOE 5400.3 Hazardous and Mixed Waste Program					
DOE 5400.4 CERCLA Requirements				X	WACs also apply
DOE 5400.5 Radiation Protection				X	Use HSRCM-1 also
DOE 5440.1E NEPA Compliance				X	WACs also apply
DOE 5480.1B ES&H Program				X	
DOE 5480.3 Safety for HAZMAT Transportation				X	WACs also apply No Design Impact
DOE 5480.4 ES&H Protection Standards				X	WACs also apply
DOE 5480.6 Safety of Nuclear Reactors				X	No Design Impact
DOE 5480.7A Fire Protection		X		X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
DOE 5480.8A Contractor Medical Program				X	WACs also apply No Design Impact
DOE 5480.9A Construction Safety & Health				X	WACs also apply
DOE 5480.10 Contractor Hygiene Program				X	WACs also apply No Design Impact
DOE 5480.11 Radiation Protection for Workers				X	Use HSRCM-1
DOE 5480.18B Training Accreditation Program				X	
DOE 5480.19 Conduct of Operations		X		X	
DOE 5480.20A Personnel Selection, Qualification, Training				X	
DOE 5480.21 Unreviewed Safety Questions				X	
DOE 5480.22 Tech. Safety Requirements				X	
DOE 5480.23 Nuclear SARs				X	
DOE 5480.24 Criticality Safety		X		X	No Design Impact
DOE 5480.26 Trending				X	No Design Impact
DOE 5480.28 Natural Phenomena		X		X	
DOE 5480.29 Employee Concerns Management				X	No Design Impact
DOE 5480.31 Readiness Review				X	
DOE 5481.1B Safety Analysis and Review System				X	No Design Impact
DOE 5482.1B ES&H Appriasal Program				X	WACs also apply No Design Impact
DOE 5483.1A OSHA for Contractors				X	WACs also apply No Design Impact
DOE 5484.1 ES&H Reporting				X	WACs also apply No Design Impact
DOE5500.1B Emergency Management System				X	Use DOE action only. See 10CFR840 also
DOE 5500.2B Emergency Categories				X	
DOE 5500.3A Planning for Emergencies				X	
DOE 5500.7B Emergency Records Protection				X	WACs also apply No Design Impact
DOE5500.10 Emergency Readiness Assurance				X	No Design Impact
DOE 5630.11B Safeguards and Security				X	No Design Impact
DOE 5630.12A S&S Inspection				X	No Design Impact

Addendum 1 to Appendix I

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
DOE 5630.15 S&S Training				X	No Design Impact
DOE 5632.1C Protection and Control S&S Interests				X	No Design Impact
DOE 5633.3B Control and Accountability of Nuc Mat				X	No Design Impact
DOE 5700.6C Quality Assurance				X	Use project QA plan.
DOE 5700.7C Work Authorization				X	For DOE action only.
DOE 5820.2A Radioactive Waste Management				X	
DOE 6430.1A Design Criteria		X		X	
DOE-STD-0101 - Compilation of Nuclear Safety Criteria for Potential Application to DOE NRNF					
DOE-STD-1020-94 Nat Phen Haz Design & Eval Crit				X	
DOE-STD-1021-94 Nat Phen Haz Perf Cat Guidelines				X	
DOE-STD-1022-94 Nat Phenomena Haz Site Char Crit				X	
DOE-STD-1023-95 Natural Phenomena Hazards Assessment Crit				X	
DOE-STD-1024 - Guidelines for Use of Probabilistic Seismic Hazard Curves at DOE Sites					
DOE-STD-1027 - Guidelines for Prelim Haz Class & Accident Analysis to comply with DOE 5480.23					
DOE-STD-1044 - Guide to Good Practices for Equipment and Piping Labeling					
DOE-STD-3003 Backup Power Sources for DOE Facilities					
DOE-STD-3006 Planning and Conduct of ORRs					
DOE-STD-3009-94 Prep Guide for DOE Non-Reactor Nuc SARs				X	
DOE-STD-3011 - Guidance for Preparation of TSR and SAR Implementation Plans					
DOE-M-5632.1C-1 Protection and Control of S&S				X	No Design Impact
DOE/EH-0173T Effluent Monitoring				X	WACs also apply
DOE/EP-0108 Fire Protection for Elec Comp/Data Proc				X	
DOE/EV-0043 Fire Protection for Portable Structures				X	No Design Impact
DOE/EV-1830-TS Guide to Reducing Rad Exposure to ALARA				X	
DOE Memorandum Revised Policy for Acceptance for ER				X	
RLID 1360.2B Unclassified Computer Security				X	No Design Impact

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN O20	COMMENT
RLID 5480.7 Fire Protection				X	
RLID 5480.29 RL Employee Concerns Program				X	No Design Impact
RLID 5480.31 Startup and Restart of Nuclear Facilities				X	
RLID 5484.1A EPS&H Reporting Requirements				X	No Design Impact
DOE/RL 92-36 Hoisting & Rigging		X		X	
DOE/RL 93-102 Fy 95 Mission Plan				X	No Design Impact
DOE/RL-XX Systems Engineering Criteria			X		Document not approved by RL.
DOE-STD-1073-93 Guide for Configuration Management			X		For guidance only.
SEN 15-90 NEPA				X	WACs also apply
SEN 35-91 Nuclear Safety Policy				X	Use HSRCM-1
HPS-SDC-4.1, Rev 12 Facility Design Loads		X		X	Applicable Seismic Criteria
HPS-SDC-5.1 HVAC				X	
SNF-RD-PM-001 SNF Program Requirements				X	
WASHINGTON ADMINISTRATIVE CODES					
51-13 Energy Code		X		X	
173-160 Construction and Maint of Wells				X	
173-201A Water Quality Standards				X	
173-200 Water Quality for Ground Water				X	
173-216 Waste Discharge Permit Program				X	
173-218 Underground Injection				X	
173-224 Water Discharge Permit Fees				X	
173-240 Sub of Plans for Waste Water Fac				X	
173-303 Dangerous Waste Regulations		X		X	
173-304 Min Stds for Solid Waste Handling				X	
173-307 Plans				X	
173-340 Model Toxic Control Regs				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
173-360 UST Regulations				X	
173-400 General Regulations for Air Poll Sources				X	
173-401 Operating Permit Regulations				X	
173-460 Controls for Toxic Air				X	
173-480 Air Quality for Radionuclides				X	
197-11 SEPA Rules				X	
246-247 Radioactive Air Emmissions				X	
246-247-050 Registration				X	
246-247-060 Air Emissions Permit				X	
246-249 Rad Waste, Use of Commercial Site				X	
246-272 On Site Sewage Systems				X	
246-290 Public Water Supplies				X	
402-40 Wash Std for Prot Against Radiation				X	
446-50 Transportation of Hazardous Wastes				X	
Tri Party Agreement				X	
REVISED CODE OF WASHINGTON					
36.58 Washington Solid Waste Disposal				X	
36.94 Sewage, Water and Drainage Systems				X	
43.21C State Environmental Policy				X	Implemented by WAC
43.200 Washington Radioactive Waste Act				X	
46.37 Vehicle Lighting and Other Equipment				X	
46.44 Size, Weight, Load				X	
49.17 Wash Industrial Safety and Health Act				X	
70.94 Washington Clean Air Act				X	Implemented by WAC
70.95 Solid Waste Management Reduction & Recycle				X	
70.96 Washington Underground Storage Tanks				X	
70.105 Hazardous Waste Management				X	Implemented by WAC

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
70.105D Toxic Control Act				X	Implemented by WAC
90.03 Water Code				X	Implemented by WAC
90.42 Washington Water Resource Management				X	Implemented by WAC
90.44 Regulation of Public Groundwaters				X	Implemented by WAC
90.48 Water Pollution Control				X	Implemented by WAC
90.52 Pollution Disclosure Act				X	Implemented by WAC
90.76 Underground Storage Tank				X	
ICRP PUBLICATIONS					
37 Rad. Protect Cost		X		X	Use HSRCM-1
NUCLEAR REGULATORY COMMISSION					
NRC Reg Guide 1.36 Thermal Insulation		X			
NUREG 0700 Control Room Design		X			
NUREG CR-3264 ALARA Maintenance		X			Use HSRCM-1
COMMERCIAL & MILITARY STANDARDS/GUIDES					
American Water Works 61		X			
ICBO Uniform Building Code		X			
NFPA-70 National Electric Code		X			
ORNL TM-10864 Remotely Maintained Equipment Des Guide		X			
PAL-1988 Health Physics Manual		X			
MIL-STD-1472D Human Engineering		X			
ANSI/ASME					
ASME B31.1 Refinery Piping		X			
ASME 14.5 Dimensioning and Tolerancing		X			
NQA-1 Quality Assurance		X			
CODE OF FEDERAL REGULATIONS					
10 CFR 20 Radiation Protection Standards		X		X	Use HSRCM-1 DOE 5480.11
10 CFR 50 Domestic Licensing of Production & Util				X	Section 50.48 and App R for NRC equivalency
10 CFR 51 Regulations for Licensing				X	Not applicable to SNFP

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
10 CFR 71 Radioactive Pkg & Trans				X	Use 49 CFRs
10 CFR 72 Licensing of Spent Fuel Storage		X		X	Not Applicable
10 CFR 73 Protection of Plants and Materials				X	Use RLID 5632.1B
10 CFR 436 Life Cycle Cost Methods & Procedures				X	Not Applicable
10 CFR 830.120 Quality Assurance	X	X		X	
10 CFR 835 Radiation Protection		X		X	
10 CFR 840 Extraordinary Nuclear Occurances					
10 CFR 961 Std Contact for Disposal of SNF & HLRW				X	
10 CFR 1021 NEPA				X	Use WAC
29 CFR 1910 OSHA Act		X		X	
29 CFR 1926 Construction OSHA				X	
40 CFR 6.302g Fish & Wildlife				X	
40 CFR 52 Ambient Air Quality				X	Use WAC
40 CFR 58 Ambient Air Quality Surveillance				X	
40 CFR 60 Stds of Perf for New Stationary Sources				X	
40 CFR 61 Haz Air Emissions Stds				X	Use WAC
40 CFR 122 Permitting Reqmnts for Land Disp Fac				X	
40 CFR 124 Procedures for Decision Making				X	
40 CFR 125 Criteria and Stds for NPDES				X	
40 CFR 191 Management & Disposal of SNF & TRW				X	
40 CFR 240 Guidelines for Thermal Processing				X	
40 CFR 241 Guidelines for Land Disp of Solid Waste				X	
40 CFR 260 Haz Waste Management System				X	
40 CFR 261 Identification and Licensing				X	
40 CFR 262 Stds Applicable to Generators				X	Use WAC
40 CFR 264 Stds for Owners & Operators				X	WACs also apply

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
40 CFR 265 Interim Status Standards				X	
40 CFR 268 Land Disposal Restrictions				X	Use WAC
40 CFR 271 Req for Auth of State Haz Waste Prog				X	
40 CFR 300 Nat Oil & Haz Sub Poll Cont Plan				X	
40 CFR 1500 Purpose, Policy and Mandate				X	
40 CFR 1501 NEPA & Agency Planing				X	
40 CFR 1502 Environmental Impact Statement				X	
40 CFR 1503 Commenting				X	
40 CFR 1504 Predecision Referrals				X	
40 CFR 1505 NEPA & Agency Decision Making				X	
40 CFR 1506 Other Requirements of NEPA				X	
40 CFR 1507 Agency Compliance				X	
40 CFR 1508 Terminology & Index				X	
41 CFR 109 DOE Property Management				X	For DOE action only
43 CFR 11 Nat Resources Damage Assessments				X	
49 CFR 172 Dims for Placard Holder				X	
49 CFR 173 Requirements for Pack & Ship				X	
49 CFR 393 Parts & Accessories Nec for Safe Op				X	
49 CFR 566 Manufacturer Identification				X	
49 CFR 567 Certification				X	
49 CFR 571 Federal Motor Vehicle Safety Stds				X	
US CODE					
15 USC 2601 Toxic Substance Act				X	Use RCW
16 UCS 661 Protection and Conservation of Wildlife				X	
16 USC 1531 Endangered Species Act				X	
16 USC 2901 Fish and Wildlife Conservation				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
25 USC 3001 Native American Graves Protection				X	
29 USC 651 Occupational Safety & Health				X	
33 USC 1251 Clean Water Act				X	
42 USC 1996 American Indian Religious Freedom				X	
42 USC 2011 Atomic Energy Act				X	
42 USC 4321 NEPA of 1969				X	Use RCW
42 USC 5801 Energy Reorganization Act of 1974				X	
42 USC 6901 Solid Waste Disposal				X	
42 USC 7101 DOE Organization Act				X	
42 USC 7401 Clean Air Act	X			X	Use RCW
42 USC 9601 Compensation and Liability				X	
42 USC 10101 Nuclear Waste Policy Act				X	
49 USC 1802 Haz Materials Transportation Act				X	
46 FR 42237 Responses to Environmental Stds				X	
EO-12316 Responses to Environmental Stds				X	
PL 92-500 Clean Water Act				X	Use RCW
PL 101-189 Defense Authorization Act				X	Implemented by CFRs
"WHC" DOCUMENTS					
HSRCM-1 Hanford Rad Control Manual		X		X	
CM 1 Company Policies and Charters				X	
CM 1-3 Requirements & Procedures				X	
CM 1-5 Std Operating Procedures				X	
CM 1-8 Work Management				X	
CM 2-2 Material Management Manual				X	
CM 2-3 Property Management Manual				X	
CM 2-5 Management Control System			X	X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN O20	COMMENT
CM 2-6 Data Administration Standards				X	
CM 2-10 Cost Accounting Manual				X	
CM 2-14 Haz Material Packaging & Shipping				X	
CM 2-15 Training Administration				X	
CM 3-5 Document Control				X	
CM 3-10 Software Practices		X		X	
CM 4-2 Quality Assurance		X		X	
CM 4-3 Industrial Safety				X	
CM 4-5 QA Qual & Instructions				X	
CM 4-6 Compliance Assurance				X	
CM 4-7 Unclassified Computer Security				X	
CM 4-11 ALARA Program Manual				X	
CM 4-14 Radiological Controls				X	
CM 4-16 Dosimetry/Medical Services				X	
CM 4-29 Criticality Safety		X		X	
CM 4-33 Security Manual				X	
CM 4-35 Safeguards Material Control				X	
CM 4-38 NDE Process				X	
CM 4-40 Industrial Hygiene				X	
CM 4-41 Fire Protection				X	
CM 4-43 Emergency Management				X	
CM 4-44 Emergency Preparedness				X	
CM 4-46 Safety Analysis		X		X	
CM 4-50 Safeguards Accounting				X	
CM 5-4 Laboratories Administration				X	
CM 5-8 Pu Finishing Plant Administration				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
CM 5-9 PUREX/UO3 Plant Administration				X	
CM 5-13 K Basins Policy Manual				X	
CM 5-16 Solid Waste Management				X	
CM 5-34 SWD Operations Administration				X	
CM 6-1 Standard Engineering Practices		X	X	X	
CM 6-2 Project Management				X	
CM 6-3 Drafting Standards				X	
CM 6-10 Welding Manual				X	
CM 6-12 Project Procedures				X	
CM 7-4 Environmental Monitoring				X	
CM 7-5 Environmental Compliance		X		X	
CM 8-7 Operations Support Systems				X	
CM 8-9 Workmanship Standards				X	
EP-0009 Acronyms and Abbreviations				X	
EP-0063-4 Solid Waste Acceptance				X	
EP-0231-5 Surplus Facilities Program Plan				X	
EP-0496 Pollution Prevention Implementation				X	
EP-0722 Systems Engineering F&Rs				X	
EP-0779 Architecture Systhesis Basis				X	
EP-0830 SNF Path Forward			X		
GG-DWG-01 Preperation & Control of Drawings				X	
GG-DWG-02 Layering Conventions				X	
GG-DWG-03 Drawing Index	X	X			
GG-DWG-04 Parts List/BOM	X	X			
GH-CLIM-01 Hanford Site Climate Data		X			
IP-0117 Procedure Development				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
IP-0240 Operating Procedures Format				X	
IP-0263 Bldg Emergency Plan East Patrol Bldg				X	
IP-0382 Nuclear Materials Safeguards Users				X	
IP-0565 Safeguards Disk Procedures				X	
IP-0821 Plutonium Operation Admin				X	Not applicable to SNFP
IP-0836 Order Compliance Admin				X	Not applicable to SNFP
IP-1026 Engineering Practice Guidelines				X	
IP-1043 Occupational ALARA Program				X	Use HSRCM-1
IP-1117 Systems Engineering Manual			X		
IP-1140 Procedure Development & Control Services				X	
S-0436 Performance Specifications	X				
SD-GN-DGS-30011 Radiological Design Guide		X		X	
SD-GN-ER-1006 K-Basin Floor Loads				X	
SD-GN-ES-30006 Criteria for Uniform Bolting Preloads				X	
SD-MA-SPP-001 Welding Procedure Supporting Document				X	
SD-NR-SA-024 Structural Feasibility of Consolidation				X	
SD-SNF-CM-001 SNF Configuration Management			X		
SD-SNF-CM-003 SNF Interface Control			X		
SD-SNF-DB-004 SNF Project Seismic Design Criteria, NRC Equiv.					
SD-SNF-DGS-001 K-Basin Design Guidelines				X	
SD-SNF-SD-002 SNF Technical Baseline			X		
SD-SNF-SD-003 SNF Technical Baseline			X		
SD-SNF-SEMP-001 SNF Engr Management Plan	X				
SD-SNF-TI-009 Design Basis Feed Preparation				X	
SD-SNF-TI-012 Underwater Fuel Survey				X	
SD-WM-OSR-006 OSRs for KE & KW Basins				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
SD-WM-SAR-062 SAR for N-Reactor Fuel				X	
SN-SNF-SP-005 Integrated Process Survey				X	
SNFP-SE-006 Managing SNF			X		
SNF-RD-PM-001 Program Requirements Document				X	
SP-078 Conduct of Operations Manual				X	
SP-0843 FMEF Maintenance Inspection Plan				X	
SP-0866 Conduct of Maintenance				X	Use WHC-SP-0835
SP-1144 Path Forward Acquisition Strategy				X	Has been replaced
SP-1148 SNF Project Management Plan			X		
OTHER DOCUMENTS					
Imp Plan for DNFSB 92-3 & 92-7			X		
DOE-RL 95-AHW-003 Approval of Path Forward				X	Has been replaced.
DOE-RL 95-SFD-132 Approval of Path Forward				X	Has been replaced.
DOE-RL 95-SFD-135 Additional IPS Comments				X	
Memo of Agreement on Path Forward				X	
Revised Policy of Acceptance for ER			X		
Hanford Site Systems Engr Manual			X		Not specific to SNFP
Site Sys engr config Mngmt Plan			X		Not specific to SNFP
Sitewide Sys Engr Management Plan			X		Not specific to SNFP
DNFSB 92-3-HB Operational Readiness Review				X	
DNFSB 92-7 Training and Qualifications				X	
DNFSB 94-1 DNFSB Safety Board Recommendation				X	
Memorandum, 3/1/95 SNF Vulnerability Action Plan				X	
Record of Decision Prog SNF Management & INEL ER&WM				X	
Future Site WG				X	
FY1995 Hanford Mission Plan Vol 1, Site Guidance, Sept 1994				X	
MRP 1.1 Managing DOE Directives				X	
MRP 2.16 Processing Control Manual Sys Proc				X	
MRP 4.16 Administering Progressive Discipline				X	
MRP 4.19 Overtime and Shift Diff for Nox-Exempt Emp				X	

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
MRP 5.44 Waste Minimization Program				X	
MRP 6.15 Facility Shutdown, Standby & Transfer				X	
WHC 9553866-Letter Rec Ingegrated Process Strategy				X	
DOE EM-36, 9 Nov 94 Lytle Ltr to Grumbly, App of Path Forward				X	Not specific to SNFP
ADDITIONAL NRC REQUIREMENTS					
WHC-SD-SNF-DB-002, Table 5.b As relates to fire protection					Confirm Safety Class Fire Protection not req.
10 CFR Part 50.48 & Appendix R As relates to fire protection					Confirm Safety Class Fire Protection not req.
10 CFR Part 72.122(c) As relates to fire protection					Confirm Safety Class Fire Protection not req.
Regulatory Guide 1.76 As relates to tornado criteria					Not applicable, No Safety Class equipment
SECY-93-087 As relates to tornado criteria					Not applicable, No Safety Class equipment
NUREG/CR-4461 As relates to tornado criteria					Not applicable, No Safety Class equipment
Potential Revisions to SRP-3.5.1.4, Rev 2 As relates to tornado criteria					Not applicable, No Safety Class equipment
WHC-SD-SNF-DB-002, Table 5.c As relates to tornado criteria					Not applicable, No Safety Class equipment
10 CFR Part 72.24 As relates to tornado criteria					Not applicable, No Safety Class equipment
10 CFR Part 72.122 As relates to tornado criteria					Not applicable, No Safety Class equipment
Reg Guide 1.97, Section 50.49(e) (5) As relates to Safety Class 1 electrical equipment					Not applicable, No Safety Class equipment
Reg Guide 1.89, Section 50.49 (f) (1-4) As relates to Safety Class 1 electrical equipment					Not applicable, No Safety Class equipment
10 CFR Section 50.63, Loss of all alternating current power					Evaluate loss of ac power
IEEE Std 484-1987 As relates to safety class 1 batteries					
IEEE Std 535-1986 As relates to safety class 1 batteries					
IEEE Std 603-1991 As relates to safety class 1 I&C systems					Not applicable, No Safety Class equipment
ANSI/ANS-8.3-1986 As relates to criticality alarm systems					Confirm that criticality is not possible
NUREG - 0700 Review against DOE6430.1A					Review
SRP 18.1 Review against DOE6430.1A					Review
Reg Guide 1.26 - As relates to assigning appropriate ASME Section III code classes					Use to assist
Reg Guide 1.84 and 1.85 - As relates to assigning ASME Section III for Safety Class I cases					Not applicable, No Safety Class equipment

REFERENCED DOCUMENT	IS IN SOW	IS IN 0435	IS IN SEMP	IS IN 020	COMMENT
ANSI/ANS N509-1989, ANSI/ANS N510-1989 As relates to Safety Class 2 & 3 HVAC systems					Applicable
Reg Guide 1.140 As relates to Safety Class 2 & 3 HVAC systems					Applicable
ANSI/ANS-57.1 and ANSI/ANS-57.2 As applies to lifting MCOs and Casks					Not Applicable, MCOs & casks not lifted
Generic Letters 88-14, 89-10 and 89-13 - As applicable to Safety Class 1 mechanical systems					Not applicable, No Safety Class equipment
WHC-CM-4-2 App. A, E13, Rev 1 - As applicable to safety class 1 procurement specifications					Not applicable, No Safety Class equipment
10 CFR 830.120 - Applys to changes in WHC QA Plan WHC-SP-1131					DOE ROO to review & approve changes
10 CFR 50.55(e), DOE 5000.3B, WHC-CM-1-5, Section 7.1, Rev 0 Conditions of Construction Permits					Implement WHC Occur Reporting System
10 CFR Part 50, Appendix B and 10 CFR 72 Subpart G Apply WHC quality requirements to SNFP					Ensure WHC quality reqs remain in effect
IEN 95-29 As applies to potentially defective Safety Class 1 equipment.					Review bulletins
10 CFR Section 20.1601, Section 20.1003, Section 20.1301 As applies to high radiation areas					Not applicable, no high radiation areas as defined
10 CFR Section 72.104 - Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS					
10 CFR Section 72.106 Controlled areas of an ISFSI or MRS					5 rem for onsite worker from DBA
Reg Guide 8.8 - As applies to piping design considerations for systems that carry radioactive material.					Applicable
10 CFR Section 72.24 and Reg Guide 3.48 - As applies to requirements not in DOE 5480.23 and DOE-STD-3009-94					Applicable to SARs
10 CFR 20, 10 CFR 70.59, and 10 CFR 835 - As applicable to effluent monitoring.					Applicable
10 CFR 50, Appendix A, General Design Criteria - As applicable to nuclear safety equivalency.					Review during definitive design
SRP 9.1.2, Rev 3, and NUREG-0612					Incorporate a criticality values of 0.95 for Keff.
ANSI/ANS-57.9-1992 Design Criteria for an Independent SNF Storage Installation					Applicable only to CSB
10 CFR Section 72.3 - As applies to Important to Safety SCCs and consider them as Safety Class 1.					No applicable SCCs

APPENDIX J

OPERABILITY AND MAINTAINABILITY ASSESSMENT

APPENDIX J - OPERABILITY AND MAINTAINABILITY ASSESSMENT

OPERABILITY AND MAINTAINABILITY ASSESSMENT for the HOT CONDITIONING SYSTEM EQUIPMENT of the K-BASIN SPENT NUCLEAR FUEL STORAGE PROJECT

1.0 INTRODUCTION

The purpose of this report is to assess the operability and maintainability of the Hot Conditioning System Equipment Of The K-Basin Spent Nuclear Fuel Storage Project as described in the Conceptual Design Report.

Beyond ensuring that the process system will perform its intended function, a key design criteria is ensuring that the mechanical and electrical systems can operate reliably under expected conditions with acceptable maintenance requirements while simplifying operation and maintenance by site operations personnel. Operability and maintainability are important to the efficient performance of process functions within predetermined schedules, determining manpower requirements, controlling maintenance costs, and keeping worker radiation exposure ALARA.

The level of development of the design in progress affects the type of assessment that can be performed and the format of its results. A design in a conceptual phase necessarily lacks details to permit a detailed assessment. Instead, the most important potential findings of a conceptual design review would be conclusions that particular design concepts are flawed to the point that detailed design could not be expected to be satisfactory. This would require a change to the design concept.

The next most important findings of an operability and maintainability review of a conceptual design are identification of the most significant challenges facing the detailed designer in achieving a satisfactory final product. Next, any other observations made while looking for the above two types of findings should be mentioned. Finally, specific recommendations are offered.

This report will follow the format described above.

2.0 SUMMARY OF RESULTS

There are no apparent conceptual design flaws which would threaten the beginning of detailed design. Overall design, layout, and equipment selection present no major operability or maintainability concerns. Three areas of significant challenge for detailed design are identified and two recommendations offered as well as a number of specific observations. Subsequently, the findings of this group were independently reviewed by others with similar background in the nuclear power industry.

3.0 DISCUSSION

3.1 Methodology

The review was conducted in several steps. Copies of the Conceptual Design Report were distributed for familiarization to four reviewers with operations and maintenance experience. An initial meeting was held for preliminary discussions, question and direction. Next, the experts reviewed the material individually and accumulated comments. A final group discussion developed consensus and provided the material for the report.

3.2 Conceptual Flaws

The most important conclusion reached was that there are no apparent conceptual design flaws which would threaten the beginning of detailed design. Overall design, layout, and equipment selection present no major concerns. Despite the design challenges discussed below, we believe that the correct concepts are being employed and a satisfactory detailed design can be completed.

3.3 Challenges for Detailed Design

3.3.1 The detail design of the process enclosure will be a challenge. This tool will be critical. It will have many moving parts e.g. welding support and remote, leak-tight connections exposed to thermal cycling. There are similar design requirements (and even more challenging) at the Defense Waste Processing Facility (DWPF) at Savannah River which should provide valuable insight during the detailed design.

A Failure Modes and Effects Analysis should be done in parallel with the design process as a design tool to determine critical parts, potential failures/maintenance, spares etc. See Section 3.5.1

3.3.2 Welding the top hat will be time consuming. The welding equipment will need to be specially designed, and will be complex. Considerable attention must be paid to reliable operation while allowing for variations to be expected over the population of MCOs to be processed. The complexity will provide a great deal of opportunity for maintenance problems. See Section 3.5.2

3.3.3 The detailed designer must look carefully at radiation monitoring equipment for potential impact on operation and maintenance. Scheduled preventative maintenance should be performed on this equipment to assure that they continue to function as they are intended.

3.4 Other Observations

In searching for flaws in design concept and major design challenges, we have made the following observations.

3.4.1 The detailed designer needs to look carefully at the placement of critical valves and at the detailed maintenance that may need to be performed to make sure that they function correctly (e.g. pressure actuated relief valves), facilitate testing requirements and don't leak under any potential operating conditions.

3.4.2 Make sure that the process enclosure can handle inspection and cleaning fluid waste such as dye penetrant if used.

3.4.3 Consider the potential impact on maintenance requirements of off normal operations e.g. over temperature, over pressurization. This could result from a control system failure or a failure of a component such as chilled water pump.

3.4.4 Consider the implications of failures of support systems such as chilled water, service air, electrical, HVAC.

3.4.5 Section 2.2.1.2.1 of the Conceptual Design notes that since Report VPS VAC 1104 will operate at low capacity this will likely ensure that design life will be achieved. Operation at low capacity can actually shorten the life of some equipment (e.g. diesels, some centrifugal pumps etc.)

3.4.6 Make sure that maintenance of control system components such as sensors, detectors, and transmitters is addressed in the detailed design including replacement, adjustment, and calibration.

3.4.7 Consider cooler failure and potential impact on other system equipment.

3.4.8 Consider the life expectancy and potential for maintenance of electric heaters to be specified.

3.4.9 Ensure that the detailed design properly addresses process monitoring instrumentation such as O_2 from the standpoint of replacement, maintenance and calibration. Ensure that their potential impact on production and safety in the event of failure or off normal operation is addressed.

3.4.10 Make sure that equipment critical to production and safety is identified so that it will be appropriately maintained to ensure function e.g. purge valves, purge supplies, blower seal system, over pressure protections, detectors etc.

3.4.11 Consider the implications of bellows failure in the oven.

3.4.12 What is the reliability history for turbomolecular pumps. What is impact of failure? What are failure modes and mitigating maintenance requirements?

3.4.13 Is the service air system critical to safety and production? If so, performance monitoring may be needed. To preclude equipment damage or personnel injury, ensure the system fails safe on loss of electrical power or pneumatics.

3.4.14 Make sure that the trench covers can be removed easily e.g. crane or lifting device located to support removal.

3.4.15 Make sure that equipment in trench is arranged to facilitate maintenance including valves, piping, instrumentation etc.

3.4.16 Make sure that the remote maintenance tooling in the process enclosure addresses the potential for fastener or "pop up" spring failure.

3.4.17 Remote maintenance tooling in the process enclosure should address over torque potential where applicable.

3.4.18 Make sure that lifting devices, lighting, power and service air required to easily conduct maintenance is addressed in the detailed design.

3.4.19 Avoid the possibility of water in the trench. If this cannot be done, provide means to keep it out of the oven pit

3.4.20 Make provisions for cleaning the weld surfaces following each grinding step.

3.4.21 Although it is outside of the scope of this review, the design constraints on the MCO filter may be difficult to meet. This interface could affect the detailed design if it is changed.

3.5 Recommendations

3.5.1 Prepare and maintain a Failure Modes and Effects Analysis during the detailed design. This would provide:

- means to identify systems critical to safety
- means to identify systems critical to production
- upset conditions which might impact equipment operations or maintenance
- identification of scheduled and preventative maintenance which would be required
- identification emergency procedures required
- means to estimate maintenance staffing
- means to estimate dose resulting from maintenance
- identify critical spares needed
- identify additional process monitoring which would facilitate/delete maintenance

There are a number of software tools available that can be used to guide the above work. These tools provide a structured, consistent methodology for conducting a maintenance and operability review. They also provide documentation of the maintenance and operability program basis.

3.5.2 Consider welding plugs in the MCO ports to seal them rather than using a "top hat" cover.

Advantages:

Speed: Steam generator tube plug welding experience suggests a single pass tig weld, which could be autogenous (no filler) if designed properly. Production rates of one tube per hour including plug installation, weld and inspection are typical in steam generators.

Tooling already developed: Steam generator tooling could be adapted to support this application.

Inspection: Steam generators tube plugging operations use only visual inspection with good results.

Repair is straight forward: Tooling already exists to remove a plug weld and re-install. In steam generators this can be done repeatedly.

Potential cost impact.

Disadvantage:

Would need to address stacking and future drying if required i.e. how to make new connections after welding in/removing plug.

APPENDIX J - OPERABILITY AND MAINTAINABILITY ASSESSMENT

REFERENCES

1) Hot Conditioning System Equipment, K-Basin Spent Nuclear Fuel Storage Project, 90% Submittal, Conceptual Design Report

APPENDIX K

COMMENT DATABASE

Project 2318: Hot Conditioning CDR Comments

PART 1: COMMENTS / DISPOSITION

APPENDIX K: HOT CONDITIONING COMMENT DATABASE

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Alaconis, W.C. 90% CDR	1	All comments from the 60% CDR Review must be answered. To date no response has been given.	no	All responses to the 60% design comments will be included in the final CDR.	closed
Alaconis, W.C. 90% CDR	2	The concept of manipulator assisted operation is acceptable, however the ability of the manipulator to preform all of the required functions within the process enclosure needs to be demonstrated with in the time estimates of the CDR.	no	The time estimates in the CDR are based upon experience. A time and motion study for the process enclosure will be an element of the definitive design	DD
Alaconis, W.C. 90% CDR	3	The dose estimate assumed a solid 1" steel process enclosure to develop the calculations (no viewing window). The process enclosure must have a shielded window to allow the operator 100% visual observation of the manipulator movement and function. The video viewing will not provide the 3D reference required.	no	The process enclosure design will incorporate a shielded window.	closed
Alaconis, W.C. 90% CDR	4	If the HCSE does not plan on using the helium and nitrogen banks that are being installed by Fluor Daniel in the CSB design, then section 4 (interfaces) lacks the appropriate requirements for siting HCS gas trucks around the facility. Civil and structural interfaces will be required with FD.	no	The HCSE design team will provide any civil/structural design required for these tanks. The tanks will be provided after the CSB construction is complete.	closed
Alaconis, W.C. 90% CDR	5	The current dose estimates of 5 mRem/hr while manning the manipulator operating station is not acceptable. This exceeds 10 CFR 835 requirements of 20% of 835.202. Based on available data there will be approximately 2300 operating hours per year on the process enclosure shared by two operators per shift. At 384 hours (2300/6) per operator per year a dose rate of less than 2.6 mRem/hr at the operating station will result in 1R per operator. As a result of this data a final design estimate of less than 2.5 mRem/hr would be expected.	no	Agree. Will incorporate during definitive design. See Curt Miska comments 12-15 and resolution.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Alaconis, W.C. 90% CDR	6	There appears to be a disconnect between the Project Management Plan and the CDR with regard to deliverables in the M&O Manual area. Clarify what the actual deliverables will be in this area and the anticipated content.	no	The M&O manuals are not currently in Merricks scope.	closed
Alaconis, W.C. 90% CDR	7	The general area dose estimate of 2 mRem/hr is high. The current CSB operating deck area dose rate estimate is 0.25 mRem/hr. Use of the 0.25 mRem estimate would be more accurate.	no	Agree. The definitive design will reflect the 0.25 mrem/hr criteria.	DD
Burns, B.M. 90% CDR	1	2.0 Process, p 12 of 57, pgph 3: "Exposed uranium reacts with oxygen and continues to do so until the surface is passivated." According to "Technology of Uranium" (Galkin et al, PNNL library # TN 799.U7 G3) p 15, "the oxide film does not protect the metal against further oxidation." Provide a source that shows passivation is possible.	no	Text will be revised to eliminate passivation and to give the reason for the oxidation step.	closed
Burns, B.M. 90% CDR	2	Figures 2.2-1, 2.2-2, and 2.2-3 not provided.	no	Figures were inadvertently left out. They will be included in the final CDR.	closed
Burns, B.M. 90% CDR	3	2.2.1.2.1, page 16, pgph 2: Blower configured for "base case pressure of 13 psia". Will it ve able to accomodate the requirement (in 2.2.1.2, p 11) to handle 115 psia helium?	no	The requirement has been changed to 25 psia to meet other MCO restrictions. A new blower that operates in this pressure range has been selected. Previous blower was suitable for operation at 115 psia.	closed
Burns, B.M. 90% CDR	4	2.2.1.2.3, p 17: Cold trap and HEPA is rated for 100 psi. 2.2.1.2 allows up to 115 psia for optional operation. Even if 100 psig, this is slightly less than 115 psia.	no	As noted in previous comment, operating pressure will now be restricted to 25 psia.	closed
Burns, B.M. 90% CDR	5	Item 8, p 25 (Section 2.2.4), last sentence: "... when H2 and H2 ..." Would this be H2 and H2O?	no	Yes, correction will be made.	closed
Burns, B.M. 90% CDR	6	2.2.5, pgph 2: You need to ensure any power cutout due to a security system activation will not cut power to essential (safety class? others?) systems.	no	Essential operations will have a dedicated UPS. These systems will be identified during definitive design.	closed
Burns, B.M. 90% CDR	7	2.2.5, item 6, p 28: Need to ensure process gas which goes to MCO will be only inert gas, and that O2 will be shut off. This came to mind assuming we're in the ixidation phase, and power was lost, we don't want to add O2 uncontrolled.	no	The systems will be designed to safety shutdown by providing control system with UPS and by slightly pressurizing the MCO with inert gas before closing all valves.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Cowan, R.G. 90% CDR	1	Several interfaces with the MCO are very similar to those at CSB such as receiving venting and should have common solutions The design should attempt to use the same approach where possible during detailed design.	no	The interfaces with the MCO are similar for the CSB, CVDS and HCSE. The interfaces are being coordinated with these teams and with the MCO design team.	closed
Cowan, R.G. 90% CDR	2	Port covers should be removed at CSB receiving and should not be handled at HVC.		Handling will be required if it is determined that closure of the MCO will be accomplished by seal welding the port covers at the completion of the hot conditioning process.	closed
Cowan, R.G. 90% CDR	3	Single pass air flow directly around the MCO should be used in place of water cooled circulating air. Although this may indrease the stack flow, it would be a much easier system to maintain and get through safety.	no	A water study will be included in the CDR to address this issue. Final resolution will be during definitive design.	DD
Cowan, R.G. 90% CDR	4	Design for premixed oxygen/argon from cylinders outside.	no	We will be using premixed oxygen as you suggest. The present design will accommodate that mode.	closed
Cowan, R.G. 90% CDR	5	The HEPA filter on the outside will likely trap all Cs and should include shielding.	no	A Cs trap will be located in the trench where shielding will be provided by the trench walls and cover. The trap will be changed using the manipulator in the process enclosure. This trap will be cooled to trap the Cs.	DD
Cowan, R.G. 90% CDR	6	Welding in the oven is not a good idea as this will ask each station to do too many functions. One pit designed for welding will work better even with the extra transfer. With a good design on shielding, it should be possible to do a manual setup and automatic wald for closure.	no	Welding will be done with a welding machine operated from the process enclosure. The process enclosure will service all six process pits with one welder. Welding at the pit does not alter the oven design. If welding were to be moved to the seventh pit with a dedicated welder, the process enclosure would still be needed for weld inspection and repair so it would still have multiple functions to perform.	closed
Cowan, R.G. 90% CDR	7	The proposed vacuum bottle with air heating seems a good concept but if the MCO group will comment to the stepped design for the MCO, it should be possible to support both the MCO and vacuum bottle from a top flange. This has a lot of advantages for process (the MCO top would not move during heating) and shielding. (I did not see how the shielding would work as shown.)	no	The new design from the MCO contractor accommodates top support of the MCO.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Goldman, L. 90% CDR	1	Using refrigerants containing halogens around the MCO during HCS operations makes me nervous. They could get inside and react or break down at temperature to an acid forming gas such as HC1, a diatomic halogen, or poison gasses. If we had an unexplained loss of refrigerant, freon or suva for example, who could say it did not end up inside the MCO and reacted inside the heated MCO. Then that MCO would be put up as a "suspect", as potentially damaged from the halogens.	no	The cooling for the MCO vacuum system is with ambient air which leaves no possibility for halogen entry. As currently conceived, the air would be cooled by a closed water loop and the water would be cooled by a refrigerent loop.	closed
Goldman, L. 90% CDR	2	I wasn't close enough to see the PFD. Was the residual gas analyser going to be used to measure the input and output streams of the MCO to determine take up of oxygen by the inside of the MCO? Was the output gas stream containing water and H2 going to be measured as it comes out of the MCO? Or how was O2 take up inside the MCO going to be determined?	no	The oxygen analyzer is on the MCO gas circulation line. We can determine the O2 uptake within the MCO by knowing the circulation rate and taking interval samples.	closed
Kurtz, J. 90% CDR	1	Not much in detail about rad monitoring equipment for the workplace. Just a small section in the ALARA section. We will require the use of CAMS and other monitoring that requires power, etc. Request you expand on this or say they will leave it up to us.	no	Specific details of the radiation monitoring system will be developed during detail design of the HCSA in accordance with the criteria for the CSB.	closed
Kurtz, J. 90% CDR	2	Looking over the exhaust instrumentation, I get the feeling that it may be excessive. I thing you need to have the environmental folks look this over. When the CSB was reviewed, some of that was bound to be excessive and expensive.	no	For the conceptual design effort a conservative stack monitoring system was selected. The system may be simplified during definitive design.	DD
Kurtz, J. 90% CDR	3	If we want to use the PING-3B Particulate/Iodine and Noble gas monitors in the exhaust, I have two brand new, never been used PING-1A units that were purchased for encapsulation. These are equivalent to the 3B's except for the dual range noble gas. We spent about 30K on each of these.	no	Use of the new PING-1A units will be evaluated during definitive design. This cost reduction opportunity is appreciated.	closed
Kurtz, J. 90% CDR	4	Looking at these PINGs and our requirements, I'm not sure that these will do the job. The Iodine channels on these units are designed to measure I-131 activity. The I-129 we are going to try to measure only emits a 40 KeV gamma. Theoretically, the unit can be adjusted to see this but would be at the extreme low end and would be subject to noise problems. The current best technology for monitoring I-129 involves sampling with cartridge filter and laboratory analysis with low energy gamma detector.	no	The application of these units will be investigated during definitive design. The Iodine trap will use the same cartridge filter so Iodine release is not anticipated to be a problem.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Lucas, C. 90% CDR	1	Section 2.9:1) Waste items described in the earlier sections include; dye penatrant, cleaning fluid, developer, buffer pads, etc. Non of these items are described in the solid waste section.2) Other disposal requirements need to be listed besides WAC 173-303 such as WHC EP 0063 Solid Waste Acceptance Criteria.3) All of the potential streams appear to be workable, I am assuming that the project will develop an approved disposal path and summary as a part of the design so we don't design a waste stream that is cost prohibitive to operate (cartridge filters). For example, having units to be disposed actually sized to fit in an existing approved container (get packaging folks on board), and handling methods that do not require high dose expenditure.4) I would recommend getting Acceptance Services representation in on this early to make the road smoother.	no	We will comply with your suggesstion with the details to be worked out during definitive design.	closed
Merkling, T. 60% CDR	1	Overhead/Drawing of Cell. This drawing shows a CAM (Continuous Air Monitor) located in the center of the cell. Comment: 1) Ensure that the CAM is of proper sensitivity to detect the nuclides of interest, 2) Ensure that the location of the detector/sample hose is such that the nuclides of interest are correctly monitored, 3) Ensure that calibration/maintenance of the CAM can be performed with exposure to radiation ALARA.	no	CAM will be specified during definitive design in accordance with these recommendations. It is anticipated that maintenance can be performed while process enclosure is in cold status, i.e. not servicing any of the process pits.	DD
Merkling, T. 60% CDR	2	Hot Treatment Process Operations Cell Functional Description. Steps that involve manned entry for survey of the cell (steps 24, 58). Comment: From a logistics standpoint of making an entry into a confined/contaminated space from a radiologically clean space, recommend that surveys for radiological contamination be performed using the remote manipulator with sample smears being passed out through the pass-through box for analysis. Try to eliminate manned entry until all safety conditions are determined remotely.	no	Recommendations will be incorporated in the definitive design of process enclosure.	DD
Merkling, T. 60% CDR	3	Shielding and Radiation Exposure Analysis. Comment: Consider an ALARA analysis for maintenance/calibration activities in addition to the ALARA analysis already performed for normal HVC work tasks.	no	There is no maintenance/calibration activity anticipated when the MCO is present. Traps and HEPA filters are installed in the trench to assure that process equipment is not contaminated. Maintenance on equipment should be cold.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 60% CDR	4	Shielding and Radiation Exposure Analysis. Comment: Section 2.0, To avoid the pitfall of using a single exposure number (single numbers give the impression that they are exact), recommend using a range for estimating the total exposure. This range would be based on the task times spent in the radiation field. Suggest getting with SNF Operations and fine-tuning the duration times for the activities and calculating a range of times (say for "Undoing Top Fasteners, instead of exactly 10 minutes, give a range of 6 to 12 minutes or whatever is agreed by yourself and operations).	no	Yes. We are working on a PERT analysis of the production schedule. This will be delivered during detailed design.	DD
Merkling, T. 60% CDR	5	Shielding and Radiation Exposure Analysis. Comment: Section 3.1. The sentence "The workforce and time required to perform each exposure activity was estimated" needs to be changed to reflect a combined effort between the ALARA analysis engineer and SNF Operations arriving at an accurate time determination (see above comment).	no	Operations input has been requested. The final analysis that incorporated the maintenance estimates will be completed during definitive design.	DD
Merkling, T. 60% CDR	6	ALARA Implementation Plan. Comment: Reference current/correct documents. 1) Third paragraph, delete first sentence (10 CFR 835 is the design authority). 2) Third paragraph, third sentence, Add "design objective for" between ",,,federal law governing" and "radiation exposure,,," 3) same sentence, delete "in." 4) Delete "DOE Order 5480.11, Radiation Protection for Occupational Workers," and replace with "DOE Notice 441.1, Radiological Protection for DOE Activities." 5) Section 2.0, a) Replace DOE Order 5480.11 with DOE Notice 441.1, b) Replace WHC-CM-4-11 with "WHC-IP-1043, WHC Occupational ALARA Program, c) Replace "DOE N5480.6" with "DOE/EH-0256T."	no	Comments incorporated into the 90% Conceptual ALARA Implementation Plan.	closed
Merkling, T. 60% CDR	7	ALARA Implementation Plan. Comment: Section 3.0 A 3. When the hole cover is pulled, is there a possibility for additional radiation exposure from gamma scatter or "ceiling shine"? If an analysis shows that this is possible, then it needs to be included in the exposure estimate.	no	Sky shine analysis will be incorporated in detailed design.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 60% CDR	8	ALARA Implementation Plan. Comment: Section 4.D.3. This section states that "the design will include Continuous Air Monitors (CAMs) capable of detecting,,," To meet 10 CFR 835 and HSRCM requirements, an analysis would need to be performed that shows the potential of airborne activity during normal activities. Also, an engineering study (smoke test) should be performed to ensure correct location(s) of the sampler/monitor.	no	Will incorporate in detailed design and in startup testing (smoke tests, etc.)	DD
Merkling, T. 60% CDR	9	Operations and Maintenance Philosophy. Comment: Administrative limit. 1) Section 1.0.B. Change the sentence to allow the facility to manage the administrative levels accordingly. Suggest "The radiation doses of a given worker will be administratively controlled per HSRCM-1." 2) Section 4.0, first paragraph, first sentence. Change this sentence to read "The administrative radiation exposure limitation for the HVCE will be per the HSRCM-1."	no	Comments incorporated into the 90% Conceptual O/M Philosophy section.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 60% CDR	10	Operations Maintenance Philosophy. Sections 4.1, 4.2, 4.3 and 4.5. Background: 10 CFR 835.403(a)(1) states that "air sampling shall be performed in occupied areas where, under typical conditions, an individual is likely to receive an annual intake of 2 percent or more of the specified ALI values. §835.403(a)(2) states that "Real-time air monitoring,,,,shall be performed in normally occupied areas where an individual is likely to be exposed to a concentration of airborne radioactivity exceeding 1 DAC as specified in Appendix A of this part or where there is a need to alert potentially exposed individuals to unexpected increases in airborne radioactivity levels." HSRCM-1, Article 553.1 states that ",,, area radiation monitors,,, should be installed in frequently occupied locations with the potential for unexpected increases in dose rates,,". Article 553.3 states "The need and placement of area radiation monitors should be documented,,,,,." Comment: Reading these four sections (Respiratory Protection, Respiratory Protection Program, Respirator Use, and Radiological Alarm System) and seeing words such as "evaluate actual intakes" looks like we are designing a facility where we expect airborne radioactivity and unexpected increases in dose rates from "typical conditions." I do not believe that this should be the case. Suggest rewording or deleting these sections unless an analysis indicating that airborne radioactivity (and unexpected increases in dose rates) is in fact, going to be normal conditions. The Section 4.4, Emergency Respiratory Protection should cover all off-normal airborne activities.	no	Comments incorporated into the 90% Conceptual O/M Philosophy section.	closed
Merkling, T. 60% CDR	11	Section 4.0 Radiation Safety and Exposure Control. General Comment: Replace all references to 10 CFR 20 and 10 CFR 72 with appropriate DOE references 10 CFR 835 and DOE Order 5400.5. Quote these appropriate rules and requirements as needed.	no	Suggested revisions will be incorporated into the Final Conceptual design report.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 90% CDR	1	Definitions, Cold Trap; 2.1 Sequence Description, ID 25.0; Comment: I 129 is a concern because like tritium it is an internal exposure problem and a low energy beta emitter (0.15 Mev) which cannot be detected using normally used portable RC survey instruments. Since it cannot be easily detected and it is most likely present, a characterization study needs to be performed to ratio Cs 137 and I 129. Once this ratio is known, any detected Cs 137 can be coupled with the known I 129/Cs 137 ratio and accountability can be taken for all radionuclides of concern.	no	The ratio of Cs-137 to I-129 is known for the design basis fuel and is documented in the WHC design basis feed document. Draft environmental permitting documentation indicates that mitigation (I-129 removal) is not required. The design of the Cold Trap will continue in detailed design, and the need for I-129 removal will be reassessed at that time.	DD
Merkling, T. 90% CDR	2	2.1, Sequence Description, ID 5.0, 2.8. Comment: How does the enclosure seal to the floor? If there is no seal, or the seal depends on the ventilation system to provide a continuous positive air flow, then this design idea needs to match the expectations of the Safety Analysis and possible accident scenarios to prevent potential radiological releases under all possible accident scenarios.	no	It is anticipated that an inflatable seal will be provided.	closed
Merkling, T. 90% CDR	3	2.1, Sequence Description, Section 2.1 ID 8.0, ID 105, ID 106; Section 2.8 ID 8.0, 9.0; and Drawing SK2-2-300420 Comment: Per the Definitions on page v, this annular space cover has been eliminated. If this is true, reference to the cover here and throughout the document needs to also be eliminated.	no	The baseline design still requires the annular space cover but it is anticipated that it will be eliminated during detailed design. The definition will be revised.	closed
Merkling, T. 90% CDR	4	2.1, Sequence Description, ID 52 - 89: Comment: Is a visual/dye penetrant inspection sufficient for a Safety Class application?	no	The new weld test proposal from the MCO designers specifies ultrasonic testing. This will be incorporated in the detail design of the HCSE.	closed
Merkling, T. 90% CDR	5	Section 2.2.1.2.1, Gas Pumps: Comment: Delete "high-level" from last sentence of first paragraph. The vacuum pump should be radiologically surveyed first and then disposed of as needed based on the survey. This is in keeping with the statement on page 57 of 57 of the same section, "failed equipment will be disposed of appropriately based on a radiation survey."	no	Text changed as recommended.	closed
Merkling, T. 90% CDR	6	Section 2.2.4.9: Comment: Change I-131 to I-129, and Kr-86 to Kr-85. This is in keeping with decay patterns and what is noted in drawing 300413. If spontaneous fission is a problem, then I-131 could be present. As noted in comment 1, a characterization study needs to be performed to calculate the amounts of each of these isotopes.	no	Text changed as recommended.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 90% CDR	7	Section 2.3.1, Reference Standards; Comment: Add 40 CFR 61, (NESHAPs for radiological discharge points)	no	Suggested addition will be made.	closed
Merkling, T. 90% CDR	8	Section 2.3.4 Equipment Description and 3.2.8 I & C interface "The HCSE will provide the stack monitoring system." Comment: Effluent monitoring and controls shall comply with the requirements of 40 CFR 61 and the DOE 5400 series. Before the type of monitoring equipment is decided/designed, the project needs to analyze for what it is monitoring (isotope(s) and amount discharged from normal operations as well as releases from DBAs). These evaluations are usually a part of the SAR. This characterization study estimates/calculates the total amount of radionuclides/isotopes transportable to upstream and downstream of the MCO filters and process filters (normal operations and DBA with Safety Class SSCs [i.e. MCO]). This information can then be used to calculate if a monitoring or only a sampling system is needed, and depending on what is needed, what type and sensitivity of instrumentation/sampler will be needed. Without this information, it is hard to design a stack monitoring/sampling system.	no	A conservative stack monitoring system is shown in the CDR. The design will be revisited during definitive design with these considerations in mind.	closed
Merkling, T. 90% CDR	9	Section 2.6.2.1, page 39 of 57, second paragraph, "The wetted surfaces,,,,, reach the pump." Comment: Delete "and gasses" as the gasses will pass through the system and up the stack. Delete "Kr" as this is a gas, and delete "Xe" as this isotope is not present. Consider adding "Co" as this isotope was mentioned earlier in the report.	no	Suggested changes will be made.	closed
Merkling, T. 90% CDR	10	Section 2.8.2 Comment: Delete "high." 10 CFR 835 has a specific definition for high radiation area with rigid access controls.	no	Suggested changes will be made.	closed
Merkling, T. 90% CDR	11	Section 2.8, Process step F12; Comment: Is the location of the TV camera and equipment considered for ease of maintenance for ALARA considerations?	no	ALARA will be considered in the selection of the camera location during definitive design.	closed
Merkling, T. 90% CDR	12	Section 2.9.11. Comment: On what is this "1 per MCO" replacement frequency based? The radiation dose will be based on Cs 137. The MCO filter is designed to filter the majority of all articulates thus the cold trap should remain reasonably Cs free.	no	The estimate of 1 per MCO is intended to be conservative. Experience will dictate the actual change our rate.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Merkling, T. 90% CDR	13	Appendix B, 1.0 Introduction, second paragraph; Comment: Add narrative to address the minimization of radiation exposure. See narrative in Section 3B, page 5 of 8 of this same section for example.	no	Comment incorporated.	closed
Merkling, T. 90% CDR	14	Appendix B, 4.0, B; Comment: What is the source of this "shall" statement of not exceeding 5.0 mrem/hr?	no	Document revised to reflect 2.5 mrem/hr criteria. This is per 10 CFR 835.202.	closed
Merkling, T. 90% CDR	15	Appendix C, Section 3.3, page 3 of 9; Comment: This exposure result should include exposure from maintenance activities as mentioned in Appendix B, section 2 C, "The determination should include normal operations and maintenance/repair exposure.	no	Agree. An estimate of maintenance related exposure will be added to this analysis during definitive design.	DD
Merkling, T. 90% CDR	16	The information listed in the vendor section for the stack iso-kinetic sampling head is incorrect. The Eberline ALPHA6 is an in-line sampler head which draws a sample from an iso-kinetic sampling array or a shrouded probe (it is not the probe itself). The project still needs a sampling probe (iso-kinetic or shrouded).	no	Probe will be specified in definitive design stage.	closed
Merkling, T. 90% CDR	17	Drawing SK-300413; Comment: Delete "Xe-127" from the drawing, this isotope is not available.	no	We will delete Xe-127 from SK-300413	closed
Merkling, T. 90% CDR	18	Drawing SK-300413; Comment: The Eberline PING-3B is listed as the instrument offered to detect Iodine 129. I do not believe that this PING-3B instrument is sensitive enough to detect the low levels of this low energy beta emitter. It was designed to detect the higher energy I-131 in higher concentrations than I-129.	no	We will review the Eberline PING-3B capability regarding I-129 and make any changes necessary during definitive design.	closed
Merkling, T. 90% CDR	19	Drawing SK-2-300417; Comment: The drawing gives the look of concrete over the trench [31.72 inches to the left and 81.63 inches to the right of the 3 inch steel plate over the center of the MCO]. The narrative in appendix B, page 4 of 8 states that the trench will be covered with steel to provide shielding. Which is correct? Change the drawing to reflect the steel over the trench. Also, there is possible scatter through the 10 inch push-through HEPA filters as the filters are configured in the drawing.	no	The trench cover will be fabricated of steel. Drawing will be clarified.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 60% CDR	1	Please provide clear descriptive names for major pieces of equipment to eliminate confusion. Also consider providing a numbering scheme that would coordinate the block flow diagram with the process sequence etc.	no	A section that defines names for major pieces of equipment has been added to the CDR and these names are used throughout. Coordination of block flow diagrams with process sequence will be done during definitive design.	DD
Miska, C.R. 60% CDR	2	The process sequence appears to be founded on the assumption that the MCO will have some TBD valves rather than the existing MCO design with quick disconnect fittings. While I do not like the MCO "quick" disconnect fitting the HCS 90% conceptual design will need to be baselined to the MCO design. Unless "we" can decide on a specific alternative and convince the MCO team and others to design, test, and implement this concept, then we must baseline to the existing MCO design.	no	Agree. Will reissue the sequence to allow for remote connection of quick disconnects.	closed
Miska, C.R. 60% CDR	3	The HCS design needs to provide HEPA filtration on the supply lines to the MCO. Note the Lab has recently experienced a contamination spread (Cs ?) while they were working on a furnace gas supply line outside of the hot cell.	no	Has been incorporated in 90% conceptual design. Added VPS-F-1107 on the dip-tube side of the MCO.	closed
Miska, C.R. 60% CDR	4	The RGA instrument should be able to sample the offgas prior to the gas cooler/cold trap. I suggest that the RGA be set up to sample the gas from several locations, (supply gas, offgas prior to cooler, after cooler, and just prior to return to the MCO). It is suggested that this instrument be for process control purposes, and that a reliable simple to calibrate flammable gas analyzer etc be use to determine that H2 concentration limits are met. This simple reliable instrument could then ensure compliance with safety limits.	no	Issue will be subject of study during definitive design.	DD
Miska, C.R. 60% CDR	5	The Shield Plug will likely need to be held in place in the MCO vault cover prior to lifting the vault cover. This detail should be developed in such a way as to essentially preclude damage to the MHM / Vault Cover / Process Enclosure from improper operation of the restraint. A likely solution would be to design this restraint as part of the pick point for tipping the MCO vault cover. If this was done then the cover would be constrained when lifted and the restraint would always be removed prior to process enclosure removal.	no	Agree. Will include in definitive design of process pit cover.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 60% CDR	6	Why are we bolting down the MCO Vault Cover? Note if the intent is to leave the MCO rupture disk active during processing and to bolt down the cover to mitigate the potential rupture disk actuation then the following should be considered: 1) The current rupture disk design is teflon coated (will not work well at processing temperatures) 2) A recent change is in the works to change the rupture disk pressure to 25 PSI to preclude the consequences of a high pressure blowdown event which was adversely driving the CSB (they would have needed more SC 1 systems).	no	Cover not bolted. Sequence of operations corrected in 90% conceptual report.	closed
Miska, C.R. 60% CDR	7	The Process Enclosure sketch shows the wheels located on the wrong side of the enclosure.	no	Two alternates for process pit layout were included in 60% CDR. Ther wheels were right for one of these. The other has beed selected so the sheels will be rotated.	closed
Miska, C.R. 60% CDR	8	Moving the Process Enclosure with a cable winch would likely present a tripping hazard etc. Would it be practical to provide movement capability to the process enclosure.	no	Enclosure will be moved with electric tow motor. Incorporated in 90% conceptual design.	closed
Miska, C.R. 60% CDR	9	With the current sketch of the oven the Process Enclosure would not provide adequate shielding for the worker. The best design solution would likely be to reduce the gap between the oven wall and the shielding to much less than the ~1 foot shown in the sketch to keep the shielding on the Process Enclosure to a minimum.	no	Shielding added in 90% conceptual design. Sholder on MCO will help reduce exposure.	closed
Miska, C.R. 60% CDR	10	A "rubber seal" on the bottom of the process enclosure may be necessary to allow this enclosure to meet safety class confinement requirements with imposing a requirement for 1E power.	no	Rubber seal included in 90% conceptual design.	closed
Miska, C.R. 60% CDR	11	The process enclosure needs to provide space for storing 6 insulating covers and 6 annular space covers unless space for these items is provided in the area below each MCO vault cover. Note surveying and removal of these items to a regulated staging are is a much less desirable alternative.	no	The proposed MCO with a shoulder eliminates the need for the annular space cover. It is possible that the insulating covers can be stored in the trench. This will be finalized during definitive design.	DD
Miska, C.R. 60% CDR	12	The design of the Annular Space Cover should be such that it precludes engagement of the MHM grapple to the MCO with the cover in place. If this is not done some positive means must be provided to preclude damage to the MCO, MHM, and furnace by lifting the MCO at inappropriate times with furnace pieces in the way.	no	MHM interlock discussed in 90% conceptual design.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 60% CDR	13	Step #24 survey cell should be revised.Routine manned entry into the process enclosure should be avoided whenever possible, especially when surface contamination status is unknown. A manipulator survey of key locations is suggested instead, possibly with pass through of survey swipes for counting.	no	Revised in 90% conceptual report.	closed
Miska, C.R. 60% CDR	14	Step # 28 and 29 may need to be switched to determine if the dryness criteria is met at the end of the 300 degree hold step. Note I do not think that this type of test would be meaningful.	no	Revised in 90% conceptual report.	closed
Miska, C.R. 60% CDR	15	Step # 25The Process Enclosure needs to be raised before the power is disconnected.	no	Agree. Changed in 90% conceptual report.	closed
Miska, C.R. 60% CDR	16	Consider attaching the Process Enclosure to the Process Module with an umbilical cord to allow its activities to be surveiled by the PLC control system.	no	Agree. Will be incorporated in definitive design.	DD
Miska, C.R. 60% CDR	17	Consider locating a furnace PLC "idiot"/status light where it can be observed by the operator moving and operating the Process Enclosure. These "idiot"/status lights would show what part of the process each individual station was in, and would help preclude an operator from inadvertently performing actions on the wrong MCO (station 2 instead of station 3 for example). Also it would likely be helpful for the DCS to have a similar "status board" screen with the status of each of the 6 process stations shown pictorially at the same time.	no	Will be incorporated in detailed design. Agree this and several other visual aids will be provided to the operators. As these are developed they will be added to the appropriate P&IDs during definitive design. The technology exists to mount a system monitor on the Process Enclosure with communications being either a cable or infrared. The Process Enclosure operator should have access to the same data as the control room operators.	DD
Miska, C.R. 60% CDR	18	Step 34 Why is the MCO backfilled to a slight negative pressure, this is not consistent with the performance specification.	no	Will be corrected to agree with the performance spec.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 60% CDR	19	Water should not be used as a coolant for the process offgas unless it is demonstrated that it is impractical to use other design solutions such as an air to air heat exchanger. Note this also applies to a lesser degree to the process heating/cooling system. Use of water as a coolant in an offgas system located directly above a 300 degree C MCO filled with damaged reactive fuel would raise safety questions that would likely have adverse cost and schedule impacts. Water cooling of the offgas hydraulically above the MCO provides the potential for "steam explosions", fuel ignition, and resultant loss of MCO boundary scenario's that would be very difficult to address.	no	A study is being developed to be included in the final CDR. The study will address the issue of water use in the HCSE. The water coolers, for the heating/cooling system, with features to prevent water entering the process equipment will be retained for the 90% CDR.	closed
Miska, C.R. 60% CDR	20	I would like to see heat transfer calculations that show that the cooldown of the MCO head occurs in a reasonable time while complying with the 100 degree C maximum MCO temperature difference limit called out in the performance specification.	no	The calculation in the 60% CDR has been replaced by a calculation from Q-Matrix that addresses this issue. The heating and cooling profile must be optimized during definitive design to meet this restriction.	DD
Miska, C.R. 60% CDR	21	The Vacuum pump down calculation needs to be redone. Pumping down the MCO to 10 torr will take longer than the time indicated to transfer the free space gas volume of the MCO.	no	This calculation is incorrect and has been redone using the method described in Perry's Chemical Engineers Handbook, 2E With this calculation, the evacuation time has been increased by a factor of 6 to 7.	closed
Miska, C.R. 60% CDR	22	Review of the Heat transfer calculations by WHC indicates that the calculated inside heat transfer coefficient Hi = 1, and the calculated outside heat transfer coefficient Ho = 5 are likely conservative.However a concern was expressed that the spiral flow envisioned to enhance the outside coefficient likely could not be maintained over the full MCO height with only a 1" gap.	no	Recent information from Q-Matrix indicates that the heat transfer calculations are not conservative as they show heat up in 20 hours + rather than 12 and the 100 degree temperature difference across the MCO is exceeded. Additional calculations are required during definitive design.	DD
Miska, C.R. 90% CDR	1	Page iii AcronymsThe acronym list is a good idea, but it does not contain very many of the acronyms used throughout the document (like PLC, PMC....) It would be more beneficial if someone would take the time to look for all the acronyms in the document.	no	Acronym list will be revised to capture all acronyms used in the document.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	2	Sec 1.0 page 1, Appendix E page 1, and throughout documentPlease use the issued revision 0 of HCS performance specification, not the old draft revision A. Please discuss with WHC if specific information in rev A is required that is not in rev 0. (search doc for rev A)Note revision 1 of this document will be issued in the near future and direction will likely be given to use revision 1 for the detailed design phase.	no	Document will be revised to reference Rev 0.	closed
Miska, C.R. 90% CDR	3	Sec 1.0 Page 3Statement that "the proposed HCSE conceptual design should be able to achieve whatever degassing specification is established by simply heating and pumping longer" is not totally valid. Some of the residual moisture (contributor to pressure in sealed interim storage) after hot conditioning is expected to be tightly associated with fuel oxides and sludge, thus holding at the design temp can not remove all residual moisture from oxides. However if oxide inventory is low enough then maximum residual moisture criteria can be met. Suggest deletion of sentence from report.	no	Sentence will be deleted as suggested.	closed
Miska, C.R. 90% CDR	4	Section 2.0 pages 6, 7, 8, 9, 47, 48, 49, 50, 53, 54 ... Please revise document to show weld inspection technique more suitable for remote implementation (radiograph or X-ray for example). Alternately for CDR indicate in text that more appropriate weld inspection techniques would greatly improve the probability that the process enclosure will meet duty cycle requirements (will not adversely constrain throughput). Note I believe DP inspection was chosen at CVD because that weld design would not allow full penetration inspection.	no	The new weld test proposal from the MCO designers specifies ultrasonic testing. This will be incorporated in the detail design of the HCSE.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	5	Section 2.0, page 11, 2.2.1.2 (Pressurized Operation), also 4.0 page 3 interface MCO7The process can should not be designed to support operation at 115 PSIA. The MCO performance specification/ interface agreements etc require it to be maintained below 75 PSID when the temperature is above 200 deg C. Note also that this pressure is above the current rupture disk design pressure (25 PSI) and thus would require covering or replacing the rupture disk.Note the heating and cooling durations in the performance specification are not hard and fast design criteria but targets. We should have sufficient excess design capacity that pressurized heatup and cool down should not be required (especially after eliminating the cool down durations for that would have been required for hands on access to the MCO.Note also if the lobe rotor pump is a high capacity pump this raises difficulty in dealing with particulate entrainment, and line break accident analysis.Note if gas circulation pump is required to guarantee vacuum pump life a more appropriate gas circulation device should be chosen (regenerative blower for example). A lobe rotor would not be dependable in this service, (it would fail catastrophically the first time flow was inadvertently isolated or restricted).	no	The process will be designed to support operation at 25 psia rather than 115 psia. A magnetically coupled regenerative blower as recommended is now shown in the CDR. A pumping study will be performed during definitive design to select the most appropriate pump for this service.	closed
Miska, C.R. 90% CDR	6	2.0, Page 12, Third full paragraphSecond sentence is incorrect "Exposed uranium reacts with oxygen and continues to do so until the surface is passivated." This is incorrect because the uranium will continue to oxidize as long as oxidant is present. This is true in part because uranium does not form a true "passive" surface upon oxidation (the oxidation products begin to spall after reaching a certain thickness).	no	Replace first two sentences with the following: During the lower temperature partial oxidation phase of the hot conditioning process, low concentrations of oxygen are introduced into the MCO in an inert carrier gas stream. This low concentration of oxygen consumes highly readtive sites on the fuel inside the MCO, reducing the chemical reactivity of the damaged fuel matrix that may be present in the MCO. Not the reactive sites consumed by this partial oxidation may include small fuel fragments, high surface area uranium hydride particles, and high surface area uranium metal particles created by the thermal decomposition of uranium hydride.	closed
Miska, C.R. 90% CDR	7	2.0, Page 32, 2.4.2 and 2.4.5,Why is it advantageous to use a radio modem to communicate between the PMC and the PLC (why is mobility required). Also what is the PMC (I did not see it defined in the control section). Note the safety analyst are already complaining about not liking reliance on PLC to respond appropriately. The potential for radio interference just adds fuel to that potential disagreement. (NOTE PUREX had big problems with portable 2 way radio's disrupting sensitive equipment like central fire alarm dispatch panels).	no	During the oral presentation it was incorrectly stated that a radio modem would be used for data communication between the process module and the control room. This circuit is hard wired and signals are multiplexed over 2 conductors. A radio modem is only used between the mobile process enclosure and the control room and only to monitor inputs such as temperature and other parameters which are not used in closed loop control circuits. If communication via radio modem is erratic, this would not impact any of the control circuits.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	8	2.0, page 43, Instrument Air SystemWhy are we providing instrument air, has it been decided that the CSB instrument air supply will not be used?	no	The instrument air system in the CSB is at the opposite end of the building. In order to minimize the impact of the HCSE on the CSB design, it will not be extended to the HCSE.	closed
Miska, C.R. 90% CDR	9	3.0, Page 1 and 2 HCSE layout More detail is needed than is provided on the referenced drawing SK-2-3-00421. For example the exact size of the shuttle table pit needs to be specified.Note also that the dimension from the centerline of the nearest obstruction east-west and north south is not as shown on SK-2-3-00421 (greater clearance is required). Also floor elevations need to be specified unless the entire floor is at one elevation.Note recessing the skid and waste storage area may be highly desirable to prevent water from process cooling leaks, or fire protection systems from reaching the furnace or CSB vault tubes.	no	Shuttle table no longer required as MHM box beam has been raised to 9 ft and process enclosure will be less than 9 ft. It has been determined that the floor will not be recessed since leakage from process cooling water will be contained by the process module and no fire protection water is required.	closed
Miska, C.R. 90% CDR	10	3.0, page 3, Trench CoverI strongly suggest specifying the design of the trench to HCSA designer such that a trench cover greater than 6" could be supported (design strong enough to support a stepped cover extending below lip for trench cover). I recommend designing to support something like 8-10 inches of steel. This would allow the HCSE designers more flexibility to go above 6 inches for trench covers if required for any reason.	no	Trench will be specified as suggested.	closed
Miska, C.R. 90% CDR	11	Appendix (general)Please tab each appendix separately. Also please try to arrange the vendor cut sheets in a logical order if possible (group like equipment i.e. hepa filters)	no	Appendices will be tabbed as suggested and cut sheets will be organized alphabetically by equipment number.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	12	Appendix, SK-2-300418 (Oven Assembly)As shown the furnace shielding will likely result in much more than the 5mR/Hr operator dose rate discussed in the shielding section. As shown in the sketch a "direct view" of unshielded side of MCO would exist it looks like this would result in effectively less than 2 inches of shielding with process pit covers up and enclosure in place. This will give an totally unacceptable dose rate.Note when I estimate the potential dose to worker at the enclosure using a factor of 4 reduction in dose per inch of steel, a factor of 4 reduction to correct the dose from 1 meter to the dose at 2 meters, and the safeguards dose of ~65 R/hr from the side of an unshielded MCO at 1 meter (for average fuel not peek shielding design fuel), I end up with a dose rate to the operator at the process enclosure greater than 1,000 mR/Hr. This is three orders of magnitude greater than what the design dose rate should be. Even if concrete is added to the open space to the left side of sketch SK-2-300418 a severe dose problem would still exist due to the direct beam from the heating/cooling piping on the right side of drawing SK 2-300418. It is very likely that this type of shielding design deficiency could not be adequately address with the process enclosure, and thus must be addressed via the design of the furnace. Note to ensure the success of the HCS project it is essential to be confidant that the pit dimensions and "floor loadings" given to the HCSA designers will be adequate to provide for this necessary shielding close to the MCO. It is suggested that the steel top shield shown on the sketch be greatly increased in diameter to eliminate any "direct view" of the unshielded portion of the MCO.	no	These comments address the shielding analysis and the resulting dose rates above the oven and at the process enclosure. The dose rates calculated for the currently envisioned oven and process enclosure are "ballpark" accurate. I agree that a more detailed (Monte-Carlo) analysis chould be performed (Comment 15) given the complex geometries involved. I also agree that more shielding can, and chould, be incorporated into the oven/process enclosure design to lower the currenly projected dose rate at the operator station and the general area dose rate above the oven. This will be incorporated during the definitive design. Various design options will be evaluated and a rough contour dose rate map (with and without the process enclosure) will be provided to demonstrate the feasibility of the design. The oven and shielding desing as currently depicted does leave a small unshielded solid angle to the process enclosure. The will be fixed by adding shielding to either the oven or process enclosure - the closer to the source, the better. The shielding and dose rate issures are manageable and will be addressed and resolved during definitive design. Text of Exposure Analysis has been revised to reflect options for reducing dose rates.	DD
Miska, C.R. 90% CDR	13	Appendix B, Alara Implementation Plan, page 6, Item B Criteria "Maximum exposure shall not exceed 5.0 mR/Hr on the average." is inappropriate for application as an acceptable design dose for personnel performing routine (extended duration work) at a remote operator console. Note this is especially inappropriate when it is considered that the impact of the viewing window was ignored, and that the dose calculations were likely highly optimistic (at best).	no	See response to comment 12.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	14	Appendix C ShieldingSee above comments on non-conservative shielding estimation. Also the duration allowance for work by the process enclosure may be non conservative (I would not be surprised if the enclosure is in use nearly all the time that the MHM is not in it's way), thus the dose rate that the worker receives from this source must be minimized. As discussed above this may best be done by optimizing the design of the furnace. Note assuming adding shielding will just be added to the process enclosure will greatly increase the floor loading, and will likely require abandoning the viewing window (which I am not willing to give up).Note the reflected dose when the process pit covers are open must also be considered. This bounce could greatly increase the "background dose" potentially invalidating the .25 mr/Hr shielding design criteria for the CSB as well as adding significantly to the worker dose.	no	See response to comment 12.	DD
Miska, C.R. 90% CDR	15	Appendix C ShieldingProvide a rough dose contour map around the furnace (with or without the shielding of the process enclosure). I see view angles that are not consistent with the 5 mr dose at the process enclosure or the design maximum of 5 mr. Note WHC is pursuing getting this type of dose contour map via Jay Lan but this will require ~ 2 months to complete.	no	See response to comment 12.	DD
Miska, C.R. 90% CDR	16	Appendix D, O&M Philosophy, Page 1: I do not believe that the CSB is designed for workers to routinely wear protective clothing. I believe that the CSB and thus the Annex should be designed for access in street clothes, with temporary RCA's being used as necessary.	no	Agree. Document has been revised.	closed
Miska, C.R. 90% CDR	17	Appendix D, O&M Philosophy, Page 1, CThe expected process duration for HCS is 2 years with a 10 year design life for the equipment and 75 year design life for the annex. Note this was not clear in the equipment performance specification, but will be clarified in REV 1 of the equipment performance specification.	no	Comment incorporated.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	18	Appendix D, O&M Philosophy, Page 2, Equipment SelectionAdd new item, components potentially requiring maintenance or replacement in the furnace should be designed for remote manipulator replacement if at all possible. Note contact maintenance of this equipment would only be possible after removal of the MCO, and shielding or removal of accumulated dose contributors (contaminated process lines, cold traps, and filters).	no	Comment incorporated.	closed
Miska, C.R. 90% CDR	19	Appendix D, O&M Philosophy, Page 3This page contains several "relics" from CVD that must be eliminated including "Drying Bays", "Internal Washdown", "baged connections", "Hood".	no	Agree. Document has been revised.	closed
Miska, C.R. 90% CDR	20	Appendix D, O&M Philosophy, Page 3&4, Radiation Safety, second sentence in sectionChange to read: Preliminary estimates suggest that this can be achieved through a combination of shielding near the MCO integral to the furnace assembly, and shielding provided by the process pit covers or process enclosure.	no	Comment incorporated	closed
Miska, C.R. 90% CDR	21	Appendix D, O&M Philosophy, Page 6, ShieldingSection on normally Occupied areas implies a dose rate in these areas of 1/2 mR/Hr. This is not consistent with the 2 mR/Hr used in appendix C. I believe that the "background dose" through the shielding with the trench covers down should be <1/2 mR/Hr.	no	Agree. Shielding design will relect criteria of 0.25 rem/hr. See Walt Alaconis comment #7 and resolution.	closed
Miska, C.R. 90% CDR	22	Appendix D, O&M Philosophy, Page 8, Second SentenceThe statement that "the facility will be considered an HC-3 facility..." is not consistent with the HC-2 indicated on page 1 of the introduction to the 90% CDR. At this point in time I tend to agree with assuming HC-2 designation.	no	Document revised to reflect HC-2 designation.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	23	Appendix E, Understanding of Performance SpecificationThis section needs to provide clear indication where the process design is not consistent with the performance specification. An example is page 2 "Cool Down for Connection" rather than repeat the performance specification this appendix should indicate that this process step is not needed because remote connection will be utilized. It should also be noted that this change will reduce the heating duration as well and will thus beneficially affect the process cycle time. Another example of what should have been present in this section is the proposed deviation from the firm requirement to eliminate reactive fluids (water) for heating or cooling the MCO process offgas.This type of presentation would allow formally accept the proposal to eliminate the cool down step from the performance specification, and modify future revisions of the performance specification accordingly. This type of candid evaluation of compliance with the performance specification will also encourage thorough consideration of the issue, and help clarify where deviation from the performance specification is not allowed. Examples of areas where deviation of from the performance specification are proposed by the equipment designer which will not be allowed include exceeding the MCO design pressure limit of 75 PSIA at temperatures above 200 degrees C, and the use of water for cooling the process offgas.	no	Section will be revised to reflect current design in terms of initial cooldown, use of water, etc. A study on the use of water for cooling will be included in the final CDR.	closed
Miska, C.R. 90% CDR	24	Appendix E, page 2, Receipt, c)Correct TypoThere is no such thing as a MHM Process Station.	no	Typo will be corrected.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	25	Appendix E, page 3, Partial Oxidation a)Revise to indicate... The MCO cooling system (MCS) will be required to maintain the desired setpoint temperature during partial oxidation.Note until detailed analysis are completed it is not known if the energy release from fuel oxidation will exceed heat loss, or heat addition will be required to obtain the desired fuel temperature. For example 10 SCFM of gas flow with a 2% depletion of oxygen would equal roughly 3,000 watts of power. It would be expected to have an oxygen depletion of about .5% or less, and the "baseline" temperature may be raised above the initial 150 degrees C setpoint (up to a maximum of 250 degrees C) until the single pass oxygen depletion approaches this amount. Note that .5% oxygen depletion at 10 SCFM the power output from oxidation would be on the same order of magnitude as the decay heat of the fuel, implying good ability to control fuel temperature and thus oxidation rate.	no	Suggested clarification will be included in final CDR.	closed
Miska, C.R. 90% CDR	26	Appendix E, page 4, Final Cool DownWith the remote manipulation of the MCO head in the proposed hot conditioning design there is no need to cool down the MCO and fuel to temperatures indicated in the performance specification. The MCO wall and fuel will however need to be cooled down sufficiently to ensure that the specified maximum temperature for storage (and presumably for handling in the MHM) will not be exceeded. The current specified maximum MCO wall temperature allowed for storage is 132 degrees C to prevent the fuel temperature from exceeding 205 degrees C.	no	We will incorporate your comments	closed
Miska, C.R. 90% CDR	27	Appendix E, page 16-18 Appendix A, B, and C The use of appendix A, B, and C to appendix E is confusing especially when the main appendices are not tabbed in the book please "restructure" Appendix E to eliminate this confusion.	no	Appendix E will be restructured such that the appendices will be called addendums.	closed
Miska, C.R. 90% CDR	28	Appendix E, page 16The title for this section "APPLICABLE REQUIREMENTS FOR THE VACUUM DRYING MODULE SUBPROJECT DESIGN" is inappropriate. This is the Hot Conditioning System (HCS), or Hot Conditioning System Equipment (HCSE), please refer to the subproject as such.	no	Correction will be made.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	29	Appendix GPlease try to tabulate and organize the information in this appendix better (a table of contents and page numbering for this appendix may be required). Obviously this is a detail issue that is nice but not mandatory, however breaking the appendix into logical tabbed sections as a minimum would help.	no	We concur. A calculation log will be generated and added to Appendix G.	closed
Miska, C.R. 90% CDR	30	Appendix G, last two pages (PART I/E-9)It is not clear what the purpose is for these two page, or even if they belong in this document.	no	This was not intended. These pages will be removed.	closed
Miska, C.R. 90% CDR	31	Appendix H, Vendor cut sheetsIt appears that a divider is needed prior to vendor cut sheets. My book goes directly from appendix G to the vendor cut sheets (Appendix H).	no	Tabbed divider will be added.	closed
Miska, C.R. 90% CDR	32	Appendix H, Vendor cut sheetsPlease try to tabulate and organize the information in this appendix better (a table of contents and page numbering for this appendix may be required). Obviously this is a detail issue that is nice but not mandatory, however grouping like information, and breaking the appendix into logical tabbed sections as a minimum would help.	no	Information in Appendix H will be organized alphabetically by equipment number.	closed
Miska, C.R. 90% CDR	33	Appendix H, Vendor cut sheetsPlease include vendor information for the manipulator proposed for the process enclosure. This is a vital piece of equipment which requires additional information to allow fair evaluation of its capabilities (for those of us who are not familiar with this particular manipulator).	no	We will incorporate your comments in the final CDR.	closed
Miska, C.R. 90% CDR	34.1	Comments 34.1-34.6 refer to Appendix H, Vendor cut sheets, and P&ID SK-2-300413 Flanders G-1 Bag In/Bag Out housings. 1) Per the P&ID these filters are located inside the trench (changed remotely with the manipulator). Having been involved with the change out of several of these filters in the past I am not sure that they are suitable for remote operation without significant modification.	no	Filters in trench will be custom design to facilitate manipulator change out.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	34.2	2) A fluid seal filter is unacceptable for this application unless the equipment designer can provide a bullet proof case that it is incredible (< 1 EE-6) for significant quantities of seal fluid (grease) to leave the filter system and enter the MCO. Note < 100 grams of organic would significantly degrade the capacity of the MCO to contain the hydrogen pressure from radiolysis of retained water in interim storage. Further more if these seal fluids contain halogens they could potentially degrade the performance of the MCO (Safety Class 1 boundary).		Seal fluids will be eliminated.	closed
Miska, C.R. 90% CDR	34.3	3) Restriction on high temperature: The vendor cut sheet Bulletin No. 936 page 3 indicates that maximum temperature for the fluid seal is 392 degrees F (200 degrees C). It is questionable if the G-1 gasket seal housing could be made to work (would pass DOP testing) if the filters are installed remotely, and are thermally cycled. Note that the Flanders cut sheets also indicate that for high temperature application special sealants are required for gasket sealed units, and refers to page 8 which is not included in this appendix.	no	Metal filters will not have the temperature restrictions.	closed
Miska, C.R. 90% CDR	34.4	4) Restriction on high pressure: The vendor cut sheets indicate that the G1 housing with a high pressure design is only good for 15 PSI positive or 14.7 PSI negative. This would not be compatible with a pressurized circulation system, and would could not be taken credit for unless all credible system pressurization mechanisms are eliminated.	no	Custom designed metal filters will not have this pressure restriction.	closed
Miska, C.R. 90% CDR	34.5	5) Room for the filter housings: It is not clear that there is room in the process trench or furnace pit as it is being designed to install these filter housings and filters.	no	Metal filters will be custom designed for this application to fit in the available space.	closed
Miska, C.R. 90% CDR	34.6	6) Suggested approach for this filter: It is suggested that further investigation be performed to identify suitable filters for this difficult application. One potential worth considering is PALL sintered metal filters, for example at one time the Hanford site HWVP project was planning on using Pall Sintered metal media for testable HEPA filtration. I know that PALL makes sintered stainless steel HEPA media in various configurations, the question is do they have a housing configuration that is suitable (testable).	no	Metal filters will be specified in the final CDR.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	35	Appendix H, Vendor cut sheets, VPS-BLO-11-61) I suspect that the equipment specified on the cut sheet is an inappropriate application for a highly reliable low pressure hot gas recirculation blower. Note high pressure circulation is not required or desirable. Sufficient design capacity should exists to process the MCO in the allocated time without resorting to such drastic measures.2) If this process blower (lobe rotor pump proposed) is a high capacity device this raises greater difficulty in dealing with particulate entrainment, and line break accident analysis. It appears from the vendor cut sheets that the smallest blower that could operate with a 15 PSIG pressure rise would have a capacity of ~70 CFM at 2 PSIG pressure rise. 3) If gas circulation pump is required to guarantee vacuum pump life a more appropriate gas circulation device should be considered (regenerative blower for example). A lobe rotor would not be dependable in this service, (it would fail catastrophically the first time flow was inadvertently isolated or restricted). This type of blower would be acceptable only if sufficient control interlocks were in place to detect and prevent inappropriate operation.4) This type of blower has a oil lubricated gear case. This could be a big problem, equipment that contacts process gas should not contain organic or water unless the equipment designer can establish that loss of significant quantities (<100 grams) of oil, or water to the process gas / MCO is incredible (<1EE-6 frequency per year).	no	A study will be proposed for definitive design to select a more appropriate blower with a low pressure range. We are using a magnetically coupled regenerative blower in the final CDR.	closed
Miska, C.R. 90% CDR	36	Appendix H, Vendor cut sheets, VPS-CLR-1103, and VPS PFR-1101As indicated in the performance specification water shall not be used to cool the process gases that contact the fuel. Water shall not be used as a coolant for the process offgas unless it can be demonstrated by the equipment designers that all other design solutions are impractical. If no other design solutions are available the system designer mush establish a design that has features that make it easy to demonstrate that it would be incredible (<1EE-6/year) to have significant quantities of water enter the MCO or create excessive steam pressures upon contacting hot equipment.	no	A study of water use for cooling is being developed based on this comment and discussions with the PHA team. The study will be included in the final CDR.	closed
Miska, C.R. 90% CDR	37	Misc.Provide design concept for shuttle table to move the process enclosure out of the way of the MHM.	no	Design concept will be provided.	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Miska, C.R. 90% CDR	38.1	Misc. It is strongly suggested that if the offgas piping associated with the furnace are intolerant of rotational misalignment that a feature be provided by the HCS equipment designer to reestablish proper MCO rotational position. This could be done by providing a "turntable" in the welding pit for occasional "off normal" use. Alternately a turntable could be incorporated into the furnace.	no	A turn-table is being developed for the top of the oven to properly orient the MCO.	closed
Miska, C.R. 90% CDR	38.2	SK-2-300413 P&IDThe RGA instrument for gas sampling needs to measure both the supply and exhaust gas concentration, potentially even before and after the gas cooler and traps if we can get significant mass removal (condensation).	no	(re RGA sampling points) We will comply with your suggestion.	closed
Miska, C.R. 90% CDR	39	SK-300413 P&IDThe oxygen supply system needs some more thought and work in the detailed design phase. The story for pre dilution of the oxygen (buy at <20% oxygen in inert gas) add at limited rate (orifice) to recirculating offgas, with measurement to confirm that oxygen concentration does not exceed maximum allowable concentration).	no	The gas supply system will be revised to provide these monitoring points.	DD
Miska, C.R. 90% CDR	40	SK-300413 P&IDThe design should reflect a high reliability flammable gas monitor or similar device to ensure that the offgas concentration is maintained low enough to preclude combustion (easy to use / maintain safety significant system).	no	Study in detailed design.	DD
O'Neill, C. 90% CDR	1	The CDR should include either a HVAC Zone drawing or a description of the zones.	no	The interior of the MCO and connected process equipment will be Zone 1. The process pit, trench, and process enclosure will be Zone 2 and everything else will be the same zone as the CSB. The text will be modified to reflect this.	closed
O'Neill, C. 90% CDR	2	Section 2.9, Solid Waste. This section identifies "Getter and Charcoal Beds" as being a solid waste. The design does not include any of these items.	no	Depending upon the final selection of the stack monitoring system, these materials could be in it.	closed
O'Neill, C. 90% CDR	3	Section 2.9, Solid Waste. The filters from VPS-F-1102 and VPS-F-1107 are not listed here as waste.	no	VPS-F-1102 has been eliminated and is part of VPS-PFR-1101. This filter as well as VPS-F-1107 will be listed in the solid waste section.	closed
O'Neill, C. 90% CDR	4	Section 3.3.2.2, stack description. The location of the stack should be coordinated with the CSB sub-project to make sure there is no conflicts.	no	The suggested coordination is planned with the HCSA and CSB design teams.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
O'Neill, C. 90% CDR	5	Drawing SK-2-300413, Sh.2. Filters VPS-F-1102 and VPS-F-1107, this type of filter cannot withstand high pressures. If the high pressure option that is mentioned in the CDR is proposed than a different type of filter (metal) will have to be used.	no	These filters, Flanders G-1 can be procured in ASME rated enclosures capable of withstanding 100 psi according to the supplier we spoke to. That is one of the chief reasons these units were specified. Subsequent changes to the design however have removed the requirement for this high pressure and the filters will be reevaluated for 25 psi service.	DD
O'Neill, C. 90% CDR	6	Drawing SK-2-300413, sh.2. Filter VPS-F-1102, this type of filter cannot withstand high temperature. A metal filter should be used in this location.	no	Filter VPS-F-1102 is now anticipated to be a metal filter..	closed
O'Neill, C. 90% CDR	7	Drawing SK-2-300421. The equipment shown on this drawing does not match the equipment shown on SK-2-300413, sh.3. The layout of the equipment should include the ductwork to make sure there is space for the installation.	no	Space in the area of the Service Module does not appear to be a problem so the effort was not expended to show the ductwork during conceptual design. The ductwork will be designed early in the definitive design effort.	DD
Ruff, E.S. 90% CDR	1	General Note 1: I would like to compliment Paul Smith, Martin Muller, and Lauren Ames on their presentation. The design review was conducted in a very thorough and professional manner. They have generated a good conceptual design study for the hot conditioning project.	no	Your compliment is certainly appreciated.	closed
Ruff, E.S. 90% CDR	2	General Note 2: I don't have a copy of the conceptual design document, so, I am unable to give page number references for my comments. Comments in this RCR are based on the oral presentation given in the design review meeting.	no	Noted, no action required.	closed
Ruff, E.S. 90% CDR	3	A significant amount of time is consumed during heat-up of the MCO because internal differential temperatures are limited to 50 deg. C.Suggestion: It would probably be worth additional analysis time to try and develop a rational for increasing the allowable temperature differential.	no	Agreed, subsequent calculations have identified the 100 C temperature requirements for all components of the MCO to be an even more restrictive parameter.	closed
Ruff, E.S. 90% CDR	4	I agree with a comment made during the meeting that suggested the following: If possible, use a direct refrigerant coil for cooling, not water heat exchangers.	no	A water study that addresses this issue will be included as an appendix in the CDR.	DD
Ruff, E.S. 90% CDR	5	Observation: In performing grinding operations to affect weld repairs, you will also need a vacuum-type system to clean up the grinding swarf (dust).	no	Good catch, the required functions fo the process enclosure will be expanded to include cleanup of the grinding swarf. Perhaps a vacuum tube that follows the grinder.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Ruff, E.S. 90% CDR	6	Regarding MCO orientation for process connection operations:I believe that it is wishful thinking to expect all of the MCO vessels to maintain an unchanging rotational orientation from CSB to K-Basin, to Cold Vacuum Drying Facility, to CSB storage tube, to Hot Conditioning Furnace.Hence, some sort of rotational alignment capability for the MCO must be present in the Hot Conditioning Facility. As mentioned in the meeting, this could be a turntable with "high temperature bearings" in the conditioning furnace. Alternatively, a "room temperature" turntable could be placed in the spare furnace well.	no	The oven top is being revised to include a tapered roller bearing plate that will allow rotational orientation of the MCO.	closed
Ruff, E.S. 90% CDR	7.1	Comments on Process Enclosure shielding:Observation 1: Based on the table of radiation exposures presented in the design document, most of the hot conditioning dose is taken by the operator in the Process Enclosure module.Observation 2: It was stated that the Process Enclosure was designed primarily as a "constraining device" to prevent the operator from getting direct radiation shine from the open end of the furnace well. To whit, the Process Enclosure structure is conceptually designed using 1" plate steel, with no built-in shielding.	no	This issue was also identified by Curt Miska, please refer to Curt Miska comments 12-15 and the proposed resolutions.	DD
Ruff, E.S. 90% CDR	7.2	(Continued, No. 7 above.)I recommend that the Process Enclosure front wall, front window, and floor be designed using as much operator shielding as weight/load limits allow.In addition, overhead shielding and back-wall shielding for the Process Enclosure should also be added to protect the operator from reflected radiation shine.	no	See response to comment 7.1.	DD
Smith, C.M. 90% CDR	1	Sec 1.0, Page 1 of 3 Add CVDS to acryonym list.	no	CVDS will be added to the acryonym list.	closed
Smith, C.M. 90% CDR	2	Sec 1.0, Page 1 of 3 How does processing the SNF into MCO's fit into the final disposition of this material? What is the overall milestone/decision that this processing supports?	no	Introduction will be expanded to answer these questions.	closed
Smith, C.M. 90% CDR	3	Sec 2.0, Page 12 of 57 #2.2.1.2.2 To further heat transfer/heat-up, or cool down have you considered pre-heating the Helium purge gas going into the MCO? Why/Why not?	no	The circulating helium will be heated or cooled separately from the MCO when the MCO is being heated or cooled. Preheating new helium when it is added at other times would not provide a significant difference in overall cycle times as the heat capacity of one helium charge is small compared to the heat capacity of the other components.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Smith, C.M. 90% CDR	4	Appendix H Need Table of Contents listing the vendor cut sheets for somewhat easier reference. Note: The scroll pump looks like an excellent choice for a vacuum pump. Varian is reputable.	no	An index to the vendor cut sheets will be provided and the cut sheets will be organized alphabetically by the equipment piece number.	closed
Smith, C.M. 90% CDR	5	Sec 2.0, Page 14, 21, 25 Where are the figures? Supplement supplied?	no	The figures were inadvertently left out of the 90% design package. They were transmitted following the meeting and will be included in the final CDR.	closed
Smith, C.M. 90% CDR	6	Sec 2.2.3 Page 20 of 57 Has any energy recovery been considered such as using counterflow heat exchanges to preheat gas going to the heaters from another MCO that is being cooled?	no	Each MCO stands alone. While this idea would certainly conserve energy it has not been implemented for two reasons: (1) MCO cycle times will be unpredictable so there is no assurance that another will be in the proper point of its process sequence to take advantage of energy savings and (2) the cost of the complex valving and ducting would exceed the savings in energy that would result. Another concern would be cross contamination should one MCO system have a leakage problem.	closed
Smith, C.M. 90% CDR	7	Sec 2.2.4 Page 24 of 57 This sequence of operation does not reference any of the SK-2-300XXX drawings and should! The process (written) is very difficult to follow without reference to the sketches. Add "See SK-2-300413, sheet, Appendix A."	no	References to the P&IDs will be included in the text.	closed
Smith, C.M. 90% CDR	8	Sec 2.2.4, Page 26 of 57 paragraph #13 Another major process after welding is the inspection of the weld.	no	Weld inspection will be added.	closed
Smith, C.M. 90% CDR	9	Sec 2.3.3 Page 30 of 57 Variable speed fan drivers are used for the varying flow rates needed for processing a range of cells at one time. Good design!	no	Compliment appreciated, no action required.	closed
Smith, C.M. 90% CDR	10	Sec 2.5 Page 35 of 57 (last paragraph) A variety of welding processes shoud be explored. Perhaps the robot can do the welding. If this is chosen, extra care in selecting a robot and controller/computer that is compatible with the electrical and RF spikes that are produced during welding processes is needed. Some robotic systems (ASEA) are designed specifically for welding operations. However, here there is a size constraint.	no	A welder has been proposed by WHC for this purpose, see Section H for the vendor cut sheet. The specific design will be selected during definitive design after the MCO design has been finalized.	DD
Smith, C.M. 90% CDR	11	Sec 2.7.1 Page 41 of 57 Chilled water system. Does the process actually use a glycole mixture that can be chilled below freezing? Will that be needed to achieve the final cool-down cycle?	no	An unspecified refrigerent is proposed for the chilled water system. A closed loop water system is proposed for inside the HCSA. A water vs air cooling study will be included in the CDR.	DD

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Smith, C.M. 90% CDR	12	Appendix H (Vendor Cut Sheets) Also SK2-2-300420 Heat exchanges, pumps, heaters, chillers, filters etc., but not much for the process enclosure. Information needed on the manipulator, detectors, and other bought-out-parts (BOP). (wheel drivers etc).	no	Cut sheets for the manipulator and welder have been included in the CDR. No wheel drivers are proposed, a motorized hand cart will be used to push/pull the enclosure into position.	closed
Smith, C.M. 90% CDR	13	Page 52 of 57 (Function F1) I would suggest rails for the X-direction and some small amount of Y-positioning within the enclosure. Standard train rails and wheels could handle the large load and do not require custom fabrication. (Advantage for transporting to the facility on train rails ???)	no	One requirement from the MHM subproject is that there be no projections above floor level. Sunken rails are not desirable since they would have a greater impact on the HCSA design and could be contamination traps.	closed
Smith, C.M. 90% CDR	14	Page 52, F1 At the end of travel for stowage either a turntable could be used or a platform that supports the rails and moves cross-ways on another set of rails (low profile). With the amount of utilities required at the process enclosure on overhead utility should probably be supplied.	no	Subsequent to the 90% design presentation the MHM design team raised the box beam to 9 feet so it can now pass over the process enclosure which will be lowered to less than 9 feet. The need for the shuttle table is gone.	closed
Smith, C.M. 90% CDR	15	Page 52, F2 The whole enclosure doesn't need to lift, only a skirt is necessary if at all. Perhaps the seal could drag on the floor.	no	This suggestion will be incorported into the design of the process enclosure during definitive design. Currently an inflatable seal is proposed so contact with the floor during transportation won't be necessary. Absence of contamination on the interior of the enclosure will be verified before the floor seal is broken.	DD
Smith, C.M. 90% CDR	16	Page 52, F3 It was suggested at the design review that a hydraulic actuator for the pit cover could be installed into the floor. That would be great. I suggest that you look carefully at utilizing a 4-bar mechanism type of hing for this cover to minimize the swing spare required inside the process enclosure. Note in the figure beside that the lid top swings from positions 1 - 6 to open. (a drawing, not included here, was attached to this comment).	no	This concept will be evaluated further in definitive design, it certainly shows promise.	DD
Smith, C.M. 90% CDR	17	Page 53, F6 Having stereo vision on the manipulator near the tool interchange plate is probably more advantageous than a force feedback system. Though the operator can usually view directly and look at the overview monitor, the additional view (especially in stereo) will provide very meaningful assistance. If a force feedback system is implemented, it should reflect the world or tool orientation force reflections rather than the individual joint forces. Joint forces are meaningless to a remote operator!	no	Your comments are appreciated and will passed on to the definitive design team who will be dealing with the details of the manipulator system.	DD

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Smith, C.M. 90% CDR	18	Page 53, F7, F9, F10, F11 All power tools should be pneumatic, they are safer, easier to operate, easier to radiation harden, less maintenance, run cool, high power-to-weight ratio.	no	Final tool selection will be made during definitive design. These are all good reasons to select a pneumatic operator.	DD
Smith, C.M. 90% CDR	19	Page 53, F12 This camera should have all remote functions (focus, zoom, macro iris) and include a light source with variable intensity control. There is an excellent system that uses a single camera system and produces 3-D viewing that this should incorporate. See Al Pardini, WHC, 376-9464.	no	Final camera selection will be made during definitive design. These recommendatins will be considered and Mr. Pardini's name will be given to the detail design team.	DD
Smith, C.M. 90% CDR	20	Page 54, F14, F15 Another inspection method would be much nicer in a robot-handled package such as an eddy-current sensor.	no	Subsequent to the 90% design presentation it was determined that ultrasonic testing would be used.	DD
Smith, C.M. 90% CDR	21	Page 54, F17 Consider in-floor hydraulic actuator.	no	Drums with an internal shield will be interfaced with the process enclosure so expended Cs traps can be placed in them. These drums will have shielded lids that will require removal. As such an in-floor hydraulic actuator is not appropriate but a hydraulic actuator mounted on the process enclosure wall should be considered.	DD
Smith, C.M. 90% CDR	22	Page 54, F18 The automatic tube welder should be self contained and not require the robot to positioning it for fine movement welding operations.	no	WHC has proposed a welder for this purpose. It appears that this welder contains the suggested features.	DD
Smith, C.M. 90% CDR	23	Facilities/Utilities Support: Section 3.0 Page 3 of 11 Table: Nothing is included for providing pneumatic utility service to the process enclosure from the facility. A seperate hydraulic supply may even get utilized.	no	The current concept is that the process enclosure will be moved into position and then an umbilical will be plugged into the required services. The plug-in point will be in the trench cover so the required services will run in the trench.	DD
Smith, C.M. 90% CDR	24	SK-2-300417 Consider using double sealing, remotely operable (with manipulator) quick disconnects.	no	Quick disconnets of the type described are considered to be the baseline design. An alternate connector that is more compatible with the process is being designed. The commercial nuclear power industry has experienced considerable difficulties using quick disconnects for this service.	DD
Smith, C.M. 90% CDR	25	DWG 420 Process enclosure: Why is everything so high off the ground? The wheels should be recessed into the walls and the platform level lowered.		The height is driven by the reach of the manipulator is placing a spent cold trap in a shielded drum, and the length of the process pit cover when it is opened (hinge on one end). The height has been reduced to less than 9-ft to pass under the box beam of the MHM.	Closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Smith, D. 90% CDR	1	Introduction page 1. The last paragraph states that the process will be designated as a Hazard Category 2 system. Hazard Categories are specified for facilities, not for systems. DOE-STD-1027 allows for facility segmentation in determining Hazard Category but the HCSA does not meet the criteria for being designated seperately from the CSB. This report should note that the HCSA is part of the CSB and the CSB is HC-2. A final hazard category for the CSB will need to consider the impacts of HCS accidents.	no	The introduction will be revised to reflect this comment.	closed
Smith, D. 90% CDR	2	Appendix E. The functions and requirements should identify the acceptance criteria for the SNF. The confinement function of the HCS should be better defined. For example, the allowable leak rate at the design pressure should be identified since the design does not provide active confinement during accident conditions. The ventilation flow needs to be specified based upon routine and upset conditions during the HCS process. The design pressure and temperature for the confinement needs to be specified based on potential accidents (to be addressed in the PSE). The design needs to provide the capability to periodically test the confinement function and replace seals when required. The HEPA filters need to be designed for accident temperatures and pressures.	no	Appendix E only addresses the performance specification, the functions and requirements were not available until too late in the CDR development phase to include and evaluation of them in the CDR. The F&R evaluation report will be written early in the definitive design phase and these comments will be incorporated into it.	DD
Smith, D. 90% CDR	3	Appendix E. WHC-CM-4-46 should be specified to identify the design requirements for safety class and significant items. Also it appears strange to have appendices in an appendix (Appendices A, B, and C to appendix E).	no	We will revise the final CDR to incorporate your first comment. For the second comment, the performance specification report was written as a standalone document and then incorporated into the CDR thus leading to the appendix in an appendix dilema. The Appendix E attachments are now referred to as addendums.	closed
Zaman, A.A. 60% CDR	1	Section 2.0: "Cool Down Process Connection." There will be some free water left over from the CVC process. Specify or estimate the amount and list whether this free water demands consideration for further action (conditioning) in the Hot Conditioning Facility.	no	It would be expected that only a small amount of free water would remain after cold vacuum drying, however, it would not be improbable that several MCO's would contain a greater total water inventory after cold vacuum drying than is allowed by the Hot Conditioning Product criteria (1.67 Kg per WHC-SD-SNF-OCD-001). It should be noted that this question is really "what is the Cold Vacuum Drying product criteria." This question should be directed to the CVD project. (They are preparing a CVD product criteria document.)	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Zaman, A.A. 60% CDR	2	Section 2.0: Some of the temperatures of the defined conceptual processes are potentially close to the ignition point for pyrophoric materials in fuels (eg U-hydrides). Data on ignition point and process temperature selection based on the minimum risk for ignition needs to be established and justified.	no	This is not an equipment conceptual design question, this is a question pertaining to the overall SNF process strategy selection. Please refer to the IPS training strategy document "Integrated Process strategy for K Basin Spent Nuclear Fuel", WHC-SD-SNF-SP-005, to obtain this type of background information.	closed
Zaman, A.A. 60% CDR	3	Section 2.0: Options for the use of other gases (N2, etc) need to be explored due to the recent study (TI-021) on Hydrogen detonation.	no	The strategy to preclude Hydrogen burn events provided in the Hot Conditioning Performance Specification, being implemented by the design is to provide a system design that will ensure both an inert environment in the MCO, and dilute hydrogen concentrations to less than 2% (<1/2 of the lower flammable limit in air.) This is a very conservative approach and should keep the probability of hydrogen ignition very low.	closed
Zaman, A.A. 60% CDR	4	Section 5.0: A - The requirements for participation of the Spend Nuclear Fuels Safety (Independent) need to be laid out. This is in view of the requirements in DOE 5480.5 (contractual obligation), DOE 4700 and SNF Safety Management Plan.	no	This is not a valid comment against the equipment conceptual design. This is a Hot Conditioning Project Management document question. If after reviewing this document questions still remain, you should contact Rick Bradshaw for further clarification.	closed
Zaman, A.A. 60% CDR	5	Section 5.0: B - The DOE Order lists ASME/ANSI B31.3 under the "Reference Standard and Guides."	no	Page 8 of the Performance Specification Report, DOE 6430.1A General Design Criteria, does idicate that ASME B31.1 Chemical Plant and Petroleum Refinery Piping standard and the Industrial Vacuum Practices are considered to be supplemental standards that will be used for the HVCE design.	closed
Zaman, A.A. 60% CDR	6	Section 5.0: B - There are additional divisions/sections that are important for design consideration of the Hot Conditioning Facilities. Example, 0110-6.1 Fire Protection. 0110-99.0, 1319, etc. Add these sections. Add generic statement regarding other than listed reference.	no	The criteria evaluaton document developed for the Hot Vacuum Conditioning equipment goes into the applicability of the general design criteria in more extensive detail. This document will be included in the final CDR.	closed
Zaman, A.A. 60% CDR	7	The most important manual is SHC-CM-4-46. It provides guidance on safety analysis (hazards, acident, risk, etc) and safety classification.	no	Further review of the HCS performance specification will be done during the detailed design and this potential reference requirement will be discussed with the HCS design authority to determine whether it is applicable to the HCS equipment design.	closed
Zaman, A.A. 60% CDR	8	Consider reference to DOE 5480.24, 5480.31, 5480.22, etc.	no	See response to comment #7 above.	closed
Zaman, A.A. 60% CDR	9	Does this facility need to be designed and operated to NRC equivalency?	no	This is the equipment conceptual design, not the facility design. Please refer facility design questions to the facility designer (Fluor).	closed

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REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Zaman, A.A. 60% CDR	10	Depending on the Safety Classification of the Hot Conditioning Facilities, the configuration in drawings may change (eg SC1 will require redundant and single failure proof power supplies/utilities for safe shut down.)	no	Comment noted. No reply needed.	closed
Zaman, A.A. 90% CDR	1	The Preliminary Safety analysis/evaluation needs to be performed to identify the safety class and safety significant structure, systems and components per DOE 5480.23 (section 9.0) DOE 6430.1A (110-5.2) and WHC-CM-4-46. The information in the drawing needs to be checked against the accident mitigation function specified in the safety analysis. This could not be done.	no	A PSAR is being developed in parallel with the CDR. No safety class systems have been identified. The design team will continue to work with the safety team to define mitigation measures.	closed
Zaman, A.A. 90% CDR	2	a) We recommend that the 90% design report should add discussion on the NRC equivalency issue and impact on the process and facilities design. b) Has the evaluation (by NEC experts) been done to see where the identification and application of NFPA Article 504 ("Intrinsically Safe" systems) apply?	no	NRC equivalency is addressed in the criteria evaluation that will be in the final CDR. NFPA evaluation will be conducted during definitive design.	DD
Zaman, A.A. 90% CDR	3	The discussion in the text/report is based on the normal operations. Need to cover off-normal, accident and design basis accident.	no	These operations are addressed by the PHA which is being developed by WHC. Results of the hazards analysis qre being incorporated into the design.	closed
Zaman, A.A. 90% CDR	4	Introduction, p 1, pgph 2: The conditions of high pH in (borated water) and high temperature may produce corrosion of the stainless steel. What is the potential generation of hydrogen gas by this process? Refer to NRC notice 96-34. (Need a copy? Call me at (509) 376-1692.)	no	When the MCO reaches the HCSE process only chemically bound water (no free water) will be present, so corrosion of the SST is not anticipated to be a problem. Hydrogen gas will be generated when the uranium and zirconium hydrides decompose. These will be removed before a flammable concentration is reached. The process gases will be continuously monitored for hydrogen.	closed
Zaman, A.A. 90% CDR	5	Introduction, p 3, pgph 1: Hot conditioning facility will need to work with the specified design life of 6 yr for the CSB-MHM. Suggest clarification.	no	The hot conditioning program is scheduled to be complete in two years.	closed
Zaman, A.A. 90% CDR	6	Section 2.1, pgph 4: The CSB MHM is designed to -27 F to 115 F ambient temperature. The interfaces with the hot conditioning oven need to be identified and ensured compliance.	no	Maximum MCO storage tube temperatures are expected to be about 150 degrees-C, which is the temperature of the MCO's when they are removed from the oven. the MHM design conditions are being re-evaluated by the MHM design team to assure compatibility.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Zaman, A.A. 90% CDR	7	Section 2.0 Process, ID 47.0: Visual inspection of a weld in a safety class MCO boundary may not be acceptable. ASME sec. III and applicable V and IX may need to be researched to determine the minimum requirements (radiography, ultrasonic, etc.)	no	This will be revised to reflect ultrasonic weld testing rather than dye penetrant.	closed
Zaman, A.A. 90% CDR	8	Section 2.2.1.2.1: The Helium blower VPS-BLO-1106 is identified as "spark proof". The right terminology from NEC (NFPA 70, article 504) is "intrinsically safe" and may go beyond the blower itself to its electrical/grounding/piping systems. If intent is to prevent hydrogen ignition ("classified hazardous location"), correct the terminology.	no	The text has been revised.	closed
Zaman, A.A. 90% CDR	9	Section 2.2.1.2.3: Since the MCO is designed to 150 psig, the pressure rating of the system (specifically components close to the MCO) be safe at that rating. The text calls out 100 psi ("a" or "g").	no	Although the MCO is designed for 150 psig, it is configured with a rupture disc with a 25 psig rating. This rating sets the design pressure of the components within the system. The HCSE system will also include rupture discs.	closed
Zaman, A.A. 90% CDR	10	Section 2.2.1.2.4: a) If the PLC are relied on the automatic shut-down for the design basis accident (impacting off-site public) then their qualification requirements are going to be stringent (IEEE 323, 344, etc) and costly. This needs to be addressed clearly here.	no	The interlocks prevent subsequent actions from taking place if the interlock logic is not satisfied. This is not automatic shutdown. The PLC may require operator intervention if all interlocks or sequences have not been satisfied. The system will shut down in a passively safe configuration.	closed
Zaman, A.A. 90% CDR	11	Section 2.2.2.3.1: Was the induction electrical heating considered for the process?	no	Induction heating was considered but abandoned in favor of convective heating as the convective heating system can be used for both heating and cooling. Induction heating would not be able to assure that the MCO would not heat up faster than 50 degrees-C/hr or that all parts of the MCO would be within 100 degrees-C of the same temperature.	closed
Zaman, A.A. 90% CDR	12	SK-2-300412: The pump VPS-VAC-1104 needs to be slected such that operator or maintenance error does not help reverse the flow and pressurize the MCO. Hazards/Accident assessment will need to adress such accident and mitigation features.	no	This particular vacuum pump, of scroll design, will not pump gas if operated backwards. It is also connected to a single phase power source which will not reverse if connected incorrectly.	closed
Zaman, A.A. 90% CDR	13	Section 2.2.2.3.2: Missing content? If so, please provide write-up.	no	Inclusion of this section was not intended. Text will be corrected.	closed
Zaman, A.A. 90% CDR	14	Section 2.2.3.1.3.1: The water cooling system may need detection device for radioactivity that are potentially available from accumulation over time from MCO surface/leakage, etc.	no	There is an air barrier between the water system and the MCO, thus no contamination or buildup over time is expected.	closed

REVIEWER	COMMENT #	COMMENT	HOLD POINT	DISPOSITION	STATUS
Zaman, A.A. 90% CDR	15	Section 2.2.4, item 3: Assign identification number to the block valve.	no	Assignment of valve ID numbers will be done at the definitative design stage.	DD
Zaman, A.A. 90% CDR	16	Section 2.3.1: The codes need to be identified along with date/revision, eg ASME AG-1, ASME N509, etc.	no	The exact standards that apply will be specified during definitive design.	DD
Zaman, A.A. 90% CDR	17	Section 2.7.4: The air receiver if supporting a safety class of safety significant function may need to have capacity and classification thereto.	no	This receiver is a utility and not meant to support a safety class function. It will be U stamped to assure design and construction in accordance with ASME Section 8, Division 1.	closed
Zaman, A.A. 90% CDR	18	Section 2.9: The Facility has the responsibility to characterize their waste before shipment to storage (ie burial ground, WRAP, etc) This function is missing from the document.	no	Characterization of the waste will be done in the waste storage room. The text will be revised to reflect this function.	closed
Zaman, A.A. 90% CDR	19	Section 4.0, Interface #MHM3: Current direction is to allow a mazimum clearance of about seven feet between the floor and the MHM superstructure. Thsi won't allow the 11'-9" Process Enclosure (SK2-2-300420) to passunder the MHM. (Contact Gerry Bazinet of CSB for current information.)	no	The configuration shown in the 90% CDR anticipated that the enclosure would be moved out of the path of the MHM rather than pass under it. Subsequently it has been determined that the MHM box beam will be raised to 9 ft and the process enclosure height will be reduced to 8 ft 6 in.	closed
Zaman, A.A. 90% CDR	20	SK-2-300413, sheet 2: To keep the MCO isolated, a HEPA filter may be needed between the block valve and the device VPS-PFR-1101.	no	Drawing will be revised to incorporate the filter as recommended.	closed

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Project 2318: Hot Conditioning CDR Comments

PART 2: INDEX OF REVIEWERS

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NAME	PHONE	ORG/GROUP	LOCATION
Alaconis, W.C.	(509) 376-9390	SNF Operations	MO-285
Burns, B.M.		WHC	WHC 78
Cowan, R.G.		WHC 335	
Goldman, L.	(509) 373-6371	Process Engineering	MO-285
Kurtz, J.			
Lucas, C.	(509) 373-1006	OPS Analysis/ Waste Handling	MO-102
Merkling, T.	(509) 373-9412	Nuclear Safety	2751E
Miska, C.R.	(509) 376-7103	SNF Engineering	MO-285
O'Neill, C.	(509) 373-7642	ICF Kaiser	2261 STEVENS
Ruff, E.S.	(509) 376-1943	Mech Eng ICFKH	H5-70
Smith, C.M.	(509) 375-3915	PNNL	2400 STVCN
Smith, D.	(509) 372-3623	SAR Engineering	2751E/C-101
Zaman, A.A.	(509) 376-1692		B1-10

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APPENDIX L

USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

APPENDIX L - USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

1.0 STATEMENT OF PROBLEM

The proposed process for removing chemically bound water and hydrides from the SNF in the MCOs following the cold vacuum drying process involves heating the SNF to temperatures of 300 to 350°C and drawing a vacuum. This heating is followed by cooling the SNF back to 150°C for oxidation of exposed uranium surfaces. The process involves cooling in the following process streams.

A. Helium Recirculating Through MCO

During both the heatup and cool down phases, helium is continuously recirculated through the MCO to: a) enhance the heat transfer rate; b) allow monitoring of the heatup/cool down rate; and c) allow monitoring of the released gases. Two cooling steps are proposed for this stream.

1. Cold Trap - The released gases could include cesium so a cold trap will be provided before the gases exit the trench in order to remove the cesium before it can plate out in the above grade piping where it would result in unacceptable radiation exposure to personnel in the HCSA. In this case, cold is a relative term, the gases must be cooled to approximately 100°C.

2. Prior to Vacuum Pump/Recirculation Pump - The vacuum pump that has been selected for the HCSE has a temperature limitation of 40°C for the gases entering the pump. The recirculation pump can be specified for higher temperatures so it does not present the limitation that the vacuum pump does.

B. Cooling Air Recirculating Through Oven

It is proposed to cool the MCO from approximately 300°C to 150°C by recirculating air through the annular space between the MCO and the oven. The heat that is transferred to this air must subsequently be removed before the air is returned to the oven.

The most straight forward means of cooling the gases is to use a refrigerant system to chill water which can then be used to cool the process gases. The downside to this approach is threefold: 1) if liquid water is introduced into an MCO that has been heated to 300°C, a steam explosion could occur; 2) if water

APPENDIX L - USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

is introduced into an oven that has been heated to 300°C, a steam explosion could occur; and 3) water in a cool MCO would require that the hot conditioning process be repeated.

To preclude water being introduced into an MCO which is in a storage vault, water is not allowed within the CSB storage vaults. The fire hazards analysis for the CSB has determined that a water-based fire protection system is not required in any areas where MCOs are handled.

2.0 PURPOSE

The purpose of this study is to identify and evaluate possible options for cooling the MCO and the recirculating helium loop in the HCSE process.

3.0 CRITERIA

If water is to be introduced into the HCSE process, then the following criteria for protection of the MCO must be satisfied. Intrinsically safe mechanisms must be designed into the cooling system such that water is excluded from the MCO during normal operations, abnormal operations, and accident conditions such as breaching of a process line or vessel. This includes both the MCOs in storage tubes in the CSB and MCOs in the HCSE process pits. Additionally, the water must be controlled such that it is not allowed to be in contact with hot surfaces such as the interior of the oven. Any system that violates these criteria is not acceptable if air from the HCSA is used for cooling then, whatever system is chosen should have minimal impact on the HCSA air and heat balance. The selected system should also conform to the HCSA criteria for constant velocity in the exhaust stack which has been set in the project's application for an air emissions permit.

4.0 COOLING SYSTEM ALTERNATIVES

The cooling methods/alternatives that have been identified and that are evaluated in this study to provide the required cooling are: a) Draw air from HCSA; b) use the 150 cfm of ventilation air from the process pit; c) cool with a gaseous coolant such as carbon dioxide or helium and d) use a chilled water system with intrinsically safe features.

APPENDIX L - USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

Alternative A - Draw Air From HCSA

Air drawn from the HCSA through a HEPA filter would be used as required and then exhausted through HEPA filtration and into the HCSA stack. The MCO oven represents from 90 to 95 percent of the cooling load while the helium circulation loop represents the remaining 5 to 10 percent of the load. The volumetric intake air rate to the MCO is 750 cfm and the combined rate to both of the circulating heat exchangers is 75 cfm.

Prior to its introduction to the MCO oven, the air would be blended with circulating hot air to achieve the programmed inlet temperature, thus the amount of air required from the HCSA would vary, increasing with time, as the programmed inlet temperature dropped through the cooling period. The exhaust temperature would reach a maximum of approximately 260°C at the initial stages of cooling. This hot air would be combined with the ventilation air from the other MCO pits and be sent to the stack at a maximum of 100°C if two MCOs were being cooled simultaneously.

Air piped to the helium cooling loop would be at the free air temperature of 20°C. Compared to the volumetric requirement for the MCO oven, the amount of air required for helium loop cooling would be approximately 5 percent of that required for the MCO oven. Exhaust air from the helium loop cooling would be combined with the exhaust from the MCO oven before being sent through a HEPA and up the HCSA stack.

Alternative B - Use the 150 cfm of Ventilation Air discharging from the Process Pit Ventilation

A constant 150 cfm of process pit ventilation air would be used for both MCO cooling and helium exchanger cooling. This air, having passed through a HEPA filter, would be heated to a temperature of approximately 25°C, having picked up approximately 5 degrees from heat losses around the top of the MCO. As in the previous alternative, it would be blended with circulating air to achieve the programmed inlet temperature for MCO cooling. The cooling air to the MCO oven may have to be operated at a higher temperature than what is called for by the cooling temperature profile, owing to the 150 cfm restriction. This would have the effect of increasing the time required for cooling. This option should be studied further.

Approximately 5 percent of the pit ventilation exhaust would be piped to fin tube exchangers in the helium circulation loop. After picking up heat there the exhaust would then join the exhaust from the MCO oven to be directed through HEPA filtration and up the stack. The combined exhaust ventilation air from all of the MCO process pits would result in a stack temperature of up to 100°C.

APPENDIX L - USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

Alternative C - Cool With a Gaseous Coolant Such as Carbon Dioxide or Helium

Candidate gaseous cooling media includes helium, nitrogen and carbon dioxide. All gasses would be handled under pressure to increase the heat capacity per unit volume. While helium and nitrogen would remain as gas, carbon dioxide could be used above its critical point as a supercritical fluid. In this state, the distinction between gas and liquid is lost and the fluid would exhibit the properties of liquid CO_2. The triple points of helium and nitrogen are at too high a pressure for their use as supercritical fluids to be practical.

The cooling media would be chilled using a conventional refrigerant expansion system. The cold gas would be then moved to the process heat exchangers where it would pick up heat from the circulating load. In the case of the MCO oven, this would be the load of the air circulating at 750 cfm and in the case of the helium loop, this load would come from the helium.

Alternative D - Use a Chilled Water System With Intrinsically Safe Features

Intrinsic safety can be achieved for cooling the MCO oven air with chilled water. The chilled water would receive heat from the exhaust MCO oven air. Water entry to the MCO oven could be prevented by piping the circulating air stream through a 125-gallon knockout pot that separates and collects any water leakage, thereby preventing entry to the MCO oven area. The water would be confined to the process module, well away from the oven. The cooling water loop would be contained by double walled piping to preclude water leaks from reaching the HCSA floor. The process module would be designed to contain any leakage from the exchangers as well as to serve as a drain for the outer pipe of the cooling water loop.

Intrinsic safety through indirect heat exchange between the helium circulation loop and chilled water is another matter. No intrinsically safe system for heat exchange in this application can be foreseen. All indirect heat exchange methods can have safeguards but not intrinsic safety. For this reason, water cannot be considered for helium circulation cooling.

5.0 EVALUATION OF ALTERNATIVES

Alternative A - Draw Air From HCSA

When air is drawn from the HCSA, it must be made up by the building's HVAC system to maintain proper air balance in the annex. With variable flow of air drawn from the annex, the amount of which depends upon the cooling requirements of the MCO, increased control sophistication and increased capacity must be provided. This added complexity to HCSA ventilation requirements makes this option undesirable. The flow through the HCSA stack would also be variable.

Alternative B - Use the 150 cfm of Ventilation Air discharging from the Process Pit Ventilation

The HCSA ventilation system is designed to deliver 150 cfm to each of six MCO vaults, the use of this air for ventilating the vaults does not preclude its use in subsequent cooling applications. While not as effective as chilled water in being able to achieve patterned temperature control of the MCO, it can be done if some extension of the time required for cool down is permitted. For heat transfer from the helium circulation loop only, no reduction in the time required for cooling would be apparent.

Alternative C - Cool With a Gaseous Coolant Such as Carbon Dioxide or Helium

Chilling through the use of high pressure gasses or supercritical fluids requires attention to pressure containment of these fluids. While adequate heat transfer can be obtained, the fluid system needed to accommodate this consists of extra pressure rated pumps or blowers, receivers and piping. Careful attention must be paid to the installation of this equipment, making sure that all leaks are stopped. The consequences of small leaks is the loss of potentially expensive heat transfer fluid, while massive leakage of materials such as nitrogen and more importantly CO_2 could result in the displacement of air, thereby creating an atmosphere adjacent to the leakage which cannot be safely occupied.

Alternative D - Use a Chilled Water System With Intrinsically Safe Features

Intrinsic safety, excluding water from the area of the MCO oven can be assured through the installation of a knockout interceptor in the air line. Since intrinsic safety cannot be obtained for the circulating helium stream, air cooling using the heat capacity of a portion of the MCO pit exhaust is suggested.

6.0 RECOMMENDATIONS

Our conceptual design shows and thereby recommends a combination of Alternative B and Alternative D. This system combines the practicality of controllable temperature obtainable with mechanical refrigeration with the availability of ample heat capacity for helium cooling from MCO pit exhaust air.

APPENDIX L - USE OF COOLING WATER IN THE HOT CONDITIONING SYSTEM

Prior to implementation of this method, a complete heat balance will be conducted using any revised cooling temperature profile which may result as a result of the recently completed Q-Matrix study and the effect the 100°C temperature flux specification has upon the programmed cooling temperature profile.

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