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K Basin Sludge Removal
Temporary Sludge Storage Tank System

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U.S. Department of Energy Contract DE-AC06-96RL13200

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The preconceptual design for the temporary sludge storage tanks project will provide designs for the storage of radioactive sludge retrieved from the K Basins. Preconceptual designs are developed for two storage tank systems (i.e., double-contained receiver tank [DCRT] type and critically safe geometer). Two tank options are evaluated for the critically safe tank system. One system assumes the K basin sludge has been pre-treated (e.g., dissolution and coprecipitation with an added newtron absorber) and uses DCRT type tanks for sludge storage.

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Preconceptual Design Report

K Basins Sludge Removal Temporary Sludge Storage Tank System

Work Order E33936

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

PRECONCEPTUAL DESIGN REPORT

K BASINS SLUDGE REMOVAL
TEMPORARY SLUDGE STORAGE TANK SYSTEM

Work Order E33936

Prepared for

DE&S Hanford, Inc.
Richland, WA

Prepared by

Fluor Daniel Northwest
Richland, WA

PRECONCEPTUAL DESIGN REPORT

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Prepared for

DE&S Hanford, Inc.
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APPENDICES:

ABBREVIATIONS

AABC	Associated Air Balance Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
AWS	American Welding Society
DCRT	double-contained receiver tank
HEME	high efficiency moisture eliminator
HEPA	high efficiency particulate air
HLAN	Hanford local area network
HMT	hydrogen mitigation test
HVAC	heating, ventilating, and air conditioning
HWVP	Hanford Waste Vitrification Project
ICE	instrumentation/control/electrical
IEEE	Institute of Electrical and Electronics Engineers
ITRS	initial tank retrieval system
MCC	motor control center
MOV	motor-operated valves
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OIS	Operator Interface System
PC	personal computer
PLC	programmable logic controller
PSE	preliminary safety evaluation
PVC	polyvinyl chloride

SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TMACS	Tanks Monitoring and Control System
TWRS	Tank Waste Retrieval System
UPS	uninterrupted power supply
VSD	variable speed drive
WAC	Washington Industrial Safety and Health Act

PRECONCEPTUAL DESIGN REPORT

K BASINS SLUDGE REMOVAL TEMPORARY SLUDGE STORAGE TANK SYSTEM

Work Order E33936

1.0 INTRODUCTION

Shipment of sludge from the K Basins to a disposal site is now targeted for August 2000. The current path forward for sludge disposal is shipment to Tank AW-105 in the Tank Waste Remediation System (TWRS). Significant issues of the feasibility of this path exist primarily due to criticality concerns and the presence of polychlorinated biphenyls (PCBs) in the sludge at levels that trigger regulation under the Toxic Substance Control Act. Introduction of PCBs into the TWRS processes could potentially involve significant design and operational impacts to both the Spent Nuclear Fuel and TWRS projects if technical and regulatory issues related to PCB treatment cannot be satisfactorily resolved.

Concerns of meeting the TWRS acceptance criteria have evolved such that new storage tanks for the K Basins sludge may be the best option for storage prior to vitrification of the sludge. A recommendation for the final disposition of the sludge is scheduled for June 30, 1997. To support this decision process, this project was developed. This project provides a preconceptual design package including preconceptual designs and cost estimates for the temporary sludge storage tanks. Development of cost estimates for the design and construction of sludge storage systems is required to help evaluate a recommendation for the final disposition of the K Basin sludge.

2.0 SUMMARY

The preconceptual design for the temporary sludge storage tanks project will provide designs for the storage of radioactive sludge retrieved from the K Basins. Preconceptual designs are developed for two storage tank systems (i.e. double-contained receiver tank [DCRT] type and critically safe geometry). Two tank options are evaluated for the critically safe tank system. One system assumes the K basin sludge has been pre-treated (e.g. dissolution and coprecipitation with an added neutron absorber) and uses DCRT type tanks for sludge storage. These are cylindrical, single-shell tanks 6.1 m (20 ft) in diameter and 3.7 m (12 ft) high. This system is described in Section 3.0 of this report. The second system assumes the sludge has not been pre-treated and uses "critically safe" tanks for storage. These tanks have geometric configurations which minimize the risk of a criticality. One option for the critically safe tank system utilizes an array of pipe annulus tanks, which have an outside diameter of 1.4 m (4.5 ft) and an inside diameter of 0.9 m (3 ft). This system is described in Section 4.0 of this report. The second option for the critically safe tank system uses a "harp" shaped tank. This design is described in Section 5.0 of this report. Other alternatives for mixing and transferring the sludge during its storage period are discussed in Section 6.0.

All of the sludge storage systems share some basic features and requirements. The sludge will be removed from the K Basins, pre-treated if required, and delivered to the storage tanks via a sludge transportation system (truck with sludge tank and off loading pump). The slurried sludge will be off loaded into the storage tanks. Mixing pumps or other means will be used to mobilize the waste during the storage period until the waste is to be retrieved and transferred to a processing facility.

The scope of work for this project includes preconceptual designs, with cost estimates for the design, procurement, and installation of each of these three systems. The following items are required for each storage system:

- Mixing for sludge mobilization.

- A means for decanting liquid between the two DCRTs, and a means to pump decanted liquid as well as the sludge out of the tanks and back into a transport tank.

- A programmable logic controller (PLC) and personal computer (PC) based control system with an operator station that includes functions to monitor, alarm, and control the storage systems for each tank.

- Instrumentation required to measure the effects and results of mixing operations and the physical characteristics of the waste during storage and prior to transfer, including tank waste levels, and waste temperatures.

- Equipment and containers for removal, cleaning, decontamination, transport, storage, and burial of contaminated components.

- Utilities for storage and retrieval operations (e.g. electrical power, sanitary water, raw water).

- Site preparation for the installation of tanks and equipment.

- A ventilation system to maintain temperatures within the tanks to acceptable levels.

- Water addition capability to bring sludge properties into compliance with storage and slurry transfer specifications, which are to be developed.

- Flush capability for decontamination purposes.

The cost estimates for the three sludge tank systems are in Appendices A, B, and C. The estimates do not include site costs and other project costs.

Total estimated design and construction costs for the DCRT type system:

Total Cost -	$ 9,520,605
50% Contingency -	$ 4,760,311
Total Dollars -	$14,280,916

Total estimated design and construction costs for the critically safe annulus tank system are as follows:

Total Cost -	$11,275,612
50% Contingency -	$ 5,637,814
Total Dollars -	$16,913,426

Total estimated design and construction costs for the critically safe harp tank system are as follows:

Total Cost -	$15,362,553
50% Contingency -	$ 7,681,284
Total Dollars -	$23,043,837

3.0 DCRT TYPE SLUDGE STORAGE SYSTEM

3.1 GENERAL DESCRIPTION

This section describes the DCRT type sludge storage system, including required ancillary equipment and support facilities. Some of the preconceptual designs for equipment and support facilities are based on similar designs from past projects. No formal sizing or design calculations were used in these preconceptual designs.

The system consists of two 95 000 L (25,000-gal), stainless steel, single shell tanks contained in a below grade cast-in-place concrete vault. The vault is lined with stainless steel to a height capable of containing the volume of the largest tank. The roof of the vault forms the floor of a concrete process pit which contains process piping, mixer pump motors, transfer pump motors, instrumentation components and other service lines. Concrete coverblocks for radioactive shielding form the top of the process pit. A ventilation system for cooling and containment purposes brings outside air into the vault and sludge tanks and exhausts the air through a high efficiency particulate air (HEPA) filtration system. A building next to the storage vault houses all of the instrumentation, control, and electrical (ICE) monitoring equipment required to support the system during sludge storage and retrieval.

The outline specification for the DCRT type system is in Appendix D.

Figures of the sludge storage tank system are shown in Appendix G.

3.2 ICE BUILDING AND UTILITIES

<u>Civil</u>

The project area is bound on the north by the 7th Street extension, on the south by the proposed access road to the under construction Canister Storage Building, approximately 186 m (610 ft) east of Akron Avenue, and 137 m (450 ft) west of the Spent Nuclear Fuels/Canister Storage Building isolation fence. (See Figure 1, Appendix G)

The existing contours slope from southeast to northwest from an approximate elevation of 215.5 m to 214.0 m (707 to 702 ft) above sea level in a distance of approximately 69 m (225 ft).

The planned excavation activities will occur in an existing construction lay down area. All areas graded or excavated will be stabilized with crushed gravel. Excavation will be required for the storage tank vaults, a new road, HVAC pads, ICE Building, water lines, and electrical and instrumentation conduits. Excavation, trenching, and shoring will be performed in accordance with Washington Administrative Code (WAC), Washington Industrial Safety and Health Act, Title 296, and Labor and Industries, Part N "Excavation Trenching and Shoring." Excess excavated soil will be leveled to existing contours.

Excavation will be required for a new electrical duct bank from the existing 3-phase, 4-ire, 1600 A, 480 V, Hanford Waste Vitrification Project (HWVP) switchboard "SB-2T-05" to the new motor control center (MCC) in the ICE Building.

A 4.6 m (15-ft) wide asphalt pavement loop will be located north of the proposed Canister Storage Building access roadway. The storage tank vault, HVAC pads, and ICE Building will be located inside the loop. A temporary truck load-out retention basin, sized to retain a 28 400 L (7500 -gal) spill, will be located on the new loop road adjacent to the tank vault.

All survey data, soil samples, site planning, grading, and excavations will comply with DOE Order 6430.1A.

Architectural

The ICE Building will be a 9.75 m by 7.32 m (32- by 24-ft) pre-engineered, rigid-frame metal building. The eave height will be 3 m (10 ft) above the finished floor elevation.

The foundation system will consist of individual footings and piers with a continuous perimeter wall. Footings will be approximately 1070 mm (3 ft 6 in.) square by 400 mm (1 ft 4 in.) thick with a 150 mm (6-in.) slab-on-grade.

The exterior building surface will be constructed of an exposed or concealed fastener, galvanized sheet metal skin system (0.7 mm [24-gage] minimum thickness) attached to a self-framing metal structure. The galvanized metal components of the ICE Building will be painted to extend the life of the galvanized coating.

The ceiling/roof support structure will have exposed purlins, rafters, and beams.

Sheet metal exterior walls, sheet metal roofing, metal window and door frames, and the building perimeter foundation will be insulated to meet American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 90 thermal transmittance criteria.

Interior wall surfaces will be covered by a vapor barrier and will be protected from the floor to 2.4 m (8 ft) above the floor by a layer of taped and painted gypsum board.

The reinforced concrete floor will be covered with vinyl flooring tile.

The new monitoring stations will be equipped with stools and/or chairs for operator use. Ergonomic criteria will be considered in furniture selection.

Fire Protection

Automatic fire alarm and a preaction automatic fire sprinkler system will be installed in the ICE Building. The fire alarm system will include manual pull stations at the exits, smoke detection, sprinkler system waterflow alarms, sprinkler system control valve tamper supervision, and audible and visual alarm warning devices. Fire alarms will be connected to the radio fire alarm reporter box to transmit alarms to the Hanford fire department.

The preaction automatic sprinkler system will be supplied from an existing raw water system. The supply line lead-in will include a post indicator valve. A strainer will be installed at the base of the system riser. Water to the sprinkler system piping will be released by activation of the fire alarm system.

Exits and exit lighting will be provided in accordance with National Fire Protection Association (NFPA) NFPA 101, Life Safety Code.

Heating, Ventilating, and Air Conditioning

The ICE facility will be maintained at a summer inside design temperature of 26 °C (78 °F) with an outside temperature of 35.5 °C (96 °F) dry bulb and 19.5 °C (67 °F) wet bulb. The winter inside design temperature will be maintained at 22 °C (72 °F) with an outside design temperature of - 5 °C (5 °F).

The facility will be mechanically cooled using heat pumps for both summer cooling and winter heating. Electrical resistance heaters will supply supplemental heating in the event the temperature drops below a predetermined setpoint.

Approximately 42 kW (12 tons) of air-conditioning will be required for summer cooling and 20 kW of electric resistance heating for winter conditions.

All equipment and components will conform to ASHRAE standards, supply duct-work will conform to both ASHRAE and Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards.

Automatic control setback and shutdown devices with manual override features will be provided. Use of separate or dual setting thermostats, switches, time clocks, or connections for on/off control will be considered for control of air-conditioning to raise cooling setpoint during summer unoccupied periods and to control the heating setpoint during winter unoccupied periods.

All air handling units (heat pumps) will recirculate air and will also be designed to automatically use outside air quantities up to 100% of the fan system capacity for cooling the space, with the exceptions noted in ASHRAE Standard 90. Economizer cycle control shall not be used for the heat pumps where introduction of the additional outside air would actually increase energy consumption.

Sanitary and Raw Water

A 100 mm (4-in.) raw water line for fire protection will tie into an existing 300 mm (12-in.) raw water main approximately 117.3 m (385 ft) east of the proposed ICE Building. A 50 mm (2-in.) sanitary water line for a safety shower will tie into an existing 250 mm (10-in.) sanitary water main approximately 107.3 m (352 ft) east of the storage tank vault. The new raw and sanitary water lines will be provided with adequate valving. A 50 mm (2-in.) raw water line is branched to a water filter shed. The raw water is filtered and the flowrate monitored to provide mixer pump bearing cooling and tank water makeup. A 50 mm (2-in.) line will extend from this enclosure to the process pit.

Compressed Air

Use of compressed air is currently not required for this preconceptual design. However, an air compressor is provided in the ICE Building for future use and is included in the cost estimate.

Hot Water

A spray wash assembly will be located around the mixer and decant/transfer pumps for decontamination during their removal. A hose connection will be available for hook up to a portable hot water supply system, which will be provided by others.

Electrical Service and Distribution

The electrical service and distribution system will provide a motor control center (MCC), emergency backup generator, uninterrupted power supply (UPS), transfer switch, dry-type transformer, panelboards, electrical service duct bank and feeders. All equipment will be in accordance with the National Electrical Code and DOE Order 6430.1A.

The electrical service will be from an existing 3-phase, 4-wire, 1600 A, 480 V, HWVP construction switchboard "SB-32T-005 which is fed from a 13.8 kV- 480Y/277 V, 1000 kVA pad-mounted, dry-type transformer. An alternative electrical service source will be from another HWVP construction switchboard "SB-32T-004" which is fed from a 13.8 kV - 480Y/277 V, 1500 kVA pad-mounted, dry-type transformer.

A new 400 A feeder breaker will be installed in the switchboard. The electrical service feeders (2-parallel feeder) will be routed in an underground concrete-encased (2) -100 mm (4-in.) polyvinyl chloride (PVC) ductbank to the new MCC.

The ICE Building will be used to house the instrumentation and control equipment, an air compressor, and electrical equipment including the MCCs, panelboards, transformers, UPS, diesel generator and automatic transfer switch. A grounding grid will be installed around the ICE Building.

The power service meter and enclosure will be mounted outside on an exterior wall or rack where the electrical service enters the ICE Building.

The electrical power distribution system will be from a 3-phase, 3-wire, 480 V MCC that will serve the following storage tank loads:

1. (Two) decant/transfer pumps

2. (Two) winch motors

3. (Two) mixer pumps

4. (One) sump pump

5. (Two) ventilation exhaust fans, (one exhaust fan on standby)

6. (One) ventilation supply fan

7. (One) ventilation supply fan electric duct heater

8. (Two) electric duct heater, (one electric duct heater on standby)

9. (One) air compressor as required

10. (One) lot outdoor site lighting

11. (One) instrumentation UPS and output panelboard

12. (Two) building heat pumps w/auxiliary heaters

13. (One) dry-type transformer and panelboard for miscellaneous 120/208 V loads

A 100 kVA diesel generator will be used to provide electrical backup power to the tanks ventilation system and sump pump via an automatic transfer switch feeding the new MCC.

A UPS with an output panelboard will be used to provide uninterrupted power to critical instrumentation/control system equipment including the exhaust air monitoring system.

The motor speed requirements may vary during normal operation, therefore a variable speed drive controller will be used for each of the mixer pump motors and transfer pump motors.

No cathodic protection systems exist within the former HWVP construction site and no future systems are planned.

Heat tracing will be provided for the exposed piping subject to freezing.

3.3 TANK VAULT AND OTHER STRUCTURES

Tank Vault/Process Pit

The DCRT vault will be a 16.5 m (54-ft) by 10.4 m (34-ft) by 7.9 m (26-ft) cast-in-place concrete structure. The walls and ceiling will be 610 mm (2-ft) thick and the floor 1220 mm (4 ft). The floor of the vault will be sloped to drain into a sump. The process pit will be located on the roof of the vault and the whole structure buried below grade (See Figures 2 and 3).

An intrusion-resistant coverblock design will be provided utilizing a three-part coverblock assembly. The coverblocks will have an overall thickness of 1220 mm (2 ft) and will be keyed for radiation protection. Lifting bails will be provided in coverblocks similar to the hydrogen mitigation test (HMT) coverblock design.

Inside surfaces of pit walls, slab, and coverblocks will have a washable protective coating to facilitate future decontamination.

Sleeve penetrations will be provided in the walls for required service lines.

3.4 SPECIAL EQUIPMENT AND PROCESS SYSTEMS

Transfer System

The transfer system for sludge off load and retrieval from the tank is shown on the piping flow diagram. (See Figure 5.) The Sludge Transportation System, which is provided by others and is not part of this project's cost estimate, brings the sludge to the off load area. This system provides the pump and hose to connect to the shielded off load piping system. The slurried sludge is pumped through an encased line into the process pit and down into the storage tanks. There is interconnecting piping to allow the transfer of the contents of one tank to the other tank. Modes of system operation include: dilution, decant/transfer, recirculation, and secondary containment liquid removal.

- The dilution mode will be used to add filtered raw water to the sludge by injecting water directly into the tank (in-tank dilution). The amount of water added is monitored and will maintain the required water/sludge ratio needed for sludge storage. The dilution mode will also be used to add water to attain the required fluid properties for slurry transfer out of the tanks.

- The decant/transfer mode will be used to pump water, after sludge settling, into the other tank or out to a transport tank/truck. This mode will also be used to retrieve the sludge contents from the storage tanks and pump them into the portable tank for transfer to a treatment facility.

- The recirculation mode will be used to recirculate the tank contents via the decant/transfer pump. When acceptable fluid properties are obtained, the transfer to the portable tank can be initiated.

- A sump pump will be used to transfer liquids that may collect in the secondary containment liner to either tank.

DCRT Mixing System (Typical for 2 tanks)

The mixing of tank contents will be provided by one mixer pump, approximately 56 kW mechanical (75 hp), that will be installed in a tank riser. The mixer pump will operate at a variable speed while the tank contents are thoroughly mixed. The 56 kW mixer pump will add a maximum of 62 kW (212,000 Btu/hr) of energy to the waste in the tank at full speed. The added mixer pump energy, based on a 20% usage time, will be accounted for by the HVAC system so no adverse effects occur to the structure of the tanks or the waste itself. During the interim storage period (≤30 years), the mixer pump will be operated on a preventive maintenance schedule. At the end of interim storage, the sludge will be thoroughly mixed and transferred out of the tank for treatment and permanent storage.

Heating and Ventilation

The ventilation system for the sludge storage tanks and vault area consists of a supply unit and two exhaust trains. The supply unit requires an airflow of 700 L/s (1500 cfm) of air. The exhaust trains each have the capability of exhausting 825 L/s (1750 cfm) of air. Only one exhaust train will be in operation, while the other is in a standby mode. The supply fan is interlocked with the exhaust trains. The supply fan cannot start until one of the exhaust fans is energized and has established a negative pressure in the tanks and vault area. The exhaust trains will be connected to emergency power.

The concrete vault area will be maintained at a pressure between -125 Pa and 250 Pa (- 0.5 in. to 1.0 in. wg) relative to atmosphere, each tank will be maintained at a pressure between -375 Pa and 750 Pa (-1.5 in. to 3.0 in. wg) relative to atmosphere. The supply fan will be controlled by a vane inlet damper which will maintain the vault negative pressures. The exhaust fan will maintain a constant exhaust airflow, but will not permit the negative pressure in the storage tanks to fall below a predetermined setpoint.

There will be no cooling of the airstream during cooling months, the supply inlet air will be heated with an explosion-proof electric heater during the heating months and maintain the vault area at approximately 7 °C (45 °F). A manual bypass with a butterfly valve is furnished on the supply side, and will be used when filter replacement is required.

The exhaust air in the vault area will be combined with the air from the storage tanks. The inlet of each tank will have a manual isolation valve. This valve will be used to set the tank negative pressure. The airstream from the tank will be exhausted through a chevron blade impingement moisture separator and a stainless steel wire mesh assembly. The chevron will remove entrained water droplets in sizes of 10μm and larger in diameter, while the wire mesh moisture separator will remove water droplets in the range of 10 μm and below. The exhaust air will be heated to reduce the relative humidity to approximately 70% to protect the HEPA filters from excessive moisture.

Condensation from each section of the exhaust train will be drained to a seal pot and then drained to the storage tanks in the vault. The exhaust air is filtered through one stage of prefilters and two stages of HEPA filters. Each stage of HEPA filters is aerosol testable by means of an installed aerosol test section. The air is discharged to the atmosphere through a 15 m (50-ft) high stack which is monitored and sampled for radioactive particulates.

<u>Supply Unit</u>

The supply unit is comprised, in the direction of airflow, of the following components:

- Rainproof storm louver
- Containment damper
- Explosion proof electric heater rated at 22 kW
- 45% efficient prefilters
- Inlet aerosol test section
- One stage of HEPA filters
- Outlet aerosol test section
- Supply fan rated at 700 L/s (1500 cfm) at approximately 2000 Pa (8-in. wg)
- The round supply ductwork will be schedule 10 carbon steel pipe and schedule 40 fittings

- Butterfly valve
- Supply diffusers
- Condensate drain piping will be installed to remove any moisture which may occur.

Exhaust Trains

The exhaust trains are comprised, in the direction of airflow, of the following components:

- Stainless steel schedule 5S pipe and fittings
- Butterfly valves
- Exhaust grilles
- De-entrainer assemblies
- Explosion Proof electric heater rated at 10 kW
- Differential pressure gages
- 45% efficient prefilters
- Inlet aerosol test section
- First stage of HEPA filters
- Combination aerosol test section
- Second stage of HEPA filters
- Outlet aerosol test section
- Exhaust fan rated at 825 L/s (1750 cfm) at 2750 Pa (11-in. wg)
- Automatic controlled butterfly valve
- Condensate drain piping will be installed to remove any moisture which may occur

Instrumentation and Control

Control Room Equipment

The ICE Building will contain a PC with a Human-Machine Interface (HMI) software package installed (e.g., Intellution FIX32 or Citect, latest release of either). Graphic display screens will be designed with the HMI software to provide a complete operator interface station (OIS). The OIS will allow the operator to monitor any process parameter controlled or monitored by the PLC, initiate any required control function, annunciate any alarm condition, and view trending information. The OIS will retain a historical database of trending information that can be up-loaded for further analysis. As a minimum, the OIS will have screens to depict the physical routing between the tanks and the truck load/unload station. The system will have a misrouting prevention control that provides alarms and interlocks to allow operation of the system only in a safe and intended manner.

Pump Instrumentation

Signals from the field instruments will be sent to the OIS in the ICE Building for remote monitoring. Process parameters will be measured by the instruments as listed in the table below.

All mixer pump signals will be sent to the PLC. The PLC will also receive signals from the mixer pump variable speed drives (VSDs) and the mixer pump turntable motors. The PLC will send and receive signals to and from the VSDs for controlling and monitoring the mixer speed, and starting and stopping the pumps and turntables. The mixer pump vendor will provide the necessary instrumentation to gather the following process parameters as listed below.

All transfer pump signals will be sent to the PLC. The PLC will also receive signals from the transfer pump VSDs. The PLC will send and receive signals to and from the VSD for controlling and monitoring the pump speed and starting and stopping the pumps. Instruments on the discharge of the transfer pump will measure pressure, temperature and flow as listed below.

Process Parameters List

Item	Process Parameter	Instrument	Remarks
1	Tank waste and dome space temperatures	RTD probe	Allows OIS via the PLC to monitor temperatures at 600 mm (2-ft) vertical intervals within the tank waste and vapor space. The temperature probe will be capable of withstanding the fluid jet forces from the mixing pump.
2	Tank liquid level	Enraf level transmitter	Displacer sized for detecting supernatant densities
3	Tank sludge level	Enraf level transmitter	Displacer sized for detecting sludge densities
4	Tank dome space pressure (vacuum)	Rosemount differential pressure transmitter	Loss of negative pressure (vacuum) indicates an HVAC problem and will shutdown operations
5	Tank dome space H^2 (hydrogen) concentration	SHMS cabinet	Provides hydrogen concentration and alarms and will shutdown operations on high-high alarm

Item	Process Parameter	Instrument	Remarks
6	Tank exhaust air temperature	RTD probe	Allows OIS via the PLC to monitor exhaust air temperature
7	Tank exhaust airflow	Pitot tube probe and Rosemount differential pressure transmitter	
8	Tank exhaust air radiation	Air Monitor Corp.	
9	Mixer pump motor amperage	VSD software function	Digital link to the PLC provides motor amps and/or power usage data to OIS, as well as complete remote monitoring and control capability.
10	Mixer pump speed	VSD software function	Digital link to the PLC provides pump speed data to OIS, as well as complete remote monitoring and control capability.
11	Mixer pump upper and lower bearing temperatures	RTDs	Allows OIS via the PLC to monitor bearing temperatures.
12	Mixer pump motor winding temperature	RTD	Allows OIS via the PLC to monitor motor winding temperature.
13	Mixer pump upper and lower bearing vibration	PMC/BETA vibration transmitter	Signal shall be suitable for vibration signature analysis in both displacement and velocity.
14	Transfer pump motor amperage	VSD software function	Digital link to the PLC provides motor amps and/or power usage data to OIS, as well as complete remote monitoring and control capability.
15	Transfer pump speed	VSD software function	Digital link to the PLC provides pump speed data to OIS, as well as complete remote monitoring and control capability.
16	Transfer pump motor winding temperature	RTD	Allows OIS via the PLC to monitor motor winding temperature.
17	Transfer pump discharge pressure	Rosemount pressure transmitter	Allows OIS via the PLC to monitor pump discharge pressure to determine pipe blockage, etc.
18	Transfer pump discharge temperature	RTD	Allows OIS via the PLC to monitor pump discharge temperature
19	Transfer pump discharge flow	Fisher & Porter Magflow meter	Allows OIS via the PLC to monitor pump discharge flow for totalizing purposes
20	Valve positions	Valve limit switches	Limit switches give positive indication of valve positions for all valves to PLC for misrouting control, monitoring, etc.

Item	Process Parameter	Instrument	Remarks
21	Raw water duplex strainers differential pressure	Rosemount differential pressure transmitter	High differential pressure across strainers indicates cleaning is required.
22	Process pit, tank vault and off load piping leak detection	Tank farm intrinsically safe leak detection system	Detected leaks will shutdown recirculation and transfer operations. It will not interface with the Master Pump Shutdown System since the interim sludge storage tanks are an isolated system.

Valves

Several motor-operated valves (MOVs), some with position switches (open/close), and some with both position switches and transmitters (modulating), will be used in the transfer system.

Leak Detection

Leak detection systems will be used in the off load encasement, process pit, and the tank vault. The off load encasement provides secondary containment for the primary transfer hose and pipe connecting the transport truck tank with the sludge storage tanks. Leak detectors are provided at both ends of the off load encasement. The process pit, which provides secondary containment for piping contained in the pit, will have leak detection. The tank vault with liner, which provides secondary containment for the sludge tanks and any piping in the vault, will have leak detection provided in the sump area. The signals from this system will be sent to the PLC.

Radiation Monitoring

All radiation monitoring instruments will be used to provide signals to the PLC.

Tank Monitoring and Control System (TMACS) Interface

In order to allow for remote monitoring of the interim sludge tanks by operations personnel, the monitoring and control system for the tanks shall interface with the TMACS. Wireless Ethernet bridges will be used to transmit any or all of the data being monitored at the OIS in the ICE Building to the TMACS control room OISs, possibly via HLAN.

PLC & Instrumentation Transmitter Enclosures

The PLC equipment and the transmitters for the field instrumentation will be housed in NEMA 12 enclosures in the ICE Building. The instrumentation signal processing devices for all other equipment not located in the tank will be housed in cabinet(s) near the equipment they service.

Each cabinet will have a UPS to provide stable power for the electronic equipment.

Removal and Decontamination System

When in-tank mixer and decant/transfer pumps are removed, they must be decontaminated and contained to minimize exposure to the environment and personnel during transit and storage. Decontamination will reduce the level of waste classification.

A flexible receiver system will be used to bag the in-tank components while they are being withdrawn from the tank. The system will withdraw the components from the tank into a pleated, laminated-vinyl synthetic fabric bag and crimp the bottom to seal the contents.

A high-pressure washing system will decontaminate the in-tank components of the pumps. The system will provide hot water at 20.7 MPa (3,000 psi) and up to 3.2 L/s (50 gpm) to clean the components as they are being withdrawn from the tank. The system consists of a hot water supply, a high-pressure pump, and high-pressure hoses, which are assumed to be provided by others. This project will provide the remainder of the washing system, starting with a hose connection. From this connection, pipe and valving is provided to a wash ring that sits on top of the riser in the process pit and dispenses several jets of hot water onto the component for cleaning. The removal and decontamination systems will be similar to those designed for Project W-151, "Tank 241-AZ-101 Waste Retrieval System."

Flush water will be provided by the sludge transportation system to flush the off-load piping of slurried sludge, if required. Equipment required for this off-load flush operation is not part of this project's scope.

4.0 CRITICALLY SAFE TANK SYSTEM - ANNULUS TANKS

4.1 GENERAL DESCRIPTION

This section describes the critically safe sludge storage tank system using annulus tanks, including required ancillary equipment and support facilities. This system has 60 smaller annulus tanks in a below grade vault and has a different layout than the DCRT configuration. The annulus tank system uses air diaphragm pumps with a piping manifold and MOV system for sludge mixing and transfer. The ICE Building, utilities, and instrumentation for this system is similar to the DCRT type system.

The outline specification for the critically safe annulus tank system is in Appendix D.

Figures of the critically safe annulus tank system are shown in Appendix H.

4.2 ICE BUILDING AND UTILITIES

Civil

Civil construction activities are the same as described in Section 3.2 of this report, except a larger excavation area is needed for the 15 m by 20 m (50-ft by 66-ft) vault (See Figure 20 in Appendix H). This size could be altered by adjusting the tank diameters to height ratios used in this study.

A shielded valve/pump room is located above every 10 annulus tanks. The retention basin and transfer piping between the valve/pump rooms and the load in/load out (off load) area will be the same as described in Section 3.0.

Architectural

An ICE Building will be required for the annulus tank system. The construction of the ICE Building is assumed to be the same as described in Section 3.2.

Fire Protection

The fire protection system will have the same features as described in Section 3.2.

HVAC

The HVAC system for the ICE Building will have the same features as described in Section 3.2.

Sanitary and Raw Water

Raw filtered water is required as makeup water for the tanks should the sludge become too dewatered. The pumps will also require flushing prior to maintenance. The same water filter station described in Section 3.2 is used.

Sanitary water should not be used as makeup water because of the chlorine.

Compressed Air

Two air compressors are to provide air needed to power the transfer pumps. Each 18.7 kW (25 hp) compressor is capable of providing 50 L/s (105 cfm) at 690 kPa (100 psi) which will provide enough air to drive two pumps running at the same time during the mixing mode of operation. This capacity would allow each tank to be turned over every 4 hours. In keeping one compressor in standby, each tank could be turned over every 8 hours.

Hot Water

No hot water is required.

Electrical Service and Distribution

The electrical service will be from the same HWVP construction switchboard "SB-32T-005," except the electrical service will be only 300 A. An alternative electrical service source will be from another HWVP construction switchboard "SB-32T-004."

A new 300 A feeder breaker will be installed in the switchboard. The electrical service feeder will be routed in an underground, concrete-encased (1) -80 mm (3-in.) PVC duct bank to the new MCC.

The ICE Building will be used to house the instrumentation and control equipment, electrical equipment including an MCC, panelboard, dry-type transformer, UPS, diesel generator and mechanical equipment such as the air compressors. A grounding grid will be installed around the ICE Building.

The power service meter and enclosure will be mounted outside on an exterior wall or rack where the electrical service enters the ICE Building.

The electrical power distribution system will be from a 3-phase, 3-wire, 480 V MCC that will serve the following critically safe annulus tank loads:

1. (One) sump pump
2. (Two) ventilation exhaust fans, [(1) exhaust fan on (standby)]
3. (One) ventilation supply fan
4. (One) ventilation supply fan electric duct heater
5. (Two) electric duct heater, (one electric duct heater on standby)
6. (Two) air compressors
7. (One) lot outdoor site lighting
8. (One) dry type transformer and panelboard for miscellaneous 120/208 V loads
9. (One) UPS and output panelboard
10. (Two) building heat pumps with auxiliary heaters.

A 100 kVA diesel-generator will be used to provide electrical backup power via an automatic transfer switch feeding a new 3-phase, 3-wire MCC.

A UPS with an output panelboard will be used to provide uninterrupted power to critical instrumentation/control system equipment including the exhaust air monitoring system.

No cathodic protection systems exist within the former HWVP construction site and no future systems are planned.

Heat tracing will be provided for the exposed piping subject to freezing.

4.3 TANK VAULT AND OTHER STRUCTURES

Tank Vault

The annulus storage tank vault will be a 20.1 m (66-ft) by 15.2 m (50-ft) by 11.3 m (37-feet) cast-in-place concrete structure. The walls will be 610 mm (2 ft) thick, the floor 1220 mm (4 ft) thick, and the ceiling 1520 mm (5 ft) thick. The floor of the vault will be sloped to drain into a shielded sump. The valve/pump rooms will be located on the roof of the vault. Finish grade will be to the top of the vault ceiling (See Figures 21 and 22).

Valve/Pump Rooms

All valve and pumping operations will be controlled from the ICE Building. The valve/pump rooms will be concrete structures located above the 10 tanks which they service. The concrete will provide radiation shielding. The room roof will be coverblocks for service access.

4.4 SPECIAL EQUIPMENT AND PROCESS SYSTEMS

Annulus Tank Transfer/Mixing System (Typical for 60)

The sludge will be received at the off-load station described in Section 3.4. The shipping truck will provide the pump to transfer the sludge into the tanks. The critically safe tank arrangement provides tanks which have been sized so that a single critically safe tank will hold the contents of one transporter (6 m^3). A single nozzle will connect to a manifold located in the respective valve/pump room. The manifold will be used to route the sludge to a tank in the array. Valves will be interlocked using the computer control system to prevent incorrect routing and subsequently accidental overfilling of a tank. In addition, each tank will be provided with a high-limit alarm which will automatically prevent excess liquid from being placed in the tank.

Two air driven diaphragm pumps, one being redundant, will be coupled to each cluster of ten annulus tanks. These pumps will provide all of the pumping required for dewatering, tank content mixing, and removing the sludge from the tanks.

Dewatering may be desirable. A pipe will be provided into the tank to a predetermined depth. Water will be pumped out of the tank to a tank truck to be returned to the K Basins.

The mixing of tank contents will be provided by recirculating the tank contents using the air driven diaphragm pumps to draw liquid from the upper portion of the sludge and discharging it through four jets at the bottom of the tank to produce a turbulent swirling effect in the bottom of the annulus tank. The pump is capable of circulating 6.3 L/s (100 gpm) through the jets. During the interim storage period (≤30 years), the recirculation will be done on a regular schedule to resuspend the sludge up to 4 times each day.

At the end of interim storage, the sludge will be thoroughly mixed and transferred out of the tank for treatment and permanent storage using the same pump as used for recirculation.

During the recirculation phase, a small side stream could be diverted to a shielded glovebox located adjacent to the pump room and a sample can be obtained using an "Isolock" type in line sampler. A sheetmetal building similar to that at 219S could be used to enclose the glovebox. For this preconceptual design, components and equipment for sampling are not included in the cost estimate.

Heating and Ventilation

The tank off gas ventilation and the vault ventilation system will provide adequate cooling. The function and the components for the critically safe annulus tanks ventilation system is identical to the DCRT ventilation system, with the exception that the inlet and outlet ductwork (piping) is manifolded and the inlet is 50 mm (2-in.) diameter and the outlet is 40 mm (1-1/2 in.) diameter. The airflow from each tank is approximately 9.5 L/s (20 cfm) and is typical for 60 tanks, compared to approximately 295 L/s (625 cfm) each for the DCRTs.

Instrumentation & Control

Control Room Equipment

Control room equipment will be the same as described in Section 3.4, with a few exceptions. This critically safe tank system has 60 smaller, annulus shaped tanks with much of the same instrumentation requirements for each tank as the DCRT type system. The following parameter list has these requirements. All in tank sensors will be inserted through risers in the top of the tanks extending through the vault cover.

Process Parameters List

Item	Process Parameter	Instrument	Remarks
1	Tank waste and dome space temperatures	RTD probe	Allows OIS via the PLC to monitor temperatures at 610 mm (2-ft) vertical intervals within the tank waste and vapor space for each tank.
2	Tank liquid level	RF probe	Tank waste level for each tank.
3	Tank dome space pressure (vacuum)	Rosemount differential pressure transmitter	Loss of negative pressure (vacuum) indicates an HVAC problem and will shutdown operations for each tank.
4	Tank dome space H^2 (hydrogen) concentration	SHMS cabinet	Provides a single hydrogen concentration and alarms for all 60 tanks and will shutdown operations on high-high alarm
5	Tank exhaust air temperature	RTD probe	Allows OIS via the PLC to monitor single exhaust air temperature for all 60 tanks.
6	Tank exhaust airflow	Pitot tube probe and Rosemount differential pressure transmitter	Provides a single exhaust airflow measurement for all 60 tanks.
7	Tank exhaust air radiation	Air Monitor Corp.	Provides a single exhaust air radiation measurement for all 60 tanks.
8	Transfer pump motor amperage	VSD software function	Digital link to the PLC provides motor amps and/or power usage data to OIS, as well as, complete remote monitoring and control capability.
9	Transfer pump speed	VSD software function	Digital link to the PLC provides pump speed data to OIS, as well as, complete remote monitoring and control capability.
10	Transfer pump motor winding temperature **NOT REQUIRED**	RTD	Allows OIS via the PLC to monitor motor winding temperature.
11	Transfer pump discharge pressure	Rosemount pressure transmitter	Allows OIS via the PLC to monitor pump discharge pressure to determine pipe blockage, etc.
12	Transfer pump discharge temperature **NOT REQUIRED**	RTD	Allows OIS via the PLC to monitor pump discharge temperature
13	Transfer pump discharge flow	Fisher & Porter Magflow meter	Allows OIS via the PLC to monitor pump discharge flow totals for mass balance purposes

Item	Process Parameter	Instrument	Remarks
14	Valve positions	Valve limit switches	Limit switches give positive indication of valve positions for all valves to PLC for misrouting control, monitoring, etc. (7 MOV's/tank X 2 position switches /MOV X 60 tanks = 840 position switches)
15	Raw water duplex strainers differential pressure	Rosemount differential pressure transmitter	High differential pressure across strainers indicates cleaning is required.
16	Valve/Pump Rooms, tank vault and off load encasement piping leak detection	Tank farm intrinsically safe leak detection system	Detected leaks will shutdown mixing and transfer operations. It will not interface with any master pump shutdown system since the interim sludge storage tanks are an isolated system.

Pump Instrumentation

The pumps are procured with an internal leak detector to detect ruptured diaphragms. The pump also has built in speed control.

Valves

Approximately 500 motor-operated valves (MOVs), some with position switches (open/close), and some with both position switches and transmitters (modulating), will be used in the transfer and mixing system.

Leak Detection

The same leak detection as described in Section 3.4 will be used, except that a leak detector for each valve/pump room will be required.

Radiation Monitoring

All radiation monitoring instruments will be used to provide signals to the PLC.

TMACS Interface

This interface is the same as discussed in Section 3.4.

Removal and Decontamination System

The tanks and piping can be flushed as tanks are emptied. The only equipment located in the tanks will be instrumentation sensors which could be abandoned in the tanks when the facility is decommissioned.

5.0 CRITICALLY SAFE TANK SYSTEM - HARP TANKS

5.1 GENERAL DESCRIPTION

This section describes the support facilities required for the critically safe sludge storage tank system using harp tanks. The below grade vault configuration, ICE Building, utilities, and some of the instrumentation are similar to those for the annulus tank system. The outline specification for these parts of the tank system are in Appendix D. Sludge mixing and transfer operations for the harp tank system uses power fluidic components which are described in the AEA Technology report in Appendix E. Power fluidics is a generic name for maintenance free nuclear equipment. This report states how these components will be used in the harp tank system and discusses alternatives for sludge mixing, transfer, and sampling. Drawings for the critically safe harp tank system are shown in Appendix I.

5.2 ICE BUILDING AND UTILITIES

It is assumed that the ICE building and utility services required for the HARP tank system design option are the same as for the annulus tank design except as noted below.

Electrical Service and Distribution

The electrical service will be either from the HWVP construction switchboard "SB-32T-005" or "SB-32T-004," except that the electrical service will be smaller (200 A). A new 200 A feeder breaker will be installed in the switchboard. The electrical service feeder will be routed in an underground, concrete-encased (1) - DN50 (2-in.) PVC duct bank to the new MCC.

The electrical power distribution will be from a 3-phase, 3-wire, 480 V MCC that will serve the tank cooling system equipment, UPS, and output panelboard for instrumentation, and a shielded isolation, 30 kVA, 3-phase, 480 V -208Y/120 V dry-type transformer feeding a panel board for the 110 V ac requirements of the transfer and mixing pumps.

5.3 TANK VAULT AND OTHER STRUCTURES

The tank vault layout described in Section 4.3 for the annulus tank system is used for the harp tank system. No information on the layout for the fluidic pump control and equipment housing was provided from AEA Technology. It is assumed the required housing would utilize a similar concrete valve/pump room design.

5.4 SPECIAL EQUIPMENT AND PROCESS SYSTEMS

Harp Tanks Mixing System

See AEA Technology report, section 5.0.

Transfer System

The same sludge transportation system and off-load piping system described in Section 3.4 is used in the HARP tank system. Dewatering and sludge retrieval information is in the AEA Technology report, Section 5.0.

Heating and Ventilation

The same ventilation system described in Section 3.4 is used for tank cooling, except that the supply and exhaust piping would be manifolded to each of the eight HARP tanks.

Instrumentation and Control

See AEA Technology report for instrumentation and controls for the fluidic system (i.e. sludge mixing and transfer system). Other instrumentation and controls are similar to those in Section 4.4 for the annulus tank system.

Control Room Equipment

Similar to the annulus tank system.

Pump Instrumentation

See the AEA Technology report.

Valves

See Section 3.4.

Leak Detection

See Section 3.4.

Radiation Monitoring

See Section 3.4.

TMACS Interface

See Section 3.4.

PLC & Instrumentation Transmitter Enclosures

See Section 3.4.

Removal and Decontamination System

The tanks and piping can be flushed as tanks are emptied. The only equipment located in the tanks will be instrumentation sensors which could be abandoned in the tanks when the facility is decommissioned.

6.0 PROCESS ALTERNATIVES

6.1 MIXING AND TRANSFER FOR DCRT TYPE SYSTEM

The AEA Technology report in Section 4.0, provides a description for these alternatives.

6.2 MIXING FOR ANNULUS TANKS

The AEA Technology report, Section 5.4 provides a description for this alternative.

7.0 SAMPLING ALTERNATIVES

See the AEA Technology report.

8.0 IDENTIFICATION OF ASSUMPTIONS AND UNCERTAINTIES

INTERFACES

The K Basins sludge storage tank system project will interface with project W-379, "Canister Storage Building," which is currently under construction.

Interfaces with other projects and operations have not been identified.

The following assumptions for the ventilation system of the K Basin sludge storage tanks were made:

- The gas stream does not contain radioiodine or any other constituents which require charcoal adsorption filtration, or that a scrubber for the gas stream is required.
- The amount of entrained moisture in the gas stream which may be present will be removed by a standard blade-impingement type chevron and moisture separator (wire mesh pad). A high efficiency moisture eliminator (HEME) is not required.
- Back flushing of the de-entrainer assembly for dissolved solids is not required.
- The waste in the tank is at ambient conditions. Further assume that the ambient condition is 27 °C (80 °F).
- A temperature rise of 56 °C (100 °F) is allowed.

- For the purpose of determining the airflow rate, a 56 kW (75 hp) motor was used operating at 20% of the time.
- A fire suppression system for the HEPA filters will not be required.
- Heating and cooling for the ICE facility were assumed; no calculations were performed to determine unit sizes.
- Heating requirements for the vault area were assumed; no calculations were performed.

9.0 REFERENCES

1. Letter of Instruction, R. J. Lodwick(Duke Engineering & Services Hanford,Inc.) to J. L. Wise (Fluor Daniel Northwest), "K Basins Sludge Removal System, Preconceptual Design For Temporary Sludge Storage Tanks," Work Order E33936, Project A.13, Document No. DESH-9753990, May 6, 1997.

2. Codes and Standards

Associated Air Balance Council (AABC).

Air Movement and Control Association, inc. (AMCA)

AMCA 99-86	Standards Handbook
AMCA 201-90	Fan Application Manual - Fans and Systems
AMCA 210-85	Certified Ratings Program Air Performance
AMCA 500-89	Test Methods for Louvers, Dampers, and Shutters

American National Standards Institute (ANSI)

ANSI\AFBMA 9-1978	Load Rating and Fatigue Life for Ball

	Bearing
ANSI\AFBMA 11-1978	Load Rating and Fatigue Life for Roller Bearings

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (ASHRAE)

Standard 62	Ventilation for Acceptable Indoor Air Quality
Standard 90	Energy Conservation in New Building Design

Applications Handbook

Equipment Handbook

Fundamentals Handbook

Refrigeration Handbook

Systems Handbook

American Society of Mechanical Engineers

ASME AG-,	Code on Nuclear Air and Gas treatment
ASME B16 series	Fittings, Flanges and Valves
ASME B31.1	Power Piping
ASME N509	Nuclear Power Plant Air Cleaning Units and Components
ASME N510	Testing of Nuclear Air Cleaning System

American Welding Society (AWS)

AWS D1.1 (1986)	Structural Welding Code - Steel
AWS D1.3 (1981)	Structural Welding Code - Sheet Steel
DOE-6430.1A	Department of Energy General Design Criteria
ERDA 76-21 (ORNL-NSIC-65.1)	Nuclear Air Cleaning Handbook

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 112 (1984)	Test Procedure for Polyphase Induction Motors and Generators

National Electrical Manufacturers' Association (NEMA)

NEMA MG-1 (1978)	Motors and Generators

Sheet Metal and Air Conditioning Contractors National (SMACNA)

HVAC Duct Construction Standards--Metal and Flexible

HVAC Duct Design Manual

Round Industrial Duct Construction Standards

APPENDIX A

COST ESTIMATE: DCRT SYSTEM - OPTION 1

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR01 - PROJECT COST SUMMARY

PAGE 1 OF 8
DATE 06/11/97 12:29:26
BY LHR, DEA, RW

SORT	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
FDNW	FLUOR DANIEL NORTHWEST	9,520,605	50	4,760,311	14,280,916
	PROJECT TOTAL	9,520,605	50	4,760,311	14,280,916

TYPE OF ESTIMATE	STUDY - ORDER OF MAGNITUDE JUNE 11, 1997		REMARKS: DRAFT
FDNW LEAD ESTIMATOR		ESTIMATING MANAGER	
PROJECT MANAGER			
CLIENT			

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR02 - WORK BREAKDOWN STRUCTURE (WBS) SUMMARY

PAGE 2 OF 8
DATE 06/11/97 12:29:28
BY LHR, DEA, RW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
112000	DEFINITIVE DESIGN-CAT 2	1022856	0	1022856	0.00	0	1022856	50	511428	1534284
121001	ENGINEERING/INSPECTION-ONSITE E/C	438328	0	438328	0.00	0	438328	50	219164	657492
SUBTOTAL 1	ENGINEERING	1461184	0	1461184	0.00	0	1461184	50	730592	2191776
220001	PROCUREMENT-O/C	4949316	0	4949316	0.00	0	4949316	50	2474658	7423974
SUBTOTAL 2	PROCUREMENT	4949316	0	4949316	0.00	0	4949316	50	2474658	7423974
320000	PROJECT SUPPORT	158071	29638	187709	0.00	0	187709	50	93855	281564
320001	GENERAL CONTRACTOR	1692919	317423	2010342	0.00	0	2010342	50	1005173	3015515
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
SUBTOTAL 321	"ICE" BUILDING CONSTRUCTION	241882	45354	287236	0.00	0	287236	50	143620	430856
322001	TANK VENTILATION SYSTEM	342231	64168	406399	0.00	0	406399	50	203200	609599
323001	INSTRUMENTATION SYSTEM	34596	6487	41083	0.00	0	41083	50	20542	61625
324001	PIPING HEAT TRACE SYSTEM	19821	3716	23537	0.00	0	23537	50	11769	35306
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
SUBTOTAL 32	FIXED PRICE CONSTRUCTION	2619035	491070	3110105	0.00	0	3110105	50	1555061	4665166
SUBTOTAL 3	CONSTRUCTION	2619035	491070	3110105	0.00	0	3110105	50	1555061	4665166
PROJECT TOTAL		9,029,535	491,070	9,520,605	0.00	0	9,520,605	50	4,760,311	14,280,916

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR03 - ESTIMATE BASIS SHEET

DATE 06/11/97 12:48:58
BY LHR, DEA, RW

1. ESTIMATE PURPOSE

ORDER OF MAGNITUDE ESTIMATE: THIS ESTIMATE WILL TO BE USED FOR BUDGETING PURPOSES ONLY.

2. ESTIMATE TECHNICAL BASIS

A. THIS ESTIMATE HAS BEEN PREPARED FOR THE K-BASINS TEMPORARY SLUDGE STORAGE TANKS PROJECT AS REQUESTED BY DE&S HANFORD, INC.
B. A DESCRIPTION OF THE TECHNICAL SCOPE OF WORK MAY BE FOUND IN THE FOLLOWING REFERENCE DOCUMENTS:
   LETTER OF INSTRUCTION (LOI) #E33936.
   REQUEST FOR ESTIMATE DATED 13 MAY 1997.
   PRE-CONCEPTUAL DESIGN REPORT "TEMPORARY SLUDGE STORAGE TANKS FOR K-BASINS SLUDGE REMOVAL", SNF-PCDR-E33936-001, REV.0, DATED JUNE 1997.
C. THIS ESTIMATE ALSO UTILIZES A STANDARD FDNW DEFINED CODE OF ACCOUNTS.

3. ESTIMATE METHODOLOGY

A. DIRECT COSTS:
A SPECIFIC ANALOGY TECHNIQUE AND EXPERT OPINION TECHNIQUE HAS BEEN UTILIZED IN THE PREPARATION OF THIS ESTIMATE.
(1) CONSTRUCTION LABOR, MATERIAL AND EQUIPMENT UNITS HAVE BEEN ESTIMATED BASED UPON SIMILAR WORK ON OTHER PROJECTS. THE UNITS MAY HAVE BEEN FACTORED/ADJUSTED BY THE ESTIMATOR AS APPROPRIATE TO REFLECT INFLUENCES BY CONTRACT, WORK SITE, OR OTHER IDENTIFIED PROJECT OR SPECIAL CONDITIONS.
(2) FLUOR DANIEL HANFORD & PROJECT HANFORD MANAGEMENT (PHMC) SUBCONTRACTOR DIRECT COSTS FOR DUKE ENGINEERING & HANFORD, INC. HAVE BEEN PROVIDED BY FDNW PROJECT MANAGEMENT FOR INCLUSION INTO THIS ESTIMATE.

B. DIRECT COST FACTORS
(1) SALES TAX HAS BEEN APPLIED TO ALL MATERIALS AND EQUIPMENT PURCHASES AT 8%.
(2) NO WAREHOUSING COSTS ARE SHOWN SINCE THEY ARE CONSIDERED TO BE INCLUDED IN THE MATERIAL PROCUREMENT RATE (MPR).
(3) CONSUMABLES ARE ESTIMATED AT 3.2% OF DIRECT CRAFT LABOR COSTS.
(4) NO PREMIUM PAY INCLUDED IN THE ESTIMATE.
(5) CONTRACT ADMINISTRATION FACTOR OF 18.75% HAS BEEN APPLIED TO THE DIRECT CONTRACT VALUE WHICH INCLUDES COSTS FOR BID PACKAGE PREPARATION, CONTRACT MANAGEMENT & ADMINISTRATION AND PROJECT MANGEMENT & PLANNING SUPPORT.

C. INDIRECT COSTS
FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED ARE THE FOLLWOING PERCENTAGES: LABOR = 25.0 %, EQUIMENT USE = 25.0 %, MATERIAL = 25.0 %, SUBCONTRACT = 10.0 %, AND EQUIPMENT = 0% , AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL REPORT.

D. RATES
(1) FLUOR DANIEL NORTHWEST LABOR RATES ARE BASED UPON THE FLUOR DAINEL FEDERAL OPERATIONS (FEDFO) DISCLOSURE STATEMENT AND APPROVED PROVISIONAL BILLING RATES. FOR ESTIMATING PURPOSES, AVERAGE RATES BY OPERATIONS CODE HAVE BEEN DEVELOPED BASED UPON RECENT COST HISTORY.

4. ESCALATION

NO ESCALATION HAS BEEN INCLUDED SINCE A SCHEDULE WAS NOT PROVIDED.

5. CONTINGENCY

A CONTINGENCY ANALYSIS HAS BEEN PERFORMED AND IS DOCUMENTED IN FDNWR06 REPORT OF THIS ESTIMATE.

6. REMARKS

MAJOR ASSUMPTIONS WHICH HAVE BEEN MADE IN THE PREPARATION OF THIS ESTIMATE ARE AS FOLLOWS:

A. SITE ALLOCATIONS ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
B. OTHER PROJECT COSTS (OPC) ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
C. THE ESTIMATE IS BASED ON THE DESIGN AND INSTALLATION OF (2EA) 25,000GAL DCRT TANKS.
D. THE ESTIMATE ASSUMES ENGINEERING, DESIGN, AND E&I DURING CONSTRUCTION PERFORMED BY FDNW.
E. CONSTRUCTION WORK TO BE ACCOMPLISHED DURING NORMAL WORKING HOURS BY A FIXED PRICE CONSTRACTOR.
F. NO HAZARDOUS WASTE REMOVAL OR DISPOSAL COSTS ARE INCLUDED.
G. THE ESTIMATE ASSUMES NO RADIATION WORK WILL BE ENCOUNTERED.

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR04 - DOE COST CODE ACCOUNT SUMMARY

PAGE 5 OF 8
DATE 06/11/97 12:29:30
BY LHR, DEA, RW

COST CODE/WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING									
112000	DEFINITIVE DESIGN-CAT 2	1022856	0	1022856	0.00	0	1022856	50	511428	1534284
121001	ENGINEERING/INSPECTION-ONSITE E/C	438328	0	438328	0.00	0	438328	50	219164	657492
TOTAL 000	ENGINEERING	1461184	0	1461184	0.00	0	1461184	50	730592	2191776
550	OTHER STRUCTURES									
220001	PROCUREMENT-O/C	4949316	0	4949316	0.00	0	4949316	50	2474658	7423974
320000	PROJECT SUPPORT	158071	29638	187709	0.00	0	187709	50	93855	281564
320001	GENERAL CONTRACTOR	1692919	317423	2010342	0.00	0	2010342	50	1005173	3015515
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
322001	TANK VENTILATION SYSTEM	342231	64168	406399	0.00	0	406399	50	203200	609599
323001	INSTRUMENTATION SYSTEM	34596	6487	41083	0.00	0	41083	50	20542	61625
324001	PIPING HEAT TRACE SYSTEM	19821	3716	23537	0.00	0	23537	50	11769	35306
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
TOTAL 550	OTHER STRUCTURES	7568351	491070	8059421	0.00	0	8059421	50	4029719	12089140
PROJECT TOTAL		9,029,535	491,070	9,520,605	0.00	0	9,520,605	50	4,760,311	14,280,916

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR05 - ESTIMATE SUMMARY BY CSI DIVISION

PAGE 6 OF 8
DATE 06/11/97 12:29:32
BY LHR, DEA, RW

CSI	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
ENGINEERING										
00	TECHNICAL SERVICES	1461184	0	1461184	0.00	0	1461184	50	730592	2191776
	TOTAL ENGINEERING	1,461,184	0	1,461,184	0.00	0	1,461,184	50	730,592	2,191,776
CONSTRUCTION										
02	SITEWORK	200040	37508	237548	0.00	0	237548	50	118775	356323
03	CONCRETE	794473	148964	943437	0.00	0	943437	50	471719	1415156
05	METALS	469824	27342	497166	0.00	0	497166	50	248583	745749
06	WOOD AND PLASTICS	194400	0	194400	0.00	0	194400	50	97200	291600
07	MOISTURE AND THERMAL	3459	649	4108	0.00	0	4108	50	2054	6162
08	DOORS,WINDOWS AND G	8279	1552	9831	0.00	0	9831	50	4916	14747
09	FINISHES	172800	32401	205201	0.00	0	205201	50	102601	307802
11	EQUIPMENT	2662200	0	2662200	0.00	0	2662200	50	1331100	3993300
13	SPECIAL CONSTRUCTION	17000	3188	20188	0.00	0	20188	50	10094	30282
15	MECHANICAL	1874657	158110	2032767	0.00	0	2032767	50	1016385	3049152
16	ELECTRICAL	1013148	51718	1064866	0.00	0	1064866	50	532437	1597303
40	PROJECT MANAGER	158071	29638	187709	0.00	0	187709	50	93855	281564
	TOTAL CONSTRUCTION	7,568,351	491,070	8,059,421	0.00	0	8,059,421	50	4,029,719	12,089,140
PROJECT TOTAL		9,029,535	491,070	9,520,605	0.00	0	9,520,605	50	4,760,311	14,280,916

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR06 - CONTINGENCY ANALYSIS BASIS SHEET

PAGE 7 OF 8
DATE 06/11/97 12:49:27
BY LHR, DEA, RW

1. DEFINITION OF CONTINGENCY AS PROVIDED BY DOE
==
"CONTINGENCY COVERS COSTS THAT MAY RESULT FROM INCOMPLETE DESIGN, UNFORESEEN AND UNPREDICTABLE CONDITIONS, OR UNCERTAINTIES WITHIN THE DEFINED PROJECT SCOPE. THE AMOUNT OF CONTINGENCY WILL DEPEND ON THE STATUS OF DESIGN, PROCUREMENT, AND CONSTRUCTION; AND THE COMPLEXITY AND UNCERTAINTIES OF THE COMPONENT PARTS OF THE PROJECT. CONTINGENCY IS NOT TO BE USED TO AVOID MAKING AN ACCURATE ASSESSMENT OF EXPECTED COST" (OFFICE OF WASTE MANAGEMENT (EM-30) COST AND SCHEDULE GUIDE).

2. CONTINGENCY ALLOWANCE GUIDELINES
==================================
THE DOE GUIDELINE CONTINGENCY ALLOWANCE FOR A PLANNING ESITMATE - EXPERIMENTAL/SPECIAL CONDITIONS = UP TO 50%

2. METHODOLOGY
===========
CONTINGENCY IS EVALUATED AT THE LOWEST WORK BREAKDOWN STRUCTURE (WBS) LEVEL WITHIN THE COST ESTIMATE DETAILS. IT IS SUMMARIZED AT UPPER WBS LEVELS AND REPORTED ON THE SUMMARY REPORTS.

3. ANALYSIS
========
AN ASSESSMENT OF DESIGN MATURITY, WORK COMPLEXITY AND PROJECT UNCERTAINTIES HAS BEEN PERFORMED. AN EXPLAINATION OF THIS ASSESSMENT AND CONTIGENCY RATES WHICH HAVE BEEN ADDED TO THE COST OF WORK ARE AS FOLLOWS:

WBS (1XXXXX DESIGN & E/I) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (2XXXXX PROCUREMENT) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (3XXXXX CONSTRUCTION) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAA1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (2EA 25,000GAL) ROM ESTIMATE, OPT 1
FDNWR07 - CONSTRUCTION MANAGEMENT/OTHER COST SUMMARY

PAGE 8 OF 8
DATE 06/11/97 12:29:33
BY LHR, DEA, RW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCTION MANAGEMENT %	CONSTRUCTION MANAGEMENT TOTAL	OTHER COSTS	SUB TOTAL
112000	DEFINITIVE DESIGN-CAT 2	1022856	0.00	0	0	0
121001	ENGINEERING/INSPECTION-ONSITE E/C	438328	0.00	0	0	0
220001	PROCUREMENT-O/C	4949316	0.00	0	0	0
320000	PROJECT SUPPORT	158071	18.75	29638	0	29638
320001	GENERAL CONTRACTOR	1692919	18.75	317423	0	317423
321001	"ICE" BUILDING - SITE WORK	12000	18.75	2250	0	2250
321002	"ICE" BUILDING - UTILITIES	43041	18.75	8070	0	8070
321003	"ICE" BUILDING - STRUCTURE	56691	18.75	10631	0	10631
321004	"ICE" BUILDING - HVAC SYSTEM	28516	18.75	5347	0	5347
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	18.75	4576	0	4576
321006	ELECTRICAL SERVICE EQUIPMENT	77228	18.75	14480	0	14480
322001	TANK VENTILATION SYSTEM	342231	18.75	64168	0	64168
323001	INSTRUMENTATION SYSTEM	34596	18.75	6487	0	6487
324001	PIPING HEAT TRACE SYSTEM	19821	18.75	3716	0	3716
325001	ELECTRICAL SERVICE DUCTBANK	43804	18.75	8213	0	8213
326001	ELECTRICAL SITE LIGHTING	37158	18.75	6967	0	6967
327001	GROUNDING & LIGHTNING PROTECTION	10640	18.75	1995	0	1995
328001	EMERGENCY GENERATOR	37913	18.75	7109	0	7109
PROJECT TOTAL		9,029,535		491,070	0	491,070

APPENDIX B

COST ESTIMATE: ANNULUS TANK SYSTEM - OPTION 2

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR01 - PROJECT COST SUMMARY

PAGE 1 OF 8
DATE 06/11/97 12:30:51
BY LHR, DEA, RLW

SORT	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
FDNW	FLUOR DANIEL NORTHWEST	11,275,612	50	5,637,814	16,913,426
	PROJECT TOTAL	11,275,612	50	5,637,814	16,913,426

TYPE OF ESTIMATE	STUDY - ORDER OF MAGNITUDE	JUNE 11, 1997	REMARKS: DRAFT
FDNW LEAD ESTIMATOR		ESTIMATING MANAGER	
PROJECT MANAGER			
CLIENT			

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR02 - WORK BREAKDOWN STRUCTURE (WBS) SUMMARY

PAGE 2 OF 8
DATE 06/11/97 12:30:53
BY LHR, DEA, RLW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
112000	DEFINITIVE DESIGN-CAT 2	1554208	0	1554208	0.00	0	1554208	50	777104	2331312
121001	ENGINEERING/INSPECTION-ONSITE E/C	666128	0	666128	0.00	0	666128	50	333064	999192
SUBTOTAL 1	ENGINEERING	2220336	0	2220336	0.00	0	2220336	50	1110168	3330504
220001	PROCUREMENT-O/C	4350548	0	4350548	0.00	0	4350548	50	2175274	6525822
SUBTOTAL 2	PROCUREMENT	4350548	0	4350548	0.00	0	4350548	50	2175274	6525822
320000	PROJECT SUPPORT	222475	41714	264189	0.00	0	264189	50	132095	396284
320001	GENERAL CONTRACTOR	1769747	331828	2101575	0.00	0	2101575	50	1050789	3152364
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
SUBTOTAL 321	"ICE" BUILDING CONSTRUCTION	241882	45354	287236	0.00	0	287236	50	143620	430856
322001	TANK VENTILATION SYSTEM	1504223	282042	1786265	0.00	0	1786265	50	893133	2679398
323001	INSTRUMENTATION SYSTEM	57101	10706	67807	0.00	0	67807	50	33904	101711
324001	PIPING HEAT TRACE SYSTEM	36932	6925	43857	0.00	0	43857	50	21929	65786
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
SUBTOTAL 32	FIXED PRICE CONSTRUCTION	3961875	742853	4704728	0.00	0	4704728	50	2352372	7057100
SUBTOTAL 3	CONSTRUCTION	3961875	742853	4704728	0.00	0	4704728	50	2352372	7057100
PROJECT TOTAL		10,532,759	742,853	11,275,612	0.00	0	11,275,612	50	5,637,814	16,913,426

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR03 - ESTIMATE BASIS SHEET

PAGE 3 OF 8
DATE 06/11/97 12:55:47
BY LHR, DEA, RLW

1. ESTIMATE PURPOSE

ORDER OF MAGNITUDE ESTIMATE: THIS ESTIMATE WILL TO BE USED FOR BUDGETING PURPOSES ONLY.

2. ESTIMATE TECHNICAL BASIS

A. THIS ESTIMATE HAS BEEN PREPARED FOR THE K-BASINS TEMPORARY SLUDGE STORAGE TANKS PROJECT AS REQUESTED BY DE&S HANFORD, INC.
B. A DESCRIPTION OF THE TECHNICAL SCOPE OF WORK MAY BE FOUND IN THE FOLLOWING REFERENCE DOCUMENTS:
   LETTER OF INSTRUCTION (LOI) #E33936.
   REQUEST FOR ESTIMATE DATED 13 MAY 1997.
   PRE-CONCEPTUAL DESIGN REPORT "TEMPORARY SLUDGE STORAGE TANKS FOR K-BASINS SLUDGE REMOVAL", SNF-PCDR-E33936, REV.0, DATED JUNE 1997.
C. THIS ESTIMATE ALSO UTILIZES A STANDARD FDNW DEFINED CODE OF ACCOUNTS.

3. ESTIMATE METHODOLOGY

A. DIRECT COSTS:
A SPECIFIC ANALOGY TECHNIQUE AND EXPERT OPINION TECHNIQUE HAS BEEN UTILIZED IN THE PREPARATION OF THIS ESTIMATE.
(1) CONSTRUCTION LABOR, MATERIAL AND EQUIPMENT UNITS HAVE BEEN ESTIMATED BASED UPON SIMILAR WORK ON OTHER PROJECTS. THE UNITS MAY HAVE BEEN FACTORED/ADJUSTED BY THE ESTIMATOR AS APPROPRIATE TO REFLECT INFLUENCES BY CONTRACT, WORK SITE, OR OTHER IDENTIFIED PROJECT OR SPECIAL CONDITIONS.
(2) FLUOR DANIEL HANFORD & PROJECT HANFORD MANAGEMENT (PHMC) SUBCONTRACTOR DIRECT COSTS FOR DUKE ENGINEERING & HANFORD, INC. HAVE BEEN PROVIDED BY FDNW PROJECT MANAGEMENT FOR INCLUSION INTO THIS ESTIMATE.

B. DIRECT COST FACTORS
(1) SALES TAX HAS BEEN APPLIED TO ALL MATERIALS AND EQUIPMENT PURCHASES AT 8%.
(2) NO WAREHOUSING COSTS ARE SHOWN SINCE THEY ARE CONSIDERED TO BE INCLUDED IN THE MATERIAL PROCUREMENT RATE (MPR).
(3) CONSUMABLES ARE ESTIMATED AT 3.2% OF DIRECT CRAFT LABOR COSTS.
(4) NO PREMIUM PAY INCLUDED IN THE ESTIMATE.
(5) CONTRACT ADMINISTRATION FACTOR OF 18.75% HAS BEEN APPLIED TO THE DIRECT CONTRACT VALUE WHICH INCLUDES COSTS FOR BID PACKAGE PREPARATION, CONTRACT MANAGEMENT & ADMINISTRATION AND PROJECT MANGEMENT & PLANNING SUPPORT.

C. INDIRECT COSTS
FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED ARE THE FOLLWOING PERCENTAGES: LABOR = 25.0 %, EQUIMENT USE = 25.0 %, MATERIAL = 25.0 %, SUBCONTRACT = 10.0 %, AND EQUIPMENT = 0% , AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL REPORT.

D. RATES
(1) FLUOR DANIEL NORTHWEST LABOR RATES ARE BASED UPON THE FLUOR DAINEL FEDERAL OPERATIONS (FEDFO) DISCLOSURE STATEMENT AND APPROVED PROVISIONAL BILLING RATES. FOR ESTIMATING PURPOSES, AVERAGE RATES BY OPERATIONS CODE HAVE BEEN DEVELOPED BASED UPON RECENT COST HISTORY.

4. ESCALATION

NO ESCALATION HAS BEEN INCLUDED SINCE A SCHEDULE WAS NOT PROVIDED.

5. CONTINGENCY

A CONTINGENCY ANALYSIS HAS BEEN PERFORMED AND IS DOCUMENTED IN FDNWR06 REPORT OF THIS ESTIMATE.

6. REMARKS

MAJOR ASSUMPTIONS WHICH HAVE BEEN MADE IN THE PREPARATION OF THIS ESTIMATE ARE AS FOLLOWS:

A. SITE ALLOCATIONS ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
B. OTHER PROJECT COSTS (OPC) ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
C. THE ESTIMATE IS BASED ON THE DESIGN AND INSTALLATION OF (60EA) ANNULUS TANK SYSTEM.
D. THE ESTIMATE ASSUMES ENGINEERING, DESIGN, AND E&I DURING CONSTRUCTION PERFORMED BY FDNW.
E. CONSTRUCTION WORK TO BE ACCOMPLISHED DURING NORMAL WORKING HOURS BY A FIXED PRICE CONSTRACTOR.
F. NO HAZARDOUS WASTE REMOVAL OR DISPOSAL COSTS ARE INCLUDED.
G. THE ESTIMATE ASSUMES NO RADIATION WORK WILL BE ENCOUNTERED.

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR04 - DOE COST CODE ACCOUNT SUMMARY

DATE 06/11/97 12:30:55
BY LHR, DEA, RLW

COST CODE/WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING									
112000	DEFINITIVE DESIGN-CAT 2	1554208	0	1554208	0.00	0	1554208	50	777104	2331312
121001	ENGINEERING/INSPECTION-ONSITE E/C	666128	0	666128	0.00	0	666128	50	333064	999192
TOTAL 000	ENGINEERING	2220336	0	2220336	0.00	0	2220336	50	1110168	3330504
550	OTHER STRUCTURES									
220001	PROCUREMENT-O/C	4350548	0	4350548	0.00	0	4350548	50	2175274	6525822
320000	PROJECT SUPPORT	222475	41714	264189	0.00	0	264189	50	132095	396284
320001	GENERAL CONTRACTOR	1769747	331828	2101575	0.00	0	2101575	50	1050789	3152364
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
322001	TANK VENTILATION SYSTEM	1504223	282042	1786265	0.00	0	1786265	50	893133	2679398
323001	INSTRUMENTATION SYSTEM	57101	10706	67807	0.00	0	67807	50	33904	101711
324001	PIPING HEAT TRACE SYSTEM	36932	6925	43857	0.00	0	43857	50	21929	65786
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
TOTAL 550	OTHER STRUCTURES	8312423	742853	9055276	0.00	0	9055276	50	4527646	13582922
PROJECT TOTAL		10,532,759	742,853	11,275,612	0.00	0	11,275,612	50	5,637,814	16,913,426

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR05 - ESTIMATE SUMMARY BY CSI DIVISION

PAGE 6 OF 8
DATE 06/11/97 12:30:57
BY LHR, DEA, RLW

CSI	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
ENGINEERING										
00	TECHNICAL SERVICES	2220336	0	2220336	0.00	0	2220336	50	1110168	3330504
	TOTAL ENGINEERING	2,220,336	0	2,220,336	0.00	0	2,220,336	50	1,110,168	3,330,504
CONSTRUCTION										
02	SITEWORK	215750	40453	256203	0.00	0	256203	50	128102	384305
03	CONCRETE	986153	184904	1171057	0.00	0	1171057	50	585529	1756586
05	METALS	352870	41013	393883	0.00	0	393883	50	196942	590825
06	WOOD AND PLASTICS	180000	0	180000	0.00	0	180000	50	90000	270000
07	MOISTURE AND THERMAL	3459	649	4108	0.00	0	4108	50	2054	6162
08	DOORS,WINDOWS AND G	8279	1552	9831	0.00	0	9831	50	4916	14747
09	FINISHES	255300	47869	303169	0.00	0	303169	50	151585	454754
11	EQUIPMENT	20000	0	20000	0.00	0	20000	50	10000	30000
13	SPECIAL CONSTRUCTION	17000	3188	20188	0.00	0	20188	50	10094	30282
15	MECHANICAL	4127773	307155	4434928	0.00	0	4434928	50	2217465	6652393
16	ELECTRICAL	1923364	74356	1997720	0.00	0	1997720	50	998864	2996584
40	PROJECT MANAGER	222475	41714	264189	0.00	0	264189	50	132095	396284
	TOTAL CONSTRUCTION	8,312,423	742,853	9,055,276	0.00	0	9,055,276	50	4,527,646	13,582,922
	PROJECT TOTAL	10,532,759	742,853	11,275,612	0.00	0	11,275,612	50	5,637,814	16,913,426

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR06 - CONTINGENCY ANALYSIS BASIS SHEET

DATE 06/11/97 15:38:31
BY LHR, DEA, RLW

1. DEFINITION OF CONTINGENCY AS PROVIDED BY DOE

"CONTINGENCY COVERS COSTS THAT MAY RESULT FROM INCOMPLETE DESIGN, UNFORESEEN AND UNPREDICTABLE CONDITIONS, OR UNCERTAINTIES WITHIN THE DEFINED PROJECT SCOPE. THE AMOUNT OF CONTINGENCY WILL DEPEND ON THE STATUS OF DESIGN, PROCUREMENT, AND CONSTRUCTION; AND THE COMPLEXITY AND UNCERTAINTIES OF THE COMPONENT PARTS OF THE PROJECT. CONTINGENCY IS NOT TO BE USED TO AVOID MAKING AN ACCURATE ASSESSMENT OF EXPECTED COST" (OFFICE OF WASTE MANAGEMENT (EM-30) COST AND SCHEDULE GUIDE).

2. CONTINGENCY ALLOWANCE GUIDELINES

THE DOE GUIDELINE CONTINGENCY ALLOWANCE FOR A PLANNING ESITMATE - EXPERIMENTAL/SPECIAL CONDITIONS = UP TO 50%

2. METHODOLOGY

CONTINGENCY IS EVALUATED AT THE LOWEST WORK BREAKDOWN STRUCTURE (WBS) LEVEL WITHIN THE COST ESTIMATE DETAILS. IT IS SUMMARIZE AT UPPER WBS LEVELS AND REPORTED ON THE SUMMARY REPORTS.

3. ANALYSIS

AN ASSESSMENT OF DESIGN MATURITY, WORK COMPLEXITY AND PROJECT UNCERTAINTIES HAS BEEN PERFORMED. AN EXPLAINATION OF THIS ASSESSMENT AND CONTIGENCY RATES WHICH HAVE BEEN ADDED TO THE COST OF WORK ARE AS FOLLOWS:

WBS (1XXXXX DESIGN & E/I) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (2XXXXX PROCUREMENT) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (3XXXXX CONSTRUCTION) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAB1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (60EA DONUT TANK) ROM EST., OPT. 2
FDNWR07 - CONSTRUCTION MANAGEMENT/OTHER COST SUMMARY

DATE 06/11/97 12:30:58
BY LHR, DEA, RLW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCTION MANAGEMENT %	CONSTRUCTION MANAGEMENT TOTAL	OTHER COSTS	SUB TOTAL
112000	DEFINITIVE DESIGN-CAT 2	1554208	0.00	0	0	0
121001	ENGINEERING/INSPECTION-ONSITE E/C	666128	0.00	0	0	0
220001	PROCUREMENT-O/C	4350548	0.00	0	0	0
320000	PROJECT SUPPORT	222475	18.75	41714	0	41714
320001	GENERAL CONTRACTOR	1769747	18.75	331828	0	331828
321001	"ICE" BUILDING - SITE WORK	12000	18.75	2250	0	2250
321002	"ICE" BUILDING - UTILITIES	43041	18.75	8070	0	8070
321003	"ICE" BUILDING - STRUCTURE	56691	18.75	10631	0	10631
321004	"ICE" BUILDING - HVAC SYSTEM	28516	18.75	5347	0	5347
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	18.75	4576	0	4576
321006	ELECTRICAL SERVICE EQUIPMENT	77228	18.75	14480	0	14480
322001	TANK VENTILATION SYSTEM	1504223	18.75	282042	0	282042
323001	INSTRUMENTATION SYSTEM	57101	18.75	10706	0	10706
324001	PIPING HEAT TRACE SYSTEM	36932	18.75	6925	0	6925
325001	ELECTRICAL SERVICE DUCTBANK	43804	18.75	8213	0	8213
326001	ELECTRICAL SITE LIGHTING	37158	18.75	6967	0	6967
327001	GROUNDING & LIGHTNING PROTECTION	10640	18.75	1995	0	1995
328001	EMERGENCY GENERATOR	37913	18.75	7109	0	7109
PROJECT TOTAL		10,532,759		742,853	0	742,853

APPENDIX C

COST ESTIMATE: HARP TANK SYSTEM - OPTION 3

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (8EA HARP TANK) ROM EST., OPT. 3
FDNWR01 - PROJECT COST SUMMARY

DATE 06/11/97 12:32:35
BY LHR, DEA, RLW

SORT	DESCRIPTION	ESCALATED TOTAL COST	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
FDNW	FLUOR DANIEL NORTHWEST	15,362,553	50	7,681,284	23,043,837
	PROJECT TOTAL	15,362,553	50	7,681,284	23,043,837

TYPE OF ESTIMATE	STUDY - ORDER OF MAGNITUDE	JUNE 11, 1997	REMARKS: DRAFT
FDNW LEAD ESTIMATOR	[signature]	ESTIMATING MANAGER [signature]	
PROJECT MANAGER	[signature]		
CLIENT			

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (8EA HARP TANK) ROM EST., OPT. 3
FDNWR02 - WORK BREAKDOWN STRUCTURE (WBS) SUMMARY

PAGE 2 OF 8
DATE 06/11/97 12:32:36
BY LHR, DEA, RLW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
112000	DEFINITIVE DESIGN-CAT 2	1190136	0	1190136	0.00	0	1190136	50	595068	1785204
121001	ENGINEERING/INSPECTION-ONSITE E/C	510068	0	510068	0.00	0	510068	50	255034	765102
SUBTOTAL 1	ENGINEERING	1700204	0	1700204	0.00	0	1700204	50	850102	2550306
220001	PROCUREMENT-O/C	10055480	0	10055480	0.00	0	10055480	50	5027740	15083220
SUBTOTAL 2	PROCUREMENT	10055480	0	10055480	0.00	0	10055480	50	5027740	15083220
320000	PROJECT SUPPORT	173849	32597	206446	0.00	0	206446	50	103223	309669
320001	GENERAL CONTRACTOR	1777173	333220	2110393	0.00	0	2110393	50	1055198	3165591
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
SUBTOTAL 321	"ICE" BUILDING CONSTRUCTION	241882	45354	287236	0.00	0	287236	50	143620	430856
322001	TANK VENTILATION SYSTEM	628683	117879	746562	0.00	0	746562	50	373282	1119844
323001	INSTRUMENTATION SYSTEM	49327	9249	58576	0.00	0	58576	50	29288	87864
324001	PIPING HEAT TRACE SYSTEM	36932	6925	43857	0.00	0	43857	50	21929	65786
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
SUBTOTAL 32	FIXED PRICE CONSTRUCTION	3037361	569508	3606869	0.00	0	3606869	50	1803442	5410311
SUBTOTAL 3	CONSTRUCTION	3037361	569508	3606869	0.00	0	3606869	50	1803442	5410311
PROJECT TOTAL		14,793,045	569,508	15,362,553	0.00	0	15,362,553	50	7,681,284	23,043,837

1. ESTIMATE PURPOSE

ORDER OF MAGNITUDE ESTIMATE: THIS ESTIMATE WILL TO BE USED FOR BUDGETING PURPOSES ONLY.

2. ESTIMATE TECHNICAL BASIS

A. THIS ESTIMATE HAS BEEN PREPARED FOR THE K-BASINS TEMPORARY SLUDGE STORAGE TANKS PROJECT AS REQUESTED BY DE&S HANFORD, INC.
B. A DESCRIPTION OF THE TECHNICAL SCOPE OF WORK MAY BE FOUND IN THE FOLLOWING REFERENCE DOCUMENTS:
   LETTER OF INSTRUCTION (LOI) #E33936.
   REQUEST FOR ESTIMATE DATED 13 MAY 1997.
   PRE-CONCEPTUAL DESIGN REPORT "TEMPORARY SLUDGE STORAGE TANKS FOR K-BASINS SLUDGE REMOVAL", SNF-PCDR--E33936, REV.0, DATED JUNE 1997.
   AEA TECHNOLOGY ENGINEERING SERVICES, INC. "FLUIDIC STORAGE TANKS IN SUPPORT OF THE K-BASIN PROJECT", JUNE 1997.
C. THIS ESTIMATE ALSO UTILIZES A STANDARD FDNW DEFINED CODE OF ACCOUNTS.

3. ESTIMATE METHODOLOGY

A. DIRECT COSTS:
A SPECIFIC ANALOGY TECHNIQUE AND EXPERT OPINION TECHNIQUE HAS BEEN UTILIZED IN THE PREPARATION OF THIS ESTIMATE.
(1) CONSTRUCTION LABOR, MATERIAL AND EQUIPMENT UNITS HAVE BEEN ESTIMATED BASED UPON SIMILAR WORK ON OTHER PROJECTS. THE UNITS MAY HAVE BEEN FACTORED/ADJUSTED BY THE ESTIMATOR AS APPROPRIATE TO REFLECT INFLUENCES BY CONTRACT, WORK SITE, OR OTHER IDENTIFIED PROJECT OR SPECIAL CONDITIONS.
(2) FLUOR DANIEL HANFORD & PROJECT HANFORD MANAGEMENT (PHMC) SUBCONTRACTOR DIRECT COSTS FOR DUKE ENGINEERING & HANFORD, INC. HAVE BEEN PROVIDED BY FDNW PROJECT MANAGEMENT FOR INCLUSION INTO THIS ESTIMATE.

B. DIRECT COST FACTORS
(1) SALES TAX HAS BEEN APPLIED TO ALL MATERIALS AND EQUIPMENT PURCHASES AT 8%.
(2) NO WAREHOUSING COSTS ARE SHOWN SINCE THEY ARE CONSIDERED TO BE INCLUDED IN THE MATERIAL PROCUREMENT RATE (MPR).
(3) CONSUMABLES ARE ESTIMATED AT 3.2% OF DIRECT CRAFT LABOR COSTS.
(4) NO PREMIUM PAY INCLUDED IN THE ESTIMATE.
(5) CONTRACT ADMINISTRATION FACTOR OF 18.75% HAS BEEN APPLIED TO THE DIRECT CONTRACT VALUE WHICH INCLUDES COSTS FOR BID PACKAGE PREPARATION, CONTRACT MANAGEMENT & ADMINISTRATION AND PROJECT MANGEMENT & PLANNING SUPPORT.

C. INDIRECT COSTS
FIXED PRICE CONTRACTOR OVERHEAD, PROFIT, BOND AND INSURANCE COSTS HAVE BEEN APPLIED ARE THE FOLLWOING PERCENTAGES: LABOR = 25.0 %, EQUIMENT USE = 25.0 %, MATERIAL = 25.0 %, SUBCONTRACT = 10.0 %, AND EQUIPMENT = 0% , AND ARE REFLECTED IN THE "OH&P/B&I" COLUMN OF THE ESTIMATE DETAIL REPORT.

D. RATES
(1) FLUOR DANIEL NORTHWEST LABOR RATES ARE BASED UPON THE FLUOR DAINEL FEDERAL OPERATIONS (FEDFO) DISCLOSURE STATEMENT AND APPROVED PROVISIONAL BILLING RATES. FOR ESTIMATING PURPOSES, AVERAGE RATES BY OPERATIONS CODE HAVE BEEN DEVELOPED BASED UPON RECENT COST HISTORY.

4. ESCALATION

NO ESCALATION HAS BEEN INCLUDED SINCE A SCHEDULE WAS NOT PROVIDED.

5. CONTINGENCY

A CONTINGENCY ANALYSIS HAS BEEN PERFORMED AND IS DOCUMENTED IN FDNWR06 REPORT OF THIS ESTIMATE.

6. REMARKS

MAJOR ASSUMPTIONS WHICH HAVE BEEN MADE IN THE PREPARATION OF THIS ESTIMATE ARE AS FOLLOWS:

A. SITE ALLOCATIONS ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
B. OTHER PROJECT COSTS (OPC) ARE NOT INCLUDED IN THIS ESTIMATE AT THE CUSTOMERS (DESH) REQUEST.
C. THE ESTIMATE IS BASED ON THE DESIGN AND INSTALLATION OF (8EA) HARP TANKS.
D. THE ESTIMATE ASSUMES ENGINEERING, DESIGN, AND E&I DURING CONSTRUCTION PERFORMED BY FDNW.
E. CONSTRUCTION WORK TO BE ACCOMPLISHED DURING NORMAL WORKING HOURS BY A FIXED PRICE CONSTRACTOR.
F. NO HAZARDOUS WASTE REMOVAL OR DISPOSAL COSTS ARE INCLUDED.
G. THE ESTIMATE ASSUMES NO RADIATION WORK WILL BE ENCOUNTERED.

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (8EA HARP TANK) ROM EST., OPT. 3
FDNWR04 - DOE COST CODE ACCOUNT SUMMARY

PAGE 5 OF 8
DATE 06/11/97 12:32:38
BY LHR, DEA, RLW

COST CODE/WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
000	ENGINEERING									
112000	DEFINITIVE DESIGN-CAT 2	1190136	0	1190136	0.00	0	1190136	50	595068	1785204
121001	ENGINEERING/INSPECTION-ONSITE E/C	510068	0	510068	0.00	0	510068	50	255034	765102
TOTAL 000	ENGINEERING	1700204	0	1700204	0.00	0	1700204	50	850102	2550306
550	OTHER STRUCTURES									
220001	PROCUREMENT-O/C	10055480	0	10055480	0.00	0	10055480	50	5027740	15083220
320000	PROJECT SUPPORT	173849	32597	206446	0.00	0	206446	50	103223	309669
320001	GENERAL CONTRACTOR	1777173	333220	2110393	0.00	0	2110393	50	1055198	3165591
321001	"ICE" BUILDING - SITE WORK	12000	2250	14250	0.00	0	14250	50	7125	21375
321002	"ICE" BUILDING - UTILITIES	43041	8070	51111	0.00	0	51111	50	25556	76667
321003	"ICE" BUILDING - STRUCTURE	56691	10631	67322	0.00	0	67322	50	33662	100984
321004	"ICE" BUILDING - HVAC SYSTEM	28516	5347	33863	0.00	0	33863	50	16932	50795
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	4576	28982	0.00	0	28982	50	14491	43473
321006	ELECTRICAL SERVICE EQUIPMENT	77228	14480	91708	0.00	0	91708	50	45854	137562
322001	TANK VENTILATION SYSTEM	628683	117879	746562	0.00	0	746562	50	373282	1119844
323001	INSTRUMENTATION SYSTEM	49327	9249	58576	0.00	0	58576	50	29288	87864
324001	PIPING HEAT TRACE SYSTEM	36932	6925	43857	0.00	0	43857	50	21929	65786
325001	ELECTRICAL SERVICE DUCTBANK	43804	8213	52017	0.00	0	52017	50	26009	78026
326001	ELECTRICAL SITE LIGHTING	37158	6967	44125	0.00	0	44125	50	22063	66188
327001	GROUNDING & LIGHTNING PROTECTION	10640	1995	12635	0.00	0	12635	50	6318	18953
328001	EMERGENCY GENERATOR	37913	7109	45022	0.00	0	45022	50	22512	67534
TOTAL 550	OTHER STRUCTURES	13092841	569508	13662349	0.00	0	13662349	50	6831182	20493531
PROJECT TOTAL		14,793,045	569,508	15,362,553	0.00	0	15,362,553	50	7,681,284	23,043,837

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (8EA HARP TANK) ROM EST., OPT. 3
FDNWR05 - ESTIMATE SUMMARY BY CSI DIVISION

PAGE 6 OF 8
DATE 06/11/97 12:32:40
BY LHR, DEA, RLW

CSI	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCT MGMNT	SUB TOTAL	ESCALATION %	ESCALATION TOTAL	SUB TOTAL	CONTINGENCY %	CONTINGENCY TOTAL	TOTAL DOLLARS
ENGINEERING										
00	TECHNICAL SERVICES	1700204	0	1700204	0.00	0	1700204	50	850102	2550306
	TOTAL ENGINEERING	1,700,204	0	1,700,204	0.00	0	1,700,204	50	850,102	2,550,306
CONSTRUCTION										
02	SITEWORK	215750	40453	256203	0.00	0	256203	50	128102	384305
03	CONCRETE	986153	184904	1171057	0.00	0	1171057	50	585529	1756586
05	METALS	218734	41013	259747	0.00	0	259747	50	129874	389621
06	WOOD AND PLASTICS	120000	0	120000	0.00	0	120000	50	60000	180000
07	MOISTURE AND THERMAL	3459	649	4108	0.00	0	4108	50	2054	6162
08	DOORS,WINDOWS AND G	8279	1552	9831	0.00	0	9831	50	4916	14747
09	FINISHES	255300	47869	303169	0.00	0	303169	50	151585	454754
11	EQUIPMENT	20000	0	20000	0.00	0	20000	50	10000	30000
13	SPECIAL CONSTRUCTION	17000	3188	20188	0.00	0	20188	50	10094	30282
15	MECHANICAL	10008023	159305	10167328	0.00	0	10167328	50	5083666	15250994
16	ELECTRICAL	1066294	57978	1124272	0.00	0	1124272	50	562139	1686411
40	PROJECT MANAGER	173849	32597	206446	0.00	0	206446	50	103223	309669
	TOTAL CONSTRUCTION	13,092,841	569,508	13,662,349	0.00	0	13,662,349	50	6,831,182	20,493,531
	PROJECT TOTAL	14,793,045	569,508	15,362,553	0.00	0	15,362,553	50	7,681,284	23,043,837

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (8EA HARP TANK) ROM EST., OPT. 3
FDNWR06 - CONTINGENCY ANALYSIS BASIS SHEET

DATE 06/11/97 15:39:11
BY LHR, DEA, RLW

1. DEFINITION OF CONTINGENCY AS PROVIDED BY DOE

"CONTINGENCY COVERS COSTS THAT MAY RESULT FROM INCOMPLETE DESIGN, UNFORESEEN AND UNPREDICTABLE CONDITIONS, OR UNCERTAINTIES WITHIN THE DEFINED PROJECT SCOPE. THE AMOUNT OF CONTINGENCY WILL DEPEND ON THE STATUS OF DESIGN, PROCUREMENT, AND CONSTRUCTION; AND THE COMPLEXITY AND UNCERTAINTIES OF THE COMPONENT PARTS OF THE PROJECT. CONTINGENCY IS NOT TO BE USED TO AVOID MAKING AN ACCURATE ASSESSMENT OF EXPECTED COST" (OFFICE OF WASTE MANAGEMENT (EM-30) COST AND SCHEDULE GUIDE).

2. CONTINGENCY ALLOWANCE GUIDELINES

THE DOE GUIDELINE CONTINGENCY ALLOWANCE FOR A PLANNING ESITMATE - EXPERIMENTAL/SPECIAL CONDITIONS = UP TO 50%

2. METHODOLOGY

CONTINGENCY IS EVALUATED AT THE LOWEST WORK BREAKDOWN STRUCTURE (WBS) LEVEL WITHIN THE COST ESTIMATE DETAILS. IT IS SUMMARIZE AT UPPER WBS LEVELS AND REPORTED ON THE SUMMARY REPORTS.

3. ANALYSIS

AN ASSESSMENT OF DESIGN MATURITY, WORK COMPLEXITY AND PROJECT UNCERTAINTIES HAS BEEN PERFORMED. AN EXPLAINATION OF THIS ASSESSMENT AND CONTIGENCY RATES WHICH HAVE BEEN ADDED TO THE COST OF WORK ARE AS FOLLOWS:

WBS (1XXXXX DESIGN & E/I) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (2XXXXX PROCUREMENT) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

WBS (3XXXXX CONSTRUCTION) A CONTINGENCY OF 50.0 % HAS BEEN APPLIED.....

FLUOR DANIEL NORTHWEST, INC.
DE&S HANFORD, INC.
JOB NO. E33936/F3YC4E
FILE NO. YA82SAC1

** IEST - INTERACTIVE ESTIMATING **
K-BASINS SLUDGE REMOVAL SYSTEM, TEMPORARY SLUDGE
STORAGE TANKS, (BEA HARP TANK) ROM EST., OPT. 3
FDNWR07 - CONSTRUCTION MANAGEMENT/OTHER COST SUMMARY

DATE 06/11/97 12:32:42
BY LHR, DEA, RLW

WBS	DESCRIPTION	ESTIMATE SUBTOTAL	CONSTRUCTION MANAGEMENT %	CONSTRUCTION MANAGEMENT TOTAL	OTHER COSTS	SUB TOTAL
112000	DEFINITIVE DESIGN-CAT 2	1190136	0.00	0	0	0
121001	ENGINEERING/INSPECTION-ONSITE E/C	510068	0.00	0	0	0
220001	PROCUREMENT-O/C	10055480	0.00	0	0	0
320000	PROJECT SUPPORT	173849	18.75	32597	0	32597
320001	GENERAL CONTRACTOR	1777173	18.75	333220	0	333220
321001	"ICE" BUILDING - SITE WORK	12000	18.75	2250	0	2250
321002	"ICE" BUILDING - UTILITIES	43041	18.75	8070	0	8070
321003	"ICE" BUILDING - STRUCTURE	56691	18.75	10631	0	10631
321004	"ICE" BUILDING - HVAC SYSTEM	28516	18.75	5347	0	5347
321005	"ICE" BUILDING - ELECTRICAL SYSTEM	24406	18.75	4576	0	4576
321006	ELECTRICAL SERVICE EQUIPMENT	77228	18.75	14480	0	14480
322001	TANK VENTILATION SYSTEM	628683	18.75	117879	0	117879
323001	INSTRUMENTATION SYSTEM	49327	18.75	9249	0	9249
324001	PIPING HEAT TRACE SYSTEM	36932	18.75	6925	0	6925
325001	ELECTRICAL SERVICE DUCTBANK	43804	18.75	8213	0	8213
326001	ELECTRICAL SITE LIGHTING	37158	18.75	6967	0	6967
327001	GROUNDING & LIGHTNING PROTECTION	10640	18.75	1995	0	1995
328001	EMERGENCY GENERATOR	37913	18.75	7109	0	7109
PROJECT TOTAL		14,793,045		569,508	0	569,508

APPENDIX D

OUTLINE SPECIFICATION

OUTLINE SPECIFICATION

DIVISION 2 - SITEWORK

Section 02220 Excavating, Backfilling, and Compacting

1. Excavation for underground pipe and conduit.
2. Excavation for underground concrete vault.
3. Structural backfill, compacted: WSDOT M41-10, Section 2-03.3(14)C.
4. Sand bedding for underground pipe and conduit: ASTM D 653.
5. Plastic sheet marker for buried pipe and conduit.
6. Stabilization of disturbed areas.

Section 02235 Road Subgrade and Granular Base

1. Aggregate surfacing course: WSDOT M41-10, Section 9-03.9(3), Top Course Classification.
2. Subgrade backfill, compacted: WSDOT M41-10, Section 2-03.3(14)C, Method B.
3. Stabilization of disturbed areas.

Section 02512 Hot-Laid Asphaltic Concrete Paving

1. Asphalt: WSDOT M41-10, Sections 9-02.1(2) and 9-02.1(4). Grade AR-4000W paving asphalt for use in asphaltic concrete mixture.
2. Aggregate: WSDOT M41-10, Section 9-03.8(1), (2), and (3)B, Class "B."

Section 02650 Piped Utilities

1. Buried raw and sanitary piping: Polyvinyl chloride (PVC) plastic pipe, AWWA C900. Design, AWWA M23. Installation, AWWA M23 and NFPA 24.
2. Fittings: Ductile Iron, AWWA C110; cement-mortar lined, AWWA C104. Installation, NFPA 24.
3. Valves: Provide with adjustable cast iron valve boxes.

DIVISION 3 - CONCRETE

Section 03300 Cast-In-Place Concrete

1. Concrete minimum strength: 3000 psi at 28 days.

2. Reinforcing steel: ASTM A 615, deformed, Grade 60.

3. Concrete forms: Wood, steel, or plywood.

DIVISION 5 - METALS

Section 05050 Metal Fastenings

1. Sheet metal screws, self-tapping, galvanized: IFI-113.

2. Hex head bolts, galvanized: ASTM A 307, Grade A or B.

3. Nuts, galvanized: ASTM A 563, Grade A.

4. Split lock washers, galvanized: ASTM F 436.

5. Welding: AWS D1.1, AWS D1.2, AWS D1.3 and AWS D5.2.

Section 05120 Structural Steel

1. Rolled steel shapes and plates: ASTM A 36.

2. Steel tubing: ASTM A 500, Grade B.

3. General fastening: AISC S326 and M011.

Section 05400 Cold-Formed Metal Framing

1. Joists and stringers: ASTM A 446.

2. Secondary framing: Z-shaped girts and purlins, ASTM A 446, Grade D, G80 coating weight.

Section 05500 Metal Fabrications

1. Rolled steel shapes, plates, and bars: ASTM A 36.

2. Stainless steel pit liners: Type 304L stainless steel sheet metal; ASTM A 240.

3. Steel pipe: ASTM A 53, Schedule 40.

4. Fasteners: Hilti Fastening Systems Kwik-Bolt II.

5. Galvanized pipe sleeve penetrations in concrete slab: ASTM A 500 or A 53 with A 123 zinc coating.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

Section 07100 Waterproofing

1. Concrete slab-on-grade floor: ACI 515.1R, Guide to the Use of Waterproofing, Dampproofing, Protective and Decorative Barrier Systems for Concrete.

Section 07200 Insulation

1. Perimeter foundation insulation: Extruded polystyrene foam board, 50 mm (2-inch) thick, ASTM C 578, R-10, ASTM E 84.

2. Wall insulation: Mineral glass batt, ASTM C 665, R-19, ASTM E 84.

3. Ceiling insulation: Mineral glass batt, ASTM C 665, R-30, ASTM E 84.

Section 07260 Vapor Retarders

1. Vapor barrier: 17.4 $g/(h \cdot m^2)$ (0.25 $grains/hr/ft)^2$ perm, ASTM E 96, noncombustible and flame retardant, ASTM E 84.

Section 07610 Sheet Metal Roofing

1. Zinc coated sheet metal panels: ASTM A 446, Grade G80 coating weight or ASTM A 792.

Section 07620 Sheet Metal Flashing and Trim

1. Zinc coated sheet metal flashings, gutters and downspouts: ASTM A 446, Grade G80 coating weight or ASTM A 792.

Section 07720 Roof Accessories

1. Ridge vent: Zinc coated sheet metal construction, ASTM A 446, Grade G80 coating weight or ASTM A 792.

Section 07920 Sealants

1. Construction joint filler: ASTM D 994.

2. Caulking at doors: FS TT-S-00227, Type II or FF TT-S-00230, Type II.

3. Sealant at metal siding/roofing seams: FS TT-S-00227, Type II or TT-S-00230, Type II.

4. Sealant at floor penetrations, concrete floor joints and exterior concrete landings: FS TT-S-00227, Type I, Class A.

DIVISION 8 - DOORS AND WINDOWS

Section 08100 Metal Doors and Frames

1. Insulated 44 mm (1-3/4 inch) hollow metal door with metal frame: SDI 100, SDI 108, ISDSI 1002.10; ASTM A 366 or A 569.

2. Safety vision lights in exterior doors.

Section 08710 Door Hardware

1. Door hardware: ANSI A156 Series, SDI 107.

2. Door/frame preparation: ANSI A 115.

3. Exit devices on exterior doors: ANSI A156 Series.

4. Aluminum threshold at exterior doors.

5. Weather gaskets around doors.

DIVISION 9 - FINISHES

Section 09650 Resilient Flooring

1. Vinyl composition tile flooring: ASTM F 1066, E 84, E 648, and NFPA 253 Class I finish.

Section 09805 Special Protective Coatings

1. NAAMM Metal Finishes Manual.

2. PCA IS147T, Surface Treatment for Concrete Floors Manual.

3. PCA IS001T, Effect of Substrates on Concrete and Guide to Protective Treatment Manual.

4. ACI 515.1R, Guide to Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete.

Section 09900 Painting

1. Interior and Exterior Metal Surfaces

   a. Surface preparation: SSPC Steel Structures Painting Manual, Volume 2.

   b. Application: PDCA and Wall Covering Manual.

   c. Coating color: FED-STD-595.

DIVISION 12 - FURNISHINGS

Section 12500 Furniture

1. Chairs for use at monitoring stations.

DIVISION 13 - SPECIAL CONSTRUCTION

Section 13122 Metal Building Systems

1. Metal buildings: Single-span structures, rigid-frame beam and column type.

2. Wall and roof systems: Preformed metal panels of vertical profile and accessory components.

3. Wall and roof framing: Rough opening framing for doors and other penetrations.

4. Design loads: ASCE 7 and ICBO UBC.

Section 13440 Instrumentation

PLC/PC Equipment

Allen-Bradley 1785-L20E	Ethernet PLC processor with 16K words of memory; 512 I/O maximum, any mix of discrete and/or analog; 2 ms typical scan time
Allen-Bradley 1770-XYC	CPU battery

Allen-Bradley 1771-A4B	16-slot panel mount
Allen-Bradley 1771-P4S	120 V ac; 8 A Power Supply Module; 1 slot
Allen-Bradley 1771-IFE	Analog Input Module; 8 differential or 16 single-ended inputs; 4-20 mA; backplane load 750 mA; 18 ms/8 channels or 36ms/16 channels; 12-bit resolution.
Allen-Bradley 1771-WG	Wiring Arm for 1771-IFE
Allen-Bradley 1771-IR	RTD Input Module, 6 - 100 ohm, Pt, 3-wire inputs
Allen-Bradley 1771-WF	Wiring Arm for 1771-IR
Allen-Bradley 1771-IAD	Discrete Input Module; 16 general purpose, 77-138 V ac inputs; backplane current load 250 mA
Allen-Bradley 1771-WH	Wiring Arms for 1771-IAD
Allen-Bradley 1771-OD16	Discrete Output Module; 16 isolated, 74-138 V ac outputs; backplane current load 200 mA
Allen-Bradley 1771-WN	Wiring Arms for 1771-OD16
Best Power Tech SMT-280B	Uninterruptible power supply, 280 VA/175 watts (provides power conditioning and brown-out protection for PLC rack and PC only)
PC (with HMI is OIS)	Provide computer workstation with the following minimum requirements:

200 MHz Pentium Pro
32 MB DRAM
10x CD ROM Drive
6x Read, 2x Write CD-R with hard disk backup software
2 MB VRAM Graphic Accelerator card
12-Bay Tower Case
104+ Keyboard and MS Mouse
256K Internal Cache
3Com Ethernet Adapter
16 bit Sound card w/ speakers
Latest version of Window NT
Latest version of MS Office Professional
20 inch SVGA NI Monitor
Aironet Arlan 640-2400 Ethernet bridge system for unlimited communication links, 2.4 GHz, 2 Mbps; with (2) 13 dB Yagi, directional antennas with mast mounts, (2) 1.5-meter (60 inch) bulkhead extender cables; (2) 15-meter (50-foot) antenna cables
Standard Automation Control-Plus PLC programming software
Rockwell Soft 9323-WL5300D Rockwell-Software WinLogic 5 PLC programming interface software
Citect HMI/Scada software. Full development package, with all options for Windows NT.

Field Instrumentation

Tank waste and dome space	RTD probe temperatures
Tank liquid level	Enraf level transmitter
Tank sludge level	Enraf level transmitter
Tank dome space pressure (vacuum)	Rosemount differential pressure transmitter
Tank dome space H2 (hydrogen)	SHMS cabinet concentration
Tank exhaust air temperature	RTD
Tank exhaust airflow	Pitot tube probe and Rosemount differential pressure transmitter
Tank exhaust air radiation	Air Monitor Corp.
Mixer pump motor amperage	VSD software function (included in prog. costs)
Mixer pump speed	VSD software function (included in prog. costs)
Mixer pump upper and lower	RTDs (included in bearing temps pump costs)
Mixer pump motor winding	RTD (included in temperature pump costs)
Mixer pump upper and lower	PMC/BETA vibration bearing vibration transmitter
Transfer pump motor amperage	VSD software function (included in prog. costs)
Transfer pump speed	VSD software function (included in prog. costs)
Transfer pump motor winding temperature	RTD
Transfer pump discharge pressure	Rosemount pressure transmitter
Transfer pump discharge temperature	RTD
Transfer pump discharge flow	Fisher & Porter Magflow meter
Valve positions	Valve limit switches (included in MOV costs)
Raw water duplex strainers Differential pressure	Rosemount differential pressure transmitter

Process pit, tank vault and buried transfer piping leak detection system (detectors and panel), Tank farm intrinsically safe leak detection system

DIVISION 15 - MECHANICAL

Section 15300 Fire Protection

1. Preaction sprinkler system: Designed and installed throughout ICE Building in accordance with NFPA 13, ordinary hazard occupancy classification.

2. Pipe: Schedule 40 steel with grooved or threaded fittings.

3. Preaction valve: With standard trim including watermotor gong, flow alarm pressure switch and OS&Y isolation control valve with valve position supervisory switch.

4. Strainer.

5. Fire department connection: 4-inch by 2-1/2 inch brass.

6. Sprinkler heads: 13 mm (1/2-inch) orifice, 74 °C (165 °F) rated.

7. Materials: Sprinkler system components to be UL listed or FM approved for the intended application.

8. Hydrostatic testing in accordance with NFPA 13.

Section 15493 Chemical Process Piping Systems

1. Piping, Tubing, and Fittings

    a. Piping in contact with earth or concrete shall have a protective coating.

    b. Filtered raw water piping, in Process Pit: DN50 (2 inch) Sched 40S, Pipe Code M-9.

    c. Off load primary hose: DN40 (1-1/2 inch) EPDM, 1000 kPa (150 psi) Hose and DN40 (1-1/2 inch) Sched 40S, Pipe Code M-9.

    d. Off load encasement piping: 3-inch Sched 40, Pipe Code M-9, with heat trace and insulation. Heat Trace: Self-regulating, 26 W/m (8 W/feet), Raychem 100TV1-CT; power connection kit with NEMA 4 junction box, Raychem PMKG-LP. Insulation: ASTM C552, 3-in. thick.

    e. Piping systems with Pipe Code M-9 (Off Load Primary piping, all piping inside Process Pit): Fabricated and installed in accordance with ASME B31.3 normal service. Stainless steel, ASME A 312, Grade TP 304L, seamless, Schedule 40S.

2. Pumps and Valves

    a. Mixer pumps: 56 kW mechanical (75 hp) (maximum), vertically mounted centrifugal pump with motor and variable speed drive, turntable gear drive assembly. Mixer pumps shall be similar to Project W-211 mixer pumps, but scaled down in size and capacity.

b. Decant/transfer pump: 15 kW mechanical (20 hp), vertically mounted, axial flow turbine pump, variable speed controller, total dynamic head of 30.5 m (100 feet), with suction float assembly, with 375 W (0.5 hp) load sensing winch for raising and lowering suction float assembly. (Reference H-2-820774, Sh 2 for winch).

c. Sump pump: 7.5 kW mechanical (10 hp) (maximum), total dynamic head of 20 m (65 feet), 3.2 L/s (50 gpm), vertical turbine pump.

d. Air compressor: 95 liter (25 gallon tank), 3.7 kW (5 hp), 240 V, oil free.

e. Motor-operated valves

1. 3-way, electrically operated, T-port, ball valve, buttweld ends with electric actuator and position indicating limit switches.

2. 2-way, electrically operated, full port, ball valve, buttweld ends with electric actuator and position indicating limit switches.

3. Storage tanks: (2) SST tanks, 5 mm (3/16-in.) thick, flat top and bottom, 6.1 meters (20-foot) diameter by 3.7 m (12 feet) high, with 12 risers extending up into Process Pit. See Figure 9 for riser schedule. Tank cost is based on ASME Section 8, Division 2 requirements.

4. Miscellaneous Equipment

a. Pump mounting assembly (4): SST plate, lifting attachments, etc.

b. Spray washer assembly (4): Reference H-14-100601

c. Safety shower (1): HAWS Model 8300FP, freeze proof single head shower and eye-wash.

d. Water filter shed, filters, and piping: Similar to Service Water Enclosure shown on Drawing H-14-100600, Sh 1-3 and on Drawing H-14-100597, Sh 6 (P&ID), except only (1) 5 μm filter and only one supply line to Process Pit for water makeup and mixer pump bearing cooling.

Section 15500 Heating, Ventilating, and Air Conditioning

A. Materials

1. Process round exhaust duct-work and Fittings.

a. All round exhaust duct-work and fittings shall be stainless pipe schedule 5S.

b. Flanges shall be class 125 pound lightweight slip on flanges.

c. All rectangular duct-work and fittings shall be 2.7 mm (12 ga) stainless steel welded construction, all sheet metal seams shall be seal welded.

2. Supply round duct-work

a. All round supply ductwork, except as noted, shall be carbon steel pipe schedule 10 ASTM A 53 grade A. All fittings, except as noted, shall be carbon steel schedule 40 ASTM A 53 grade A.

b. All rectangular sheetmetal duct-work and fittings shall be constructed per SMACNA HVAC Duct Constructions Standards Second Edition 1995. The duct-work shall be galvanized 1.6 mm (16 ga).

3. Duct-work reinforcements

a. Stainless steel sheet: ASTM A 240, Type 304 or 304L.

b. Carbon steel: ASTM A 36

c. Condensate piping shall be per pipe code M-31 stainless steel, welded construction.

4. Supports

a. Carbon Steel shapes: ASTM A 36.

b. Stainless steel shapes: ASTM A 276, Type 304 or 304L.

5. Insulation: UL listed in the Building Materials Directory, and carry the UL label.

a. Insulation and adhesive shall have a UL fire hazard classification of 25 maximum for flame spread and 50 maximum for smoke developed.

b. Round duct insulation

Insulation shall be Armstrong Armaflex II sheet insulation, 50-millimeter (2-inch) thick having a thermal conductivity of 0.04 W(/m·K) (0.28 Btu·in/h·ft^2·°F) at a 24 °C (75 °F) mean temperature.

c. Pipe insulation:

Pipe insulation shall be Armstrong Armaflex II, 50-millimeter (2-inch) thick having a thermal conductivity of 0.039 W/(m·K) (0.27 Btu·in/h·ft^2·°F) at a 24 °C (75 °F) mean temperature.

B. Equipment

1. Exhaust Fans: Centrifugal, arrangement 10, single width single inlet, (SWSI) upblast discharge, counter clockwise (ccw) rotation and one clockwise rotation (cw). The maximum operating temperature of the gas stream will be 82 °C (180 °F). The fan shall be spark resistant in accordance with AMCA standard 99-401-66 type A. All parts of the fan in contact with the airstream shall be of non-ferrous material. The fans shall meet the requirements of ASME N509. The fan shall be furnished with a radial type high efficiency wheel for handling clean air. The fan shall be equipped with a drain in the bottom of the fan scroll, an access door, and have a flange inlet and outlet, and a external vane inlet damper with electric actuator. The fans shall be equipped with mechanical shaft seals, and be tested per AG-1. The fans shall be equipped with AMCA labels or approved test equivalent. The fan shall be rated at 825 L/s (1750 cfm) at 2750 Pa (11-inch wg) with a 5.6 kW (7.5 hp) motor. The motor shall be in accordance with NEMA MG 1 and have a premium efficiency classification.

2. Supply Fan: Centrifugal, arrangement 10, single width single inlet, (SWSI) upblast discharge, clockwise rotation (cw). The maximum operating temperature of the gas stream will be 38 °C (100 °F). The fan shall meet the requirements of ASME N509. The fan shall be furnished with a radial type high efficiency wheel for handling clean air. The fan shall be equipped with a drain in the bottom of the fan scroll, an access door, and have a flange inlet and outlet, and a external vane inlet damper with electric actuator. The fans shall be equipped with AMCA labels or approved test equivalent. The fan shall be rated at 700 L/s (1500 cfm) at 2000 Pa (8-inch wg) with a 3.7 kW (5 hp) motor. The motor shall be in accordance with NEMA MG 1 and have a premium efficiency classification.

3. HEPA filter housings: For both supply and exhaust units shall be Flanders filter housing bag-in -bag-out, model E-6 bag-out containment housing gasket seal. Model number E-1x2-GG-F-(304)-R type 1. The filter housing shall be one filter high by two filter wide (1 x 2), the filter housing shall be rated at 945 L/s (2000 cfm) The filter housing shall be all welded construction, welding shall meet the requirements of ASME-N-509-1989, paragraph 7.3. The filter housing shall be constructed per ASME N-509-1989 and tested per ASME-N-510-1989.

   Filter housings shall be constructed from 3 mm and 1.9 mm (11 and 14 ga.) 304 stainless steel. The filter housings shall be furnished with inlet test sections (TI) test section down stream of the first stage of HEPA filters (TC) and a test section down stream of the second stage (TO).

   The filter housing shall be furnished with static pressure ports, aerosol test ports, DN 25 (1-inch) welded coupling (drain) to the bottom of the filter housing located in the center of the housing.

4. HEPA filters: Shall have metal frames, 610 mm by 610 mm by 292 mm (24 inches x 24 inches x 11.5 inches), be rated at no less than 470 L/s (1000 cfm) with a clean pressure drop of 250 Pa (1-inch wg) and meet the requirements of ASME N-509.

5. Isolation valves: Keystone figure AR1. Resilient seated/general purpose valve. See drawing for sizes. The body shall be ductile iron, the disc shall be electroless nickel coated ductile iron, and have a phosphate treated steel stem, the resilient seat shall be EPDM, the stem bushing shall be acetal and have 316 stainless steel screws, the "O" ring and stem packing shall be BUNA-N. Furnish with a gear operator. The valve shall meet the requirements of ASME N-509.

6. Actuators: Keystone model 777 electric actuator for a 300 mm (12-inch) diameter Keystone figure AR1 valves. The actuator will function either in the full open or closed position.

7. Chevron eliminator: Koch Flexichevron Style 2 mist eliminator (impingement-vane) type to remove entrained moisture of 10 microns and larger. Size for a capacity between 700 L/s and 945 L/s (1500 and 2000 cfm).

8. Demister pad: ACS Industries stainless wire mesh pad approximately 150 mm (6 inches) thick. The pad shall be sized to carry approximately 1500 to 2000 cfm of moisture laden air, and to remove water droplets of 10 μm and below.

9. Louver: Ruskin Stationary louver for the supply air unit. The louver shall protect against rain from entering the supply air unit. The louver shall be sized to carry approximately 700 L/s (1500 cfm) of outside air. The size shall be incorporated into the Flanders filter housing approximate size is 1320 mm by 760 mm (52 in. x 30 inch).

10. Heating coils: Indeeco Ultra Safe Explosion Proof Duct Heaters. The heaters shall be installed in an area approximately 1320 mm (52 inches) wide by 760 mm (30 inches) high. The supply unit will require a 32 kW heating coil, each exhaust unit will require 10 kW heating coil. The heating coils for both the supply and exhaust units shall be a fin-tubular construction, non-sparking design, with proportional solid state controllers that maintain a constant temperature or temperature rise with varying airflows. The heating coils will be installed in a ventilation system which could be exposed to hydrogen vapor. The surface temperature of the heating coils shall not exceed 160 °C (320 °F). The heating element to flange penetrations will be sealed, meeting the pressure decay test requirements of ASME N 510. The heating coil will meet the construction requirements of ASME N 509. The SCR controller with a fused disconnect switch shall be an outdoor type in a NEMA 4 enclosure. The heat transfer fluid for the heating coils shall be propylene glycol.

11. Supply unit containment damper: Flanders containment damper model ZD-4 to be installed inside a flanders 1 x 2 filter housing, 1300 mm by 760 mm (51.25 inches x 30 inches). The damper shall meet the requirements EDRA 76-21 and ASME N509.

12. Prefilters: Farr Riga-Flo /PH filter 45% efficient per ASHRAE 52-76 , size 610 mm by 610 mm by 305 mm (24 inches x 24 inches x 12 inches) rated at 470 L/s (1000 cfm) with an initial pressure loss of 27 Pa (0.11-inch wg) (2 required).

13. Duct flexible connections shall be Proco Products, Inc. Arch Type, Style 530/NN ducting expansion joint. The expansion joint shall be 150 mm (6 inches) long and 6.4 mm (1/4-inch) thick and fabricated from ethylene propylene (EPDM) and shall be resistant to radiation. See drawing for sizes.

14. HEPA filter differential pressure gauges shall be Dwyer Magnehelic Series 2000. Model 2008 range from 0 Pa to 2000 Pa (0 to 8-inch wg). Prefilter differential pressure gauges shall be model 2002 range 0 Pa to 500 Pa (0 to 2-inch wg). All differential gauges dials shall be

120 mm (4-3/4 inch) O.D. The dials will be white, with black figures, and black graduations, the magnehelics shall have zero point adjustment.

15. Diffuser: Titus, see Drawing for sizes.

16. Exhaust Grilles: Titus, see Drawing for sizes.

C. ICE Building

1. Heat pumps for ICE Building: Bard, Wall mounted Hi-Boy heat pump, model WH602-C rated at 16.5 kW (56,500 btuh) cooling, 17 kW (58,000 btuh) heating, 180 L/s (1650 cfm) at 125 Pa (0.5-inch wg) external static pressure. The Hi-Boy heat pump shall be mounted externally on the outside wall of the office trailer. Furnish with rain hood, economizer, mounting brackets, and a 10 kW supplemental electric resistance heater. Pre-filters for heat pumps shall be FARR 30/30 24 X 24 X 2, Class I 30 Efficient in accordance with ASHRAE 52-76 rated airflow 470 L/s (1000 cfm) at initial resistance of 20 Pa (.08-inch wg.) (2 Heat Pumps required).

2. Automatic temperature controls for ICE building: Automatic control setback and shutdown thermostat with manual override feature provided. Each heat pump shall be provided with its own control module.

DIVISION 16 - ELECTRICAL

Section 16300 Medium Voltage Distribution

1. Conduits

a. Electrical metallic tubing (EMT): Comply with ANSI C80.3 and FS WW-C-563.

b. Rigid galvanized steel conduit (RGS): ANSI C80.1 and FS WW-C-581.

c. Liquid-tight flexible metal conduit: NEC Article 351.

d. PVC coated rigid galvanized steel conduit: NEMA RN-1, (PVC minimum coating of 750 μm [30 mils]).

e. PVC conduit Schedule 40: NEMA TC 2

2. Conductors: Copper, 600 V, 75 °C. insulation. Type XHHW for No.4 AWG and larger conductors. Type THWN/THHN for sizes smaller than No.4 AWG.

3. Junction and pull boxes: Sized in accordance with NEC Article 370.

4. Manhole/Handhole: Utility Vault Company, sized as required for electrical service.

5. Power service meter and enclosure: As required by the on-site electrical utilities contractor.

6. Equipment enclosures

   a. ICS Type 3R or 4 (outside installation exposed to the weather)

   b. ICS Type 1 (inside building)

7. Transformers: NEMA ST-20.

   a. Ventilated, dry-type for 3-phase, 60 Hz, 480-208Y/120 V.

   b. Average temperature rise, with 40 °C maximum ambient temperature shall not exceed 150 °C with a 220 °C insulation system.

   c. (Two) - 2% FCAN and (four) - 2.5% FCBN taps.

   8. Panelboards: Comply with FS W-P-115, Type 1, Class 1.

9. Motor control centers

   a. Feeder breakers: Thermal-magnetic molded case circuit breakers

   b. Motor controllers: Circuit breaker or motor circuit protector. Push buttons, H-O-A selector switches, pilot lights, reset buttons, extra convertible normally open or normally closed contacts as required for the control system.

10. Contactors: Contactors are to be furnished with the supply and exhaust duct heaters and site lighting.

11. Variable speed controller: Adjustable frequency drive suitable for the mixer pumps and the transfer pumps.

12. UPS: kVA rating as required for instrumentation equipment requiring uninterrupted power supply, 3-phase, 4-wire, 480 V ac, 60 Hz $\pm$ 0.1 Hz

13. UPS output panelboard: 3-phase, 4-wire, 120/208 V, MCB, 24 ckt panelboard.

14. Backup diesel-electric generator: 100 kVA, 3-phase, 3-wire, 480 V ac diesel-generator.

15. Automatic transfer switch: 3-pole, 3-wire, 480 V, NEMA 1 enclosure.

16. Outside lighting

    a. Light pole: 7.6-meter (25-foot) round galvanized pole.

    b. Lighting fixture: 180 W low pressure sodium lamps at 480 V ac.

    c. Lighting fixture support: lighting mounting bracket as manufactured for the lighting fixture.

    d. Photoelectric cell: Diecast aluminum weatherproof housing hermetically sealed light sensitive element, and adjustable light level slide with turn-on range of 22 lux (2 footcandles).

17. Safety switches: Nonfusible heavy duty type HD, horsepower rated for 600 V ac.

18. Lighting fixtures

    a. Lighting fixtures: 2-34 W, T-8 lamp x 1220 mm (4 foot), fluorescent fixture, high-impact break-resistant lens, white acrylic finish on an aluminum housing, 120 V ac high efficiency electronic ballast, pendant mounting. Fixtures designated for emergency service will be provided with emergency ballast that have a battery backup power source with automatic recharge capability.

b. Exit lights: Self-illuminating units with green letters on white opaque background, surface wall mounting.

c. Exterior lights: Aluminum housing, U.V. stabilized clear prismatic lens, 90 W, low pressure sodium lamp, integral photocell, 120 V ac, ballast suitable for low ambient temperature operation.

d. Emergency lighting units: Two sealed beam lamps, maintenance-free lead calcium batteries, 1-1/2 hours, automatic recharging, pilot light, push-to-test button surface wall.

APPENDIX E

AEA TECHNOLOGY REPORT - CONCEPTUAL DESIGNS

(Provided by AEA Technology)

Final Version

CONCEPTUAL DESIGNS

FOR DCRT TYPE AND CRITICALLY SAFE HARP TANKS FOR HANFORD K-BASIN SLUDGE

June 1997

PROPRIETARY DATA

Any information contained within a deliverable required under this Contract considered proprietary by Contractor should be clearly and specifically identified by page number, paragraph and line, and the cover sheet of the deliverable marked with the following notice:

"NOTICE

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Customer reference	
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Contents

1 Introduction

This report is prepared as a deliverable against an order received from Mr D.J.La Plante of Fluor Daniel Northwest Inc. by AEA Technology plc, via AEA Technology Engineering Services Inc, contract number FDN-S0010 and reference FDNW-97-CA-0098.

The objective of this report is to present the conceptual designs of storage tanks for the K Basin project that will include Power Fluidic Elements as the key components of the design. A further document will follow and present a budget estimate +/- 30% for detailed design and manufacture of the tanks and the fluidic elements. The estimate will include system and simplified Life Time operating costs.

2 Scope of Supply and Exclusions

AEA Technology has prepared a conceptual design study, drawing on information from a meeting at Hanford (20 May 1997) and from the information supplied in document reference FDNW-97-CA-0098.

Based upon Tank vault designs supplied by Fluor Daniel Northwest Inc. (FDNW), and on information received at the prestudy meeting regarding the nature of the two feed streams, AEA Technology have carried out preconceptual designs for

2.1 SCOPE OF SUPPLY

1. Standard Tank - including in-tank fluidic pulse jet agitation, sampling and waste retrieval. Designs give indications of fluidic element support systems

2. Safe by shape tank - showing tank configurations, and systems for venting, agitation and waste retrieval.

3. Review Fluor Daniel Design of critically safe tank and include fluidic equipment where possible.

2.2 EXCLUSIONS

FDNW are informed that the following are excluded from the cost estimate:

1. Installation of the tanks, fluidic pumps, agitators and other equipment.

2. In tank cooling system for the sludge.

It should be noted that FDNW has stated that the heat generation in the stored sludge can be removed by the FDNW designed vault ventilation system.

3 POWER FLUIDIC TECHNOLOGY

Power Fluidics is the generic name for a range of maintenance free nuclear equipment. The range comprises pumps, samplers, mixers, valves and divertors all built around common principle of using one fluid, usually air, to move other fluids - radioactive liquids and sludges - in nuclear applications. The devices have no moving parts within the radioactive environment and, hence, require no maintenance for contaminated equipment. Plant operations achieve significant savings by using Power Fluidic devices in place of their mechanical equivalents by:

- Eliminating replacement costs of worn out components.
- Eliminating much routine maintenance and the associated radiation exposure.
- Reducing secondary waste due to worn out components and maintenance work.
- Reducing the health physics and safety paperwork associated with the maintenance.

- Increased plant productivity due to reduced maintenance schedules.
- Significant reduction in plant lifetime costs
- A remote system of equipment operation that will require minimum process operator interaction. Stopping and starting the equipment is done by pressing one button.
- The system can remain dormant in the tank for long periods of time and then be restarted with minimum amount of effort.
- The fluidic system is extremely flexible in that the mode of operation can be altered to suit the conditions. For example if it is found that the sludge only needs to be mixed once an hour then the fluidic system can accommodate this change by altering the parameters in the control system.
- The fluidic system will not cause excessive shear damage to the particulate breaking it into smaller particulate that will be difficult to settle and will also adhere to the tank walls more easily.
- The fluidic transfer pumps are very accurate in how much liquid they deliver. By counting the cycles of the pump the operator will be able to assess how much liquid has been transferred from the tank.

4 DCRT TYPE TANKS

DCRT stainless steel tanks with a total volume of 50,000 US gallons will be used where there is no possibility of a criticality occurring because the weight % of the fissile isotope is too low. The product to be stored in the tanks will be a ferric hydroxide floc produced by a separate process upstream of the storage tanks. This will result in a ferric floc with a particle size distribution in the range 5-20 μm. AEA Technology has extensive knowledge in the field of designing plants for ferric hydroxide floc. Design guides have been prepared by AEA Technology detailing the problems that can arise if the system is not properly designed and tested. Some of this knowledge has gone into the selection and design of the equipment but will be more relevant in the more detailed design that may follow this study.

Various permutations of tank are possible in the proposed vault, (50' x 70' x 10' 10") and some of these options are presented in drawings ,

- 0AE 771527 (2 x 25,000 gallon vertical),

- 0AE571529 (2x 25,000 gallon horizontal).

Fluidics will be installed in the tank to perform the following functions,

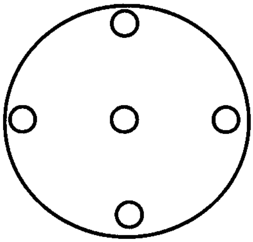
1. Mix Tank Contents and keep them mixed.
2. Transfer the contents of the tank at the end of their life.
3. Emergency emptying pumps in case of loss of integrity of the containment.
4. Sample the contents of the tank.

4.1 PULSE TUBE MIXING OF DCRT TANKS

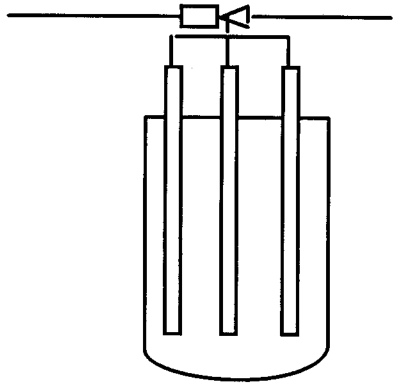
The operation of the pulse tube system is described in section 6.3. The system operates by drawing liquid from the tank from the tank into tubes and then dropping it under its own weight or a slight positive pressure, a few PSI, back into the tank. The mixing is not instantaneous and in the case of thick sludges take several hours to achieve. Once mixed the frequency of the systems operation can be reduced to keep the particulate moving.

In the case of the floc particles it is very important that the mixing is done gently to prevent excessive shear damage resulting in excessive numbers of fine particulate in the tank. AEA Technology's experience in this area has shown that particulate are more prone to adhere to the walls of the vessel and form layers. Also excessive agitation will cause splashing of the floc that results in floc depositing on the walls, drying falling back into the tank and agglomerating into asolid 'chunks' on the base of the tank. The 'chunks' will not redisolve in the floc and will only grow bigger with time.

The tank configuration selected will dictate the size and number of pulse tubes to be deployed. Generally as the density of the sludge increases the number of tubes required to maintain the suspension increases. It is standard practice where a sludge or floc is rapid settling to use up to 5 pulse tubes fed from a common suction/drive ejector. Four of the pulse tubes would be located around the circumference of the tank with one tube centrally mounted.(shown below)



Plan View



Elevation

4.1.1 SUPPORT SYSTEM REQUIREMENTS FOR PULSE TUBES

The pulse tube agitator will require the following services,

110 volt 60 hertz supply for the controller.
The controller will supply one 24 vdc, 500mA supply to the solenoid valve.

The controller will be sized to fit a 3U 19" * 350 mm Eurocard frame rack

Rack enclosure rated at IP20

Air requirement is estimated at 50-60 SCFM.

Wash water supply to flush tube internals.

4.2 TRANSFER PUMP FOR DCRT TYPE TANK

A full description of the pump and the control mechanism behind the pump is found in sections 6.

The Reverse Flow Divertor pumps, RFD's, installed in the bottom of the tanks will have two functions. The first pump is to transfer sludge out of the tank at some future date at a rate of approximately 6 $m^3\ h^{-1}$. The second pump will be designed to transfer sludge out of the tank at a higher rate in case of a tank emergency.

Both pumps can be used for additional tank agitation if it is found to be required. Alternatively the pumps can be left dormant in the base of the tank and turned on for a few cycles every month to check operation.

4.2.1 SUPPORT SYSTEMS REQUIRED FOR PUMPS IN DCRT TANKS

Both of the RFD pumps will require the following services,

110 volt 60 hertz supply for the pump controllers .
The controller will supply one 24 vdc, 500mA supply to the solenoid valve.

Pressure Transducer inputs 2 off 4-20mA inputs, excited at +24vdc by controller, normal transducer range of 10 BarA

Shielded cable runs between the controller and the pressure transducers and solenoid valves.

The controllers will be sized to fit a 3U 19'' * 350 mm Eurocard frame rack

Rack enclosure rated at IP20
Air requirement is estimated at an average of 40 SCFM for the large pump and 20 SCFM for the smaller pump. The peak flows are estimated at 80 SCFM for the large pump and 50 SCFM for the smaller pump. The peak flows will occur for a period less than ten seconds. The estimates are based on an over pessimistic estimate of the ferric floc characteristics and the final numbers should be less than those quoted above. A discussion of the air usage is presented in section 6.4.

Wash water supply to flush pump internals.

4.3 SAMPLER PUMP FOR DCRT TANK.

The operation of the sampler pump is described in section 6.2 of this report. The sampler will be used to draw samples on a periodic basis from the tank into a fully shielded sample station located outside of the concrete containment. The sampler is similar in design to those installed on the in-tank precipitation process at Westinghouse Savannah River.

Like the fluidic transfer pump the sampler can be left dormant for long periods of time with the minimum amount of maintenance. It is recommended that the pump is turned over a few cycles once a month to stop sludge settling in the lines.

4.3.1 SUPPORT SYSTEMS REQUIRED FOR SAMPLER PUMP

The sampler pump will require the following services,

110 volt 60 hertz supply for the pump controllers .
The controller will supply one 24 vdc, 500mA supply to the solenoid valve.

Pressure Transducer inputs 2 off 4-20mA inputs, excited at +24vdc by controller, normal transducer range of 10 BarA

Shielded cable runs between the controller and the pressure transducers and solenoid valves.

The controllers will be sized to fit a 3U 19" * 350 mm Eurocard frame rack

Rack enclosure rated at IP20

Air requirement is estimated at an average of 6 SCFM for the sampler pump with a peak flow of 21 SCFM for a period of 20 seconds. The suction phase requirement is 2 SCFM for the 70 second refill.

Wash water supply to flush pump internals.

110volt 60 hertz supply to sampler station for light.

Wash water supply to the sampler station.

4.4 SUMMARY OF DCRT TANK REQUIREMENTS

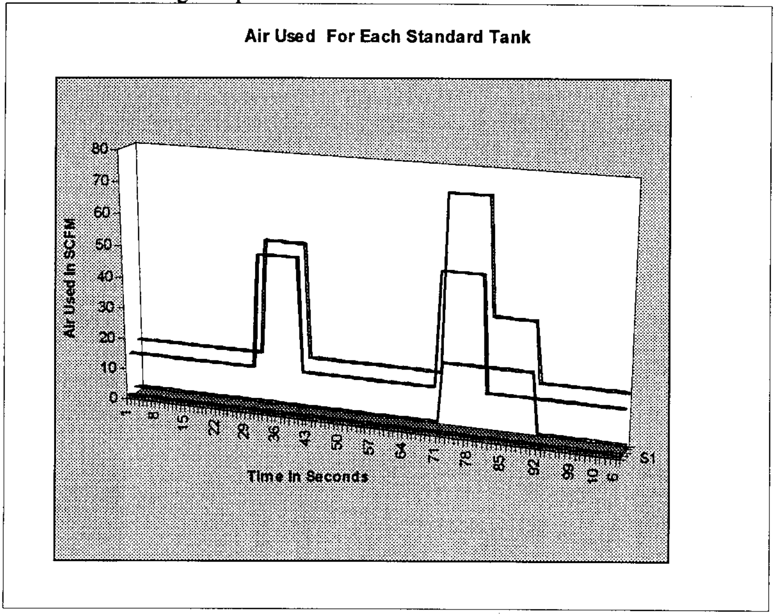
To summarize the requirements of the standard tanks. There will be,

- 4 off transfer pumps.
- 2 off sampler pumps.
- 2 off pulse tube mixing systems.

- The above systems will require 8 off 110 volt 60 Hz supplies to power the controllers.
- There will be a requirement for flush water to all 8 fluidic systems.
- There will be two sampling stations each requiring flush water and 110 volt 60 Hz supply for light
- Two instrument racks to hold the systems for the pump controller.

The estimated air requirement per tank is shown graphicallybelow. This has been based on the requirement for the transfer pumps to run at the same time as the pulse tubes in certain situations. Therefore for both tanks it is estimated at peak operation the conpressor will have to supply 140 SCFM for a period of twenty seconds at a pressure of 3.5 atmospheres. The rest of the time the supply requirement for the system will be 50 SCFM while the pulse tubes are in operation. The difference in operating requirements may be overcome by installing an air accumulator in the delivery line.

It would be expected that once the tanks are mixed the frequency of the pulse tube operation could be turned down to reduce the air consumption. This could be monitored by taking density measurements through the pneumacators



5 SAFE BY SHAPE TANKS

The safe by shape or HARP tanks (so called because of their shape) have been designed to store a maximum of 70 m^3 of 45 weight % solids settled sludge. The sludge will be transferred to the HARP tanks in 6.0m^3 batches using a road tanker of Hanford design. Each batch will contain 1.8m^3 of settled sludge and therefore 4.2m^3 of pond water. This pond water will need to be removed.

AEA Technology has extensive experience in conducting criticality calculations. From analysising the fuel enrichment is was estimated that the minimum sphere for fabricating the tank would have a diameter of 30 inches. To remain well inside the safety requirements and reduce the costs of fabricating the tanks AEA selected the next size of standard pipe down from that indicated by the criticality calculations.

AEA Technology during the course of this design considered several different designs/layouts of HARP tank and Slab tanks to accommodate the sludge. If individual HARP or slab tanks are used the number required will be in excess of fifty units. This would result in each tank requiring a transfer pump and a mixer. This scheme was thought to be prohibitively expensive and so the following scheme was devised

The proposed scheme will use 8 HARP tanks with a capacity of approximately 9.5 m^3 to accommodate the $70m^3$ of settled sludge, drawing OAE 571526.

The tank vault design prepared by FDNW provides a floor area of 50' square by 17' 6" tall. The usable height defined by the Hanford vault design is defined as 10' 10".

5.1 FILLING AND DECANTING HARP TANKS.

The particle size distribution 5 to 20 microns of the sludge is such that trying to separate the sludge from the water using a hydrocyclone will not work. The next easiest procedure is therefore to use gravity settling of the sludge to separate the solid and liquid phases.

- Ensure that an individual tank cannot be overfilled.
- Allow the pond water to separate from the sludge.

The tanks will be installed at the same height. The feed lines from the transporter to the Harp tanks will all end at some predetermined point part way down the height of the tank. Sludge will gently be transferred into the first tank. The sludge will gravity settle to form a clear liquid, a intermediate phase and an settled sludge.

The next batch of sludge that is gently transferred into the tank will displace the clear settled liquid over to the next tank. Also installed near the top of every tank will be two pneumacators or bubblers, set a few inches apart.

It is recommended that pneumacators or bubblers are used to measure the level of the liquids in all designs of tank. The pneumacator is a length of steel pipe which is installed in the tank and through which air is passed. Depending on the submergence of the end of the tube dictates the pressure required to force the air though the tube and hence a depth measurement can easily be taken.

It is also possible that be installing sets of pneumacators in pairs at varying heights in the tank that the density of the tank at that particular point can be established. Therefore periodic checks can be made on the effectiveness of the tank mixing and the mixing system adjusted accordingly. This procedure can be used for any of the tanks described in the above sections.

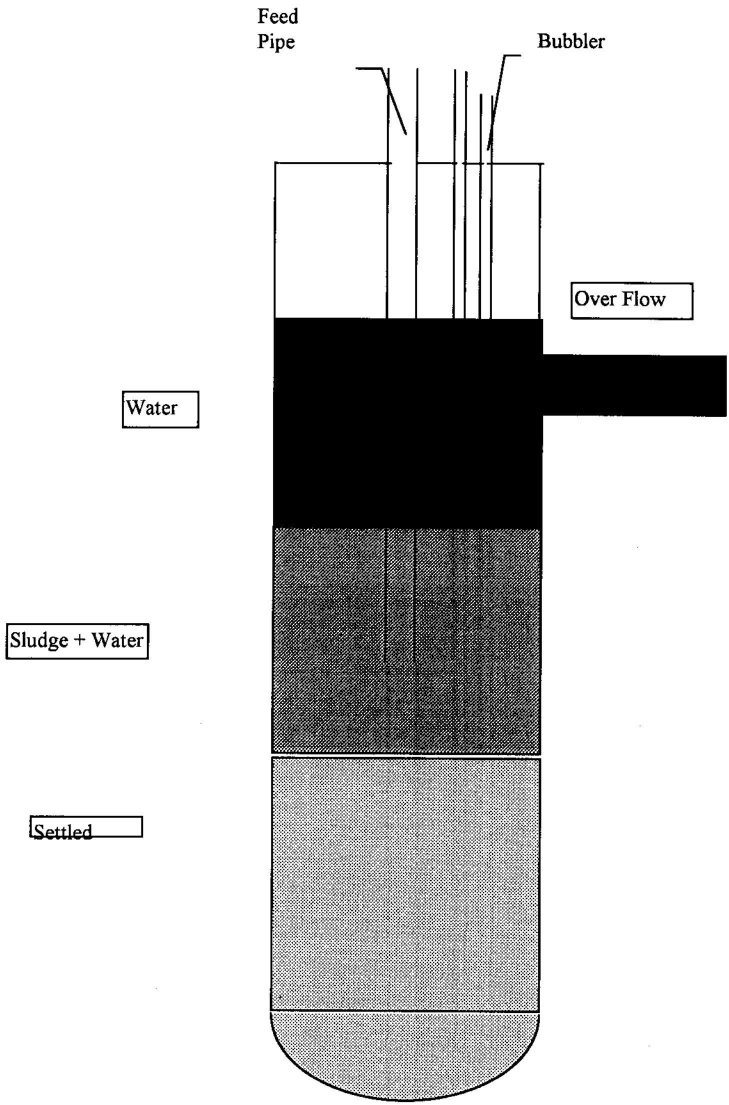
The transfers continue into the first tank until the density is showing that the tank is full of sludge. The Fluidic pump is used to gently mix the tank. The density measurement is again taken to determine the settled sludge is at the required density. Once the instrument is showing that the tank is full of settled sludge the transfer of waste from the transporter into the tank is switched to the next tank in the sequence.

It should also be possible to design the pneumacator tubing to be used to remove excess pond water from the top of each of the tanks during the filling operation. It is proposed that a vac pump is connected to a vessel which in turn is connected up to the pneumacator tubing. The excess pond water is then simply sucked off the top of the tanks.

Installing a fluidic transfer pump into the base of each tank will allow the contents of the tank to be sampled during the plant life, keep the tank gently agitated to stop the sludge sticking together and allow the sludge to ultimately be retrieved from the tanks.

During the decanting process samples can be taken from the tank to confirm the pneumacator readings.

It is feasible that adopting this concept of filling and decanting the excess water will reduce the number of transfer feed lines that are required for the filling of the tanks.


Feed
Pipe
Bubbler
Over Flow
Water
Sludge + Water
Settled

5.2 MIXING/SAMPLING/RETREVIAL PUMP FOR HARP TANK

Each of the HARP tanks is inclined to the horizontal to aid drainage towards the RFD pump, drawing 1AE 571530. The pump is used to both recirculate material within the tank, provide samples of the tank contents and empty the tank after 30 years storage. Unlike the standard tanks it is proposed to use the same RFD pump to perform both the transfer duties and the sampling duty.

The Harp tanks are manifolded to provide a common filling/liquor withdrawal point.(drawing 1AE 571526) The discharge from the RFD pump will be connected to the manifold to aid with mixing and to minimize build up of solids.

To fill the tanks, homogenized sludge from the road tanker is fed into the tanks via the common feed line. As the first two tanks are filled, the liquor sludge mixture overflows via the manifold into the adjacent vessels. Eventually the whole of the capacity will be used. This will be determined by level measurement in the limb containing the vessel filling point. The whole contents of the tanks are then allowed to settle, before water is removed from the top of the settled sludge down to a predetermined level. The tanks can then be refilled using the contents of other road tanker. Once this system is refilled, recirculation of the tank contents using the RFD pump will be performed to ensure it is uniformly mixed . This process is repeated until the $70m^3$ capacity is exhausted.

To keep the tanks mixed and reduce the requirements on the air supply it is proposed that the RFD pumps operate sequentially. The most air is used during the drive phase of the pump. Therefore the first pump will discharge, at the end of the discharge the second pump will discharge when that one is finished the third will drive and so on. There may also be a possibility to remove the requirement for a suction phase on the pump since the charge vessels will naturally fill under gravity. This will dramatically reduce the air requirement by 70 SCFM.

The sludge is evolving gas at a very high rate . It is therefore important that the sludge in the tanks is kept agitated at all times and no stagnant areas are allowed to form in the tank. If any trials are conducted on this system at some future date, AEA Technology recommends that the simulant used be a filter precoat medium known as Dicalite that has a tendency to form a solid mass in a very short time if no agitation is present. The dicalite should also match the particle size of the sludge in K Basin.

It is recommended that an air gas mixer is installed in the vent system from the tank to remove the problem of hydrogen explosion from these tanks. Alternatively the off gas from the pumps could be fed back through the tank vent space to reduce this hazard.

Redundancy in the form of an extra RFD pump will be built into each tank as emergency back up against serious problems with the regular unit.(Something that has yet to be observed despite in excess of 300 fluidic pumps operating world-wide.) The UK nuclear industry has installed the pumps as emergency back up to conventional pumps for highly active liquor storage tanks.

5.3 SUPPORT SYSTEMS REQUIRED FOR HARP TANK PUMPS

The Harp Tanks will be mixed, emptied and sampled by the eight RFD pumps. Each of the eight pumps will require the following services,

110 volt 60 hertz supply for the pump controllers .
The controller will supply one 24 vdc, 500mA supply to the solenoid valve.

Pressure Transducer inputs 2 off 4-20mA inputs, excited at +24vdc by controller, normal transducer range of 10 BarA

Shielded cable runs between the controller and the pressure transducers and solenoid valves.

The controllers will be sized to fit a 3U 19" * 350 mm Eurocard frame rack

Rack enclosure rated at IP20

Wash water supply to flush pump internals.

110volt 60 hertz supply to sampler station for light.

Wash water supply to the sampler station.

To reduce cost it may be possible to design a common shielded sample station to allow the sampling points to be brought together at one point.

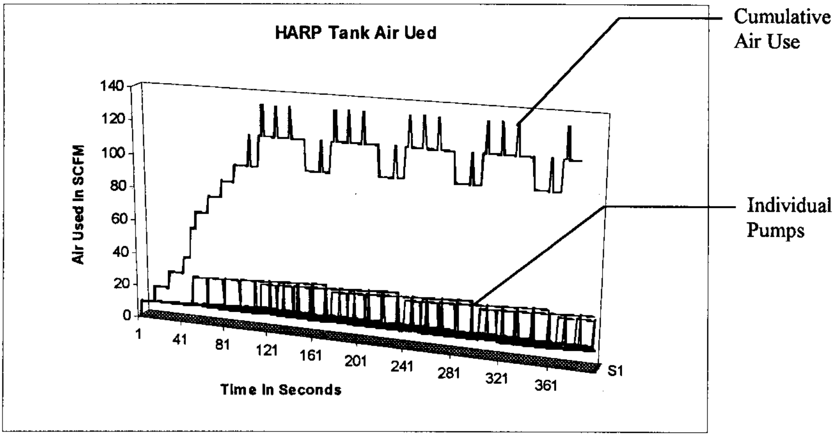
The air requirements for the system are,

The pumps will be sized to turn over the contents of the tanks at least twice an hour so it has been estimated that the flowrate will average 17 cubic meters per hour. Since there is no delivery pipework to overcome it has been estimated that the Air requirement will be,

Tank Mixing, average 10 SCFM with a peak of 28 SCFM for approximately 13 seconds.
Tank Transfer, average of 40 SCFM with a peek flow 100 SCFM for 10 seconds.

The estimated air requirement for the system is shown graphically below. It can be seen that with all the pumps running to keep the tank mixed there will be a requirement for an air supply in the range of 100 to 130 SCFM. It is recommended that an air accumulator be installed in the line to smooth out the flow.

It should be noted that if the pumps are operated sequentially so that only one pump is discharging at a time, the charge vessels of the other pumps will fill naturally under gravity reducing the air requirement to 0 to 28 SCFM for mixing.



5.4 ANNULUS TANK MIXING AND SAMPLING

FDNW provided AEA Technology with a conceptual layout of doughnut shaped critically safe vessels and as part of the work package AEA Technology were asked to look at installing fluidic mixer, transfer pumps and samplers into such a system.

AEA Technology recommends that the tanks are all linked together by overflow pipes so that during filling one tank can overflow into the next to ensure that no individual tank can be overfilled.

Due to the properties of the sludge mentioned above it is important that each of the tanks has an agitation system, due to the space limitations in the annulus tanks it was not possible to come up with a design of pulse agitation system that would ensure that the tanks were mixed. It was therefore decided that the best way of mixing the tanks would be to install a combined sampler and transfer pump into the base of each tank as shown below in the sketch.

The cost of such a system would be very prohibitive due in no small part to the requirement of having one fluidic pump per tank

The operational requirements for each of the doughnut tank pumps have been estimated as,

Each of the pumps will require the following services,
110 volt 60 hertz supply for the pump controllers .
The controller will supply one 24 vdc, 500mA supply to the solenoid valves.

Pressure Transducer inputs 2 off 4-20mA inputs, excited at +24vdc by controller, normal transducer range of 10 BarA

Shielded cable runs between the controller and the pressure transducers and solenoid valves.

The controllers will be sized to fit a 3U 19" * 350 mm Eurocard frame rack

Rack enclosure rated at IP20

The pumps will be sized to turn over the contents of the tanks at least twice an hour so it has been estimated that the flowrate will average 17 cubic meters per hour. Since there is no delivery pipework to overcome it has been estimated that the Air requirement will be,

Tank Mixing, average 6 SCFM with a peak of 20 SCFM for approximately 13 seconds.

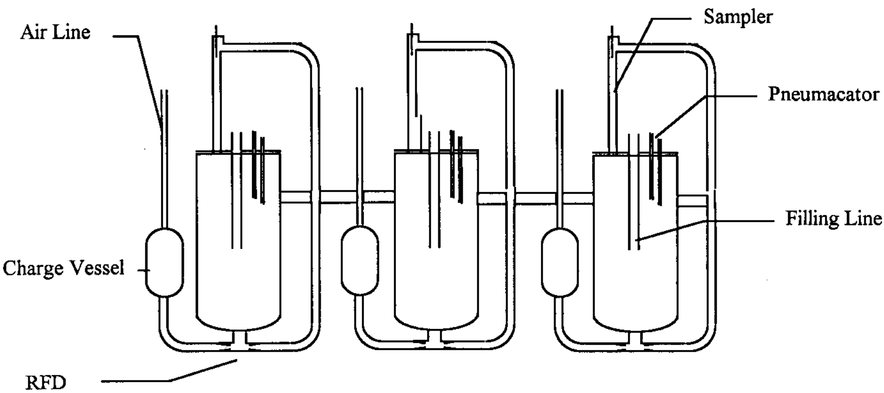
Tank Transfer, average of 40 SCFM with a peek flow 110 SCFM for 15 seconds. It should be noted that when sizing the air requirement only one of the tanks will be emptying while the other tanks are mixing.

Wash water supply to flush pump internals.

110volt 60 hertz supply to sampler station for light.

Wash water supply to the sampler station.

To reduce cost it may be possible to design a common shielded sample station to allow the sampling points to be brought together at one point.



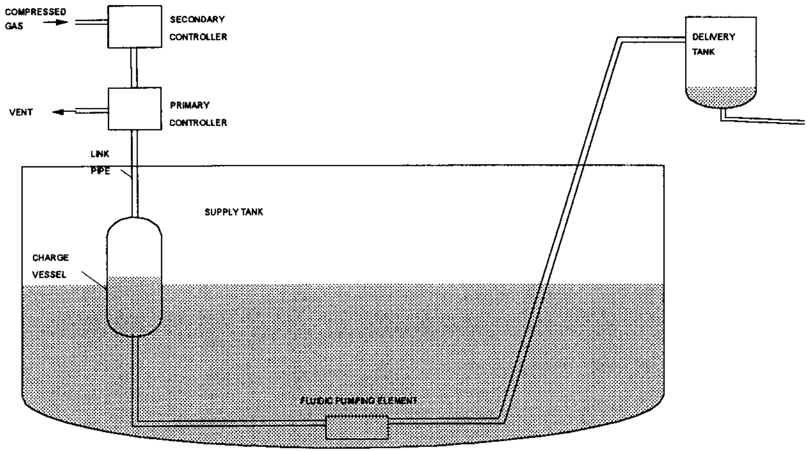
Schematic Showing Concept Of Fluidic System Installed In Annulus Tanks

6 Power Fluidic Systems

6.1 FLUIDIC PUMP OPERATION

6.1.1 General Description

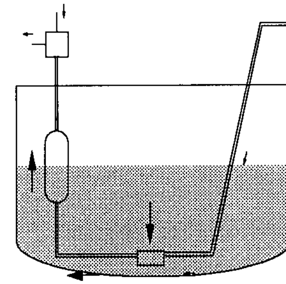
The main elements of a single acting fluidic pump are shown below and consist of:



- the **pumping element** - a passive fluidic device through which fluid enters the pump from the supply tank. The details of this element are described later
- a **charge vessel**
- a **primary controller** for providing the gas pressure and flow conditions in the charge vessel and acting as a barrier between the clean incoming compressed gas and the potentially hazardous liquid
- a **secondary controller** which handles only clean gas and provides the gas flow to the primary controller as required

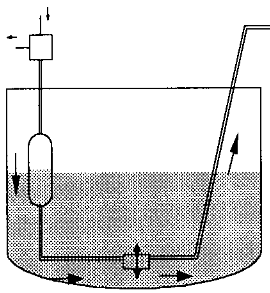
6.1.2 Cycle Operation

The pump typically operates in three phases :



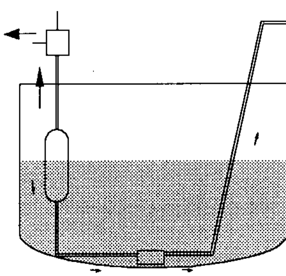
(a) REFILL

Refill Phase In this phase, liquid from the supply tank enters the charge vessel through the pumping element and the phase continues until the liquid level has reached the top of the charge vessel and enters the air link pipe. When required, a partial vacuum is applied to the charge vessel by the primary controller to augment the filling rate.



(b) DRIVE

Drive Phase In this phase, compressed gas is passed via the primary controller into the charge vessel which forces the liquid through the pumping element and along the delivery pipe into the delivery vessel. This continues until the air-liquid interface reaches the bottom of the charge vessel, at which time the compressed gas supply is terminated. The role of the pumping element in this phase is to entrain further fluid from the supply tank and into the delivery pipe or, at the very least, to minimize the amount of fluid flowing back into the supply tank.

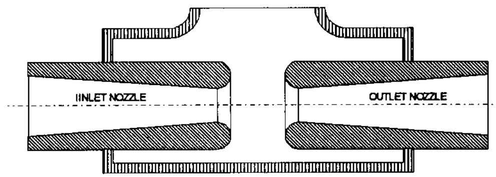


(c)VENT

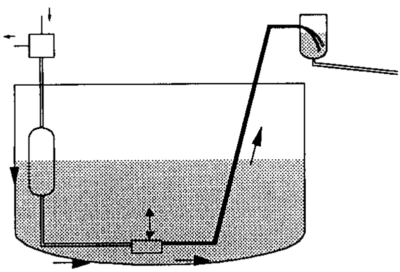
Vent Phase In this, the third and final phase, the compressed gas supply to the pump has ceased and the high pressure gas in the charge vessel is allowed to escape to vent through the primary controller. The liquid contained in the delivery pipe also tends to fall back into the charge vessel; the amount by which the pipe empties depends on the pump design, the imposed operating frequency, and the type of pump element used. When the pressure in the charge vessel has fallen close to atmospheric pressure, the refill phase recommences and the whole cycle is repeated.

6.1.3 Reverse Flow Divertor, RFD, Pumping Elements

The RFD (Reverse Flow Diverter) operates by the entrainment principle and consists of two opposed nozzles; a symmetrical design is shown in the figure.

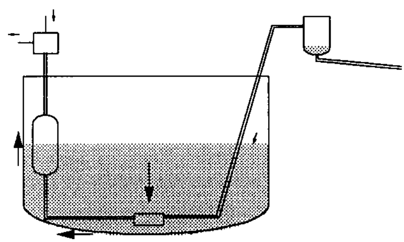


BASIC RFD DESIGN

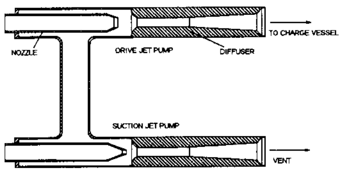


In operation as a pumping element, fluid enters the inlet nozzle during the drive phase, passes across the gap, entraining fluid from the supply tank, and the static pressure is then recovered along the outlet nozzle/diffuser section. Depending on the pressure in the delivery line, fluid from the supply tank is either entrained by the flow emerging from the nozzle or alternatively a small proportion of the nozzle flow is fed back into the tank; so called "negative entrainment".

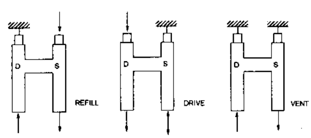
During the refill phase, liquid passes through the inlet nozzle (now acting as a diffuser) and into the charge vessel with only a relatively low resistance to flow produced by the well rounded entry to the diffuser.



6.1.4 Primary Controller



(a) JET PUMP PAIR



(b) OPERATING MODES

From the preceding paragraphs it can be seen that the requirements of the primary controller are to provide a positive gas flow and pressure to the charge vessel during the drive phase, to allow a vent path for this gas during vent, and then to provide a partial vacuum in the charge vessel during refill.

This is normally accomplished using a jet pump pair which is shown schematically in the figure together with the modes of operation for the three phases of the pump's cycle.

Other types of controller, incorporating combinations of jet pumps and vortex valves are also available for specific special duties.

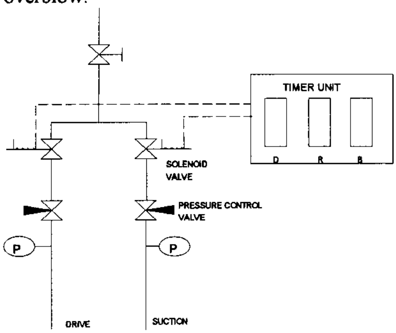
6.1.5 Secondary Controller

The requirements of the secondary controller are to provide compressed gas to the "drive" part of the primary controller during the drive phase, to switch off the gas supply during vent, and then to supply the "suction" part of the primary controller during refill. This task is often accomplished using conventional solenoid valves which only need to handle clean gas and are installed in an accessible position so that maintenance can be performed.

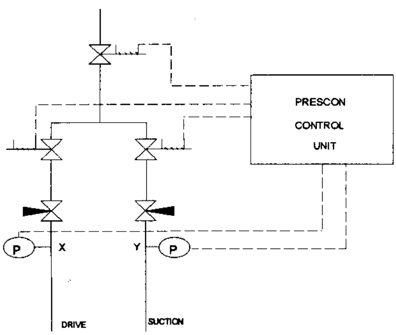
The other function of the secondary controller is to control the duration for which the gas is supplied to the primary controller, i.e. to set the phase times of the cycle. The method of achieving this is dependent on the type of pumping element used as outlined below.

6.1.6 Cycle Control and Stability

The **RFD pump system** is normally designed with the charge vessel volume several times greater than the volume of the delivery pipe. Consequently at the end of the refill phase, the delivery pipe has emptied (down to the level of the liquid in the supply tank) and the level of liquid in the charge vessel has risen in to the air link pipe to a level compatible with the amount of vacuum supplied by the primary controller. The system is then in hydrostatic equilibrium and the liquid flowrate is zero everywhere within the pump. This condition represents a datum from which each cycle of the pump commences and is necessary to avoid cycle instability and which could result in overblow.



(a) ELECTRONIC TIMER SYSTEM (OPEN LOOP)



(b) PRESCON SYSTEM (CLOSED LOOP)

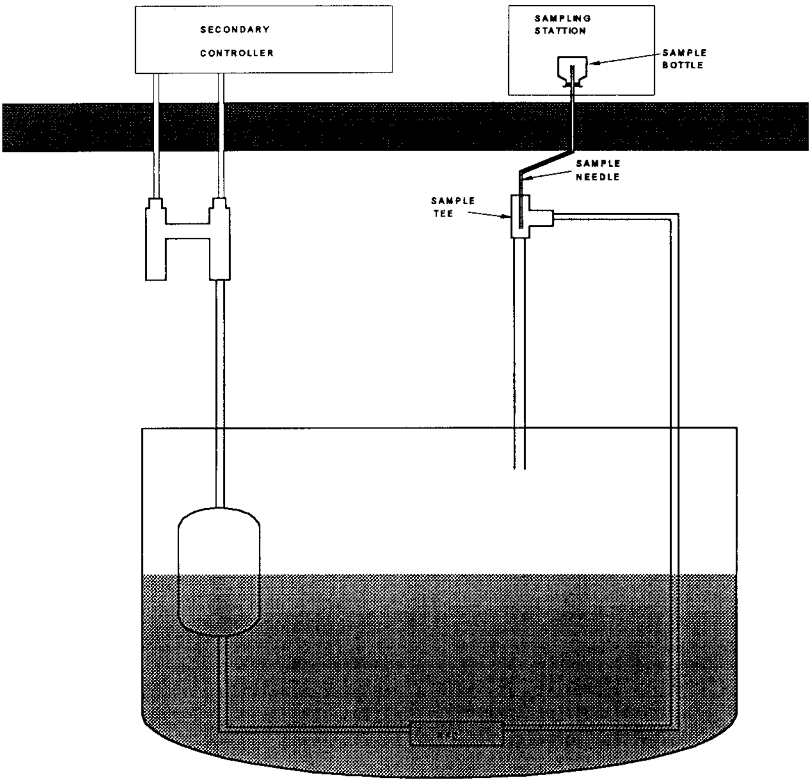
The phase sequencing of this type of pump can therefore be achieved in an open loop manner with electronic timers where the time of each phase of the pump is predetermined from experiment or theoretical predictions.

In a pumping system, irrespective of the type of pumping element employed, the time taken to refill the charge vessel increases as the level of liquid in the supply tank falls. The drawback to the use of electronic timers therefore is that in order to ensure reaching the datum position, the time for the refill phase must be set such that the charge vessel will fill even at the lowest supply tank level. This leads to very inefficient operation.

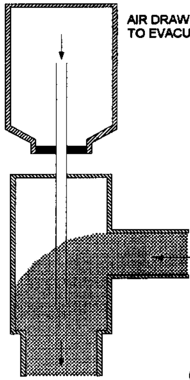
A solution to the problem is provided by the Prescon (PRESsure CONtrol) method which makes use of the observation that there is a characteristic pressure change as measured at the point X when the charge vessel becomes full. By detecting this pressure change, it is possible to start the drive phase immediately the charge vessel is full and so operate at optimum efficiency. This therefore provides a reliable, non-intrusive, closed-loop control method. In addition, the occurrence of overblow can be detected by analyzing the pressure measured at point Y.

6.2 SAMPLER SYSTEM OPERATION

A fluidic sampler comprises an RFD fluidic pump with a specially designed sampling tee installed in the discharge pipework which delivers a sample of the liquid through a sample needle to the sample bottle. The flow from a fluidic pump is intermittent, i.e. there is a delivery of liquid followed by a period where the pump is refilling. This intermittent flow is used to make the sampling system operate

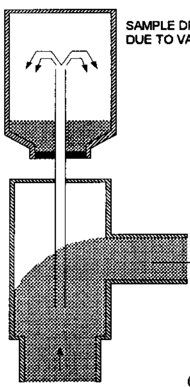


TYPICAL SAMPLER SCHEMATIC



(A) DRIVE PHASE

When the pump is delivering liquid along the delivery line the liquid will have some velocity. As the liquid passes the end of the sampling needle there is a venturi effect which draws air down the needle from a sample bottle on the other end of the needle (usually plastic with a rubber seal on the other end)



(B) REFILL PHASE

As the delivery pulse from the pump ends, the liquid velocity past the needle decreases and the partial vacuum in the bottle draws liquid back into the bottle

A sample is normally collected over a number of cycle sin this manner; the total amount of sample collected is governed by the length of the needle penetrating into the bottle.

Note the sample tee design ensures that, when no sample bottle is on the needle, no liquid passes up through the needle. If a sample pump is run without a bottle, for example to purge the sample lines, the liquid flow draws a small amount of air down through the needle into the tank. Without a bottle to hold suction, there is no driving force for liquid flow up through the needle.

6.3 DESCRIPTION OF SAMPLING STATION

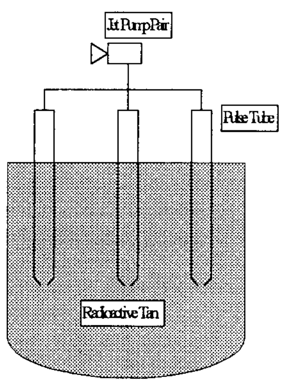
The sampler station is a self contained unit that is situated outside the primary containment. the sampler station is a fully shielded unit into which the sample from the tank can be delivered by a fluidic pump into a sample bottle as described above. A drawing of a typical sampler station has been supplied as one of the engineering drawings issued in conjunction with this report.

The sampler station is a fully remote system and through a series of levers and wheels it is possible to remotely place a sample bottle on the sample needle, collect a sample, retrieve the sample bottle and place it into the transport flask.

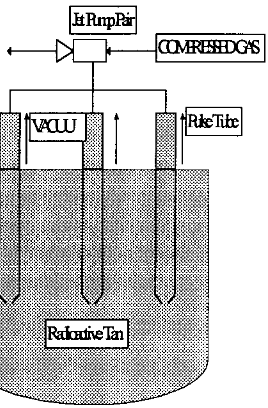
6.4 PULSE TUBE AGITATION SYSTEM.

The pulse tube agitation system is a fluidic mixing system installed to mix small particulate, generally 0 to 250 microns. The system works by installing a number of tubes around the circumference of the tank. One end of the tube is fashioned into a nozzle and the other end is connected to a jet pump. The system is designed to try and displace between 5 and 10 % of the active volume of the tank each cycle. Since the risers in the Hanford tanks are 4 inches the majority of the 10% of the displaced liquid will be outside of the tank above grade. This complicates tank top loading and shielding requirements.

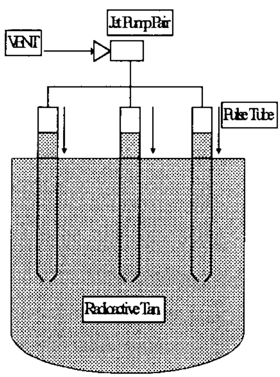
A complete discussion of the primary and secondary controller for the system is discussed in appendix A at the back of this paper. For simplicity the suck and drop system described below can be operated by simple timer relays set to give the required cycle time. The system operates as follows,



The system consists of a number of tubes that dip into the tank. The tubes are positioned around a two thirds diameter. For best results the tubes have nozzles attached at the end. The tubes are all connected back to a jet pump pair. For best results the base of the tank should be dished so particulate can not settle out in the corners. The system is normally installed during construction due to the difficulty of retrofitting the system. The system works on the principle that 5 to 10 % of the liquid volume needs to be displaced each cycle of the device to agitate the tank. Approximately three cycles are performed per minute. Normal mixing time is measured in hours.



Compressed air is turned on to the suction jet pump which applies a vacuum onto the pulse tubes, which sucks the liquid up into the pulse tubes.



After the system has reached equilibrium the compressed air to the jet pump is turned off .This allows the liquid to fall under its own weight back into the tank. Alternatively the tubes can be pressurized to a few PSI to force the liquid out at a quicker rate. The suck and drop system is inherently safe since there is no danger of forcing compressed gas through the system. The system has an inherent problem of depositing sludge into dead spots if the tubes are not properly spaced or operated at the right frequency.

6.5 PUMP PERFORMANCE

The following terminology is used in the description of fluidic pump performance:

Fluidic Pump Performance Terminology

Drive Time	= t_{drive}	= Time over which pressure is applied to the charge vessel
Vent Time	= t_{vent}	= Time over which charge vessel is allowed to depressurise
Suction Time	= $t_{suction}$	= Time over which suction is applied to refill the charge vessel

The Vent and Suction phases are often referred to as a single Refill Phase (see the description of pump operation in Section 4.1). However, when assessing air consumption of fluidic pumps it is important to use the two separate phases, primarily because no air is used during the Vent phase.

A single cycle of a fluidic pump comprises one drive phase, vent phase and refill phase, hence

Cycle Time = $t_{cycle} = t_{drive} + t_{vent} + t_{suction}$

The volume of liquid delivered from the discharge pipe in a single cycle is known as a dollop. The dollop will generally start to be delivered part way through the drive phase and will end part way through the vent phase.

Dollop Volume = V_{dollo} = Liquid delivered in a single cycle

Hence the average pumping rate from a fluidic pump is given by:

Average Pumping rate = $PR_{ave} = \frac{V_{dollop}}{t_{cycle}}$

The peak pumping rate is defined as the maximum flowrate along the discharge pipework and always occurs during the drive phase

Peak Pumping rate = PR_{peak} = Maximum flowrate along discharge pipework during the drive phase

The air used to operate the pump is supplied during the drive and suction phases:

Drive Pressure	=	P_{drive}	=	Pressure at which compressed air is supplied to the drive half of the jet pump during the drive phase
Suction Pressure	=	$P_{suction}$	=	Pressure at which compressed air is supplied to the suction half of the jet pump during the suction phase
Drive flowrate	=	Q_{drive}	=	Air flowrate supplied to the drive half of the jet pump during the drive phase
Suction flowrate	=	$Q_{suction}$	=	Air flowrate supplied to the suction half of the jet pump during the suction phase

The average air usage is therefore given by:

Average Air Usage = AU_{ave} = $\frac{Q_{drive} \times t_{drive} + Q_{suction} \times t_{suction}}{t_{cycle}}$

These air flowrates are always presented at Standard Temperature and Pressure.

A useful measure of the efficiency of a pump's operation is given by the Air Usage Ratio which is the ratio of the average air usage to the average pumping rate:

Air Usage Ratio = AUR = $\frac{Au_{ave}}{PR_{ave}}$

It should be noted that, the value of the AUR is specific to the overall pumping system, e.g. using an identical pump in a different application will generally produce a different value of AUR

7 Measurement of Tank Wall Erosion

AEA Technology has developed a device called Fleximat as part of its NDE capability. This system primarily used in the oil industry could be adapted for use in the nuclear industry to measure pipe or tank erosion in nuclear facilities.

FLEXIMAT comprises a 16 element array of composite polymer ultrasonic transducers mounted on a flexible printed circuit. The flexibility size of the transducer allows for permanent attachment to simple geometry's and areas which are awkward to inspect by conventional means, due to limited access or complexity.

The FLEXIMAT is primarily designed for the monitoring of through wall thickness reduction, local to the transducer in areas which have historically been difficult to inspect or areas prone to corrosion/erosion where permanent continuous wall thickness measurement is required. FLEXIMATs can also be utilized to monitor any through wall thickness conditions such as lamination/delimitation. The information obtained from the FLEXIMATs can be used to give accurate assessments of conditions for use in plant life management.

APPENDIX F

AEA TECHNOLOGY REPORT - COST INFORMATION

(Provided by AEA Technology)

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COST INFORMATION AND PLANT LIFETIME COSTS FOR FLUIDIC STORAGE TANKS IN SUPPORT OF THE K-BASIN PROJECT

PROJECT NO. 2865.06
UNDER CONTRACT FDN-S0010

Prepared for

FLUOR DANIEL NORTHWEST, INC.

JUNE 1997

Prepared by

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AEA

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1. INTRODUCTION

This paper reports the costs associated with supplying fluidic components for the two proposed designs of K-basin storage tanks. The paper also carries out a lifetime cost analysis of the proposed storage tanks using Power Fluidics Equipment versus 'conventional' equipment. The parameters defined for a more detailed life time cost analysis are also discussed.

2. COST OF DCRT TANKS.

2.1 BACKGROUND INFORMATION

The DCRT tanks will be used to store a Ferric Floc that is critically safe. AEA Technology has substantial experience of designing and operating radioactive waste treatment and storage systems for ferric flocs. This experience tells us that the following important parameters should be considered when designing floc handling systems:

1. Ferric floc is Non Newtonian in behavior, therefore to agitate the floc it is not acceptable to use a recirculating pump. Any agitator must sweep at least two thirds of the tank diameter to ensure mixing.

2. Ferric floc is very shear sensitive and breaks up easily in high shear fields. Therefore agitation must be gentle and prolonged to ensure effective mixing.

3. Ferric Floc is very 'sticky' by its nature and adheres to and builds up on walls and equipment quickly. There is also some evidence to suggest that the finely divided flocs may be more 'sticky' than larger floc particulate. This means that any failed equipment within the tank is likely to be more heavily contaminated, making replacement a more hazardous and costly exercise.

4. Ferric floc will naturally settle and decant itself. Left for long periods strata form within the floc where actinides can reside. For example, if one batch of floc is rich in plutonium then a stratum rich layer of plutonium floc will form.

5. If all the floc is homogeneous in nature the floc will still dewater itself if left unmixed. Over a period of time the layer at the base of the tank will become a solid cake making retrieval difficult.

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6. Splashing of the floc is to be avoided at all costs. Floc rapidly builds up on walls, dries very quickly and then falls off into the bulk liquid. Once in the bulk liquid the dry floc will not redisolve but will agglomerate into a solid mass.

2.2 FLUIDIC COMPONENTS THAT WILL BE SUPPLIED IN DCRT TANKS

Each of the DCRT tanks for storing the critically safe sludge will contain the following fluidic equipment:-

- A Transfer Pump for transferring 6 cubic meters of sludge in 2 hours. (ROM estimate \$450K +/- 30%) Does not include inactive trials for the system.
- An Emergency Emptying Pump/Back-up Pump. (ROM estimate \$450K +/- 30%) Does not include inactive trials for the pump.
- A Pulse Tube Mixer System for mixing the tank contents. (ROM estimate \$500K +/- 30%) To include trials at one half scale on suitable clay surrogate.
- Primary and Secondary Controllers for the Fluidic Systems (included in above ROM estimates).
- All solenoid valves, transducers, and regulating valve (included in above ROM estimates).
- A stand alone Fluidic Sampler for sampling the tank. (ROM estimate \$325K +/- 30%)
- A Sampler Station to collect samples (included in above ROM estimate).
- Costs include, Pressure vessel inspection, Project Management, Detailed Design, Works Testing, Delivery to site, 3 days per pump to commission.

The cost of supplying the mixing and pumping equipment for each tank is estimated at \$1.4M +/- 30% making a total of \$2.8M for the two tanks.

The cost of the fluidic sampler system for each tank is estimated at an additional \$325K +/-30% making a total of \$650K +/- 30% for both tanks.

These are budget prices which do not constitute an offer by AEA Technology to supply equipment or services.

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2.3 COST OF TWO DCRT STORAGE TANKS.

The cost of two DCRT storage tanks as described in the conceptual design document and the structural steel to support the equipment has been costed at a capital cost of $1,000,000 +/- 30%. An additional $ 360K will be required for design, engineering project management, inspection and scheme design. Costs for any support for installation or commissioning is excluded. This is a budget price and does not constitute an offer by AEA Technology to supply equipment or services.

3. Critically Safe Tanks

3.1 BACKGROUND INFORMATION

The sludge that will be stored in the critically safe tanks is known to have the following properties that are important to safe storage;

1. The sludge is still evolving gas at a high rate.
2. The sludge forms a solid mass if left unagitated for a period of time.
3. The solid sludge is difficult to break-up.
4. The fissile material content of the sludge is such that criticality calculations must be performed to demonstrate safe storage.

It is therefore important to keep the sludge agitated as much as possible.

3.2 FLUIDIC COMPONENTS THAT WILL BE SUPPLIED

Each of the 8 critically safe HARP tanks will each contain the following fluidic components,

- An RFD Fluidic Pump to be used for mixing, sampling and tank emptying. (ROM estimate $400K +/- 30%)
- An Emergency Emptying Pump. (ROM estimate $400K +/- 30%)
- Primary and Secondary controllers for the pumps (included in above ROM estimates).
- All solenoid valves, transducers and regulator valves necessary for pump operation (included in above ROM estimates).
- Costs include, Pressure vessel inspection, Project Management, Detailed Design, Works Testing, Delivery to site, 3 days per pump to commission.

The ROM estimate for supplying this equipment in each tank is $800K +/- 30%, making a total of $6.4M +/- 30%, for all eight tanks.

The price includes scale testing of the system at AEA's facility in Charlotte North Carolina in a glass or Plexiglas system.

As an additional option we can supply a sampling system comprising a sample tee and shielded sample station. The ROM estimate for this is $125K +/- 30% per tank, making a total of $1M +/- 30% for all eight tanks.

These are budget prices which do not constitute an offer by AEA Technology to supply equipment or services.

3.3 COST OF THE EIGHT HARP TANKS

The cost of eight HARP critically safe storage tanks as described in the conceptual design document and the structural steel to support the equipment has been costed at $1,370,000 +/- 30% for the capital cost. An additional $480K is required for design, engineering, project management, inspection. Support for installation or commissioning is excluded. This is a budget price and does not constitute an offer by AEA Technology to supply equipment or services.

4. LIFETIME COST ANALYSIS

AEA Technology has extensive experience in Plant Life Time Cost analysis in support of the build programs that have been conducted in Europe. The first step that is carried out is a simple life cost analysis as detailed below. If this does not yield a clear result or is ambiguous in any way then a more detailed costing is done as specified in this section. This has not been done for this application due to the clear differential in cost between the fluidic components and the conventional equipment when the simplified comparison was made. Conducting the detailed cost analysis will widen the differential between the two technologies. For information the following section has still been included.

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4.1 DETAILED LIFETIME COST ANALYSIS

The processing of liquid nuclear wastes typically requires the transfer of liquids from the storage container to the processing facility. In some applications, the transfer of radioactive liquids poses a number of problems associated with the radiological hazard arising in particular from the requirements for repair, maintenance and replacement of pump systems. The costs and radiological exposure to workers associated with the use of conventional mechanical pumps and agitators has driven the search for alternatives.

Nuclear materials reprocessing operations typically require transfer and mixing of waste materials, comprising liquids, soluble solids and sludge from interim storage tanks. This often requires that a pump be immersed in the tank contents. Traditionally, such transfer systems have used mechanical pumps. The mechanical pump has many moving parts and typically requires significant maintenance and replacement. For some applications, this can be as often as every three years, or even less. This can be extremely expensive, produces large amounts of secondary waste, and may involve substantial radiation exposure to workers.

The shortcomings associated with the mechanical given above can be overcome by using power fluidic pumps. This is a proven technology, having been in use in the UK for 15 years for nuclear waste and materials processing. Power fluidic pumps have no moving parts in contact with radioactive material that require maintenance, introduce no extra burden of waste, and have a lifetime far in excess of that of mechanical and steam jet systems. There are two basic types of fluidic pump of relevance to this work, the reverse flow divertor (RFD) pump which is adequate for most uses, and the diode pump, which is better for systems with longer delivery pipes between the stock or supply tank and the receiving vessel.

In contrast with conventional pumps, power fluidic pumps have:

- no moving parts in the tank to wear out or maintain;
- no seals or bearings to wear, leak or require replacement;
- no motors or electrical components in the tank to fail or maintain; and
- no crevices to trap contamination; fluidic pumps can be readily flushed and decontaminated.

These features provide a basic driving force for the wider introduction of fluidic pumps within nuclear materials processing facilities.

The primary drivers which have prompted the search for alternatives to conventional mechanical pump technology are as follows:

- Replacement, repair and maintenance may be expensive. In nuclear applications these costs are exacerbated by the need to manage the potential radiological exposure to maintenance staff. Management of this hazard adds to the complexity of the maintenance task and hence to its time and cost.

- Maintenance operations produce significant quantities of secondary wastes which, due to the radioactive contamination incurred in nuclear applications, are expensive to dispose and represent an adverse environmental impact.
- Even with safety procedures designed to minimize radiological exposure during maintenance and waste disposal operations, there is inevitable radiation exposure to workers.
- An additional cost to be borne by the operator is that of the down time of plant and equipment during maintenance operations. These may be particularly lengthy in nuclear facilities due to the additional complexity of maintenance tasks associated with radiological hazard management.

The above issues are indicative of the primary attributes of relevance to the study:

- financial cost;
- human health and safety risks;
- environmental impact;
- operational performance and system reliability.

In order to develop a comprehensive listing of specific attributes within these categories a systematic consideration of the nature and relevance of these primary attributes has been undertaken in respect of each phase of the life cycle. The elements of the pump component life cycle to be considered comprise the following stages:

- development;
- supply;
- installation;
- operation;
- removal;
- disposal.

For option comparison in some cases, it may be convenient to consider the phases of:

- initial deployment;
- repair and maintenance;
- operation;
- regulatory compliance;
- disposal.

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In this case, initial deployment will comprise development, and initial supply and installation costs and repair and maintenance will comprise removal of a failed pump, and supply and installation of a replacement.

The full list of relevant attributes developed on this basis is as follows.

1 Financial Costs
- 1.1 Initial investment costs
- 1.2 Repair and maintenance costs
- 1.3 Operating costs
- 1.4 Regulatory compliance costs
- 1.5 Disposal costs

2 Safety
- 2.1 Worker risk during installation, repair and maintenance
- 2.2 Worker risk during operation
- 2.3 Public risk during installation/operation
- 2.4 Worker risk during disposal
- 2.5 Public risk associated with disposal

3 Environment
- 3.1 Resource/materials use impacts associated with supply
- 3.2 Resource/materials use impacts associated with operation
- 3.3 Environmental discharges/releases during operation
- 3.4 Waste arisings on disposal

4 Performance
- 4.1 Operational performance, compatibility with operational requirements
- 4.2 Plant availability versus program requirements

4.1.1 ATTRIBUTE QUANTIFICATION AND RANKIN METHODOLOGY

The general approach to formal assessment of competing technologies in respect of the identified attributes adopted in this study is to define quantitative measures wherever possible. However, in some cases it is not practical to provide more than a qualitative statement on the nature and extent of the impact in respect of a given attribute on the basis of which an order of preference might be established. Semi-quantitative or qualitative approaches to ranking will therefore be required in respect of some assessment attributes. Key features of the ranking and quantification approach with respect to the different attribute types are as follows:-

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1 Financial costs

These are to be measured in US dollars in all cases. In line with normal financial accounting practice, future expenditures are discounted and expressed in terms of their Net Present Value according to:

$$NPV = C/(1+R)^T$$

where C is the cost incurred at the time T and R is the assumed discount rate. A discount rate of 5% has been employed in these assessments.

2 Human safety risks

Worker risks from radiological hazard is measured in terms of the dose in mSv, and from non-radiological hazard in terms of fatality (unless these can be readily dismissed as negligible by qualitative considerations). Public risks are measured in qualitative measure initially, in the following four categories: none; possible/minor; potentially significant; significant. Potentially significant and significant public risk are to be quantified as for worker risks, where a reasonable exposure scenario can be defined to provide a practicable basis for quantification.

For the purposes of comparing these measures with financial costs a conversion may be made on the assumption of an equivalence between absorbed dose and increased cancer risk and an equivalence between fatality and financial cost. Such a conversion is for broad guidance only and does not indicate an absolute equivalence. A dose conversion of 4×10^{-2} fatal cancers per Sv has been adopted[1] in the UK and a cost of $4 million per fatality has been employed in a recent US study[2] of the environmental costs of electricity, generally consistent with the value of £3.2 million ($5 million) proposed for the UK nuclear industry. On this basis, the monetary value of dose derived is $0.2 million/man Sv.

3 Environmental

Impacts are measured in terms of volume/weight/etc. used or discharged, according to circumstance. Operational power consumption represents a potentially significant contributor to environmental impacts, in respect of both resources consumed and discharges. The exact nature of the impacts will be dependent upon the power source employed. In this instance, resources consumed have been expressed in terms of the total energy requirement in kilo Watt hours (kWh), and will relate to natural resource consumption, according to the energy source employed. Typical values for discharges per unit of power conversion for fossil fuel generation have been employed and are as follows:

Carbon Dioxide (CO_2):	750-900 g per kWh
Sulphur Dioxide (SO_2):	1-15 g per kWh, median around 1.5 g per kWh
Nitrogen Oxides (NO_x)	0.5-2.5 g per kWh

4 Performance

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[1] Health & Safety Executive (1992) *The tolerability of risk from nuclear power,* HMSO, London

[2] Ottinger et al. (1990) *Environmental costs of electricity,* Oceana Publications, New York

Plant availability is measured in terms of impact of loss of availability in relation to the overall project schedule (i.e. as a proportion of operating lifetime) and, if practicable, in terms of knock-on costs of associated extension to plant operational lifetime.

Bearing in mind the lack of precision inherent in the assessment of a problem of this kind, as reflected in the above approach to measurement, it should be clear that precise quantification will often not be profitable. It is therefore possible to discard some individual attributes from detailed assessment and simplify the process where it is readily justifiable on the basis of qualitative considerations that they will be no more than minor contributors overall.

The formal assessment process cannot be expected to provide a simple numerical score representing the cost/benefit balance for deployment of a given technology. Final ranking is established after the formal assessment process in the subsequent evaluation stage and may require value judgments to be made. The difficulties to be encountered at that stage will be dependent upon the nature of the balance across all of the attributes..

The key features that can be identified from the assessment are as follows:

- due to the shorter lifetime of the mechanical pump and the need for repeated replacement, continued deployment of the mechanical pump has much higher longer term repair and maintenance costs considered over the whole plant life.
- due its lower efficiency, the fluidic pump has higher operating costs associated with energy requirements but the cost over the plant life is not significant compared with the investment and repair and maintenance costs mentioned above;
- the nature of the regulatory compliance costs for the two options are distinctly different: those for deployment of the fluidic pump are associated with initial approval of the new technology whereas those for continued use of the mechanical pump relate to on-going radiological hazard management during maintenance operations. The exact costs are difficult to quantify but are expected to be greater for continued use of the mechanical pump;
- disposal costs are considerably higher for continued deployment of the mechanical pump which gives rise to significantly greater volumes of radioactive waste;
- taking account of the balance of costs throughout the plant lifetime, deployment of the fluidic pump is much the cheaper option;
- continued deployment of the mechanical pump carries with it higher radiation doses to workers due to the need for repeated pump replacement operations during the plant lifetime and during disposal operations, although the latter are not well characterized. This dominates the risk impact and, on this basis, the fluidic pump is the preferred option;
- the requirement for frequent replacement of the mechanical pump leads to greater environmental impacts as regards the consumption of materials (predominantly steel) that make up the components of the pump and as regards radioactive waste;

- the lower energy efficiency of the fluidic pump leads to greater environmental impacts as regards energy consumption and discharges associated with the power conversion;
- taken overall, the volumes of radioactive wastes generated are judged to represent the most significant environmental impact and, on this basis, the fluidic pump is the preferred option;
- the higher reliability of the fluidic pump ensures better plant availability. However, given the high capacity of large plants in relation to the operating schedule required over the plant lifetime, this does not represent a significant factor in determining the preferred option;
- overall, in respect of each of the relevant factors of costs, human health and safety risks and environmental impacts, deployment of the fluidic pump is the preferred option.

4.2 SIMPLIFIED LIFETIME COST ANALYSIS FOR DCRT TANKS

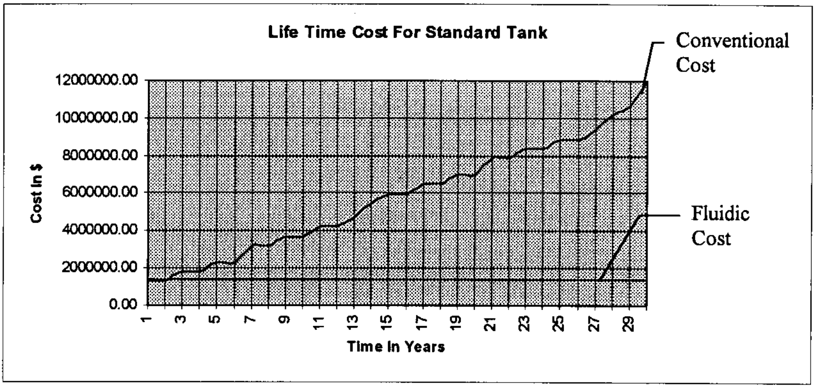
The lifetime cost analysis for the fluidic components has been based on a thirty year life expectancy for the facility. It has been assumed that once the tanks are emptied at the end of their life the fluidic components contaminated inside the tank will be treated as pipes in the tank and grouted in place. Therefore there will be no decommissioning cost associated with this equipment.

For the conventional equipment the cost and life expectancy has been outlined below,

Lifetime Cost Analysis For DCRT Tanks						
DCRT Tank	*Cost New*	*Lifetime hrs*	*Operating Time Per Day/hrs*	*lifetime days*	*Lifetime Years*	*Cost Replace Dispose*
Agitator	$350,000	5,000	7	714	2	$500,000
Transfer Pump	$200,000	5,000	2	2500	7	$400,000
Emergency Back-up pump	$200,000	5,000	1	5000	14	$400,000

These numbers equate to a total lifetime cost of approximately $12M per tank for the conventional system compared to $1.4M for the fluidic system per tank. This equates to a lifetime cost saving of $22M in 1997 dollars.

FINAL VERSION 6/9/97



Life Time Cost For One Standard Tank Containing Conventional Or Fluidic Systems

4.3 SIMPLIFIED LIFETIME COST ANALYSIS FOR HARP TANKS

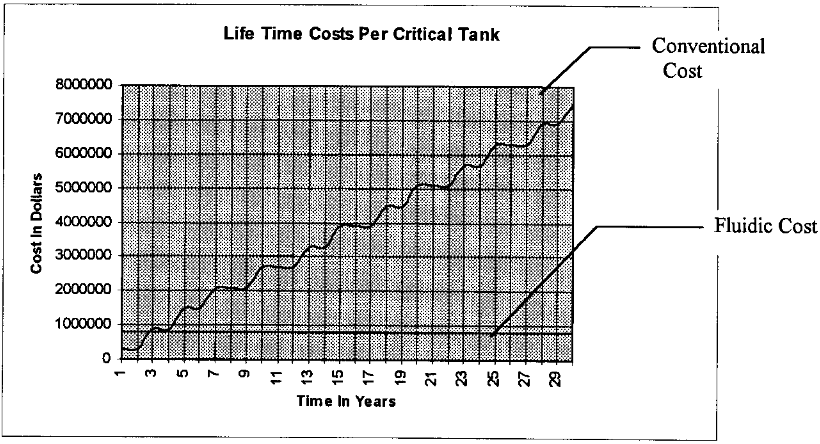
The lifetime cost analysis for the fluidic components has been based on a thirty year life expectancy for the facility. It has been assumed that once the tanks are emptied at the end of their life the fluidic components contaminated inside the tank will be treated as pipes in the tank and grouted in place. Therefore there will be no decommissioning cost associated with this equipment.

For the conventional equipment it has been assumed that two canned motor pumps are placed on each tank in a similar manner to the fluidic pumps. One pump will be the primary mixing and transfer pump and the other will be the emergency back-up pump. The cost and life expectancy has been outlined below,

Lifetime Cost Analysis For Annulus Tanks						
Annulus Tank.	*Cost New*	*Lifetime hrs*	*Operating Time Per Day/hrs*	*lifetime days*	*Lifetime Years*	*Cost Replace Dispose*
Transfer Pump	$150,000	2,000	6	365	2.5	$300,000
Emergency Back-up pump	$150,000	2,000	6	365	2.5	$300,000

These numbers equate to a total lifetime cost of approximately $7M per tank for the conventional system compared to $800K per tank for the fluidic system.

If conventional pumps were used on the 8 HARP Tanks the conventional system lifetime cost would be $56M compared to the fluidic system lifetime cost of $6.4M. This equates to a lifetime saving of $50M in 1997 dollars. Conventional pumps would also require a service bulge to facilitate remote maintenance and a final disposal route. There will also be a requirement for a shielded transport container for transporting the contaminated pumps.



Lifetime Costs For HARP Tank Containing Fluidic and Conventional Equipment.

4.4 ANNULUS TANKS

Another design option is to store the waste in 56 annulus tanks. FDNW have come up with an ingenious way of linking the 56 tanks with 16 pneumatic diaphragm pumps to keep the tanks mixed. There are 480 valves in the arrangement to facilitate the mixing. It has been difficult to quantify the life time costs but some of the major issues are detailed below.

FDNW provided the following costs for the equipment. Each pump will cost $5,000 and will run for about 1 year. Each nuclear class valve will cost $1500 and will require maintenance every five years. The cost for maintenance will be based upon 3 men working @ $65/hr for three days per 8 valves or 8 pumps. Worn out pumps will be transported in standard boxes. Worn out valve parts will be placed into nuclear storage drums for some future disposal route at a cost of $5000 per drum. Each 8 components requiring 1 drum. Since mixing will continue while the maintenance is being conducted the radiation levels in the maintenance bulge could be high. It may therefore be necessary to look at remote manipulator maintenance.

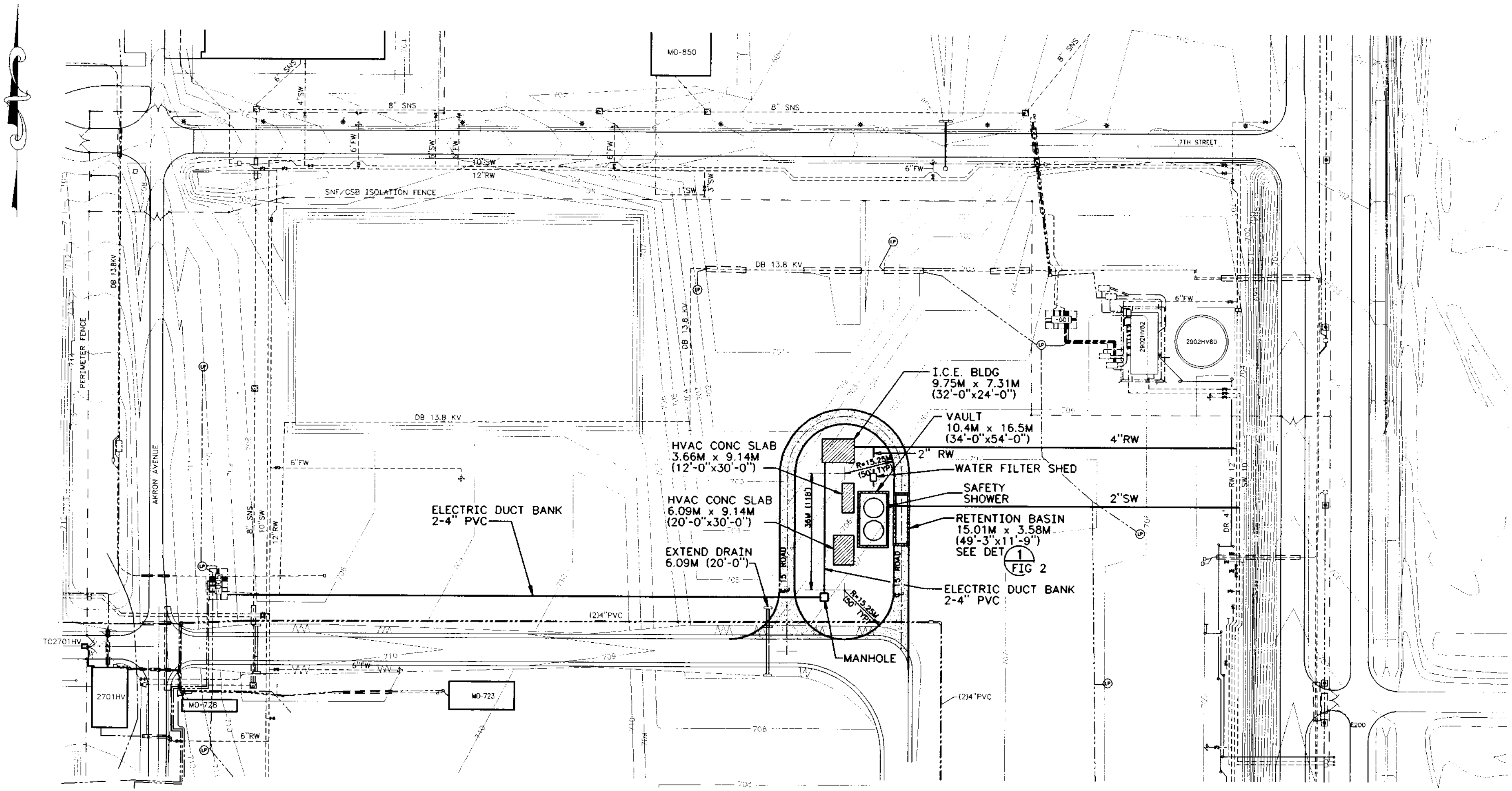
Other key factors that have not been costed are,

- Cost of maintenance bulge for the pumps.
- Cost of procedures necessary to operate all the valves in the right sequence.
- Cost of nuclear standard solenoids for opening and closing valves remotely.
- Cost of developing bespoke control system for pump operation.
- Cost of control system for pumps.
- Cost of storing secondary waste to include each drums true share of the cost of building the repository.
- Disposal route for secondary waste.
- Cost of radiation dose to mantenance staff at $0.2M per man Sv
- Cost of secondary radiation dose to operators and maintenance staff. $ 0.2M per mSv. Secondary dose defined as dose received by maintenance staff working in a maintenance facility away from the main plant handling the contaminated components or secondary waste..
- Cost of health physics cover, maintenance procedures, QA procedures.
- QA qualification for valves, solenoids and control system
- Cost of cold mock up of bulge for maintenance practice.
- Remote manipulators for maintenance of some key components.
- By far the most expensive cost will be the decommissioning and disposal of the bodies of 480 contaminated valves,16 pumps and 56 storage tanks and their structural support structures and the maintenance facility.

The estiamted cost for this system would far outway the cost of following either of the above two routes.

APPENDIX G

FIGURES: DCRT TYPE SYSTEM



SITE PLAN

SCALE: 1:600 (1"=50'-0")

LEGEND:

(LP)	AREA LIGHTING - WOODEN POLES
*	7TH STREET (EXTENSION) LIGHTING - METAL POLES
	GATE VALVE WITH POST INDICATOR
	FIRE HYDRANT
	GATE VALVE WITH VALVE BOX AT GRADE
	CONCRETE ENCASEMENT (DUCT BANK OR PIPING)
	RAW WATER (RW) OR FIRE WATER (FW) PIPING
	SANITARY WATER (SW) PIPING
	SANITARY SEWER (SNS) PIPING
	DRAIN (DR) PIPING
	13.8 KV DIRECT BURY ARMORED CABLE W/ CONCRETE CAP
	480 V DIRECT BURY POWER CABLE (MAY BE PARTIALLY ENCASED IN RACEWAY OR CONCRETE)
	DIRECT BURY LIGHTING CABLE (MAY BE PARTIALLY ENCASED IN RACEWAY OR CONCRETE)

NOTES:

1- CONTOUR ELEVATIONS HAVE BEEN SHOWN IN ENGLISH UNITS.

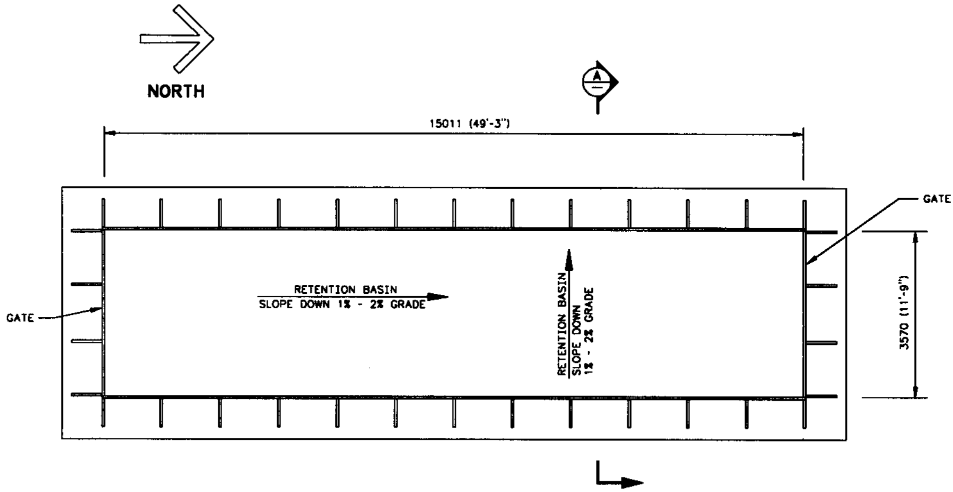
2- THE PROJECT SITE INFORMATION IS SHOWN IN METERS (M).

50' 0 50' 100'

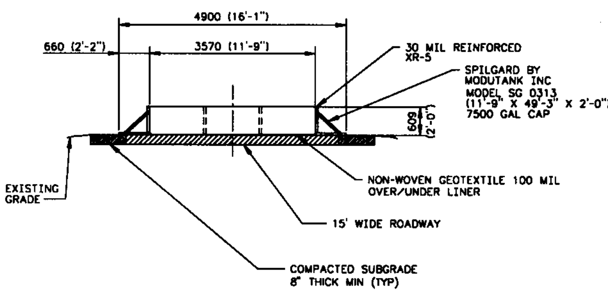
SCALE IN FEET

FLUOR DANIEL NORTHWEST

Prepared By/Date		CAD FILE
SH SMITH/05-27-97	FIGURE 1	FIG1

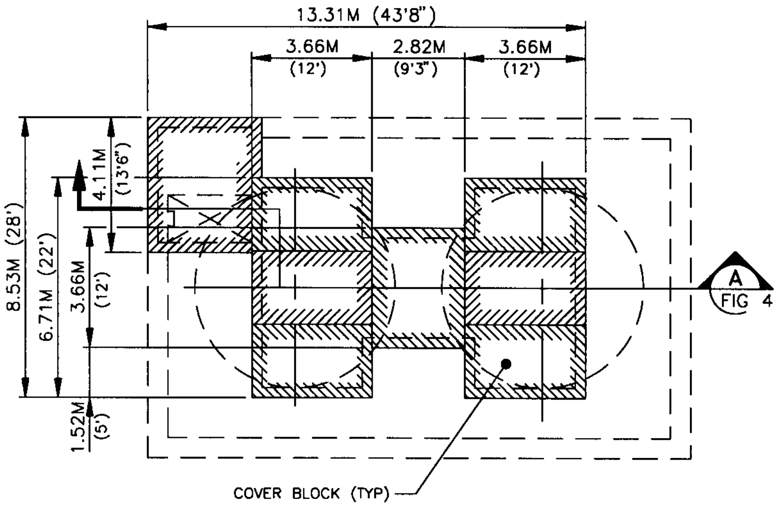


1 FIG-1 DETAIL-RETENTION BASIN
SCALE: 1:50 (1/4"=1'-0")

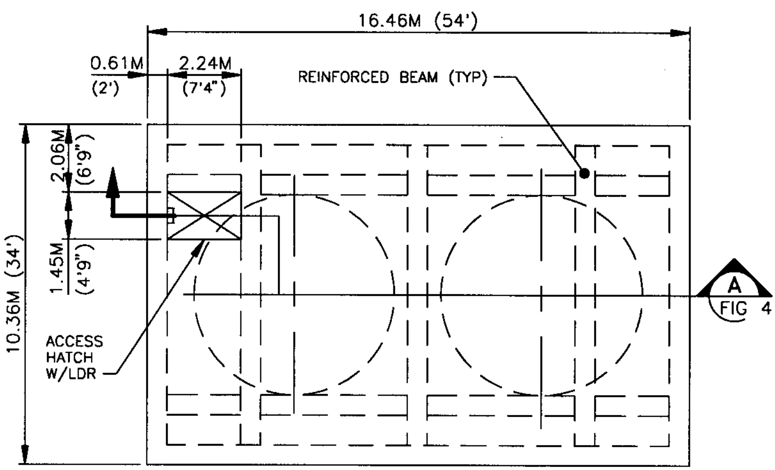


A SECTION
SCALE: 1:50 (1/4"=1'-0")

FLUOR DANIEL NORTHWEST		
Prepared By/Date S SMITH / 5-27-97	FIGURE 2	CAD FILE FIG2

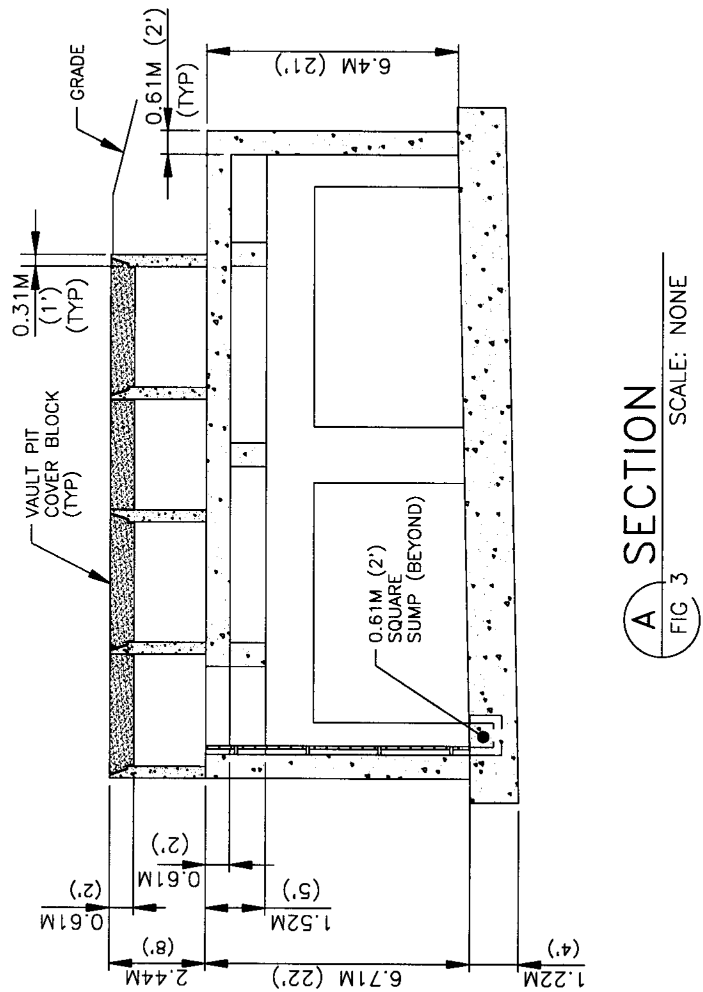


DCRT VAULT PIT PLAN



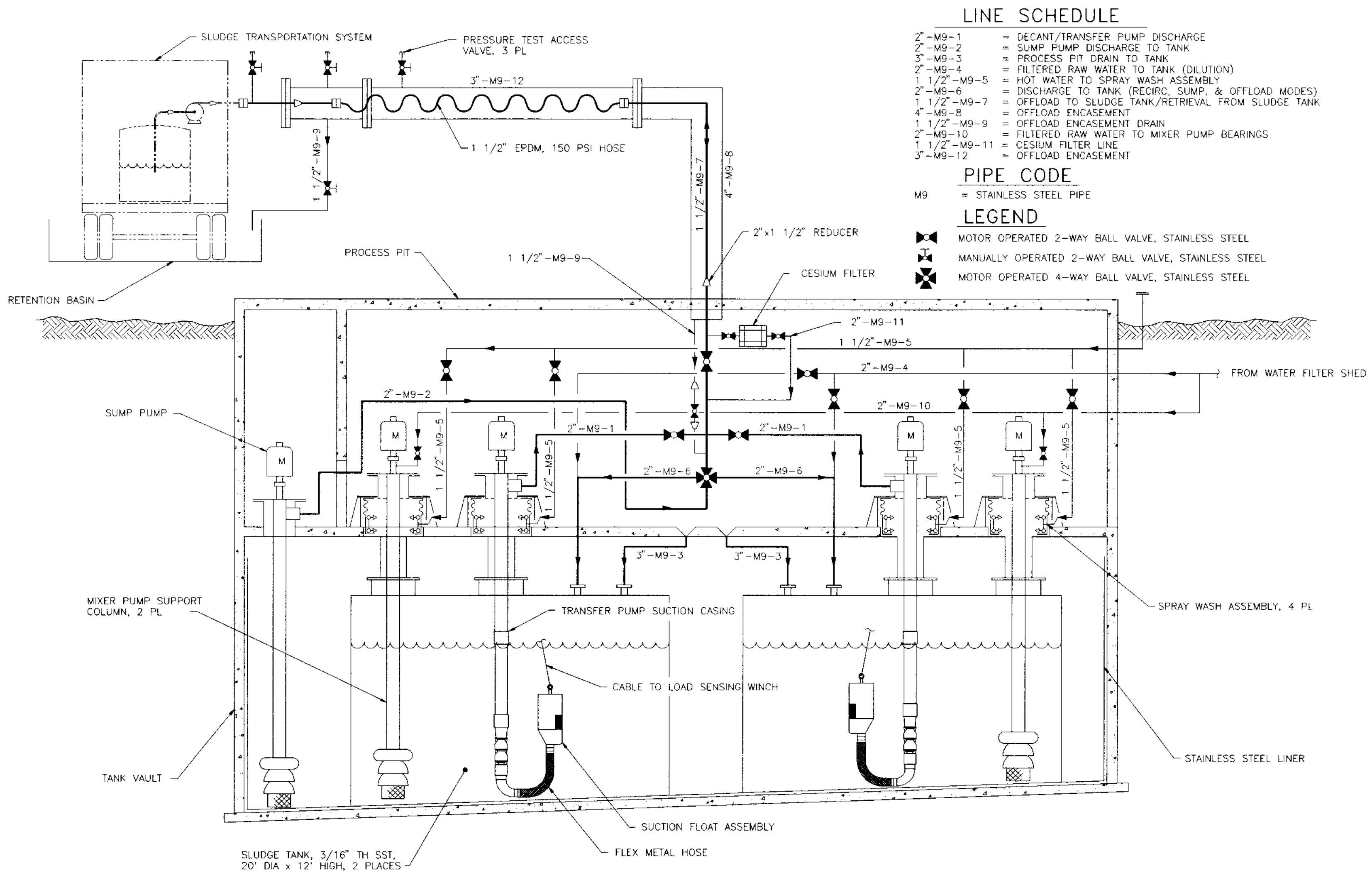
DCRT VAULT PLAN

FLUOR DANIEL NORTHWEST		
Prepared By/Date TK EHRHARD/05-29-97	FIGURE 3	CAD FILE FIG3



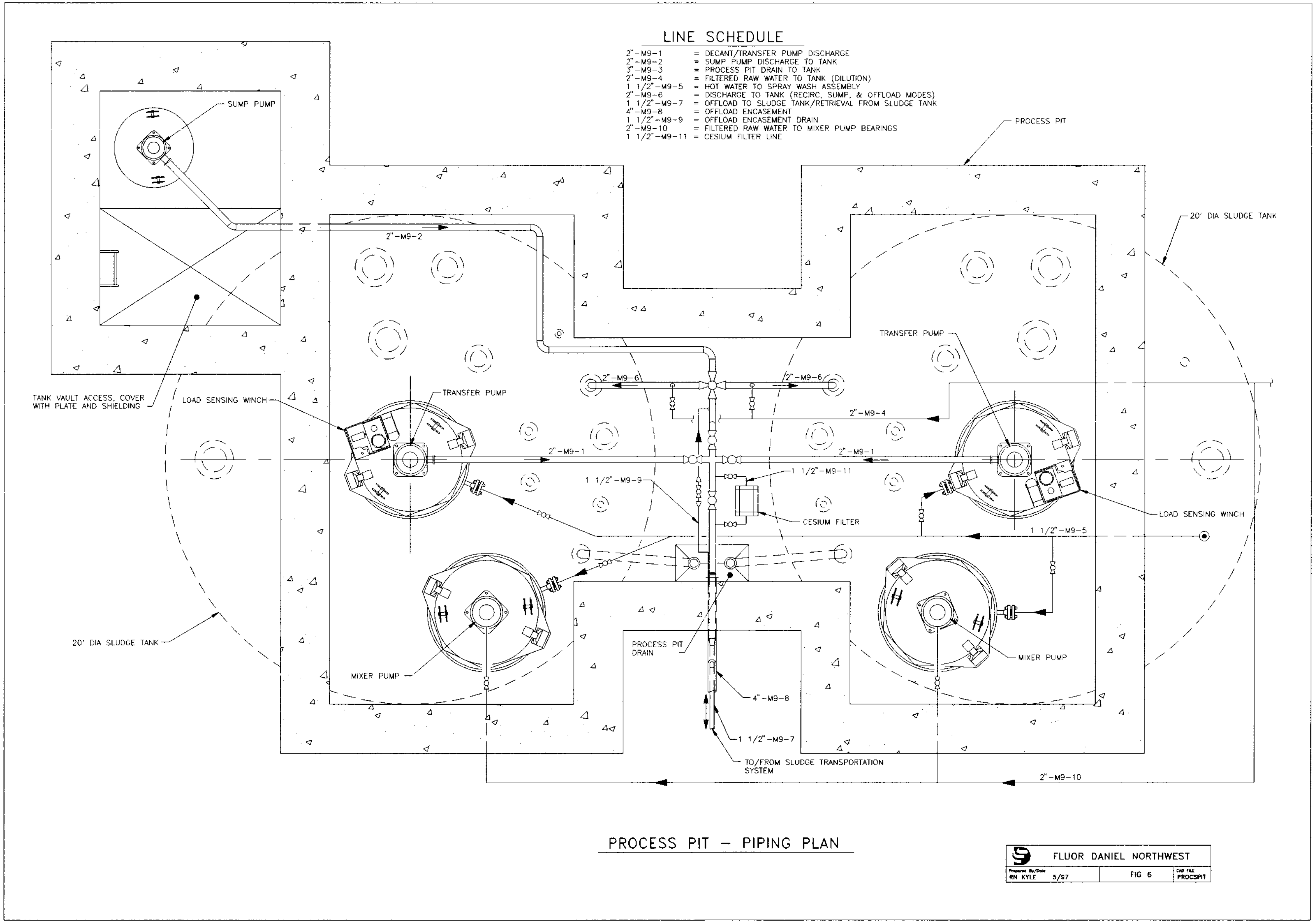
FLUOR DANIEL NORTHWEST

Prepared By/Date		CAD FILE
TK EHRHARD/05-29-97	FIGURE 4	FIG4

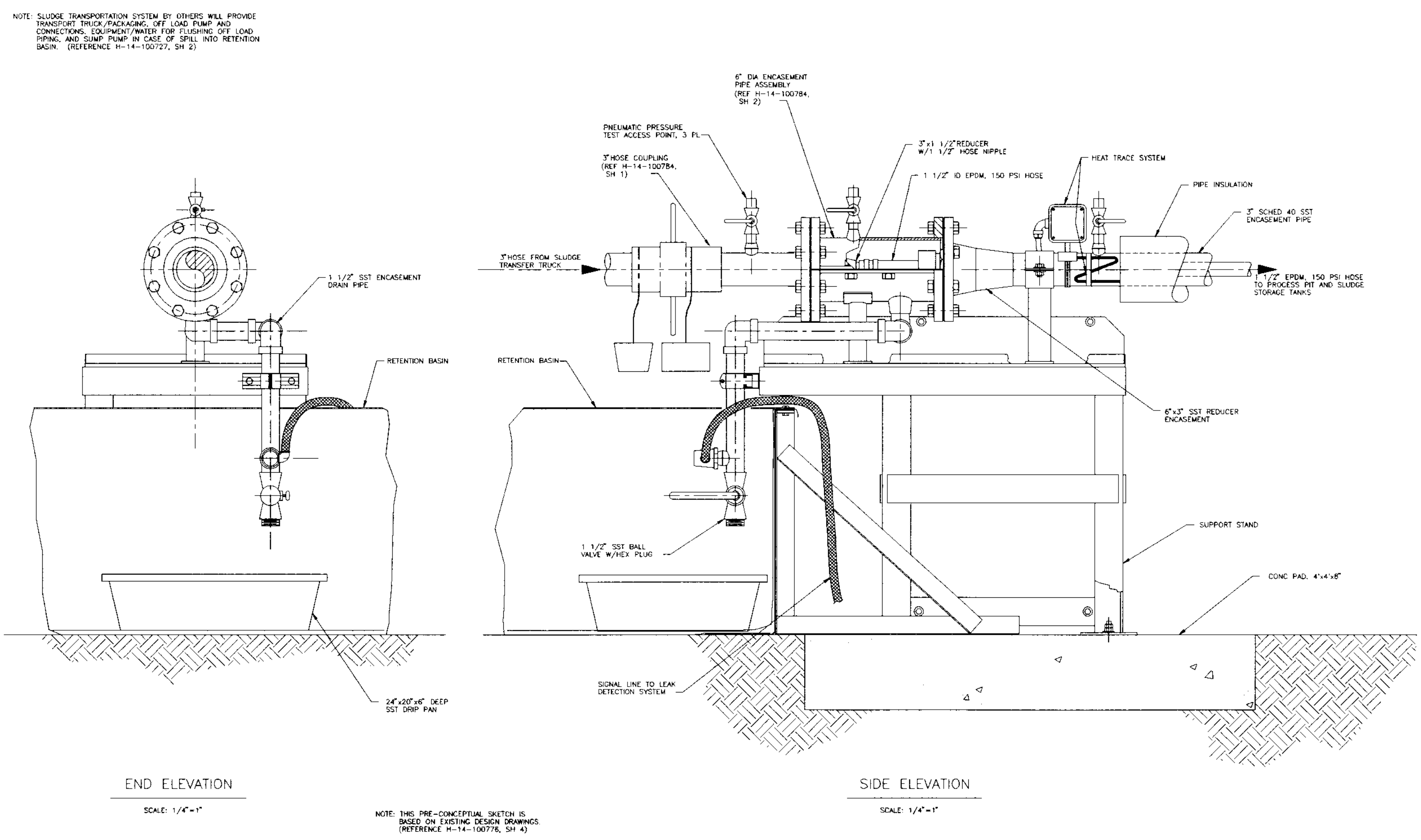


PIPING FLOW DIAGRAM - DCRT TYPE SYSTEM

FLUOR DANIEL NORTHWEST		
Prepared By/Date RN KYLE 5/97	FIG 5	CAD FILE FLOWDIAG



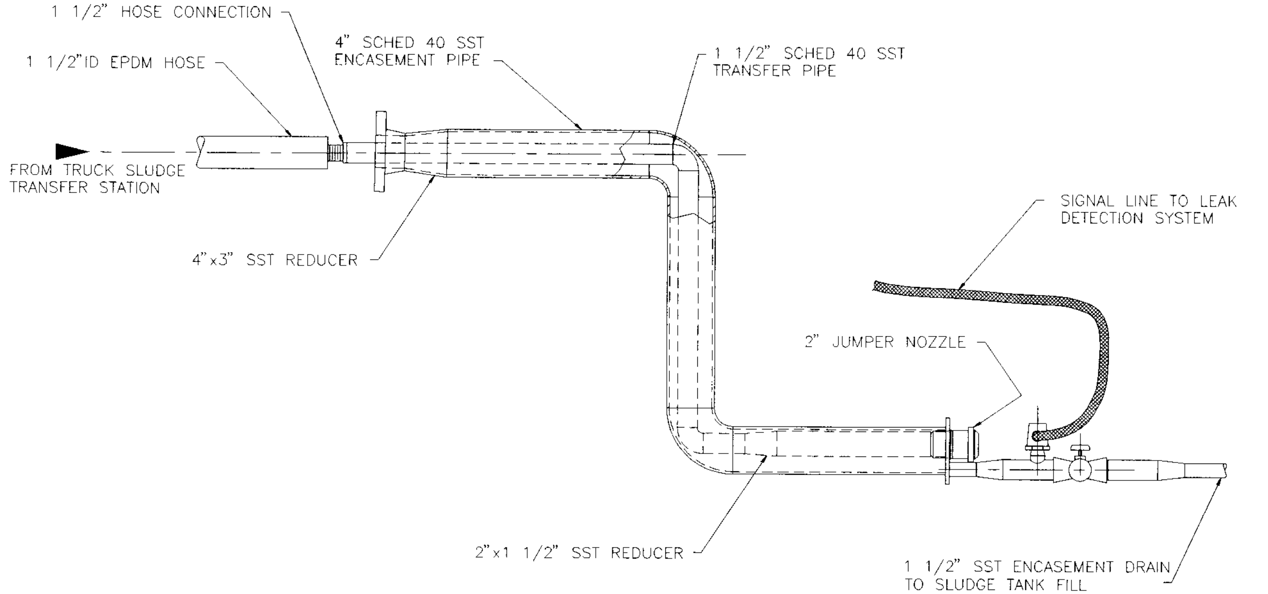
PROCESS PIT – PIPING PLAN



OFFLOAD PIPING SECTION

FLUOR DANIEL NORTHWEST		
Prepared By/Date RN KYLE 5/97	FIG 7	CAD FILE SPOOL2

NOTE: THIS PRE-CONCEPTUAL DESIGN SKETCH IS BASED ON EXISTING DESIGN DRAWINGS. (REFERENCE H-14-100780, SH 1)

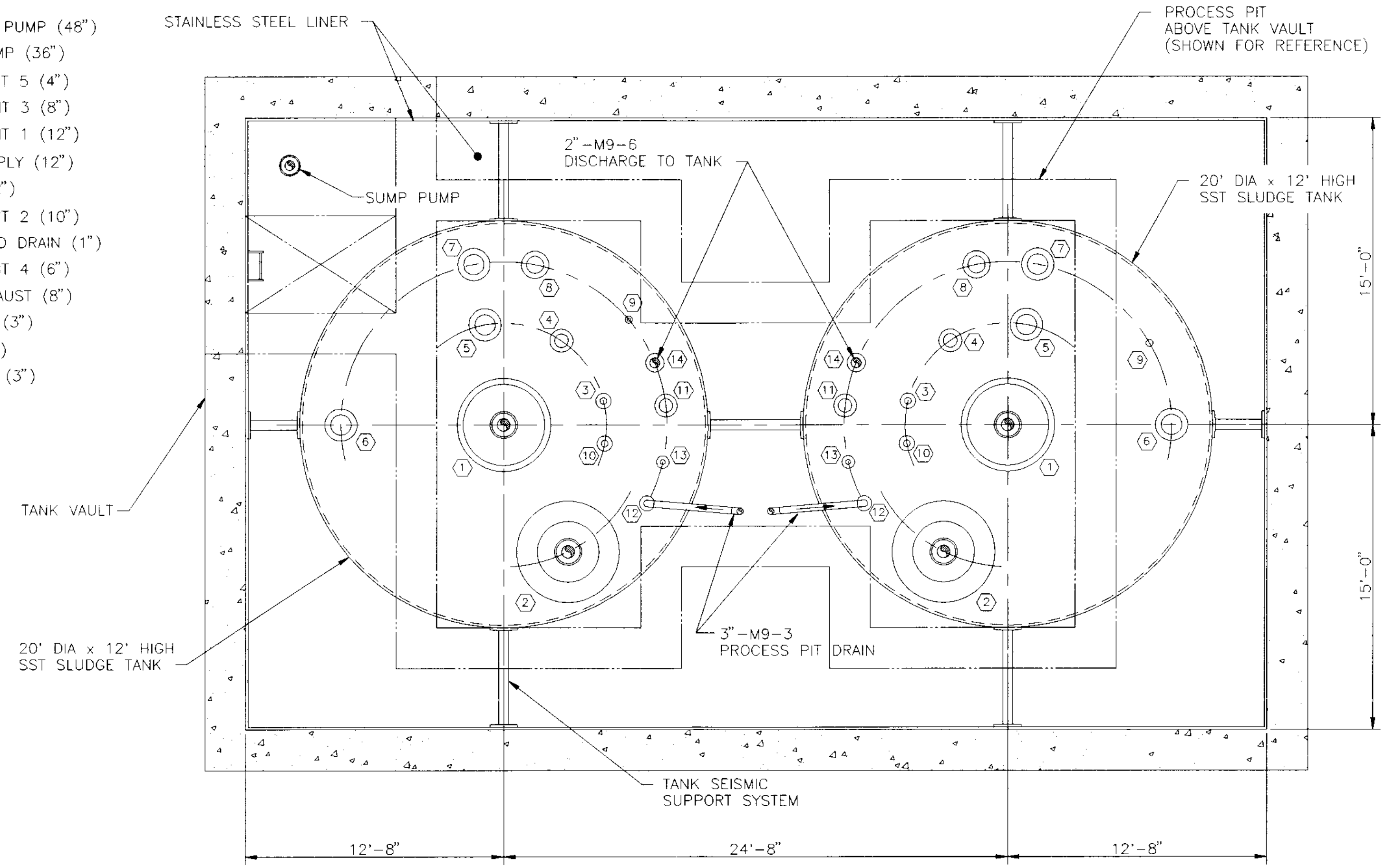


PIT ENTRY SPOOL

FLUOR DANIEL NORTHWEST		
Prepared By/Date RN KYLE 5/97	FIG 8	CAD FILE SPOOL1

RISER SCHEDULE

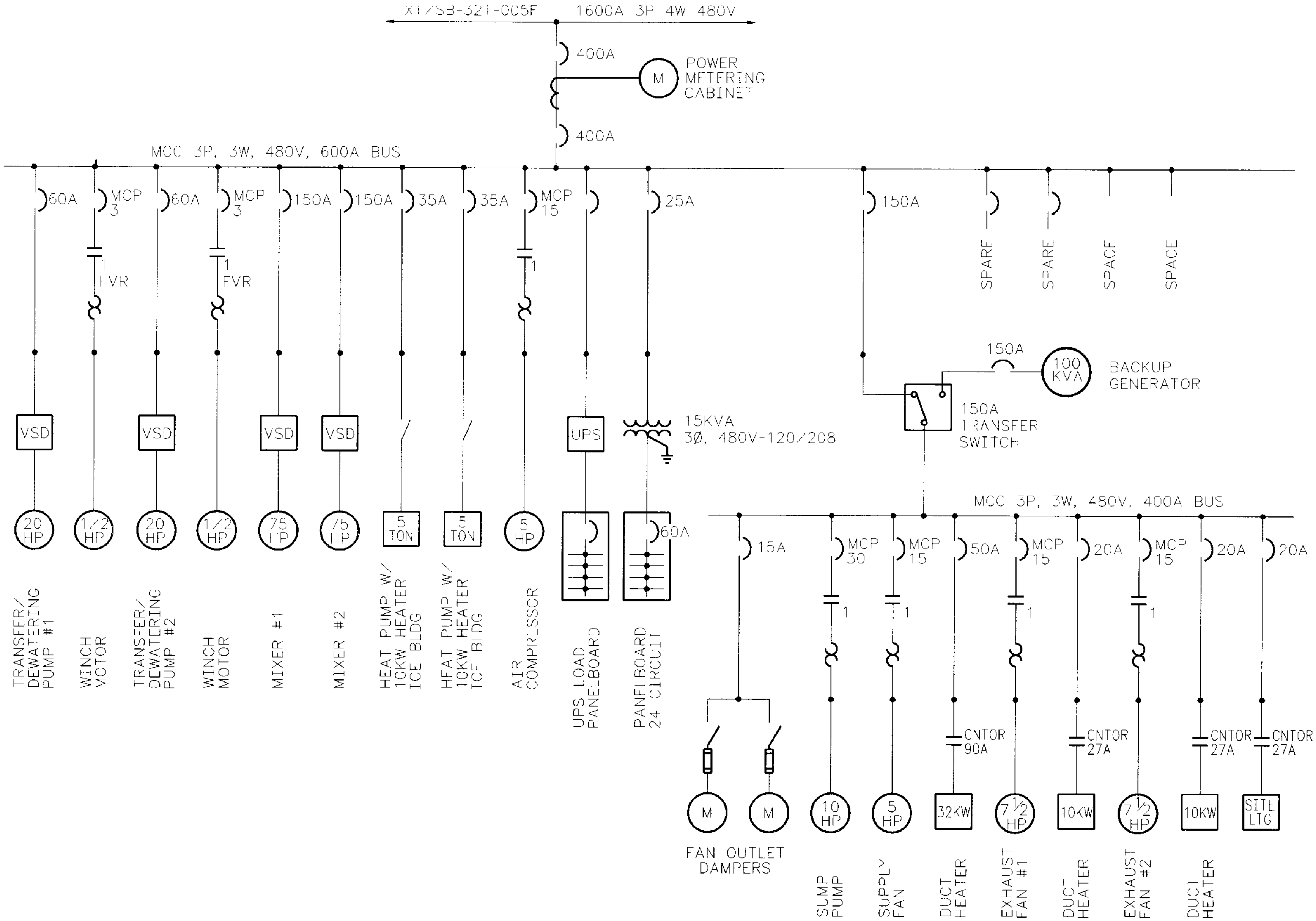
1. TRANSFER PUMP (48")
2. MIXER PUMP (36")
3. INSTRUMENT 5 (4")
4. INSTRUMENT 3 (8")
5. INSTRUMENT 1 (12")
6. HVAC SUPPLY (12")
7. SPARE (12")
8. INSTRUMENT 2 (10")
9. HVAC COND DRAIN (1")
10. INSTRUMENT 4 (6")
11. HVAC EXHAUST (8")
12. PIT DRAIN (3")
13. SPARE (4")
14. TANK FILL (3")



NOTE: THIS PRE-CONCEPTUAL DESIGN SKETCH IS BASED ON EXISTING DESIGN DRAWINGS. (REFERENCE H-14-100780, SH 1)

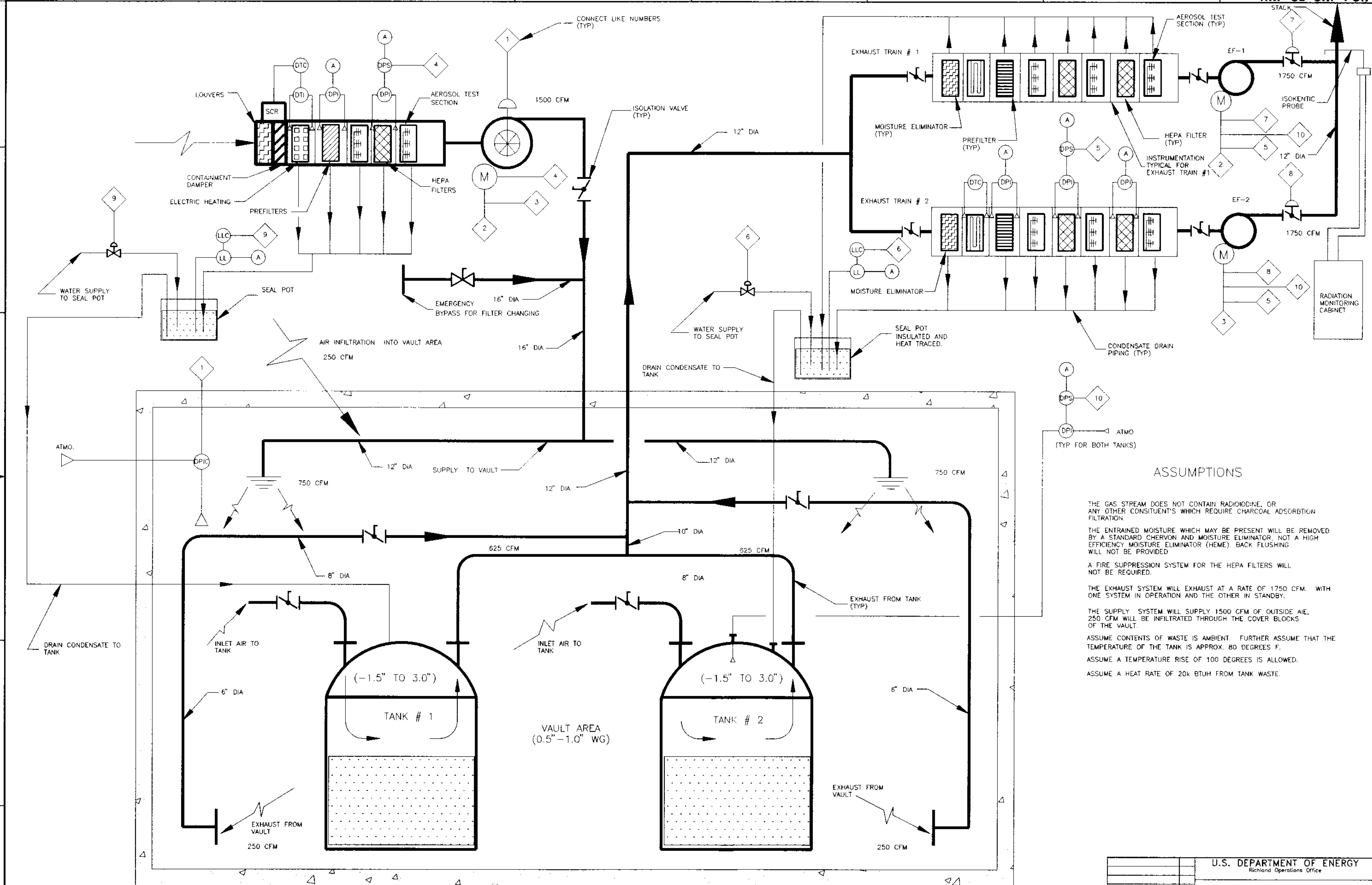
RISER SCHEDULE/PIPING PLAN – TANK VAULT

FLUOR DANIEL NORTHWEST		
Prepared By/Date RN KYLE	FIG 9	CAD FILE TANKPIT



ONE LINE DIAGRAM – DCRT TYPE SYSTEM
PRE-CONCEPTUAL DESIGN

FLUOR DANIEL NORTHWEST		
Prepared By/Date S SMITH / 5-30-97	FIGURE-10	CAD FILE FIG13



ASSUMPTIONS

THE GAS STREAM DOES NOT CONTAIN RADIOIODINE, OR ANY OTHER CONSITUENT'S WHICH REQUIRE CHARCOAL ADSORBTION FILTRATION.

THE ENTRAINED MOISTURE WHICH MAY BE PRESENT WILL BE REMOVED BY A STANDARD CHERVON AND MOISTURE ELIMINATOR. NOT A HIGH EFFICIENCY MOISTURE ELIMINATOR (HEME). BACK FLUSHING WILL NOT BE PROVIDED

A FIRE SUPPRESSION SYSTEM FOR THE HEPA FILTERS WILL NOT BE REQUIRED.

THE EXHAUST SYSTEM WILL EXHAUST AT A RATE OF 1750 CFM. WITH ONE SYSTEM IN OPERATION AND THE OTHER IN STANDBY.

THE SUPPLY SYSTEM WILL SUPPLY 1500 CFM OF OUTSIDE AIE, 250 CFM WILL BE INFILTRATED THROUGH THE COVER BLOCKS OF THE VAULT.

ASSUME CONTENTS OF WASTE IS AMBIENT. FURTHER ASSUME THAT THE TEMPERATURE OF THE TANK IS APPROX. 80 DEGREES F.

ASSUME A TEMPERATURE RISE OF 100 DEGREES IS ALLOWED.

ASSUME A HEAT RATE OF 20k BTUH FROM TANK WASTE.

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

K-BASIN SLUDGE STORAGE TANKS PRECONCEPTUAL VENTILATION FLOW AND CONTROL DIAGRAM

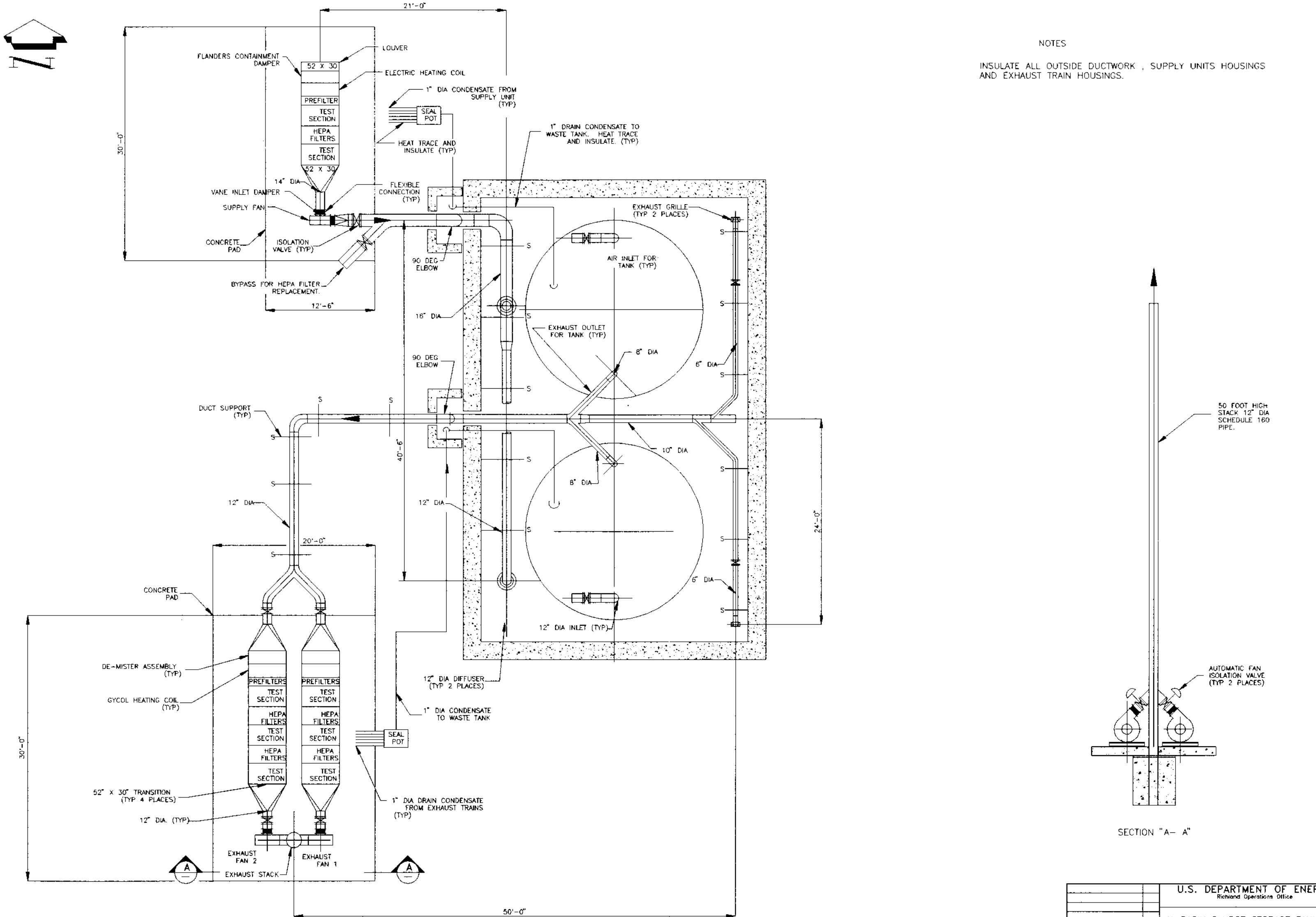
FIGURE 11

DWG NO | TITLE | DRAWING TRACEABILITY LIST | REF NUMBER | TITLE | REFERENCES | NEXT USED ON | REVISIONS | CADFILE | CADCODE

PLOT SCALE:

NOTES

INSULATE ALL OUTSIDE DUCTWORK , SUPPLY UNITS HOUSINGS AND EXHAUST TRAIN HOUSINGS.



DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REVISIONS

CADFILE | CADCODE

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

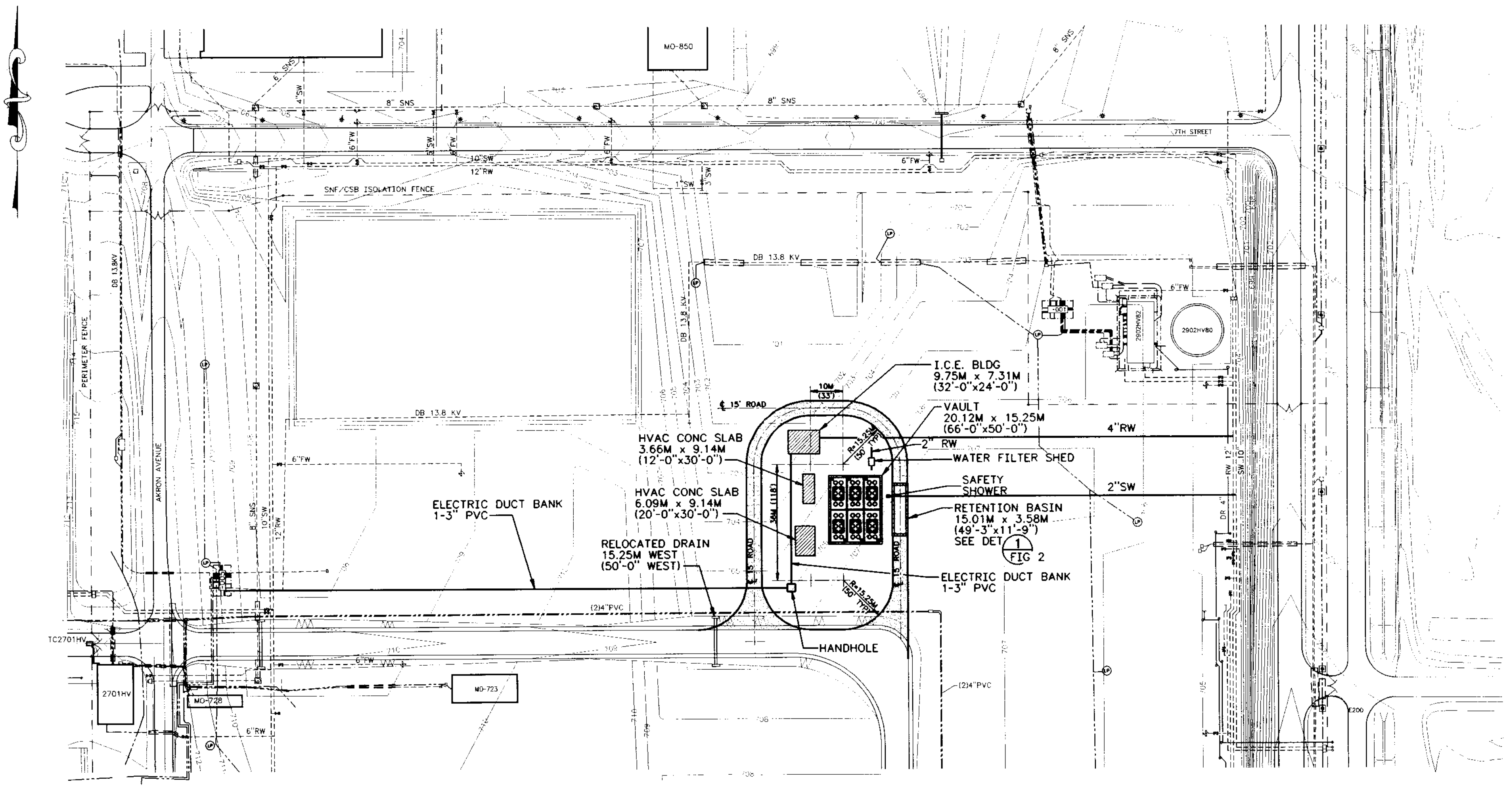
K-BASIN SLUDGE STORAGE TANKS
PRECONCEPTUAL VENTILATION TASK
PLAN AND SECTION

FIGURE 12

PLOT SCALE:

APPENDIX H

FIGURES: CRITICALLY SAFE ANNULUS TANK



SITE PLAN

SCALE: 1:600 (1"=50'-0")

LEGEND:

- AREA LIGHTING - WOODEN POLES
- 7TH STREET (EXTENSION) LIGHTING - METAL POLES
- GATE VALVE WITH POST INDICATOR
- FIRE HYDRANT
- GATE VALVE WITH VALVE BOX AT GRADE
- CONCRETE ENCASEMENT (DUCT BANK OR PIPING)
- RAW WATER (RW) OR FIRE WATER (FW) PIPING
- SANITARY WATER (SW) PIPING
- SANITARY SEWER (SNS) PIPING
- DRAIN (DR) PIPING
- 13.8 KV DIRECT BURY ARMORED CABLE W/ CONCRETE CAP
- 480 V DIRECT BURY POWER CABLE (MAY BE PARTIALLY ENCASED IN RACEWAY OR CONCRETE)
- DIRECT BURY LIGHTING CABLE (MAY BE PARTIALLY ENCASED IN RACEWAY OR CONCRETE)

NOTES:

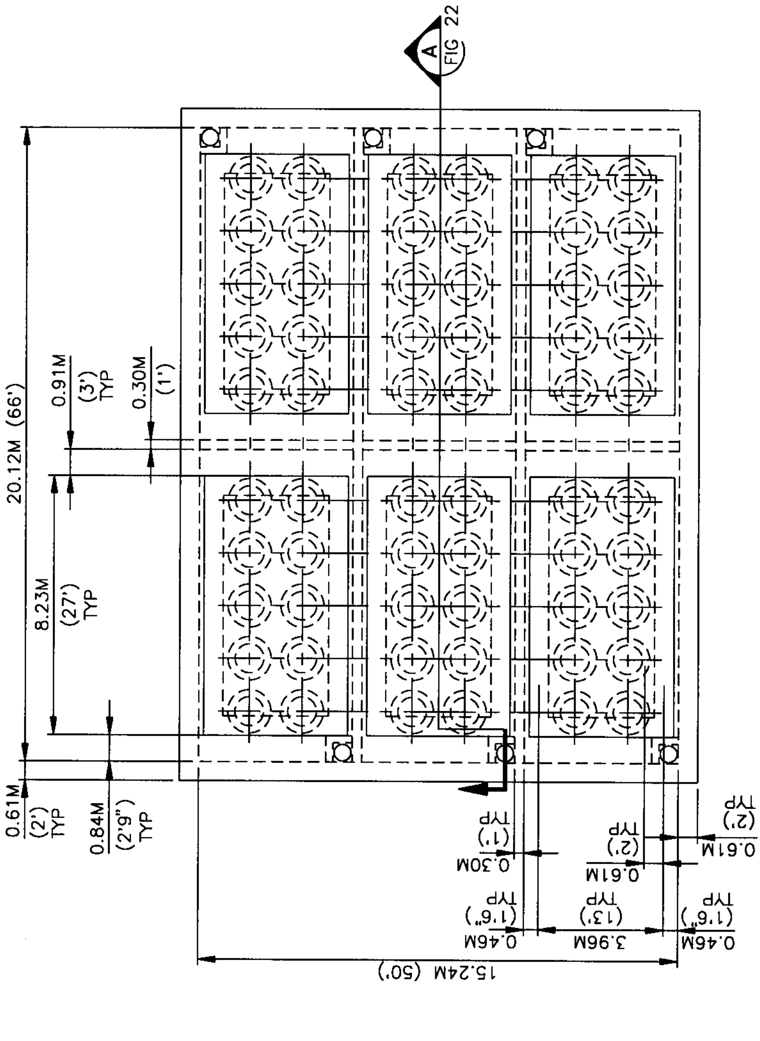
1- CONTOUR ELEVATIONS HAVE BEEN SHOWN IN ENGLISH UNITS.
2- THE PROJECT SITE INFORMATION IS SHOWN IN METERS (M).

FLUOR DANIEL NORTHWEST

Prepared By/Date: SH SMITH/05-27-97

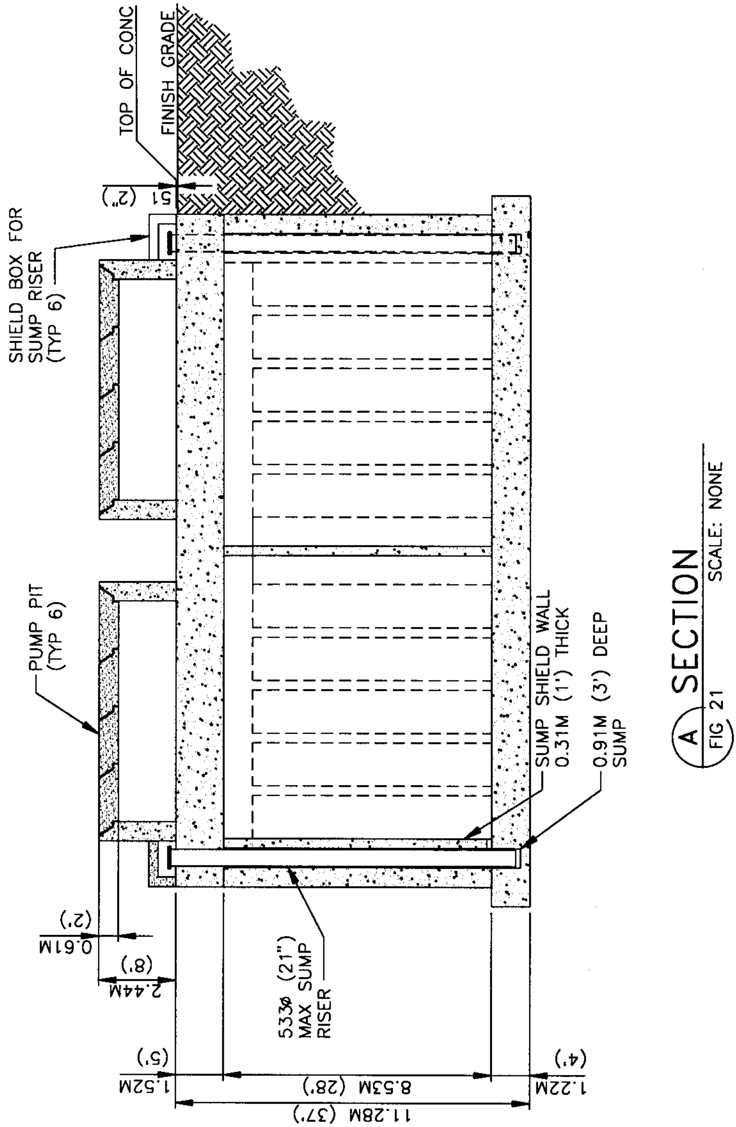
FIGURE 20

CAD FILE: FIG20

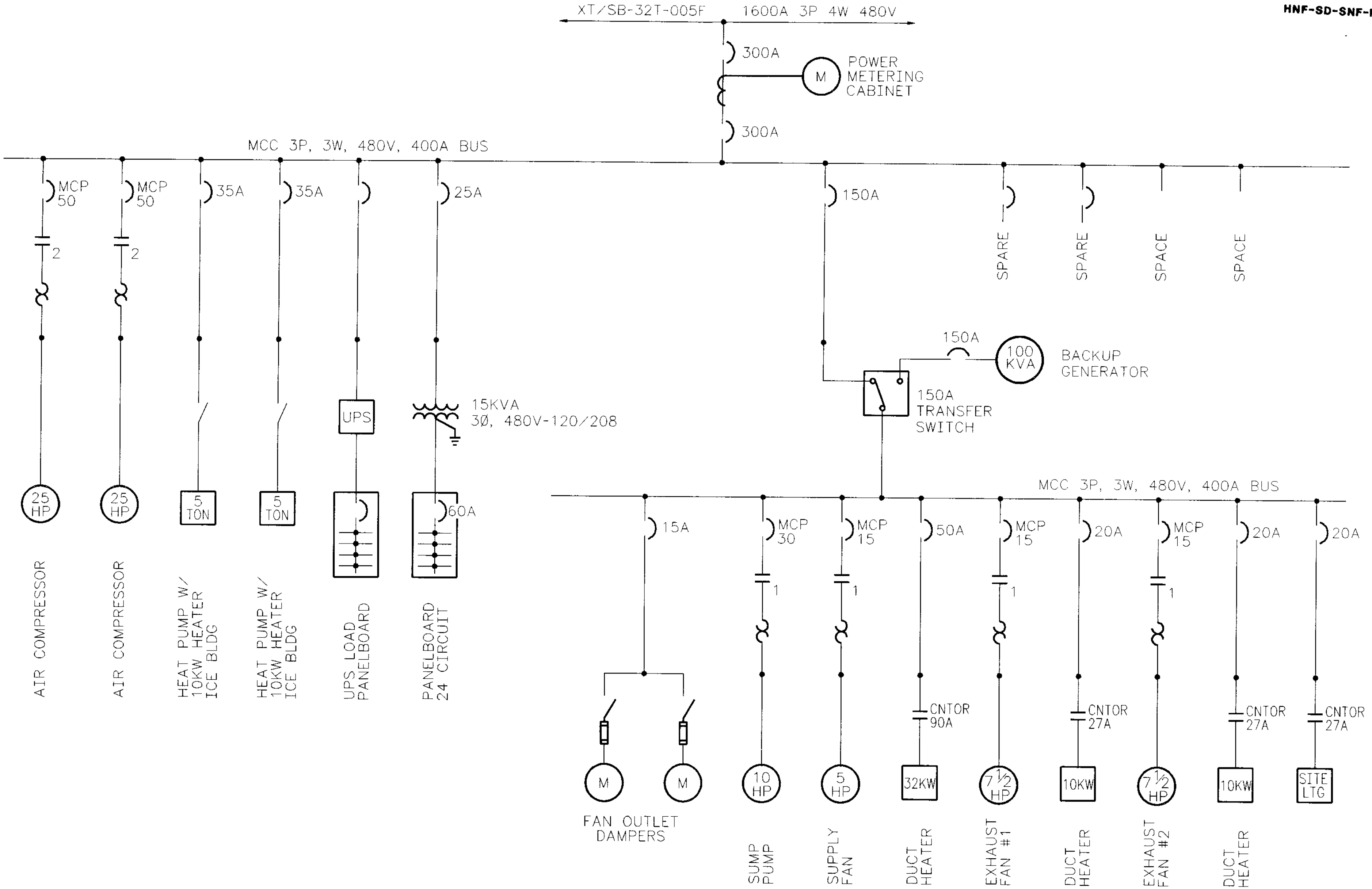


CRITICALLY SAFE ANNULUS TANK VAULT/PIT PLAN

FLUOR DANIEL NORTHWEST		
Prepared By/Date TK EHRHARD/05-30-97	FIGURE 21	CAD FILE FIG21

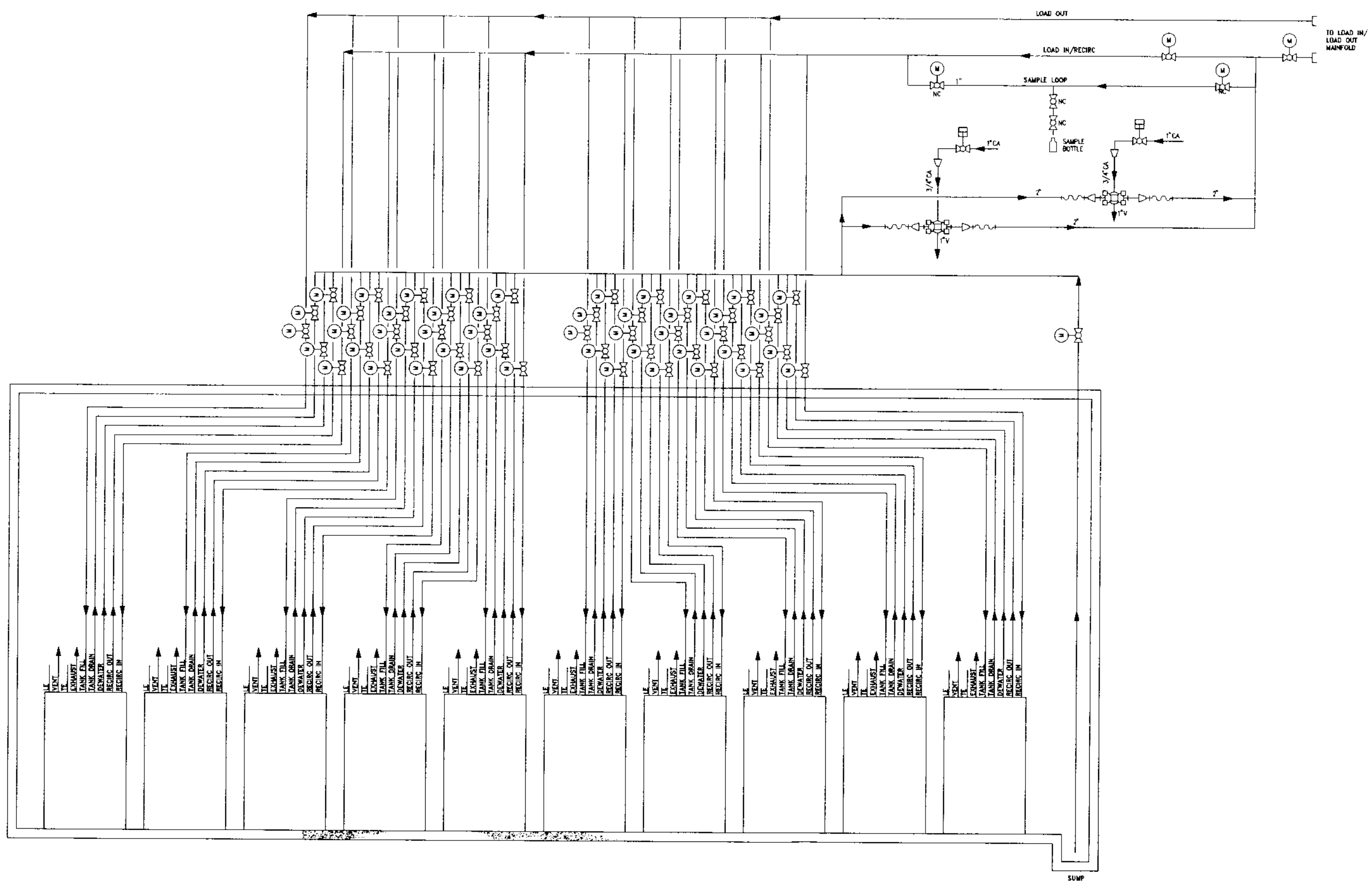


FLUOR DANIEL NORTHWEST		
Prepared By/Date TK EHRHARD/05-30-97	FIGURE 22	CAD FILE FIG22



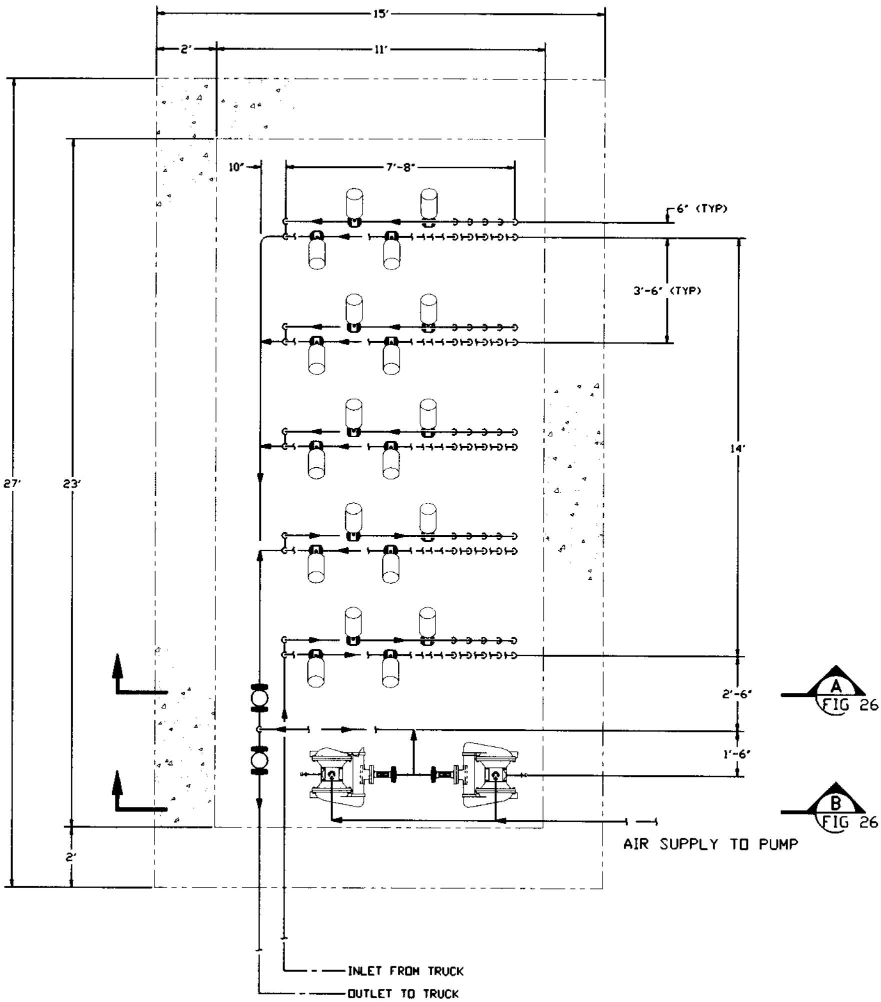
ONE LINE DIAGRAM – CRITICALLY SAFE ANNULUS TANKS
PRE-CONCEPTUAL DESIGN

FLUOR DANIEL NORTHWEST		
Prepared By/Date S SMITH / 5-30-97	FIGURE-23	CAD FILE FIG23



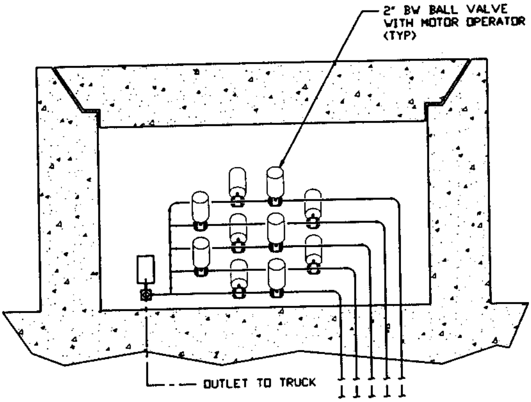
ENGINEERING FLOW DIAGRAM

FLUOR DANIEL NORTHWEST		
Prepared By/Date R MOSSBRUCKER/6-2-97	FIGURE 24	CAD FILE FIG24

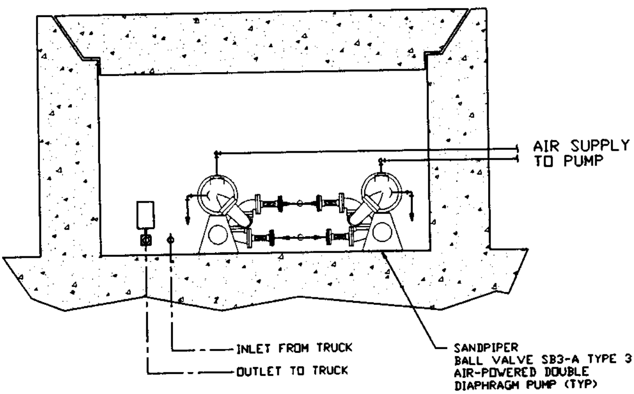


PLAN VIEW

FLUOR DANIEL NORTHWEST		
Prepared By/Date R MOSSBRUCKER/6-2-97	FIGURE 25	CAD FILE FIG25

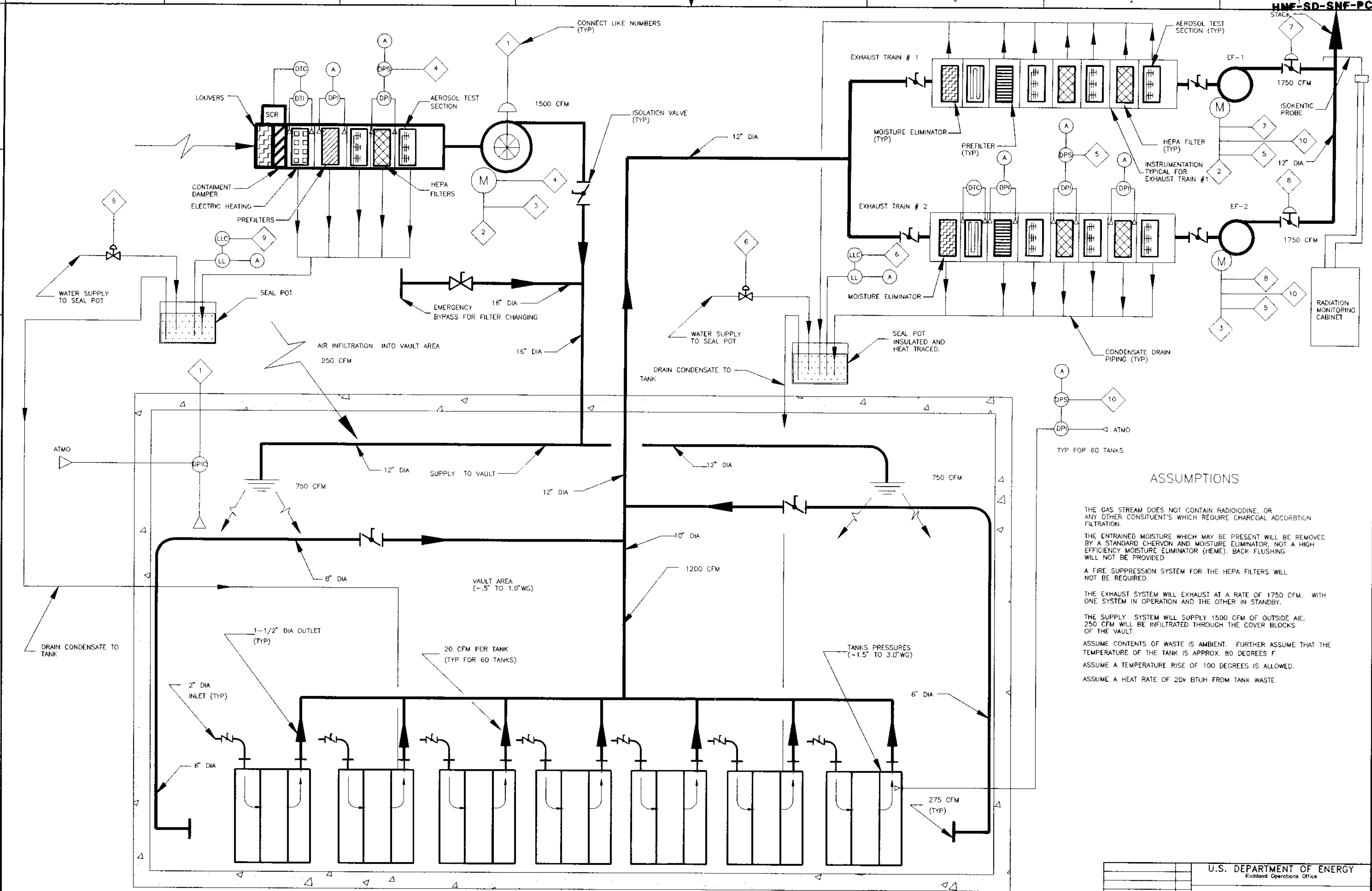


A SECTION
FIG 25 SCALE: NONE



B SECTION
FIG 25 SCALE: NONE

FLUOR DANIEL NORTHWEST		
Prepared By/Date R MOSSBRUCKER/6-2-97	FIGURE 26	CAD FILE FIG26



ASSUMPTIONS

THE GAS STREAM DOES NOT CONTAIN RADIOIODINE, OR ANY OTHER CONSITUENT'S WHICH REQUIRE CHARCOAL ADSORBTION FILTRATION.

THE ENTRAINED MOISTURE WHICH MAY BE PRESENT WILL BE REMOVED BY A STANDARD CHERVON AND MOISTURE ELIMINATOR, NOT A HIGH EFFICIENCY MOISTURE ELIMINATOR (HEME). BACK FLUSHING WILL NOT BE PROVIDED

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ASSUME A TEMPERATURE RISE OF 100 DEGREES IS ALLOWED.

ASSUME A HEAT RATE OF 20k BTUH FROM TANK WASTE.

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

K-BASIN CRITIALLY SAFE TANKS
PRECONCEPTUAL VENTILATION
FLOW AND CONTROL DIAGRAM

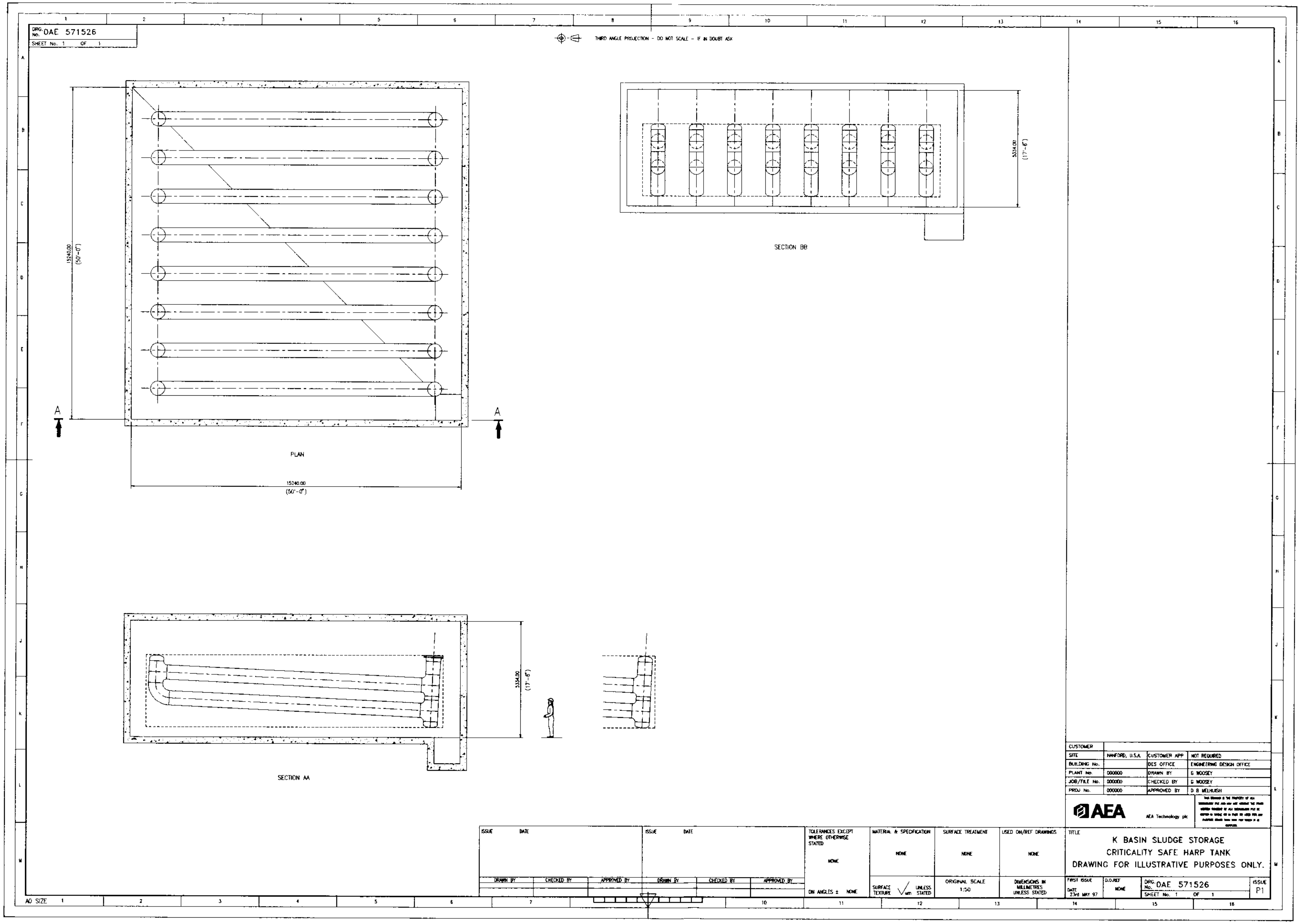
FIGURE 27

DWG NO | TITLE — DRAWING TRACEABILITY LIST
REF NUMBER | TITLE — REFERENCES
NEXT USED ON
REVISIONS
CADFILE | CADCODE
PLOT SCALE:

APPENDIX I

DRAWINGS: AEA TECHNOLOGY PRECONCEPTUAL DESIGNS

(Provided by AEA Technology)



CUSTOMER			
SITE	HANFORD, U.S.A.	CUSTOMER APP	NOT REQUIRED
BUILDING No.		DES OFFICE	ENGINEERING DESIGN OFFICE
PLANT No.	000000	DRAWN BY	G WOOSEY
JOB/FILE No.	000000	CHECKED BY	G WOOSEY
PROJ No.	000000	APPROVED BY	D B MELHUISH

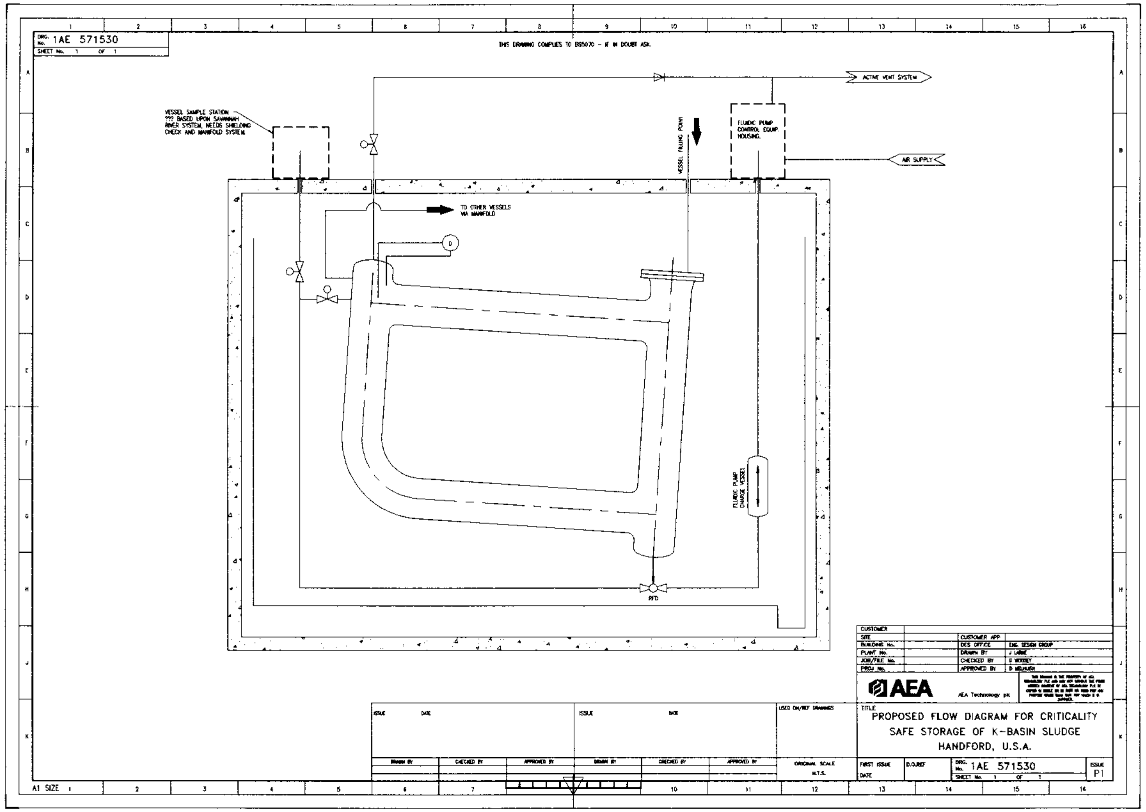
AEA
AEA Technology plc

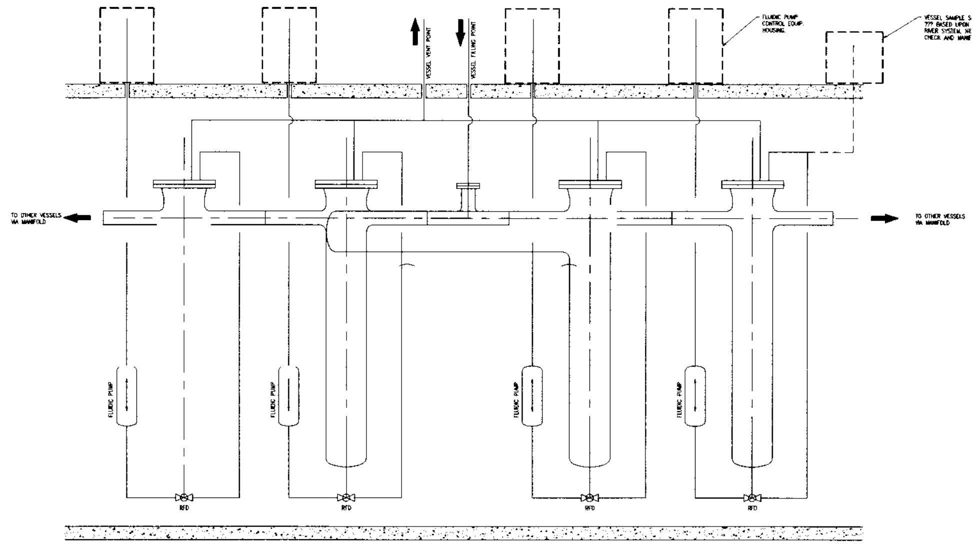
TITLE
K BASIN SLUDGE STORAGE
CRITICALITY SAFE HARP TANK
DRAWING FOR ILLUSTRATIVE PURPOSES ONLY.

TOLERANCES EXCEPT WHERE OTHERWISE STATED	MATERIAL & SPECIFICATION	SURFACE TREATMENT	USED ON/REF DRAWINGS
NONE	NONE	NONE	NONE
ON ANGLES ± NONE	SURFACE TEXTURE √ UNLESS STATED	ORIGINAL SCALE 1:50	DIMENSIONS IN MILLIMETRES UNLESS STATED

FIRST ISSUE DATE	D.O.REF	DRG. No.	ISSUE
23rd MAY 97	NONE	OAE 571526, SHEET No. 1 OF 1	P1

ISSUE	DATE	DRAWN BY	CHECKED BY	APPROVED BY


THIS DRAWING COMPLIES TO BS5070 - IF IN DOUBT ASK.
VESSEL SAMPLE STATION ??? BASED UPON SAVANNAH RIVER SYSTEM. NEEDS SHIELDING CHECK AND MANIFOLD SYSTEM.
ACTIVE VENT SYSTEM
VESSEL FILLING POINT
FLUIDIC PUMP CONTROL EQUIP HOUSING.
AIR SUPPLY
TO OTHER VESSELS VIA MANIFOLD
FLUIDIC PUMP CHARGE VESSEL
RFD
DRG. No. 1AE 571530
SHEET No. 1 OF 1
CUSTOMER
SITE
BUILDING No.
PLANT No.
JOB/FILE No.
PROJ No.
CUSTOMER APP
DES OFFICE ENG. DESIGN GROUP
DRAWN BY J. LAINE
CHECKED BY
APPROVED BY
AEA
AEA Technology plc
TITLE
PROPOSED FLOW DIAGRAM FOR CRITICALITY
SAFE STORAGE OF K-BASIN SLUDGE
HANDFORD, U.S.A.
ORIGINAL SCALE N.T.S.
FIRST ISSUE
DATE
ISSUE P1
A1 SIZE


FLUIDIC PUMP CONTROL EQUIP HOUSING.
VESSEL SAMPLE S ??? BASED UPON RIVER SYSTEM. NE CHECK AND MANI
VESSEL VENT POINT
VESSEL FILLING POINT
TO OTHER VESSELS VIA MANIFOLD
TO OTHER VESSELS VIA MANIFOLD
FLUIDIC PUMP
FLUIDIC PUMP
FLUIDIC PUMP
FLUIDIC PUMP
RFD
RFD
RFD
RFD