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1	1	Cog. Mgr. J. S. Garfield [signature] H5-49			
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Evaluation of Tank Waste Transfers at 241-AW Tank Farm

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EVALUATION OF TANK WASTE TRANSFERS AT 241-AW TANK FARM

May 1998

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CONTENTS

LIST OF TERMS

ALARA	As-low-as-reasonably-achievable
BIO	Basis for Interim Operation
CAS	Condition Assessment Survey
DOE	U.S. Department of Energy
DST	Double-shell tank
ESP	Environmental Simulation Program
GRE	Gas Release Event
HVAC	Heating, ventilating, and air conditioning
I&C	Instrumentation and control
LANL	Los Alamos National Laboratory
LAW	Low-activity waste
M&C	Monitor and control
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPSH	Net Positive Suction Head
PNNL	Pacific Northwest National Laboratory
RAM	Reliability, availability, maintainability
RCRA	*Resource Conservation and Recovery Act of 1976*
TAP	Toxic Air Pollutants
TBD	To be determined
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
WAC	Washington Administrative Code
WFD	Waste Feed Delivery

EVALUATION OF TANK WASTE TRANSFERS AT 241-AW TANK FARM

1.0 INTRODUCTION

A number of waste transfers are needed to process and feed waste to the private contractors in support of Phase 1 Privatization. Other waste transfers are needed to support the 242-A Evaporator, saltwell pumping, and other ongoing Tank Waste Remediation System (TWRS) operations.

1.1 PURPOSE OF EVALUATION

The purpose of this evaluation is to determine if existing or planned equipment and systems are capable of supporting the Privatization Mission of the Tank Farms and continuing operations through the end of Phase 1B Privatization Mission. Projects W-211 and W-314 have been established and will support the privatization effort. Equipment and system upgrades provided by these projects (W-211 and W-314) will also support other ongoing operations in the tank farms. It is recognized that these projects do not support the entire transfer schedule represented in the *Tank Waste Remediation System Operation and Utilization Plan* (TWRSO&UP) (Kirkbride et al. 1997). Additionally, transfers surrounding the 241-AW farm must be considered. This evaluation is provided as information, which will help to define transfer paths required to complete the Waste Feed Delivery (WFD) mission. This document is not focused on changing a particular project, but it is realized that new project work in the 241-AW Tank Farm is required.

1.2 BACKGROUND INFORMATION

The transfers identified in the TWRSO&UP (Kirkbride et al. 1997) have been reviewed and specific transfers were extracted for evaluation. The transfers evaluated either begin or end in one of the six 241-AW tanks. All six of the 241-AW Tank Farm tanks are involved in at least one planned transfer. Approximately 180 separate transfers were identified. Transfer routes are dependent upon the timeframe (i.e., after fiscal year 2000, the new W-314 waste transfer system will be used along with existing pipelines).

From the 180 transfers, 32 different source and receiver tank combinations were identified and engineering judgement was used to postulate transfer routes. In postulating the transfer routes, the most direct 7.6 cm (3-in.) line was used (transfers from the 242A Evaporator to tank 241-AW-106 use 5.1 cm (2-in.) lines). Equipment and systems included in the 32 separate transfer routes were evaluated using the best available drawings and other data obtained from the pump and transfer cognizant engineers, and from project information. At this point in the evaluation missing pieces of the transfer routings such as jumpers in valve or pump pits were identified.

The 180 transfers were then grouped into three categories:

1. **Feed Delivery**. This category includes transfers of diluted supernate, and slurry from tank 241-AW-101 to tanks 241-AP-102/104 and supernate transfers from tank 241-AW-104 to tanks 241-AP-102/104.

2. **Solids Cleanout from Tank 241-SY-102.** This category includes only one transfer from tank 241-SY-102 to tank 241-AW-105. The transfer from tank 241-SY-102 to tank 241-AW-105 includes approximately 4 vol% insoluble solids.

3. **Other Transfers**. This category includes the remaining approximately 175 transfers. Transfers in the "other" category are characterized as supernate transfers expected to contain less than 1 vol% solids.

Each category of transfers involves a different set of requirements as compared to the other two. As an example, tank 241-AW-101 Contains saturated salt solutions, a crust layer on the top of the tank, and a layer of sludge on the bottom of the tank. Dilution studies have not been performed on the tank, but Environmental Simulation Program (ESP)[1] modeling (included in Appendix D) indicates that most of the solids in the tank, both in the crust layer and in the sludge, are soluble. The requirements for waste retrieval from this tank will likely include: mixing the tank contents to degas; adding diluent (raw water) at the pump inlet to prevent solids from precipitating from saturated solution in the transfer line; ensuring that the pump is capable of transferring waste at a velocity of 1.8 to 2.7 m/s (6 to 9 ft/s); and finally adding diluent (raw water) directly to the tank to ensure that as much as possible of the soluble solids are dissolved and removed from the tank. Requirements for the transfers from other tanks evaluated may not include mixing, dilution, or as high of a transfer rate.

A listing of the requirements for each of the three categories was developed using *Performance Requirements for Phase 1 Waste Feed Delivery* (HNF-1985) (Claghorn et al. 1998) for category 1 transfers and engineering judgement for category 2 and 3 transfers identified above.

Pressure drop and flow rate calculations were done for a number of transfer lengths using pump curves for two different pumps and estimated density and viscosity values. These calculations are then used to estimate pressure drops and flow rates for all 32 transfer routes. Tank temperatures were evaluated and precipitation due to temperature drop was estimated for the worst case tank. Based on Calculation No W314-P-006, (A.N. Palit March 12, 1997) a temperature drop of 6°C (10°F) in the transfer lines was used in the evaluation.

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[1]ESP is a trademark of OLI Systems, Inc.

Also included in this evaluation was a review of open issues related to safety and environmental permitting of Tank Farm activities.

1.3 DOCUMENT ORGANIZATION

The main body of this document includes only a summary of the evaluation. Backup information and calculations are contained in the appendices. Section 2.0 contains process and equipment expectations and a summary of identified issues. Section 3.0 provides the conclusions and recommendations.

1.3.1 Road Map to Appendices

Appendix A contains a table listing the 32 transfer routes and the equipment and systems identified for each route. Existing equipment and planned equipment are identified as such and missing equipment is also identified. A sketch of the 241-AW Tank Farm lines including the connections to the 241-AP Valve Pit, 241-A-A Valve Pit, and to the 242-A Evaporator is also included in Appendix A. Missing jumper connections are shown on the sketch as heavy lines. The transfer schedule from the TWRSO&UP (Kirkbride et al. 1997) is also included.

Appendix B contains all of the issues identified in this evaluation. Some of the issues are general in nature and others apply to a few or even only one transfer. An opportunity was also identified in this evaluation, and is included in the issues list. These issues are summarized in Section 2.3.

Appendix C contains a table of process and equipment requirements for each of the three identified categories of transfers. The basis of the requirements, and potential issues are also listed.

Appendix D contains the calculations of pressure drop and flow rates along each of the 32 transfer routes. The section also includes the temperature evaluation.

Appendix E contains the basis and requirements to assign work scope to resolve issues within the AW Tank Farm.

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2.0 PROCESS AND EQUIPMENT EXPECTATIONS

This section is a list of process and equipment expectations. This is a summary and does not list the bases for these expectations. The bases for these expectations are listed in Appendix C. As a summary, this list is not intended to give details. The details for each process or equipment expectation are listed in Appendix C.

2.1 PROCESS EXPECTATIONS

The process expectations are as follows:

- Transfer rates for Phase 1 waste feed delivery and for slurries will be maintained at 1.8 to 2.7 m/sec (6 to 9 ft/sec).
- Temperatures and concentrations will be controlled and maintained during transfers such that no precipitates are formed.
- Supernates will contain no more than 5 vol% suspended solids.
- Solutions transferred to the evaporator will be dilute and will meet evaporator requirements.
- Evaporator will not generate solutions from which solids will form under expected storage conditions.

2.2 EQUIPMENT EXPECTATIONS

The equipment expectations are as follows:

- Tanks from which supernates are to be transferred will have appropriate pumps and ancillary equipment such that solids in solution can be limited to required levels.
- Tanks from which slurries are to be transferred will be equipped with the capability to suspend the settled solids into a slurry, and will have pumps capable of transferring slurries.
- Tanks will be equipped with pumps which are capable of transferring waste at the rate required for the transfer.
- Where necessary, tanks will be equipped with the capability of diluting or heating the waste to ensure that no precipitates are formed during the transfer.

- Tanks will have liquid level measuring capability.
- System will be capable of monitoring tank levels.
- For as-low-as-reasonably-achievable (ALARA) radiation exposure reasons, system will be capable of making routing changes in valve pits without routine pit entry.

2.3 ISSUES

The following issues related to transfers originating or terminating in the 241-AW Tank Farm were identified during this evaluation. Complete descriptions and discussions of these issues are included in Appendix B.

General

- Current risk and RAM analysis efforts are not yet complete.
- Engineering studies that are aimed at optimizing the WFD system are not yet complete.
- The transfer schedule identified in the TWRSO&UP (Kirkbride et al. 1997) reflects staging transfers that are not agreed to by TWRS operations. (Changes to the transfer schedule will occur.)
- The transfer schedule identified in the TWRSO&UP (Kirkbride et al. 1997) reflects transfer rates that cannot be achieved by existing or planned equipment. (The TWRSO&UP will be revised.)
- Dilution/dissolution studies have not been performed for tank 241-AW-101.

Transfer Pumps

- The existing pumps in the AW Farm are either incapable or only marginally capable of delivering feed at the required 1.8 to 2.7 m/s (6 to 9 ft/s) velocity.
- A pump design is needed which allows periodic preventative maintenance (i.e. pump flushing, recirculation, etc.) to improve pump reliability.
- The existing transfer pump in tank 241-AW-104 has failed; work scope and funding to replace the pump have not been identified.

- The existing pumps in most of the tanks are stick type pumps that may not be appropriate for supernate transfers.
- The Design of the Existing Supernate Flex/Float Pumps Causes Pump to Lose Prime if Transfer is Interrupted.

Mixer Pumps

- Crust Softening/Removal Techniques are not Tested.

Transfer Routings

- The current jumper system in valve pits AW-A and AW-B consists of flex and rigid jumpers and is inadequate to support transfers identified in the TWRSO&UP (Kirkbride et al. 1997).
- Current Jumper System in Pump Pit 241-AW-02A lacks the flexibility to support all of the transfers identified in the TWRSO&UP (Kirkbride et al. 1997).
- Line 3-in. SN-219-M25 is not operable due to the existence of potentially leaky cleanout boxes in the line.
- Abandonment of 241-A-A valve pit requires that line LIQW-702 be connected directly to line SN-220.

Regulatory Compliance

- Compliance of the Transfer Lines with Washington Administrative Code (WAC) 173-303, Dangerous Waste Regulations.
- Concrete line encasements are not accepted by the Washington State Department of Ecology as appropriate.
- Ancillary Equipment Secondary Containment may need coatings or liners
- Written Integrity Assessment has not been completed

Safety

- System upgrades may be required to support Authorization Basis/Basis for Interim Operation (BIO)

- It will be difficult to isolate malfunctioning systems from systems which are functioning because the BIO does not accept valves as an appropriate means of isolating active transfer equipment from inactive systems.

Instrumentation/Ancillary Equipment

- Real time automatic liquid level detection is not available in all tanks.
- Equipment/instrument control strategies are not consistent throughout the farms.
- The current system is very complex.
- Integration requirements for new and existing instrumentation and controls have not been established.

Ventilation

- Electrical supply and control circuits to primary fans were identified in 1995 as being in poor condition.
- 241-AW primary ventilation stack will likely require upgrades to provide continuous air emissions monitoring.
- 241-AW primary ventilation system may require emission controls for Toxic Air Pollutants (TAPs).
- 241-AW-101 primary ventilation exhaust has no flow measurement capability.

Electrical

- A 1995 assessment found numerous deficiencies with MCC-241-AW.
- Retrieval systems added to tank 241-AW-101 will add a significant load to the 241-AW farm electrical system.

Utilities

- Transfer line flush water flow requirements have not been established.
- The 241-AW air compressors cycle frequently resulting in early failures

Waste Retrieval

- Process requirements have not been completed for retrieval of waste from 241-AW-101.

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3.0 CONCLUSIONS AND RECOMMENDATIONS

This evaluation has identified a number of questions and issues regarding the capability of the system to support the TWRSO&UP (Kirkbride et al. 1997) identified transfers with existing or planned equipment. Some of the issues such as the failed transfer pump in tank 241-AW-104, and the lack of jumper connections in Valve Pit 241-AW-A/B would need to have already been addressed to support the identified transfers. (Two supernate transfers from AW-104 are scheduled to occur later this calendar year.)

Some of the issues such as the compliance of the existing lines with dangerous waste regulations are already being negotiated. The outcome of these negotiations is uncertain and furthermore the ramifications of negative outcomes are potentially extremely costly in terms of both budget and schedule.

Other issues such as the lack of jumpers in the AW-A and AW-B Valve Pits, and the potentially inappropriate pump types in the AW (and other farms as well) will require work scope and funding to make the necessary modifications.

A much more detailed evaluation of all the transfers should be undertaken as soon as possible. This evaluation has limited its scope to transfers originating or terminating in the 241-AW Tank Farm. The detailed evaluation should look at all transfers through the end of Phase 1 of the Waste Feed delivery mission. The evaluation should produce a complete list of performance requirements for all of the transfers. The evaluators should be given authority to make necessary changes or additions to work scope.

The opportunity of using tank 241-AW-101 as a backup in the case of a component failure in the primary transfer route from tank 241-AN-105 to the Phase 1 waste feed staging tanks should be implemented. This unique opportunity to ensure timely feed delivery and fee avoidance needs to be started now so that the W-211 Project schedule can be adjusted or accelerated as necessary before the 2001 delivery date.

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APPENDIX A

TRANSFERS

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APPENDIX A

TRANSFERS

Appendix A contains a partial list of transfers which are included in the Tank Waste Remediation System Operation and Utilization Plan (TWRSO&UP) (Kirkbride et al. 1997). The transfers listed here are scheduled to begin or end in the 241-AW Tank Farm. The first transfer listed here is scheduled to occur in calendar year 1998. The last transfer listed here is scheduled to occur in 2011. A route for each of the transfer paths was then postulated, and the existence of or plan for all necessary equipment in each transfer route was verified on best available drawings, project documents, and other available information.

Appendix A also includes a sketch of the necessary jumper connections in the AW-A and AW-B valve pits and the 241-AW-102 02A central pump pit.

Table A-1 is a listing of the transfers. Table A-2 is a listing of necessary equipment in each transfer route. Equipment is identified as either existing or planned. Table A-3 is a listing of the pipe material pressure and temperature limitation of the piping in the 241-AW Tank Farm.

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Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
			AW-106	AW-101	3/1/03	3/3/03	550,400	26	
			AW-106	AW-101	7/1/03	7/1/03	34,750	2	
			AW-106	AW-101	1/1/04	1/1/04	746	0	
			AW-106	AW-101	7/1/04	7/1/04	11,151	1	
			AW-106	AW-101	1/1/05	1/1/05	95,306	4	
			AW-106	AW-101	7/1/05	7/1/05	121,700	6	
			AW-106	AW-101	1/1/06	1/1/06	51,422	2	
			AW-106	AW-101	7/1/06	7/1/06	22,041	1	
			AW-106	AW-101	1/1/07	1/1/07	74,822	3	
			AW-106	AW-101	7/1/07	7/1/07	33,387	2	
			AW-106	AW-101	1/1/08	1/1/08	1,111	0	
			AW-106	AW-101	7/1/08	7/1/08	12,300	1	
			AW-106	AW-101	1/1/09	1/1/09	867	0	
			AW-106	AW-101	7/1/09	7/1/09	10,622	0	
			AW-106	AW-101	1/1/10	1/1/10	560	0	
			AW-106	AW-101	7/1/10	7/1/10	16,078	1	
			AW-106	AW-101	1/1/11	1/1/11	1,173	0	
			AW-106	AW-101	7/1/11	7/1/11	0	0	
		Y	AW-101	AP-102	1/9/03	1/13/03	537,200	13,013	Retrieve/Stage LAW Batch 3, Contractor 1, Envelope A
		Y	AW-101	AP-102	1/9/03	1/13/03	845,400	13,013	As-received Ghost
		Y	AW-101	AP-104	1/14/03	1/18/03	537,200	13,013	Retrieve/Stage LAW Batch 3, Contractor 2, Envelope A
		Y	AW-101	AP-104	1/14/03	1/18/03	845,400	13,013	As-received Ghost
			AP-104	AW-102	3/1/98	3/6/98	995,300	34	
			AP-107	AW-102	4/25/98	5/7/98	1,104,000	40	
			EVAPF	AW-102	10/13/98	10/14/98	195,000	0	
			AW-106	AW-102	11/6/98	11/6/98	150,000	6	
			AP-104	AW-102	10/3/98	11/10/98	1,110,000	42	
			AP-107	AW-102	2/15/99	3/9/99	1,095,000	40	
			AP-103	AW-102	7/1/99	7/8/99	1,017,000	44	
Y			EVAPF	AW-102	9/7/99	9/7/99	70,000	0	
		Y	AP-104	AW-102	9/10/99	9/29/99	1,104,000	41	
			AW-106	AW-102	10/6/99	10/7/99	300,000	13	
			AP-107	AW-102	11/1/99	11/8/99	1,110,000	43	
Y			AP-104	AW-102	7/2/00	7/8/00	1,110,000	43	

Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
Y		Y	AP-106	AW-102	10/2/00	10/4/00	474,000	16	
Y		Y	AP-106	AW-102	10/5/00	10/5/00	71,998	2	
Y		Y	AP-106	AW-102	10/6/00	10/6/00	130,000	4	
		Y	AP-106	AW-102	10/7/00	10/7/00	60,191	2	
Y			AW-105	AW-102	10/6/00	10/8/00	414,000	14	
		Y	AP-106	AW-102	10/8/00	10/8/00	0	0	
			AW-105	AW-102	10/9/00	10/10/00	213,100	7	
			AP-106	AW-102	2/7/01	2/7/01	0	0	
			SY-102	AW-102	4/4/01	4/5/01	384,000	16	
			SY-102	AW-102	4/6/01	4/6/01	10,000	0	
			AN-105	AW-102	6/10/01	6/12/01	520,100	21	
			WATER	AW-102	10/19/01	10/19/01	35,000	0	
			EVAPF	AW-102	10/19/01	10/20/01	225,000	0	
			AN-105	AW-102	12/10/01	12/10/01	35,011	1	
			SY-102	AW-102	4/4/02	4/4/02	29,999	1	
			SY-102	AW-102	4/4/02	4/4/02	4,000	0	
			AN-105	AW-102	6/10/02	6/11/02	281,100	10	
			EVAPF	AW-102	9/20/02	9/20/02	50,000	0	
			AN-105	AW-102	12/10/02	12/13/02	681,500	23	
			SY-102	AW-102	4/4/03	4/4/03	29,999	1	
			SY-102	AW-102	4/4/03	4/4/03	4,000	0	
			AN-105	AW-102	6/10/03	6/10/03	0	0	
			EVAPF	AW-102	9/20/03	9/20/03	35,000	0	
			AN-105	AW-102	12/10/03	12/11/03	268,900	9	
			SY-102	AW-102	4/4/04	4/4/04	29,999	1	
			SY-102	AW-102	4/4/04	4/4/04	3,000	0	
			AN-105	AW-102	5/12/04	5/12/04	0	0	
			AN-105	AW-102	6/10/04	6/11/04	231,200	9	
			EVAPF	AW-102	9/20/04	9/20/04	85,000	0	
			AN-105	AW-102	12/10/04	12/11/04	258,900	9	
			AN-105	AW-102	5/21/05	5/25/05	772,500	13,977	
			AN-105	AW-102	6/10/05	6/12/05	390,600	14	
			EVAPF	AW-102	9/20/05	9/20/05	35,000	0	
			AN-105	AW-102	12/10/05	12/12/05	581,100	20	
			AN-105	AW-102	6/10/06	6/14/06	872,900	30	
			AN-105	AW-102	12/10/06	12/12/06	431,900	15	
			SY-102	AW-102	4/4/07	4/4/07	29,195	1	
			AN-105	AW-102	6/10/07	6/10/07	0	0	

Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
			EVAPF	AW-102	9/20/07	9/20/07	35,000	0	
			AN-105	AW-102	12/10/07	12/11/07	259,900	9	
			SY-102	AW-102	4/4/08	4/4/08	29,999	1	
			AN-105	AW-102	6/10/08	6/10/08	0	0	
			EVAPF	AW-102	9/20/08	9/20/08	85,000	0	
			AN-105	AW-102	12/10/08	12/11/08	259,900	9	
			SY-102	AW-102	4/4/09	4/4/09	29,999	1	
			AN-105	AW-102	6/10/09	6/10/09	0	0	
			EVAPF	AW-102	9/20/09	9/20/09	35,000	0	
			AN-105	AW-102	12/10/09	12/11/09	270,900	9	
			SY-102	AW-102	4/4/10	4/4/10	29,999	1	
			AN-105	AW-102	6/10/10	6/10/10	0	0	
			EVAPF	AW-102	9/20/10	9/20/10	85,000	0	
			EVAPF	AW-102	10/19/10	10/19/10	35,000	0	
			AN-105	AW-102	12/10/10	12/11/10	285,900	10	
			SY-102	AW-102	4/4/11	4/4/11	29,360	640	
			AN-105	AW-102	6/10/11	6/10/11	50,020	2	
			AW-102	242-A	4/5/98	4/9/98	995,300	35	
			AW-102	242-A	5/5/98	5/10/98	1,104,000	39	
			AW-102	AW-106	10/28/98	10/28/98	150,000	6	
			AW-102	242-A	11/5/98	11/10/98	1,195,000	46	
			AW-102	242-A	3/5/99	3/10/99	1,130,000	36	
			AW-102	242-A	7/5/99	7/9/99	979,200	36	
			AW-102	AW-106	9/22/99	9/23/99	300,000	12	
			AW-102	242-A	10/5/99	10/10/99	1,139,000	45	
			AW-102	242-A	11/5/99	11/10/99	1,110,000	34	
			AW-102	242-A	7/6/00	7/11/00	1,145,000	36	
			AW-102	242-A	10/5/00	10/12/00	1,476,000	52	
			AW-102	242-A	6/1/01	6/3/01	394,000	16	
			AW-102	242-A	12/1/01	12/4/01	780,100	30	
			AW-102	242-A	6/1/02	6/1/02	69,010	3	
			AW-102	242-A	12/1/02	12/3/02	331,100	11	
			AW-102	242-A	6/1/03	6/4/03	715,500	24	
			AW-102	242-A	12/1/03	12/1/03	35,011	1	
			AW-102	242-A	6/1/04	6/2/04	301,900	10	
			AW-102	242-A	12/1/04	12/2/04	316,200	12	
			AW-102	242-A	6/1/05	6/5/05	872,800	31	

Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
			AW-102	242-A	11/22/05	11/25/05	425,600	15	
			AW-102	242-A	12/1/05	12/1/05	0	0	
			AW-102	242-A	6/1/06	6/4/06	581,100	20	
			AW-102	242-A	12/1/06	12/5/06	872,900	30	
			AW-102	242-A	6/1/07	6/3/07	461,100	16	
			AW-102	242-A	12/1/07	12/1/07	35,013	1	
			AW-102	242-A	6/1/08	6/2/08	289,900	10	
			AW-102	242-A	12/1/08	12/1/08	85,032	3	
			AW-102	242-A	6/1/09	6/2/09	289,900	10	
			AW-102	242-A	12/1/09	12/1/09	35,013	1	
			AW-102	242-A	6/1/10	6/2/10	300,900	10	
			AW-102	242-A	12/1/10	12/2/10	120,000	4	
			AP-101	AW-103	8/6/98	8/9/98	625,000	27	
			AN-103	AW-103	1/18/05	1/18/05	3,897	103	
			AP-101	AW-104	10/21/98	10/23/98	460,000	20	
			AW-106	AW-104	4/5/99	4/5/99	136,800	6	
			AW-106	AW-104	10/12/99	10/12/99	111,000	5	
			AN-103	AW-104	1/17/05	1/18/05	17,750	468	
			AW-104	AP-107	10/10/98	10/12/98	540,000	18	
			AW-104	AP-104	10/14/98	10/14/98	164,000	6	
			1NS96	AW-105	9/18/00	9/18/00	15,002	4,998	
			WATER	AW-105	9/18/00	9/18/00	174,000	0	
			1FL96	AW-105	9/18/00	9/19/00	53,000	0	
			1KL96	AW-105	9/18/00	9/19/00	332,000	0	
	Y		AZ-101	AW-105	10/10/00	10/10/00	142,500	0	First Wash Decant 1AZ
	Y		AZ-101	AW-105	11/30/00	12/1/00	140,200	0	Second Wash Decant 1AZ
	Y		AZ-101	AW-105	1/21/01	1/21/01	142,900	0	Third Wash Decant 1AZ
			WATER	AW-105	9/19/04	9/20/04	88,000	0	
			1FL96	AW-105	9/19/04	9/20/04	200,000	0	
		Y	SY-102	AW-105	1/1/06	1/3/06	580,400	22,129	Clean out Solids in 2SY
			AN-103	AW-105	4/2/06	4/4/06	458,900	12,056	
			AW-105	AW-102	10/6/00	10/8/00	414,000	14	

Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
			AW-105	AW-102	10/9/00	10/10/00	213,100	7	
			AW-105	AN-105	12/15/05	12/18/05	713,900	25	
			AW-105	AN-105	3/1/06	3/2/06	321,000	11	
			242-A	AW-106	4/5/98	4/9/98	168,500	35	
			242-A	AW-106	5/5/98	5/10/98	441,000	39	
			AW-102	AW-106	10/28/98	10/28/98	150,000	6	
			242-A	AW-106	11/5/98	11/10/98	585,000	46	
			242-A	AW-106	3/5/99	3/10/99	360,900	36	
			242-A	AW-106	7/5/99	7/9/99	891,000	36	
			AW-102	AW-106	9/22/99	9/23/99	300,000	12	
			242-A	AW-106	10/5/99	10/10/99	432,200	45	
			242-A	AW-106	11/5/99	11/10/99	732,200	34	
			242-A	AW-106	7/6/00	7/11/00	778,300	36	
			242-A	AW-106	10/5/00	10/12/00	87,361	52	
			242-A	AW-106	6/1/01	6/3/01	211,900	16	
			242-A	AW-106	12/1/01	12/4/01	282,600	30	
			242-A	AW-106	6/1/02	6/1/02	21,399	3	
			242-A	AW-106	12/1/02	12/3/02	34,737	11	
			242-A	AW-106	6/1/03	6/4/03	34,944	24	
			242-A	AW-106	12/1/03	12/1/03	756	1	
			242-A	AW-106	6/1/04	6/2/04	11,234	10	
			242-A	AW-106	12/1/04	12/2/04	95,369	12	
			242-A	AW-106	6/1/05	6/5/05	121,900	31	
			242-A	AW-106	11/22/05	11/25/05	51,529	15	
			242-A	AW-106	12/1/05	12/1/05	0	0	
			242-A	AW-106	6/1/06	6/4/06	22,200	20	
			242-A	AW-106	12/1/06	12/5/06	75,050	30	
			242-A	AW-106	6/1/07	6/3/07	33,509	16	
			242-A	AW-106	12/1/07	12/1/07	1,120	1	
			242-A	AW-106	6/1/08	6/2/08	12,379	10	
			242-A	AW-106	12/1/08	12/1/08	891	3	
			242-A	AW-106	6/1/09	6/2/09	10,702	10	
			242-A	AW-106	12/1/09	12/1/09	570	1	
			242-A	AW-106	6/1/10	6/2/10	16,159	10	
			242-A	AW-106	12/1/10	12/2/10	1,207	4	
			AW-106	AP-105	6/3/98	6/4/98	341,000	16	

Table A-1. Transfers. (6 Sheets)

Boot Strap	HLW Flag	LAW Flag	From	To	Start Date	End Date	Liquid (gal)	Solid (gal)	Comments
			AW-106	AP-101	10/27/98	10/28/98	289,000	13	
			AW-106	AW-102	11/6/98	11/6/98	150,000	6	
			AW-106	AP-101	12/1/98	12/3/98	563,900	25	
			AW-106	AP-101	4/3/99	4/4/99	224,000	10	
			AW-106	AW-104	4/5/99	4/5/99	136,800	6	
			AW-106	AN-106	7/20/99	7/23/99	748,000	33	
			AW-106	AP-108	7/25/99	7/25/99	143,000	6	
			AW-106	AW-102	10/6/99	10/7/99	300,000	13	
			AW-106	AW-104	10/12/99	10/12/99	111,000	5	
			AW-106	AN-101	10/13/99	10/14/99	321,000	16	
			AW-106	AN-101	12/12/99	12/15/99	732,200	33	
			AW-106	AP-107	9/14/00	9/18/00	778,200	34	
			AW-106	AP-107	11/3/00	11/3/00	86,999	5	

HLW = High-level waste
LAW = Low-activity waste.

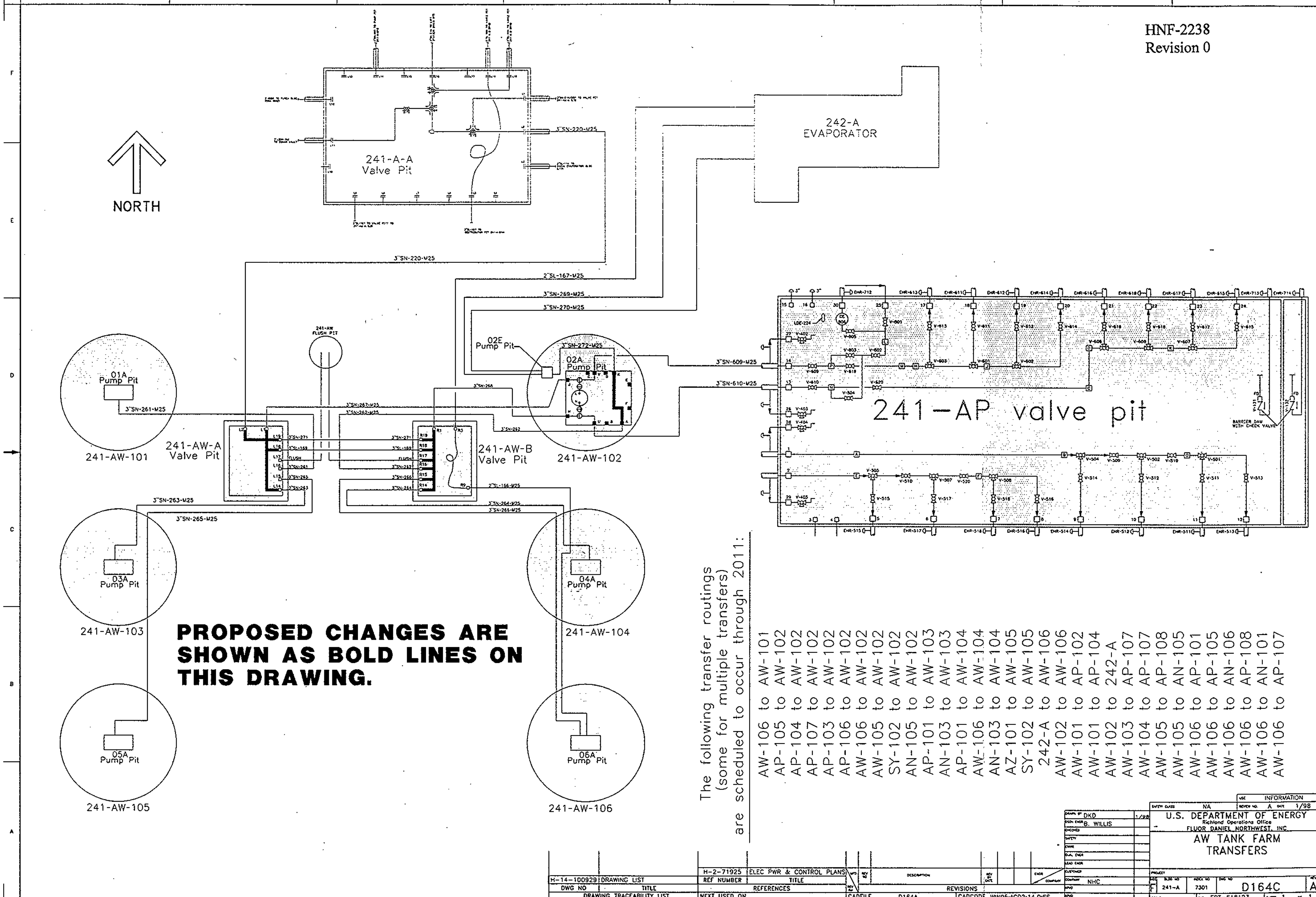
NORTH
241-A-A
Valve Pit
242-A
EVAPORATOR
3"SN-220-M25
2"SL-167-M25
3"SN-269-M25
3"SN-270-M25
02E
Pump Pit
02A
Pump Pit
3"SN-272-M25
3"SN-609-M25
3"SN-610-M25
241-AP valve pit
BARRIER DAM WITH CHECK VALVE
241-AW FLUSH PIT
01A
Pump Pit
3"SN-261-M25
241-AW-101
241-AW-A
Valve Pit
241-AW-B
Valve Pit
241-AW-102
3"SN-263-M25
3"SN-265-M25
2"SL-166-M25
3"SN-264-M25
3"SN-266-M25
03A
Pump Pit
241-AW-103
04A
Pump Pit
241-AW-104
05A
Pump Pit
241-AW-105
06A
Pump Pit
241-AW-106
PROPOSED CHANGES ARE SHOWN AS BOLD LINES ON THIS DRAWING.
The following transfer routings
(some for multiple transfers)
are scheduled to occur through 2011:
AW-106 to AW-101
AP-105 to AW-102
AP-104 to AW-102
AP-107 to AW-102
AP-103 to AW-102
AP-106 to AW-102
AW-106 to AW-102
AW-105 to AW-102
SY-102 to AW-102
AN-105 to AW-102
AP-101 to AW-103
AN-103 to AW-103
AP-101 to AW-104
AW-106 to AW-104
AN-103 to AW-104
AZ-101 to AW-105
SY-102 to AW-105
242-A to AW-106
AW-102 to AW-106
AW-101 to AP-102
AW-101 to AP-104
AW-102 to 242-A
AW-103 to AP-107
AW-104 to AP-107
AW-105 to AP-108
AW-105 to AN-105
AW-106 to AP-101
AW-106 to AP-105
AW-106 to AN-106
AW-106 to AP-108
AW-106 to AN-101
AW-106 to AP-107
U.S. DEPARTMENT OF ENERGY
Richland Operations Office
FLUOR DANIEL NORTHWEST, INC.
AW TANK FARM
TRANSFERS
DKD
B. WILLIS
NHC
NA
1/98
241-A
7301
D164C
A
EDT-618123
H-14-100929 DRAWING LIST
DRAWING TRACEABILITY LIST
H-2-71925 ELEC PWR & CONTROL PLANS
REFERENCES
D164A
CADCODE WIN95:ACD2:14.0:SS
PLOT SCALE: NTS
H-14-100935

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
242-A to AW-106 (1998-2010)	242-A to 2-in. line SL-167 to Valve Pit AW-B nozzle R3	2-in. slurry transfer line	Yes (2-in. SL-167-M25)		N/A		H-14-020802 SH 5
	Valve Pit AW-B nozzle R3 via flex jumper to Valve Pit AW-B nozzle R9	flex jumper from nozzle R3 to nozzle R9	Yes (flex jumper shown on routing board, no id number)		N/A		Routing Board
	Valve Pit nozzle R9 line 2-in. SL-166 to AW 106 Pump Pit AW-06A nozzle B	2-in. slurry transfer line	Yes (2-in. SL-166-M25)		N/A		H-14-020802 SH 3
	Pump pit AW-06A nozzle B to slurry distributor and into Tank 106-AW	Jumper from nozzle B to slurry distributor	Yes		N/A		H-14-020802 SH 3
AW-102 to 242-A (1998-2010)	Pump P-007 to nozzle B (AW-102, pump pit AW-02E)	Jumper or manifold from P-007 to nozzle B	Yes		N/A		H-14-020080 SH 2
	Nozzle B to 3-in. line SN-269 to 242-A	3-in. transfer line	Yes		N/A		H-14-020080 SH 2
AZ-101 to AW-105 (2000-2001)	Pump P-AZ-101 to nozzle U6 (AZ-101, pump pit AZ-01A)	Jumper or manifold from pump P-AZ-101 to nozzle U6		No	Yes (W-314)		W-314 Alternatives Analysis
	Nozzle U6 to 3-in. line AZ01A/NVP to valve pit NVP nozzle B	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve Pit NVP nozzle B to nozzle E	Jumper or manifold from nozzle B to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve Pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AZ-101 to AW-105 (2000-2001) (Continued)	241-AP valve pit nozzle 15 to nozzle 14	Jumper or manifold from nozzle 15 to 14		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 14 to 3-in. line SN-609 to pump pit AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle V to nozzle J	Jumper or manifold from nozzle V to nozzle J	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle J to 3-in. line SN-267 to 241-AW-A valve pit nozzle L1	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	241-AW-A valve pit nozzle L1 to nozzle L15	Jumper or manifold from nozzle L1 to L15		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L15 to 3-in. line SN-265 to AW-105 pump pit AW-05A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-05A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 1
AN-103 to AW-104 (2006)	SN pump P-007 to nozzle A (AN-103, pump pit-AN-03A)	Jumper or manifold from P-007 to nozzle A		No	Yes (W-211)		WHC-SD-W211-TDR-001
	Nozzle A to 3-in. line SN-263 to 241-AN-B valve pit nozzle R14	3-in. transfer line	Yes		N/A		H-14-020801 SH 2

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AN-103 to AW-104 (2006) (continued)	241-AN-B valve pit nozzle R14 to nozzle R15	Jumper or manifold from nozzle R14 to nozzle R15		No	Yes (W-314)		ES-314E-M40
	241-AN-B valve pit nozzle R15 to 3-in. line SN-261 to pump pit AN-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH 6
	Pump pit AN-01A nozzle A to nozzle D	Jumper or manifold from nozzle A to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle A to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 15 to nozzle 13	Jumper or manifold from nozzle 15 to nozzle 13		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 13 to 3-in. line SN-610 to pump pit AW-02A nozzle U	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit AW-02A nozzle U to nozzle H	Jumper or manifold from nozzle U to nozzle H	Yes		N/A		H-14-020802 SH 2
	Pump pit AW-02A nozzle H to 3-in. line SN-268 to 241-AW-B valve pit nozzle R1	3-in. transfer line	Yes		N/A		H-14-020802 SH 4

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AN-103 to AW-104 (continued)	241-AW-B valve pit nozzle R1 to nozzle R14	Jumper or manifold from nozzle R1 to nozzle R14		No		No	H-14-020802 SH 4
	241-AW-B nozzle R14 to 3-in. line SN-264 to AW-104 pump pit AW-04A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-04A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 5
AN-103 to AW-103 (2005)	SN pump P-007 to nozzle A (AN-103, pump pit-AN-03A)	Jumper or manifold from P-007 to nozzle A		No	Yes (W211)		WHC-SD-W211-TDR-001
	Nozzle A to 3-in. line SN-263 to 241-AN-B valve pit nozzle R14	3-in. transfer line	Yes		N/A		H-14-020801 SH 2
	241-AN-B valve pit nozzle R14 to nozzle R15	Jumper or manifold from nozzle R14 to nozzle R15		No	Yes (W-314)		ES-314E-M40
	241-AN-B valve pit nozzle R15 to 3-in. line SN-261 to pump pit AN-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH 6
	Pump pit AN-01A nozzle A to nozzle D	Jumper or manifold from nozzle A to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle A to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AN-103 to AW-103 (2005) (continued)	Valve pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 15 to nozzle 14	Jumper or manifold from nozzle 15 to nozzle 14		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 14 to 3-in. line SN-609 to pump pit AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit AW-02A nozzle V to nozzle J	Jumper or manifold from nozzle V to nozzle J	Yes		N/A		H-14-020802 SH 2
	Pump pit AW-02A nozzle J to 3-in. line SN-267 to 241-AW-A valve pit nozzle L1	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	241-AW-A valve pit nozzle L1 to nozzle L14	Jumper or manifold from nozzle L1 to nozzle L14		No		No	H-14-020802 SH 4
	241-AW-A nozzle L14 to 3-in. line SN-263 to AW-103 pump pit AW-03A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-03A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G		No		No	H-14-020802 SH 5
AW-106 to AP-101 (1998-1999)	SN pump P-017 to nozzle A (AW-106, pump pit-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AP-101 (1998-1999) (Continued)	241-AW-B valve pit nozzle R15 to nozzle R1	Jumper or manifold from nozzle R15 to nozzle R1	Yes		N/A		Routing Board
	241-AW-B valve pit nozzle R1 to 3-in. line SN-268 to AW-102 pump pit-AW-02A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	Pump pit-AW-02A nozzle H to nozzle U	Jumper or manifold from nozzle H to nozzle U	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle U to 3-in. line SN-610 to 241-AP valve pit nozzle 13	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP valve pit nozzle 13 to nozzle 18	Jumper or manifold from nozzle 14 to nozzle 18	Yes		N/A		H-14-020803 Sh 5
	241-AP valve pit nozzle 18 to 3' line SN-611 to AP-101 pump pit-AP-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020803 Sh 5
	Pump pit-AP-01A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020803 Sh 1
AN-105 to AW-102 (2003-2009)	SN pump P-013 to nozzle A (AN-105, pump pit-AN-05A)	Jumper or manifold from P-013 to nozzle A		No	Yes (W211)		WHC-SD-W211-TDR-001
	Nozzle A to 3-in. line SN-265 to 241-AN-A valve pit nozzle L16	3-in. transfer line	Yes		N/A		H-14-020801 SH 2
	241-AN-A valve pit nozzle L16 to nozzle L19	Jumper or manifold from nozzle L16 to nozzle L19		No	Yes (W-314)		ES-314E-M40

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AN-105 to AW-102 (2003-2009) (continued)	241-AN-A valve pit nozzle L19 to 3-in. line SN-268 to 241-AN-B valve pit nozzle R19	3-in. transfer line	Yes		N/A		H-14-020801 SH 5
	241-AN-B valve pit nozzle R19 to nozzle R15	Jumper or manifold from nozzle R14 to nozzle R15		No	Yes (W-314)		ES-314E-M40
	241-AN-B valve pit nozzle R15 to 3-in. line SN-261 to pump pit AN-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH 6
	Pump pit AN-01A nozzle A to nozzle D	Jumper or manifold from nozzle A to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle A to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 15 to nozzle 13	Jumper or manifold from nozzle 15 to nozzle 13		No	Yes (W-314)		W-314 Alternatives Analysis
	AP valve pit nozzle 13 to 3-in. line SN-610 to pump pit AW-02A nozzle U	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit AW-02A nozzle U to tank return nozzle L	Jumper or manifold from nozzle U to nozzle L	Yes		N/A		H-14-020802 SH 2

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AP-107 (2000)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R1	Jumper or manifold from nozzle R15 to nozzle R1	Yes		N/A		H-14-020802 SH 5
	241-AW-B valve pit nozzle R1 to 3-in. line SN-268 to AW-102 pump pit-AW-02A nozzle 14	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle H to nozzle U	Jumper or manifold from nozzle H to nozzle U	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle U to 3-in. line SN-610 to 241-AP-valve pit nozzle 13	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP-valve pit nozzle 13 to nozzle 23	Jumper or manifold from nozzle 1 to nozzle 23	Yes		N/A		H-14-020803 SH 5
	241-AP-valve pit nozzle 23 to 3-in. line SN-617 to AP-107 pump pit-AP-07A nozzle A	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AP-07A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020803 SH 2
AW-106 to AP-108 (1999)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AP-108 (1999) (Continued)	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R16	Jumper or manifold from nozzle R15 to nozzle R16	Yes		N/A		H-14-020802 SH 6
	241-AW-B valve pit nozzle R16 to 3-in. line SN-262 to AW-102 pump pit-AW-02A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 6
	Pump pit-AW-02A nozzle A to nozzle V	Jumper or manifold from nozzle A to nozzle V	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle V to 3-in. line SN-609 to 241-AP-valve pit nozzle 14	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP-valve pit nozzle 14 to nozzle 22	Jumper or manifold from nozzle 14 to nozzle 22	Yes		N/A		H-14-020803 SH 5
	241-AP-valve pit nozzle 22 to 3-in. line SN-618 to AP-108 pump pit-AP-08A nozzle A	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit AP-08A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020803 SH 4
AW-106 to AP-105 (1998)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AP-105 (1998) (Continued)	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R1	Jumper or manifold from nozzle R15 to nozzle R1	Yes		N/A		H-14-020802 SH 6
	241-AW-B valve pit nozzle R1 to 3-in. line SN-268 to AW-102 pump pit-AW-02A nozzle H	3-in. transfer line	Yes		N/A		H-14-020802 SH 6
	Pump pit-AW-02A nozzle H to nozzle U	Jumper or manifold from nozzle H to nozzle U	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle H to 3-in. line SN-610 to 241-AP-valve pit nozzle 13	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP-valve pit nozzle 13 to nozzle 24	Jumper or manifold from nozzle 13 to nozzle 24	Yes		N/A		H-14-020803 SH 5
	241-AP-valve pit nozzle 24 to 3-in. line SN-615 to AP-105 pump pit-AP05A nozzle A	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AP-05A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020803 SH 2
AW-104 to AP-107 (1998)	SN pump P-011 to nozzle A (AW-104, pump pit-AW-04A)	Jumper or manifold from P-011 to nozzle A	Yes (Pump failed)		N/A		H-14-020802 SH 3
	Nozzle A to 3-in. line SN-264 to 241-AW-B valve pit nozzle R14	3-in. transfer line	Yes		N/A		H-14-020802 SH 3

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-104 to AP-107 (1998) (Continued)	241-AW-B valve pit nozzle R14 to nozzle R1	Jumper or manifold from nozzle R14 to nozzle R1		No		No	H-14-020802 SH 4
	241-AW-B valve pit nozzle R1 to 3-in. line SN-268 to AW-102 pump pit-AW-02A nozzle H	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle H to nozzle U	Jumper or manifold from nozzle H to nozzle U	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle U to 3-in. line SN-610 to 241-AP-valve pit nozzle 14	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP-valve pit nozzle 14 to nozzle 23	Jumper or manifold from nozzle 14 to nozzle 23	Yes		N/A		H-14-020803 SH 4
	241-AP-valve pit nozzle 23 to 3-in. line SN-617 to AP-107 pump pit-AP-07A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit-AP-07A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020802 SH 2
AP-101 to AW-104 (1998)	SN pump P-001 to nozzle A (AP-101, pump pit-AP-01A)	Jumper or manifold from P-001 to nozzle A	Yes		N/A		H-14-020803 SH 1
	Pump pit-AP-01A nozzle A to 3-in. line SN-611 to 241-AP-valve pit nozzle 18	3-in. transfer line	Yes		N/A		H-14-020803 SH 1
	241-AP-valve pit nozzle 18 to nozzle 13	Jumper or manifold from nozzle 18 to nozzle 13	Yes		N/A		H-14-020803 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AP-101 to AW-104 (1998) (Continued)	241-AP-valve pit nozzle 13 to 3-in. line SN-610 to AW-102 pump pit-AW-02A nozzle U	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AW-02A nozzle U to nozzle H	Jumper or manifold from nozzle V to nozzle A	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle H to 3-in. line SN-268 to 241-AW-B valve pit nozzle R1	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AW-B valve pit nozzle R1 to nozzle R14	Jumper or manifold from nozzle R1 to nozzle R14		No		No	H-14-020802 SH 5
	241-AW-B valve pit nozzle R14 to 3-in. line SN-264 to AW-104 pump pit-AW-04A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	Pump pit-AW-04A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 3
AP-101 to AW-103 (1998)	SN pump P-001 to nozzle A (AP-101, pump pit-AP-01A)	Jumper or manifold from P-001 to nozzle A	Yes		N/A		H-14-020803 SH 1
	Pump pit-AP-01A nozzle A to 3-in. line SN-611 to 241-AP-valve pit nozzle 18	3-in. transfer line	Yes		N/A		H-14-020803 SH 1
	241-AP-valve pit nozzle 18 to nozzle 14	Jumper or manifold from nozzle 18 to nozzle 14	Yes		N/A		H-14-020803 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AP-101 to AW-103 (1998) (Continued)	241-AP-valve pit nozzle 14 to 3-in. line SN-609 to AW-102 pump pit-AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AW-02A nozzle V to nozzle J	Jumper or manifold from nozzle V to nozzle J	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02A nozzle J to 3-in. line SN-267 to 241-AW-A valve pit nozzle L1	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AW-A valve pit nozzle L1 to nozzle L14	Jumper or manifold from nozzle L1 to nozzle L14		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L14 to 3-in. line SN-263 to AW-103 pump pit-AW-03A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit-AW-03A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 3
AP-106 to AW-102 (2000)	SN pump P-006 to nozzle A (AP-106, pump pit-AP-06A)	Jumper or manifold from P-006 to nozzle A	Yes		N/A		H-14-020803 SH 4
	Nozzle A to 3-in. line SN-616 to 241-AP-valve pit nozzle 21	3-in. transfer line	Yes		N/A		H-14-020803 SH 4
	241-AP-valve pit nozzle 21 to nozzle 14	Jumper or manifold from nozzle 21 to nozzle 14	Yes		N/A		H-14-020803 SH
	241-AP-valve pit nozzle 14 to 3-in. line SN-609 to AW-102 pump pit-AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020802 SH 2

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AP-106 to AW-102 (2000) (Continued)	Pump pit-AW-02A nozzle V to tank return nozzle L	Jumper or manifold from nozzle V to nozzle L	Yes		N/A		H-14-020802 SH 2
AP-103 to AW-102 (1999)	SN pump P-003 to nozzle A (AP-103, pump pit-AP-03A)	Jumper or manifold from P-003 to nozzle A	Yes		N/A		H-14-020803 SH 1
	Nozzle A to 3-in. line SN-613 to 241-AP-valve pit nozzle 17	3-in. transfer line	Yes		N/A		H-14-020803 SH 4
	241-AP-valve pit nozzle 17 to nozzle 14	Jumper or manifold from nozzle 17 to nozzle 14	Yes		N/A		H-14-020803 SH 5
	241-AP-valve pit nozzle 14 to 3-in. line SN-609 to AW-102 pump pit-AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AW-02A nozzle V to tank return nozzle L	Jumper or manifold from nozzle V to nozzle L	Yes		N/A		H-14-020802 SH 2
AP-107 to AW-102 (1998-1999)	SN pump P-007 to nozzle A (AP-107, pump pit-AP-07A)	Jumper from P-007 to nozzle A	Yes		N/A		H-14-020803 SH 2
	Nozzle A to 3-in. line SN-617 to 241-AP-valve pit nozzle 23	3-in. transfer line	Yes		N/A		H-14-020803 SH 2
	241-AP-valve pit nozzle 23 to nozzle 14	Jumper or manifold from nozzle 23 to nozzle 14	Yes		N/A		H-14-020803 SH 5
	241-AP-valve pit nozzle 14 to 3-in. line SN-609 to AW-102 pump pit-AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020803 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AP-107 to AW-102 (1998-1999) (continued)	Pump pit-AW-02A nozzle V to tank return nozzle L	Jumper or manifold from nozzle V to nozzle L	Yes		N/A		H-14-020802 SH 2
AW-106 to AW-102 (1998)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R11	Jumper or manifold from nozzle R15 to nozzle R11	Yes		N/A		H-14-020802 SH 5
	241-AW-B valve pit nozzle R1 to 3-in. line SN-268 to AW-102 pump pit-AW-02A nozzle H	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	Pump pit-AW-02A nozzle H to tank return nozzle N	Jumper or manifold from nozzle H to nozzle N	Yes		N/A		H-14-020802 SH 2
AW-106 to AW-104 (1999)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R14	Jumper or manifold from nozzle R15 to nozzle R14		No		No	H-14-020802 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AW-104 (1999) (Continued)	241-AW-B valve pit nozzle R14 to 3-in. line SN-264 to AW-104 pump pit-AW-04A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	Pump pit-AW-04A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 3
AW-102 to AW-106 (1998-1999)	SN pump P-007 to nozzle D (AW-102, pump pit-AW-02E)	Jumper or manifold from P-007 to nozzle D	Yes		N/A		H-14-020802 Sh 2
	Nozzle D to 3-in. line SN-272 to pump pit-AW-02A nozzle K	3-in. transfer line	Yes		N/A		H-14-020802 Sh 2
	Pump pit-AW-02A nozzle K to nozzle A	Jumper or manifold from nozzle K to nozzle A		No		No	H-14-020802 Sh 2
	Pump pit-AW-02A nozzle A to 3-in. line SN-262 to 241-AW-B valve pit nozzle R16	3-in. transfer line	Yes		N/A		H-14-020802 Sh 2
	241-AW-B valve pit nozzle R16 to nozzle R15	Jumper or manifold from nozzle R16 to nozzle R15		No		No	H-14-020802 Sh 5
	241-AW-B valve pit nozzle R15 to 3-in. line SN-266 to AW-106 pump pit-AW-06A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 Sh 5
	Pump pit-AW-06A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G		No		No	H-14-020802 Sh 3

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AW-101 (2003-2006)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Pump pit-AW-06A nozzle A to 3' line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R18	Jumper or manifold from nozzle R15 to nozzle R18		No		No	H-14-020802 SH 5
	241-AW-B valve pit nozzle R18 to 3-in. line SL-169 to 241-AW-A valve pit nozzle L18	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	241-AW-A valve pit nozzle L18 to nozzle L16	Jumper or manifold from nozzle L18 to nozzle L16		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L16 to 3-in. line SN-261 to AW-101 pump pit-AW-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	AW-101 pump pit AW-01A nozzle A to slurry distributor	Jumper or manifold from nozzle A to slurry dist	Yes		N/A		H-14-020802 SH 1
AP-104 to AW-102 (1998-2000)	SN pump P-004 to nozzle A (AP-104, pump pit-AP-04A)	Jumper or manifold from P-004 to nozzle A	Yes		N/A		H-14-020803 SH 3
	Nozzle A to 3-in. line SN-614 to 241-AP valve pit nozzle 20	3-in. transfer line	Yes		N/A		H-14-020803 SH 3
	241-AP valve pit nozzle 20 to nozzle 14	Jumper or manifold from nozzle 20 to nozzle 14	Yes		N/A		H-14-020803 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AP-104 to AW-102 (1998-2000) (Continued)	241-AP-valve pit nozzle 14 to 3-in. line SN-609 to AW-102 pump pit-AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020803 SH 5
	Pump pit-AW-02A nozzle V to tank return nozzle L	Jumper or manifold from nozzle V to nozzle L	Yes		N/A		H-14-020802 SH 2
AW-101 to AP-104 (2003)	SN pump P-001 to nozzle A (AW-101, pump pit-AW-01A)	Jumper or manifold from P-001 to nozzle A		No	Yes (W-211)		WHC-SD-W211-TDR-001
	Nozzle A to 3-in. line SN-261 to 241-AW-A valve pit nozzle L16	3-in. transfer line	Yes		N/A		H-14-020802 SH 1
	241-AW-A valve pit nozzle L16 to nozzle L1	Jumper or manifold from nozzle L16 to nozzle L1		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L1 to 3-in. line SN-267 to nozzle J	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit-AW-02A nozzle J to nozzle V	Jumper or manifold from nozzle J to nozzle V	Yes		N/A		H-14-020802 SH 2
	Pump pit-AW-02E nozzle V to 3-in. line SN-609 to 241-AP valve pit nozzle 14	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	241-AP valve pit nozzle 14 to nozzle 20	Jumper or manifold from nozzle 14 to nozzle 20	Yes		N/A		H-14-020802 SH 2
	241-AP valve pit nozzle 20 to 3-in. line SN-614 to AP-104 pump pit-AP-04A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 2

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-101 to AP-104 (2003) (Continued)	Pump pit-AP-04A nozzle A to tank return nozzle E	Jumper or manifold from nozzle A to nozzle E	Yes		N/A		H-14-020803 SH 3
AW-106 to AN-101 (1999)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B valve pit nozzle R15 to nozzle R19	Jumper or manifold from nozzle R15 to nozzle R19		No		No	H-14-020802 SH 5
	241-AW-B pit nozzle R19 to 3-in. line SN-271 to 241-AW-A nozzle L19	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	241-AW-A pit nozzle L19 to nozzle L2	Jumper or manifold from nozzle L19 to nozzle L2		No		No	H-14-020802 SH 4
	241-AW-A pit nozzle L2 to 3-in. line SN-220 to 241-A-A pit nozzle L2	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	241-A-A pit nozzle L2 to nozzle L1	Jumper or manifold from nozzle L2 to nozzle L1	No		No		Routing Board
	241-A-A pit nozzle L1 to 3-in. line SN-214/201 to 241-AX-A pit nozzle L1	3-in. transfer line 3"SN-214/201	Yes		N/A		SK-A-A, SK-AX-A
	241-AX-A pit nozzle L1 to nozzle L16	Jumper or manifold from nozzle L1 to nozzle L16	Yes		N/A		Routing Board

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AN-101 (1999) (Continued)	241-AX-A pit nozzle L16 to 2-in. line SN-600 to sluice pit 241-AZ-02B nozzle U5	2-in. transfer line	Yes		N/A		H-14-101080
	241-AZ-02B pit nozzle U5 to nozzle U7	Jumper or manifold from nozzle U5 to nozzle U7	Yes		N/A		Routing Board
	241-AZ-02B pit nozzle U7 to 2-in. line SN-260 to valve pit-241-AN-B nozzle R2	2-in. transfer line	Yes		N/A		H-14-020801 SH 6
	Valve Pit 241-AN-B nozzle R2 to nozzle R15	Jumper or manifold from nozzle R2 to nozzle R15	Yes		N/A		Routing Board
	Valve Pit 241-AN-B nozzle R2 to Tank 241-AN-101 Central Pump Pit nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH 1
	Tank 241-AN-101 Central Pump Pit nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020801 SH 1
AW-106 to AN-106 (1999)	SN pump P-017 to nozzle A (AW-106, pump pit-AW-06A)	Jumper or manifold from P-017 to nozzle A		No		No	H-14-020802 SH 3
	Nozzle A to 3-in. line SN-266 to 241-AW-B pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AW-B pit nozzle R15 to nozzle R19	Jumper or manifold from nozzle R15 to nozzle R19		No		No	H-14-020802 SH 5
	241-AW-B pit nozzle R19 to 3-in. line SN-271 to 241-AW-A pit nozzle L19	3-in. transfer line	Yes		N/A		H-14-020802 SH 5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AN-106 (1999) (Continued)	241-AW-A pit nozzle L19 to nozzle L2	Jumper or manifold from nozzle L19 to nozzle L2		No		No	H-14-020802 SH 4
	241-AW-A pit nozzle L2 to 3-in. line SN-220 to 241-A-A pit nozzle L2	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	241-A-A pit nozzle L2 to nozzle L1	Jumper or manifold from nozzle L2 to nozzle L1		No		No	Routing Board
	241-A-A pit nozzle L1 to 3-in. line SN-214/201 to 241-AX-A nozzle L1	3-in. transfer line	Yes		N/A		H-14-101080
	241-AX-A pit nozzle L1 to nozzle L16	Jumper or manifold from nozzle L1 to nozzle L16	Yes		N/A		Routing Board
	241-AX-A pit nozzle L16 to 2-in. line SN-600 to 241-AZ-102 02B pit nozzle U5	2-in. transfer line	Yes		N/A		H-14-101080
	241-AZ-102 02B pit nozzle U5 to nozzle U7	Jumper or manifold from nozzle U5 to nozzle U7	Yes		N/A		Routing Board
	241-AZ-102 02B pit nozzle U7 to 2-in. line SN-260 to valve pit 241-AN-B nozzle R2	2-in. transfer line	Yes		N/A		H-14-020801 SH 6
	Valve pit 241-AN-B nozzle R2 to nozzle R19	Jumper or manifold from nozzle R2 to nozzle R19	Yes		N/A		Routing Board
	241-AN-B nozzle R19 to 3-in. line SN-268 to Valve pit 241-AN-A nozzle L19	3-in. transfer line	Yes		N/A		H-14-020801 SH 6

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-106 to AN-106 (1999) (Continued)	Valve Pit 241-AN-A nozzle L19 to nozzle L14	Jumper or manifold from nozzle L19 to nozzle L14	Yes		N/A		Routing Board
	241-AN-A pit nozzle L14 to 3-in. line SN-266 to 241-AN-106 06A pit nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH 1 and 2
	241-AN-106 06A pit nozzle A to Tank Return nozzle G	Jumper or manifold from nozzle A to nozzle G		No		No	H-14-020801 SH 4
AW-105 to AN-105 (2001-2006)	SN pump P-014 to nozzle A (AW-105, pump pit AW-05A)	Jumper or manifold from P-014 to nozzle A	Yes		N/A		H-14-020802 SH 1
	Nozzle A to 3-in. line SN-265 to 241-AW-A valve pit nozzle L15	3-in. transfer line	Yes		N/A		H-14-020802 SH 1
	241-AW-A valve pit nozzle L15 to nozzle L1	Jumper or manifold from nozzle L15 to nozzle L1		No		No	H-14-020802 SH 4
	241-AW-A pit nozzle L1 to 3-in. line SN-267 to pump pit AW-02A nozzle J	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-02A nozzle J to nozzle V	Jumper or manifold from nozzle J to nozzle V	Yes		N/A		H-14-020802 SH 2
	Pump it AW-02A nozzle V to 3-in. line SN-609 to AP valve pit nozzle 14	3-in. transfer line	Yes		N/A		H-14-020802 SH 2
	AP valve pit nozzle 14 to nozzle 15	Jumper or manifold from nozzle 14 to nozzle 15		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-105 to AN-105 (2001-2006) (continued)	241-AP Valve pit nozzle 15 to 3-in. line NVP/APVP to valve pit NVP nozzle E	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle E to nozzle A	Jumper or manifold from nozzle E to nozzle A		No	Yes (W-314)		W-314 Alternatives Analysis
	NVP valve pit nozzle A to 3-in. line AN101A/NVP to pump pit AN-01A nozzle D	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to nozzle A	Jumper or manifold from nozzle D to nozzle A		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle A to 3-in. line SN-261 to 241-AN-B valve pit nozzle R15	3-in. transfer line	Yes		N/A		H-14-020801 SH1
	241-AN-B valve pit nozzle R15 to nozzle R19	Jumper manifold from nozzle R15 to nozzle R19	Yes		N/A		H-14-020801 SH6
	241-AN-B valve pit nozzle R19 to 3-in. line SN-268 to 241-AN-A valve pit nozzle L19	3-in. transfer line	Yes		N/A		H-14-020801 SH6
	241-AN-A valve pit nozzle L19 to nozzle L16	Jumper manifold from nozzle L19 to nozzle L16		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AN-A valve pit nozzle L16 to 3-in. line SN-265 to pump pit AN-05A nozzle A	3-in. transfer line	Yes		N/A		H-14-020801 SH5

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
AW-105 to AN-105 (2001-2006) (continued)	Pump pit AN-05A nozzle A to tank return nozzle G	Jumper manifold from nozzle A to nozzle G		No	Yes (W-211)		WHC-SD-TDR-001
AW-105 to AW-102 (2000)	SN pump P-014 to nozzle A (AW-105, pump pit-AW-05A)	Jumper or manifold from P-014 to nozzle A	Yes		N/A		H-14-020802 SH 1
	Nozzle A to 3-in. line SN-265 to 241-AW-A pit nozzle L15	3-in. transfer line	Yes		N/A		H-14-020802 SH 1
	241-AW-A pit nozzle L15 to nozzle L1	Jumper or manifold from nozzle L15 to nozzle L1		No		No	H-14-020802 SH 4
	241-AW-A pit nozzle L1 to 3-in. line SN-267 to AW-102 pump pit-AW-02A nozzle J	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit-AW-02A nozzle J to tank return nozzle L	Jumper or manifold from nozzle J to nozzle L	Yes		N/A		H-14-020802 SH 2
SY-102 to AW-102 (supernate, 2002)	(From Cross-Site Tie-In Point [XTIP] west of 244-A Lift Station)						
	XTIP to 3-in. line XTIP/AN-101 to pump pit AN-01A nozzle C	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle C to nozzle D	Jumper or manifold from nozzle C to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
SY-102 to AW-102 (supernate, 2002) (Continued)	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve Pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle B to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve Pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 15 to nozzle 14	Jumper or manifold from nozzle 15 to 14		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 14 to 3-in. line SN-609 to pump pit AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle V to tank return nozzle L	Jumper or manifold from nozzle V to nozzle L	Yes		N/A		H-14-020802, Sh 2
SY-102 to AW-105 (supernate, 2005)	(From Cross-Site Tie-In Point [XTIP] west of 244-A Lift Station)						
	XTIP to 3-in. line XTIP/AN-101 to pump pit AN-01A nozzle C	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle C to nozzle D	Jumper or manifold from nozzle C to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
SY-102 to AW-105 (supernate, 2005) (Continued)	Valve Pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle B to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve Pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 15 to nozzle 14	Jumper or manifold from nozzle 15 to 14		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 14 to 3-in. line SN-609 to pump pit AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle V to nozzle J	Jumper or manifold from nozzle V to nozzle J	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle J to 3-in. line SN-267 to 241-AW-A valve pit nozzle L1	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	241-AW-A valve pit nozzle L1 to nozzle L15	Jumper or manifold from nozzle L1 to L15		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L15 to 3-in. line SN-265 to AW-105 pump pit AW-05A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-05A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 1
SY-102 to AW-105 (slurry, 2006)	(From Cross-Site Tie-In Point [XTIP] west of 244-A Lift Station)						

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
SY-102 to AW-105 (slurry, 2006) (Continued)	XTIP to High-Pressure 3-in. line XTIP/AN-104 to Tank 241-AN-104 riser TBD	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-04A, Slurry Pump P-TBD to nozzle A	Pump and Jumper or manifold from P-TBD to nozzle A		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-04A nozzle A to 3-in. line SN-264 to valve pit AN-A nozzle L15	3-in. transfer line	Yes		N/A		H-14-020802 SH 3
	241-AN-A valve pit nozzle L15 to nozzle L19	Jumper or manifold from nozzle L15 to nozzle L19		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AN-A valve pit nozzle L19 to 3-in. line SN-268 to 241-AN-B valve pit nozzle R19	3-in. transfer line	Yes		N/A		H-14-020802 SH 5
	241-AN-B valve pit nozzle R19 to nozzle R15	Jumper or manifold from nozzle R14 to nozzle R15	Yes		N/A		H-14-020802 SH 6
	241-AN-B valve pit nozzle R15 to 3-in. line SN-261 to pump pit AN-01A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 6
	Pump pit AN-01A nozzle A to nozzle D	Jumper or manifold from nozzle A to nozzle D		No	Yes (W-314)		W-314 Alternatives Analysis
	Pump pit AN-01A nozzle D to 3-in. line AN101A/NVP to valve pit NVP nozzle A	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis

Table A-2. Equipment Availability Matrix.

Transfer	Transfer route	Equipment needs	Equipment installed		Equipment planned		References
			Yes (ID or label)	No	Yes (Project #)	No	
SY-102 to AW-105 (slurry, 2006) (Continued)	Valve pit NVP nozzle A to nozzle E	Jumper or manifold from nozzle A to nozzle E		No	Yes (W-314)		W-314 Alternatives Analysis
	Valve pit NVP nozzle E to 3-in. line NVP/APVP to 241-AP valve pit nozzle 15	3-in. transfer line		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 15 to nozzle 14	Jumper or manifold from nozzle 15 to 14		No	Yes (W-314)		W-314 Alternatives Analysis
	241-AP valve pit nozzle 14 to 3-in. line SN-609 to pump pit AW-02A nozzle V	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle V to nozzle J	Jumper or manifold from nozzle V to nozzle J	Yes		N/A		H-14-020802, Sh 2
	Pump pit AW-02A nozzle J to 3-in. line SN-267 to 241-AW-A valve pit nozzle L1	3-in. transfer line	Yes		N/A		H-14-020802, Sh 2
	241-AW-A valve pit nozzle L1 to nozzle L15	Jumper or manifold from nozzle L1 to L15		No		No	H-14-020802 SH 4
	241-AW-A valve pit nozzle L15 to 3-in. line SN-265 to AW-105 pump pit AW-05A nozzle A	3-in. transfer line	Yes		N/A		H-14-020802 SH 4
	Pump pit AW-05A nozzle A to tank return nozzle G	Jumper or manifold from nozzle A to nozzle G	Yes		N/A		H-14-020802 SH 1

Table A-3. Piping Parameters.

Line number (connection points)	Material of construction (material code)	Maximum operating pressure	Maximum operating temperature	Test pressure	Flanged/ butt-welded	Reference: construction spec # and drawing #
3"LIQW-702 (204-AR to 241-A-A)	Stainless Steel (M8)	0.93 MPa (120 psig)	38°C (100°F)	1.3 MPa (180 psig)	butt-welded	B-133-C1 H-2-70706
2"SL-166 (241-AW-B to 241-AW-106)	Carbon Steel (M25)	2.9 MPa (400 psig)	171°C (340°F)	4.2 MPa (600 psig)	butt-welded	B-120-C7 H-14-020802
2"SL-167 (242-A to 241-AW-B)	Carbon Steel (M25)	2.9 MPa (400 psig)	171°C (340°F)	4.2 MPa (600 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-220 (241-A-A to 241-AW-A)	Carbon Steel (M25)	1.7 MPa (230 psig)	166°C (330°F)	2.5 MPa (350 psig)	butt-welded	B-102-C1 H-14-020802
3"SN-261 (241-AW-A to 241-AW-101)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-262 (241-AW-B to 241-AW-102)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-263 (241-AW-A to 241-AW-103)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-264 (241-AW-B to 241-AW-104)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-265 (241-AW-A to 241-AW-105)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-266 (241-AW-B to 241-AW-106)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-267 (241-AW-A to 241-AW-102)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-268 (241-AW-B to 241-AW-102)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-269 (241-AW-102 to 242-A)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802

Table A-3. Piping Parameters.

Line number (connection points)	Material of construction (material code)	Maximum operating pressure	Maximum operating temperature	Test pressure	Flanged/ butt-welded	Reference: construction spec # and drawing #
3"SN-270 (242-A to 241-AW-102)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-271 (241-AW-A to 241-AW-B)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-272 (241-AW-102 Pit 02E to 241-AW-102 pit 02A)	Carbon Steel (M25)	2.0 MPa (275 psig)	171°C (340°F)	3.2 MPa (450 psig)	butt-welded	B-120-C7 H-14-020802
3"SN-609 (241-AW-102 to 241-AP)	Carbon Steel (M25)	2.9 MPa (400 psig)	171°C (340°F)	4.2 MPa (600 psig)	butt-welded	B-340-C7 H-14-020803
3"SN-610 (241-AW-102 to 241-AP)	Carbon Steel (M25)	2.9 MPa (400 psig)	171°C (340°F)	4.2 MPa (600 psig)	butt-welded	B-340-C7 H-14-020803

APPENDIX B

TRANSFER ISSUES

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APPENDIX B

TRANSFER ISSUES

The following is a compilation of issues that are related to the transfer of waste to the Private Contractors facilities and related staging transfers that support Tank Waste Remediation System (TWRS) operations. Transfers scheduled to occur between 1/1/1998 and 12/31/2011 involving tanks in the 241-AW Tank Farm have been evaluated.

General

Issue: Current risk and RAM analysis efforts are not yet complete.

Discussion: Risks associated with the transfers are being developed along with a viable Operations and Maintenance (O&M) concept for TWRS. This new O&M Concept will include activities related to Waste Feed Delivery (WFD). Until this work is completed, project activities cannot be completely validated.

Issue: Engineering studies which are aimed at optimizing the WFD system are not yet complete.

Discussion: Several studies that have been identified for fiscal year (FY) 1998 are not yet begun. The outcome of these studies could impact the decisions made in identifying scope for completing the design of the WFD system. These studies include an alternative piping route from AN to AP other than the currently scoped W-314 effort. Also included is the control system integration study.

Issue: The transfer schedule identified in the *Tank Waste Remediation System Operation and Utilization Plan* (TWRSO&UP) (Kirkbride et al. 1997) reflects staging transfers that are not agreed to by TWRS operations. This means that operations does not feel confident several of the identified transfers can be made or funding priority has not been provided such that planning and preparation for the transfers can be performed.

Discussion: An effort must be made to gain operations agreement to the transfer schedule that will extend through FY 2000. This agreement will help establish priorities for project activities and define a basis for operations sufficient to ensure successful delivery of Envelope A waste.

Transfer Pumps

Transfers from all six tanks in the 241-AW Tank Farm are scheduled to occur before 2011. Transfer pumps are required to accomplish the transfers. Capability and functionality of the existing pumps in all six of the tanks is questionable. The following specific issues have been identified by this evaluation:

Issue: The existing pumps in the AW Farm are either incapable or only marginally capable of delivering feed at the required 1.8 to 2.7 m/s (6 to 9 ft/s) velocity. This velocity was established as a range for solids transfer in order to maintain a Reynolds number of greater than 20,000. Supernate transfers could be conducted at a slower rate.

Discussion: A Calculation of the pressure drop for a transfer from 241-AW-101 to 241-AP-102 has been prepared (attached). The calculation shows that even for a relatively short route, the existing pumps are not capable of delivering waste at 0.53 m^3/min (140 gal/min) (based on a requirement to transfer waste at 1.8 to 2.7 m/s (6 to 9 ft/sec through 3-in. pipe). The pump to be installed in the tanks under the W-211 Project will be capable of delivering the waste at 0.53 m^3/min (140 gal/min) for even the longest routes in the 200 East Tank Farms. Of the six tanks in the 241-AW Tank Farm, only tank 241-AW-101 is scheduled to receive a new transfer pump under Project W-211.

Issue: A Pump design is needed which allows periodic preventative maintenance (i.e. pump flushing, recirculation, etc.) to improve pump reliability.

Discussion: Waste in some of the tanks consists of saturated salt solution. Crystals grow on the rotating parts of the pump until the shaft cannot be turned. Other tanks contain relatively large volumes of solids. Either crystal growth or depositions of other solids are likely causes of premature pump failure. According to the Pump Cognizant Engineer, after a pump has been idle in a tank for a few years there is about a 50 percent chance the pump will operate successfully.

The current system is not designed to allow flushing or operation of the pumps in a recycle mode. Since the waste in some of the tanks is highly soluble a flush system would likely be capable of dissolving the crystals and allowing the pump to operate. Additionally, a return leg on the piping system from the pump would allow the pump to be operated routinely. Routine operation of the pumps would likely prevent or at least limit crystal growth and ensure operation of the pumps when needed for a transfer.

Issue: The existing transfer pump in tank 241-AW-104 has failed - a replacement has not been identified

Discussion: The transfer pump in 241-AW-104 is broken, and not currently scheduled to be repaired or replaced. Two transfers from tank 241-AW-104 are scheduled in October 1998 and no pump has been identified. This tank will directly support operations surrounding 241-AZ-101.

Batch 5 of Envelope A includes 3.83 ML (1,000,000 gal) of waste from 241-AW-104. No transfer pump has been identified in tank 241-AW-104 to make the required transfer.

Issue: The existing pumps in most of the tanks are stick type pumps.

Discussion: Per the *Tank Farms Pumping Equipment List* (Riesenweber 1992), most of the pumps involved in the transfers listed above are stick type pumps. These pumps are not appropriate because the intake is near the bottom of the tank and the pumps will tend to entrain solids. Nearly all of the transfers are intended to include liquids with only very limited solids content. Transfer using the existing pumps.

Issue: The Design of the Existing Supernate Flex/Float Pumps Causes Pump to Lose Prime if Transfer is Interrupted.

Discussion: The existing flex/float pumps are designed with the impellers above the tank bottom. Once the liquid level in the tank goes below the impellers, pump prime will be lost if the transfer is interrupted. The tank or at least the pump would need to be reflooded at least to the impeller level prior to finishing the transfer.

Mixer Pumps

Issue: Crust Softening/Removal Techniques are not Tested

Discussion: Crust softening prior to retrieval of waste from Tank 241-AW-101 has been identified as a necessary step in the transfer process. It is not clear that the identified method of adding diluent to top of the tank will effectively soften the crust. Testing of this method with simulated waste should be done to determine if softening is effective. Further, the conceptual crust softening method may be impractical due to tank volume constraints.

Transfer Routings

Approximately 180 individual transfers involving approximately 30 different transfer routings (see attached route list and sketches of the AW Tank Farm transfer routings) are scheduled over the next 13 years to transfer waste either to or from tanks in the 241-AW Tank Farm. Most of the transfer routes pass through either one or both of the 241-AW-A or 241-AW-B Valve Pits. The routings include at least six configurations involving six of the nozzles in the AW-A Valve Pit and at least six configurations involving at least five of the nozzles in the AW-B Valve Pit. Most of the nozzles used in each pit are involved in two or more of the configurations.

Issue: The current jumper system in valve pits AW-A and AW-B is inadequate to support transfers

Discussion: The current jumper configuration in the 241-AW-A and 241-AW-B is inadequate to support the identified transfers. Nozzle to nozzle rigid or flex jumpers without valves would be the least costly in terms of fabrication and materials. The number of configurations needed to support the identified transfers however would require frequent pit entry and jumper modifications. The following nozzles need to be connected in the 241-AW-A Valve Pit:

Nozzle L1 to Nozzles L2, L14, L15, and L16
Nozzle L2 to Nozzles L14, L15, and L19
Nozzle L19 to Nozzle L16

The following nozzles need to be connected in the 241-AW-B Valve Pit:

Nozzle R1 to Nozzles R14 and R15
Nozzle R15 to Nozzle R14, R16, and R19
Nozzle R14 to Nozzle R19
Nozzle R3 to Nozzle R9.

A suggested solution would be to design a manifold jumper system with the transfer requirements specifically in mind. A manifold system would require only valving changes to reconfigure the routing through the valve pit. The manifold system might be combined with a flush, caustic injection, and/or recycle system which would allow routine operation of the pumps (Conceptually a manifold system is not significantly different than the Project W-454 design.)

Introduction of valves in a manifold system may result in more point failures than the current system; however, more pit entries that would be required for configuration changes which support a system of flex jumpers.

Another option may be to design a better method of making jumper changes such as a vehicle with necessary confinement structures built in and a light duty (10 ton) crane. The concept would be to move the vehicle into place, open the pit, make the necessary jumper change, and close the pit all remotely. A similar design was developed for the hot conditioning annex of the canister storage building (*Hot Conditioning System Equipment Conceptual Design Report* [Merrick and Associates and W. L. Willis 1996], Drawing SK2-2-300420).

The nozzle connections listed were developed using the most likely (shortest available 3-in. routing) routings from the source tank to the destination tank. Additionally, for the return of slurry from the evaporator, the following connection in the 2-in. slurry lines needs to be made:

Nozzle R3 needs to be connected to Nozzle R9. There is currently a jumper that connects Nozzle R3 to Nozzle R9.

Issue: Current Jumper System in Pump Pit 241-AW-02A is inadequate to support transfers.

Discussion: The current Jumper configuration in Central Pump Pit 241-AW-02A does not allow a transfer from Tank 241-AW-102 to any other tank in the system without passing through the 242-A Evaporator. A jumper modification is needed to allow connection of Nozzle A to Nozzle K in the 241-AW-02A. This modification will allow transfer of waste from tank 241-AW-102 to other tanks without passing the waste through the evaporator.

Issue: Line 3-in. SN-219-M25 is not operable.

Discussion: Line 3-in. SN-219-M25 has clean-out boxes. The clean-out boxes have leaked in the past and no permanent fix has been identified. The 3-in. SN-219 connects the 241-A-B valve pit with the 241-AW-B valve pit. There is an available transfer route between the 241-A-B and 241-AW-B valve pits as follows:

Through line 3-in. SN-204 from valve pit 241-A-B to valve pit 241-A-A
Through line 3-in. SN-220 from Valve Pit 241-A-A to Valve Pit 241-AW-A
Through line 3-in. SN-271 from Valve Pit 241-AW-A to Valve Pit 241-AW-B.

Issue: Line 2-in. SL-161-M25 is not operable.

Discussion: Acid was transferred from the PUREX Facility to tank 241-AW-101 in 1984 or 1985. The transfer route used Line 2-in. SL-161-M25, a carbon steel pipe. The line failed a pressure test on 04/16/1985 and was taken out of service at that time. The transfer path may also have gone through Line 3-in. SN-271-M25, the supernate transfer line between the AW-A and the AW-B Valve Pits. If the acid transfer routing did include the supernate cross tie line, the 3-in. SN-271-M25 line may be damaged as well.

Issue: Abandonment of the 241-A-A Valve Pit requires that line LIQW-702 be connected directly to line SN-220.

Discussion: The proposed new W-314 line does not require the use of Valve Pit 241-A-A excepting waste transferred from 204-AR. A route from 204-AR to 241-AW that bypasses Valve Pit 241-A-A would allow this valve pit to be abandoned. Connect line LIQW-702 directly to line SN-220, bypassing the 241-A-A Valve Pit.

Regulatory Compliance

Issue: Compliance of the Transfer Lines with WAC 173-303 Dangerous Waste Regulations.

Discussion: The configurations of some existing piping - pit wall penetrations do not meet secondary containment requirements for tank systems because they do not ensure drainage of pipe leaks to a leak collection and removal system. Current agency agreements on other facilities (e.g., 242-A Evaporator) call for repairing/upgrading lines if unit is being modified for any other reason. Agreements with agencies may be needed if waste transfers will occur through lines with non-compliant wall penetrations.

This compliance issue includes most of the lines in the AW Tank Farm.

All non-compliant lines need to be identified. Once the complete list of non-compliant lines has been generated an alternative generation and analysis process should be used to develop a strategy for dealing with each non-compliant line.

Issue: Concrete line Encasements

Discussion: Concrete encasements have not been demonstrated to meet secondary containment requirements. Pipelines without compliant secondary containment must be leak tested on an annual basis. All non-compliant lines need to be identified. Once the complete list of non-compliant lines has been generated an alternative generation and analysis process should be used to develop a strategy for dealing with each non-compliant line.

Issue: Ancillary Equipment Secondary Containment

Discussion: Secondary containment for ancillary equipment (pits, diversion boxes, pipe trenches) must prevent migration of waste to the soil. This can be accomplished by leak testing the secondary containment. The Washington State Department of Ecology also believes these units should have coatings, but a regulatory basis for this requirement has not been found. Alternatively, an inspection schedule might be negotiated to demonstrate the condition of these units.

Issue: Written Integrity Assessment

Discussion: A written integrity assessment is required for operation of a dangerous waste tank system. A limited amount of integrity assessment work has been performed for DSTs and transfer systems. Negotiation of integrity assessment scope for TWRS facilities is ongoing.

Safety

Issue: System upgrades may be required to support Authorization Basis/BIO

Discussion: The document *Authorization Basis Assessment of Waste Feed Delivery* (Grams 1997) provides an evaluation of the Nuclear Safety Licensing needs for waste feed delivery. The evaluation was performed using the USQ process as a guide. Thus, the evaluation identifies activities that either require revisions to be included within the Authorization Basis or an Authorization Basis amendment to include the activities as authorized activities.

The first issue is the identification of activities or topics that could not be adequately evaluated at this time due to insufficient information. These activities or topics include the following:

- Returned waste eluent from waste vitrification facilities
- Return and interim storage of ion exchange media
- Waste transfer to contractor's tanks
- Maintenance of equipment critical to waste feed delivery.

The second issue is the identification of activities which have the potential for significantly changing source terms and resulting accident consequences, both radiological and toxicological. These activities include the following:

- Waste mobilization with mixer pumps
- Waste conditioning for transfer
- Transfers of slurries
- Sludge washing (caustic and water based)
- Waste feed adjustment (shimming).

Follow-on tasks to complete the evaluation of waste feed delivery activities have been identified. These tasks include a HAZOP, evaluation of source terms, evaluation of aerosol generation, criticality analysis, analysis of impact on the potential for tank bump, and evaluation of transfers from tank 241-SY-101. The results of these evaluations could either require revising the activities such that they are covered by the current Authorization Basis or an Authorization Basis amendment to include the activities as authorized activities. These issues need to be fully developed, and may lead to the need for additional engineered mitigation systems.

Issue: It will be dificult to isolate malfunctioning systems from systems that are functioning because the BIO does not accept valves as an appropriate means of isolating active transfer equipment from inactive systems.

Discussion: In transfers made in the course of Tank Farms operations prior to the implementation of the Basis for Interim Operation, using closed valves (i.e., double valve isolation) was an acceptable means of isolating active transfer equipment. In the analysis performed for the BIO, double valve isolation was not considered an effective method of preventing or mitigating leaks induced by active transfer equipment.

The main reason for not allowing double valve isolation was the fact that misroutings can occur and indeed have occurred in the past. To understand which controls, and safety systems, structures, and components (SSCs) need to be operable and in place prior to waste transfers it is necessary to understand the control philosophy that has been constructed related to waste transfers. The following control strategy for potential misrouting of waste transfers is described in the BIO:

The selected safety SSC and TSR controls for waste transfer-related accidents provide three levels of defense to prevent or mitigate the risk of these accidents caused by waste transfer misrouting.

The first level of defense requires that the controls selected to prevent or mitigate leaks from waste transfer systems (e.g., transfer system covers, transfer leak detection systems, periodic ground-level radiation surveys of single-walled, direct-buried/bermed lines) are operable or implemented for the "physically connected" topography of the waste transfer. The physically connected topography refers to piping, structures, and tanks and their associated instrumentation as follows.

1. Physically connected piping is any piping which is part of or connected to the transfer route. Piping need not be considered connected to the transfer route if it is physically disconnected by a removal of piping (i.e., air gap) or isolated with a blind flange/process blank. (Note: Closed valves do not physically disconnect piping.)

   The East/West cross-site transfer line is considered physically connected piping only when cross-site waste transfers are in progress. The East/West cross-site transfer line is the piping between 241-UX-154 diversion box and 241-ER-151 diversion box.

   An operable service water pressure detection system is considered to physically disconnect piping on either side of the detection system.

2. Physically connected structures are those structures through which physically connected piping runs, or structures that could be subject to leakage from physically connected piping.

3. Physically connected tanks are those tanks connected to the transfer route, those tanks connected to the physically connected piping, and those tanks designed to receive leakage from physically connected piping through a drain path.

This first level of defense ensures that, should a mistransfer occur because of a leaking or misaligned isolation valve, controls are operable and implemented where the waste could be misrouted to detect and/or mitigate the consequences of a potential waste leak (i.e., spray, pool, underground plume). For example, the transfer leak detection systems must be operable in all physically connected structures (i.e., process pits, diversion boxes, valve pits, and clean out boxes [COBs]) during the waste transfer.

The second level of defense is the selection of additional controls for identifying waste transfer leaks or misroutings. These controls are the TSRs for periodic material balances and periodic monitoring of interconnected tanks during waste transfers. Upon indication of a significant material balance discrepancy or unexpected tank level rise, the waste transfer would be shutdown to the limit the potential quantity of waste leaked or misrouted.

The third level of defense is controls that prevent waste transfer misrouting. These TSR controls include the following.

1. Wherever practical, isolation of piping connected to the planned waste transfer path with two closed valves in series.

2. Independent verification of the planned waste transfer route.

3. Waste transfer system and jumper configuration control.

4. Waste transfer system operations by approved procedures.

These controls reduce the likelihood of misrouting during planned waste transfers.

In summary, the selected safety SSCs and TSR controls and their required application during waste transfers provide diversity and multiple levels of defense. The controls minimize the likelihood of a waste transfer misrouting and ensure that, should a waste leak occur as a result of a misrouting, mitigative safety SSCs or TSRs are in place to reduce the accident consequences.

Because transfers involving virtually all of the DSTs and many of the SSTs are scheduled to occur, the "physically connected" system is likely to become very large and quite complex. The size and complexity of the system will likely reduce system availability.

Instrumentation/Ancillary Equipment

Issue: Automatic Liquid Level Detection Availability

Discussion: Automatic liquid level detection is not available in tank 241-AW-101 and some other tanks. Part of the system that detects misroutings is the liquid level detection. Since some of the tanks liquid level detection is manual, the ability to properly monitor and control transfers is jeopardized.

Issue: Equipment/Instrument Control

Discussion: Equipment and instrumentation control in the 241-AW Tank Farm is via local control. System upgrades are needed to ensure that the control system for the AW Tank Farm is compatible with systems used in other farms.

Issue: Current System Complexity

Discussion: The number of valves involved in the transfers (MOVs Three way, and Isolation) may increase the risk of misroutings and valve failures. Additionally, centralized control and the master pump shutdown system may result in low system availability. The current operations/maintenance philosophy may need to be revisited in light of the large number of transfers required and the impacts associated with the failure of the system to perform as required. Modifications such as new simplified jumpers and methods of isolating parts of the system entirely may be beneficial and should be evaluated.

Issue: Integration requirements for new and existing instrumentation and controls have not been established.

Discussion: Existing instrumentation and control systems need to interface with new systems. The systems need to work in a coordinated way per the operations concept. Existing and new monitoring and control systems will be operated by TWRS personnel for efficiency, all of the farms should be similar to the extent practicable (best engineering practice). Specific I&C integration requirements will be developed under an existing task by Vista Research.

Ventilation System

Issue: Electrical supply and control circuits to the primary fans are in poor condition and jeopardize the reliability of the system.

Discussion: Specific components are identified in the Condition Assessment Survey (Golberg 1996). The primary issues were that wire terminations are not properly supported and control circuits are not fully functional. LCO 3.2.1 Technical Safety Requirements (BIO) requires that the active primary ventilation system shall be operable. The basis for this requirement is the need to prevent flammable gases from accumulating in the tank headspace. Suggested scope is to write a work plan to confirm condition of electrical supply and control circuits and document specific components requiring repair or replacement.

Issue: The 241-AW primary ventilation stack will likely require upgrades to provide continuous air emissions monitoring in compliance with NESHAP.

Discussion: It is likely that the 241-AW primary ventilation stack will be redesignated from a minor to a major stack. Permitting, monitoring, and potentially treatment requirements will change. It will be necessary to upgrade the 241-AW ventilation system to be compliant with NESHAP. This is likely to require changes to the effluent monitoring system. A fully NESHAP - compliant ventilation stack system has been developed under Project W-420. The estimated project cost for a single stack is approximately $200,000. A criterion for designation of an effluent discharge stack as minor or major is whether the potential for unabated discharges results in an off-site exposure of 0.1 mrem/yr. Air modeling requirements have recently changed by a factor of 1.5. This increased factor causes the current 241-AW primary stack to exceed 0.06 mrem/yr unabated releases under current conditions. Increased releases are likely due to mixer pump operation. The design for changes to the 241-AW primary ventilation stack will be similar to the design done for the W-420 Project.

Issue: The current HVAC system does not have the capability of removing toxic pollutants from off-gas.

Discussion: This issue is particularly important during a GRE. The concentrations of volatile toxic pollutants in the tank waste are not well characterized. Release limits are not currently defined. Install or provide expansion capability for an activated carbon filter and dry scrubber system in the HVAC system to reduce or eliminate toxic pollutants from the off-gas stream. Toxic constituents are present in off-gas from the tanks potentially at concentrations which will require abatement. This follows the recommendation made in the *Initial Assessment Report HVAC Systems* (Kriskovich 1996). Adding the capability of toxic constituent removal to the HVAC systems is currently planned for W-314. Development of a basis for this requirement will require vapor space sampling of target DSTs with analysis for TAPs.

Issue: There currently is no direct method to measure the primary ventilation airflow from tank 241-AW-101.

Discussion: The filtered inlet air flowrate is monitored but this doesn't account for inleakage through pump pits, etc. It is necessary to install flow meters in tank 241-AW-101 primary ventilation exhaust ducting. Flow monitoring in conjunction with hydrogen monitoring equipment already installed, will allow for determination of the overall hydrogen generation and release rates. This information will be necessary for controlling the waste degassing operation. See *Technical Basis For Installation of the Double-Shell Tank Exhaust Flow Monitoring Systems* (Willingham 1997a) for a detailed basis and *Double-Shell Tank Primary Ventilation Exhaust Flow Monitor System Design Description* (Willingham 1997b) for conceptual design information.

Electrical

Issue: A 1995 assessment found many deficiencies with the motor control center MCC-241-AW.

Discussion: This MCC will be operational through the end of the Phase 1 Privatization so the electrical system must be repaired. A work package will be prepared to confirm the condition of MCC-241-AW and document the specific components requiring repair or replacement.

Issue: The addition of waste retrieval systems to tank 241-AW-101 will add a significant load to the 241-AW farm electrical system.

Discussion: It is not clear that the new loads that will be installed under project W-211 have been fully evaluated and compared with excess capacity in the system. The electrical transmission systems may need to be upgraded to account for the new loads. A work package will be developed to review the electrical system capability and availability versus use and document.

Utilities

Issue: Transfer line flush requirements have not be established.

Discussion: Water is needed for transfer line flushing and dilution/dissolution of waste. The current flush system at 241-AW is capable of approximately 0.23 m^3/min (60 gal/min). It is expected that the new system to be installed by project W-211 will provide up to 0.57 m^3/min (150 gal/min). Establishing a defensible basis for the flowrate will require a review of solids resuspension models and potentially pipe loop studies. A work plan and cost estimate for these activities are currently being developed by PNNL.

Issue: The 241-AW air compressors cycle frequently resulting in early equipment failures.

Discussion: The air compressors cycle every 30 to 50 seconds and experience early failures. Reliability of some of the tank farm instrumentation is based on the reliability of the compressed air system and are needed to support existing and future operations. A work package will be developed to assess the compressed air system and determine the cause of the frequent cycling. After the cause of the cycling has been determined, a scoping study of alternatives is needed to develop a project requirement. Alternatives might include repair or replacement of buried air lines if leaking or larger compressed air receiver tanks.

Waste Retrieval

Issue: Process requirements have not been completed for retrieval of waste from tank 241-AW-101.

Discussion: The process requirements for retrieval of waste from tank 241-AW-101 as feed to the privatization vendors under Phase I of the contract have not be finalized. These requirements primarily establish the design criteria and bases for the criteria for project W-211. A number of process requirement issues are provided in Table E-7 of Appendix E.

OPPORTUNITIES

The most likely transfer route to tanks 241-AP-102 and 104 flows from the north tank farms in the 200 East Area south through new lines to be provided by Project W-314. The likely route passes through several valve and pump pits and numerous valves. A failure of a component in the likely transfer route may lead to a delay in delivery of feed to the private contractor with the associated "failure to deliver" penalties.

The likely transfer route from tank 241-AW-101 to tanks 241-AP-102 and 104 uses a different set of lines than the likely route from 241 AN Farm. Tank 241-AW-101 is currently scheduled to be delivered as the third of five tanks in Envelope A. By preparing necessary transfer systems for tank 241-AW-101 earlier than the current W-211 schedule, and then rearranging the schedule such that tank 241-AW-101 is delivered at the end of envelope A, the DOE and TWRS contractor gain a higher assurance that feed delivery schedules can be met, and failure to deliver penalties avoided.

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APPENDIX C

TRANSFER REQUIREMENTS AND EXPECTATIONS

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APPENDIX C

TRANSFER REQUIREMENTS AND EXPECTATIONS

Appendix C contains a list of requirements and expectations for the transfers. The transfers were divided into three groups. The first group of transfers is the waste feed delivery transfers. The second group is one slurry transfer to clean the solids from tank 241-SY-102. The third group is all remaining transfers. The following assumptions were made

- Slurry transfers have typically been made through 2-in. lines, whereas supernatant liquids have typically transferred through 3-in. lines. The transfer velocity through a 2-in. Line is over twice as high as through 3-in. line for the same volumetric flow rate. The higher velocity helped to ensure that the solids in the slurry would not settle during the transfer and cause line pluggage. A guidance has been established that if a transfer could be done such that a Reynolds Number (Re_d) greater than 20,000 was achieved, no solids settling or line pluggage would occur. In 3-in. line, slurry with a density of 1.41 g/ml, and a viscosity of 10 cP would need to be transferred with a velocity of at least 1.83 M/sec. In order to achieve a Re_d greater than 20,000. It is assumed that this guidance only applies to slurry transfers. For supernatant transfers (which contain only liquids) there is no minimum Re_d guidance. It will be important to demonstrate that no solids will form during supernatant transfers due to temperature or concentration changes which will occur during waste dilution or transfer.

- Of the approximately 180 total transfers to or from the AW Tank Farm Tanks, only transfers from tank 241-AW-101 to tanks 241-AP-102 and 104 (four transfers), and transfers from tank 241-SY-102 to tank 241-AW-105 (one transfer) are slurry transfers. All of the other approximately 175 transfers involve only the transfer of liquids.

- Evaporator campaigns will not concentrate the waste to the point that the waste is considered a slurry. All waste transfers from the evaporator to tank 241-AW-106, and from tank 241-AW-106 to other tanks will therefore consist only of liquids.

- The W-211 Project will provide mixer pumps or an equivalent and new transfer pumps capable of meeting the pump-ability rule ($Re_D = 20,000$) in tanks 241-AW-101. This installation is scheduled to occur prior to the transfers.

- Tanks will be sampled prior to transfers and tank contents shown to be compatible.

- The Tank Farms has the capability and will maintain the capability to obtain tank samples from different levels in all tanks.

Table C-1. Transfer Process Needs.

Waste transfer set	Process needs	Basis	Equipment requirements	Comments/issues
Envelope A (Slurries/H_2 Watch List)	1. Degas the tank contents.	1. Envelope A tanks are all flammable gas watch list tanks which require degassing prior to transfer per the HNF-1985 (Draft).	1. Equipment is needed to provide mixing of tank contents such that degassing can be achieved.	1. The extent of mixing required must be determined (i.e., Solids must be stirred adequately to release gas bubbles). The tank 101-SY degassing results may be used as a basis.
	2. Dissolve 100% of soluble solids.	2. 100% of the soluble solids must be dissolved to assist in achieving the maximum order quantity (HNF-2168).	2. Equipment is needed which provides for the addition of solvent and mixing/dissolution of residual soluble salts. Equipment is also required to inspect the tank for residual solids.	2. An effective means to remove large deposits of solids on tank walls and protruding equipment (i.e., Air lift circulators, thermocouple trees) has not been demonstrated.
	3. Monitor tank contents	3. The tank level and density must be monitored to ensure process control and compliance with safety based maximum and minimum tank liquid level is per HNF-1985 and TWRSO&UP. In addition, tank AW-104 (which contains insoluble solids) contents must be monitored so that the insoluble solids fraction in the retrieved supernate does not exceed 5 vol % (TWRSO&UP).	3. Automatic tank level and SpG instrumentation must be provided for a range of 0 – 100% of tank volume and 1 – 1.5 SpG. Instrumentation must be provided in tank 104-AW to measure the solids content of the supernatant.	3. Instrumentation must be resistant to solid deposition or a means of cleaning, purging or flushing provided. An interlock is needed to activate the master pump shutdown prior to reaching the tank level (See Table A-2 in TWRSO&UP). An interlock is needed to shutdown the decant pump when the liquid level reaches 10 inches (TWRSO&UP), and/or if the solids content exceeds 5 vol %.

Table C-1. Transfer Process Needs.

Waste transfer set	Process needs	Basis	Equipment requirements	Comments/issues
Envelope A (Continued)	4. Adjust tank temperature	4. The minimum Re number required to ensure solids will remain suspended during transfer is 20,000 based on current pumpability rule.	4. Equipment or systems must be provided which maintain the feed temperature to ensure that the viscosity of the solution will be such that Re > 20,000. In addition, temperature must be such that solids do not precipitate due to temperature changes during the transfer.	4. Assumes a 3" pipe at SpG 1.0 to 1.5 and a transfer velocity of 7.6 ft/sec. Assumes temperature can be adjusted indirectly via equipment (i.e., mixer pump) operation or by heating diluent.
	5. Transfer waste	5. The waste must be transferred at a rate, which will prevent solids settling and line plugging. In addition, the pump must be capable of transferring waste in accordance with the retrieval schedule.	5. A transfer pump must be provided which will transfer the waste at a minimum rate of 140 gpm at a discharge pressure < 230 psi. Transfer pump for AW-104 must transfer supernate without disturbing sludge layer.	5. See attached calculations.
	6. Sample waste	6.Samples of the waste must be obtained prior to transfer to comply with safety/QA requirements and to ensure proper process control.	6. A location/system for obtaining grab samples must be provided.	6.
	7. Adjust tank contents	7. The tank contents must be adjusted to prevent precipitation of solids (Al, $P0_4$) during transfer, and to ensure the viscosity of the waste is such that a Re_d of 20,000 can be achieved.	7. A system/equipment must be provided to add inhibited water and NaOH solution at the pump suction discharge into the tank.	7. This system will also be used to flush the transfer line following the transfer.

Table C-1. Transfer Process Needs.

Waste transfer set	Process needs	Basis	Equipment requirements	Comments/issues
Envelope A (Continued)	8. Flush Transfer Lines.	8. Lines must be flushed (raw water) with an equivalent volume 1.5 times the transfer length to remove any static waste.	8. The equipment is assumed to be incorporated with the transfer system.	8. The flushing rate must be the same as the transfer rate to remove any solids that may precipitate or settle. It is assumed that the impact of precipitation due to flushing is negligible.
102 SY (Non Soluble Solids)	1. Monitor the tank contents.	1. The tank level and density must be monitored to ensure process control and compliance with safety based on maximum and minimum levels per HNF-1985 and TWRSO&UP.	1. Automatic tank level and SpG instrumentation must be provided for a range of 0 – 100% of tank volume and 1 – 1.5 SpG.	1. A means of cleaning or purging the instrumentation needs to be provided.
	2. Adjust the tank temperature.	2. The minimum Re number required to ensure solids will remain suspended during transfer is 20,000 per pumpability rule.	2. Equipment or systems must be provided which maintain the feed temperature to ensure that the viscosity of the solution will be such that Re > 20,000. In addition, temperature must be such that solids do not precipitate due to temperature changes during the transfer.	2. Assuming a 3" pipe at a SpG of 1.0 to 1.5 and a transfer velocity of 7.6 ft/sec. Assumes temperature can be adjusted indirectly via equipment (mixer pump) operation or by heating diluent.
	3. Transfer the waste.	3.The waste must be transferred at a rate, which will prevent solids settling and line plugging.	3. A transfer pump will be provided which will transfer the waste at a route of 140 gpm at a discharge pressure within the limits of the cross-site transfer line.	3. The transfer pump must be able to operate while the mixer pump is on. The transfer pump must withstand the forces exerted by the mixer pump.

Table C-1. Transfer Process Needs.

Waste transfer set	Process needs	Basis	Equipment requirements	Comments/issues
102 SY (Continued)	4. Adjust the tank contents	4. The tank contents must be adjusted to prevent precipitation of solids (Al, PO_4) during transfer.	4. A system/equipment must be provided to add inhibited water and NaOH solution at the pump suction and also discharge into the tank.	4. This system will also be used to flush the transfer line following the transfer.
	5. Sample the waste.	5. Samples of the waste must be obtained prior to transfer to comply with safety/QA requirements and to ensure proper process control.	5. A location/system for obtaining grab samples must be provided.	5. Assumes a mixer pump can meet the requirements.
	6. Suspend the solids.	6. Equipment must be able to mobilize the solids.	6. Equipment will be provided which will ensure that the solids can be mobilized.	6.
	7. Flush Transfer Lines.	7. Lines must be flushed (raw water) with an equivalent volume 1.5 times the transfer length to remove any static waste.	7. The equipment is assumed to be incorporated with the transfer system.	7. The flushing rate must be the same as the transfer rate to remove any solids that may precipitate or settle. It is assumed that the impact of precipitation due to flushing is negligible.

Table C-1. Transfer Process Needs.

Waste transfer set	Process needs	Basis	Equipment requirements	Comments/issues
All Others (Non Slurry Supernates)	1. Monitor tank contents	1. The tank level and density must be monitored to ensure process control and compliance with safety based on maximum and minimum tank levels per HNF-1985 and TWRSO&UP.	1. Automatic tank level instrumentation will be provided for a range of 0 – 100% of tank volume.	1. Assumes existing monitoring and control equipment/instrumentation is adequate.
	.2. Transfer waste	2. The waste must be transferred at a rate, which will support the retrieval schedule.	2. The pump must be able to decant the supernates to a level 10" above the tank solids or bottom (if solids are not present).	2. An interlock is needed to shutdown the decant pump when the supernate level reaches 10 inches above the sludge level.
	3. Sample the waste	3. Samples of the waste must be obtained prior to transfer to comply with safety/QA requirements and to ensure proper process control.	3. A location/system for obtaining grab samples must be provided.	3. Assumes existing risers/systems are adequate.
	4. Flush Transfer Lines.	4. Lines must be flushed (raw water) with an equivalent volume 1.5 times the transfer length to remove any static waste.	4. The equipment is assumed to be incorporated with the transfer system.	4. The flushing rate must be the same as the transfer rate to remove any solids that may precipitate or settle. It is assumed that the impact of precipitation due to flushing is negligible.

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APPENDIX D

CALCULATIONS

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APPENDIX D

CALCULATIONS

Appendix D contains calculations done to determine transferability of the waste along the 32 transfer paths identified in Appendix A. Transfers that deliver waste to the private contractor(s) were considered to be of utmost importance. Four of the transfers in the list deliver the diluted contents of tank 241-AW-101 to the private contractor(s) as the third feed tank in Phase 1B Envelope A.

Viscosity, density, and flow rate information is necessary to estimate the pressure drop which occurs as fluids are transferred through pipes. Viscosity and density information on the diluted waste in tank 241-AW-101 is not available, but viscosity and density information for diluted tank 241-AN-105 waste is available. The waste in tanks 241-AW-101 and 241-AN-105 is assumed for the purposes of this document to have similar density and viscosity characteristics. Given the nature of the waste in tanks 241-AW-101 and 241-AN-105, this assumption is conservative because tank 241-AN-105 has a higher solids content. The measured viscosities and densities from the tank 241-AN-105 dilution study were used in the pressure drop calculation for the transfer from tank 241-AW-101 to tanks 241-AP-102/104. A requirement has been made (Claghorn 1998) for feed delivery transfers to have linear velocities between six and nine feet per second. A velocity of 1.8 m/sec (6 ft/sec) equates to a flow of approximately 0.53 m^3/min (140 gal/min) through 3-in. pipe. A flow rate of 0.53 m^3/min (140 gal/min) is equivalent to approximately 3800 m^3 (1,000,000 gal) over five days. With the viscosity, density and velocity assumed, Reynolds numbers were calculated for three temperatures. The Reynolds numbers were used to determine friction factors and the friction factors were in turn used to estimate pressure drops per unit length of pipe. The equivalent length of pipe of the transfer route from tank 241-AW-101 to tank 241-AW-102 was calculated by summing the equivalent lengths of all of the components in the route. The pressure drop per unit length of pipe was then multiplied by the equivalent length of the transfer route to estimate the total pressure drop in the line. This calculation is included in this appendix.

It is important to note that actual pressure drop in the line is dependant on the actual flow rate, which flow rate is in turn dependant on the pump. Two pump curves were available, one for some existing pumps in the 241-AW Tank Farm, and one for a next-generation pump scheduled to be installed as part of Project W-211. It is important to note that the two pump types are likely to represent boundary conditions regarding which pumps will actually be in service when the transfers are made. The pressure drops were calculated for a fluid with a specific gravity of 1.5 and a viscosity of 5 centipoise at flow rates from 0 to 0.85 m^3 (0 to 225 gal/min). These pressure drops were used to calculate total pressure drops in lines with equivalent lengths of from 305 m to 3050 m (1,000 to 10,000 ft). With the exception of the transfers from tank 241-SY-102, all other transfers evaluated here have equivalent lengths of from approximately 305 m to 3050 m (1,000 ft to 5,000 ft). Both 2-in. and 3-in. pipe was evaluated. Curves of flow rates versus pressure drops for the given equivalent length were plotted on the pump curves. The pump should operate at the point where the curves intersect, and therefore the expected actual flow rate for the given pump can be determined. For each of the equivalent lengths expected flow rates were determined for two and three inch lines for both pump types. A curve was plotted which gives the expected flow rates for each pump type in 2-in. and 3-in. lines over the various equivalent lengths. A plot of viscosity versus density versus flow rate through three inch pipe for a Reynolds number of 20,000 is also included.

Another important issue evaluated is the total solids to be transferred. It is believed that the PHMC will be limited to 5 vol% solids in the material delivered to the private contractors. Tank 241-AW-101 currently contains approximately 27 vol% solids. Most of this material is considered to be soluble. It is important to evaluate what fraction of the material will remain a solid following dilution and dissolution prior to delivery to the private contractors. An Environmental Simulation Program (ESP)[1] water survey was performed in an attempt to determine solids content with dilution volumes of 25, 50, and 75 vol%. The results indicate that the solids content will be much less than the allowable 5 vol%.

Another important variable to evaluate is temperature. Some of the tanks contain saturated solutions. As the temperature of the saturated solutions drops, solids form. Tank temperatures were compared to tank contents. As a general rule, tanks that contain dilute solutions are cooler than tanks that contain concentrated solutions. Also, tanks that are relatively full in general have higher temperatures than tanks that are relatively empty. A notable exception is tank 241-AP-101, which contains 4224 m^3 (1,116,000 gal) of solution which is saturated in aluminum salts and some other compounds. Tank 241-AP-101 has an average temperature of 18.6 °C (65.4°F). An evaluation was made of the effect of cooling this waste by approximately 5.6 °C (10°F). It was determined that cooling this waste would result in the formation of solids, however the volume of solids in the solution remains much lower than 5 vol%.

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[1]ESP is a trademark of OLI Systems, Inc.

Calculation Prepared by W.L. Willis ________ 1/19/98
Checked by R.M. Orme ________ 1/15/98

We Need to determine the flow characteristics for a transfer from Tank 241-AW-101 to Tank 241-AP-102. First the routing to be used is needed:

Starting at Tank 241-AW-101 Central Pump Pit 01A, the routing goes through line 3"SN-261-M2 to the 241-AW-A Valve Pit. IT IS IMPORTANT TO NOTE THAT THE PIPING CONNECTIONS IN THE 241-AW-A VALVE PIT ALLOWING CONNECTION OF LINE 3"SN-261-M25 WITH 3"SN-267-M25 IS NOT CURRENTLY IN PLACE. UPGRADES TO THE JUMPER CONFIGURATION IN THE 241-AW-A VALVE PI ARE REQUIRED BEFORE THIS TRANSFER CAN BE MADE.

From the 241-AW-A Valve Pit, the routing goes through line 3"SN-267-M25 to Tank 241-AW-102 Central Pump Pit 02A.

From Tank 241-AW-102 Central Pump Pit 02A, the routing goes through line 3"SN-609-M25 to Valve Pit 241-AP.

From Valve Pit 241-AP, the routing goes through line 3"SN-612-M25 to Pump Pit 241-AP-02A, an from there into the tank.

Assumptions:

The transfer (up to 1,000,000 gallons) will need to occur over a period of no more than five days.

$$Q := \frac{1000000 \cdot gal}{5 \cdot day}$$

Or converting units

$$Flow := Q \qquad Flow = 0.309 \cdot ft^3 \cdot sec^{-1}$$

The next step is to convert the flow rate to a velocity, first we need to calculate the cross section of the piping. For Schedule 40 pipe the inside dimeter is 3.068in

$$D := 3.068 \cdot in \qquad Area := \pi \cdot \left(\frac{D}{2}\right)^2 \qquad Area = 0.051 \cdot ft^2$$

The mean velocity in the pipe is then given by dividing the flow by the cross sectional area

$$vel := \frac{Q}{Area} \qquad vel = 6.028 \cdot ft \cdot sec^{-1}$$

Now we need to determine the reynolds number in order to calculate the pressure losses in the pipe. Reynolds number for flow through a pipe is a function of the fluid density, mean velocity, pipe diameter, and fulid viscosity. Mean velocity and pipe diameter have already been defined, but we need to define fluid density and viscosity. Analysis has not been completed on the Waste in Tnak 241-AW-101, however, analysis done on Tank 241-AN-105 supernate (which is assumed to contain waste which is similar to the waste in Tank 241-AW-101) shows the following for 50% dilution:

At 25 deg C | At 45 deg C | At 65 deg C

$$\rho 25 := 1.34 \cdot \frac{gm}{mL} \qquad \rho 45 := 1.32 \cdot \frac{gm}{mL} \qquad \rho 65 := 1.31 \cdot \frac{gm}{mL}$$

$\mu 25 := 6 \cdot 10^{-2} \cdot \text{poise}$ $\mu 45 := 4 \cdot 10^{-2} \cdot \text{poise}$ $\mu 65 := 2.5 \cdot 10^{-2} \cdot \text{poise}$

Now that the density and viscosity are defined the reynolds numbers can be calculated at the various temperatures. Reynolds number is defined as follows

$$Re := \frac{\rho u D}{\mu}$$

For the temperatures listed above the reynolds numbers are as follows

$$Re25 := \frac{\rho 25 \cdot vel \cdot D}{\mu 25} \qquad Re25 = 3.197 \cdot 10^{4}$$

$$Re45 := \frac{\rho 45 \cdot vel \cdot D}{\mu 45} \qquad Re45 = 4.725 \cdot 10^{4}$$

$$Re65 := \frac{\rho 65 \cdot vel \cdot D}{\mu 65} \qquad Re65 = 7.502 \cdot 10^{4}$$

From Hydraulic Institute "Engineering Data Book" 2nd Edition, The friction factors for these reynolds numbers are:

$f25 := 0.02525$ $f45 := 0.02350$ $f65 := 0.02170$

The formula for ΔP in a pipe is given by

$$hf := f \cdot \left(\frac{L}{D}\right) \cdot \frac{V^2}{2 \cdot g}$$

Where hf is the total head loss in ft of water, f is the friction factor, L is the pipe length, D is the pipe diameter, V is the mean fluid velocity, and g is the acceleration due to gravity. By rearranging, we arrive at the pressure drop per unit length: hf/L=(f/D) X $V^2/2g$. The pressure drops per unit length for the 3 temperatures are listed below:

$$hfL25 := \left(\frac{f25}{D}\right) \cdot \frac{vel^2}{2 \cdot g} \qquad hfL45 := \left(\frac{f45}{D}\right) \cdot \frac{vel^2}{2 \cdot g} \qquad hfL65 := \left(\frac{f65}{D}\right) \cdot \frac{vel^2}{2 \cdot g}$$

$hfL25 = 0.056$ $hfL45 = 0.052$ $hfL65 = 0.048$

Now we need to determine the lengths of pipe and the eguivalent lengths of the fittings in the route. the first leg in the route is from the tank to the outlet from the 01A Central Pump Pit. The configuration of this leg is included as figure 2. The leg contains the following components

linea := 12·ft 3" schedule 40 pipe
conecta := 2 3" PUREX type connectors
twvta := 1 3" 3 way ball valve (flow through run)
lg90a := 2 3" long radius 90° elbows

The second section of the route is the 3"SN-261-M25 Line which contains the following components

lineb := 96·ft3" schedule 40 pipe
lg90b := 33" long radius 90° elbows

The third section of the route is in the 241-AW-A Valve Pit (it is important to note that the following components do not exist. Work to design fabricate and install these components is part of the W-454 Project.). The 241-AW-A Valve Pit is assumed to contain the following components:

linec := 12·ft 3" schedule 40 pipe
conectc := 3 3" PUREX type connectors
twvtc := 1 3" 3 way ball valve (flow through run)
twvbc := 3 3" 3 way ball valve (flow through branch)
blvlvc := 2 3" ball valves
lg90c := 1 3" long radius 90° elbow

The forth section of the route is the 3"SN-267-M25 Line which contains the following components

lined := 105·ft3" schedule 40 pipe
lg90d := 5 3" long radius 90° elbows

The fifth section of the route is in the Tank 241-AW-102, 02A Central Pump Pit, and includes the following components

linee := 10·ft 3" schedule 40 pipe
conecte := 2 3"PUREX type connectors
twvte := 1 3" 3 way ball valves (flow through run)

twvte := 1 3" 3 way ball valves (flow through run)

lg90e := 6 3" long radius 90° elbows

The sixth section of the route is the 3"SN-609-M25 Line which contains the following components

linef := 725·ft 3" schedule 40 pipe

lg90f := 13 3" long radius 90° elbows

The seventh section of the route is in the 241-AP Valve Pit, and includes the following components

lineg := 35·ft 3" schedule 40 pipe
conectg := 5 3" PUREX type connectors
twvtg := 1 3" 3 way ball valves (flow through run)
twvbg := 2 3" 3 way ball valves (flow through branch)
blvlvg := 3 3" ball valves

lg90g := 11 3" long radius 90° elbows

st90g := 1 3" standard radius 90° elbow

The eigth section of the route is the 3"SN-612-M25 Line which contains the following components

lineh := 410·ft 3" schedule 40 pipe

lg90h := 8 long radius 90° elbows

The ninth and last section of the route is in the 241-AP-02A Central Pump Pit, and includes the following components

linei := 45·ft 3" schedule 40 pipe
conecti := 5 3" PUREX type connectors
twvti := 3 3" 3 way ball valve (flow throuth run)

lg90i := 7 3" long radius 90° elbows

st90i := 1 3"standard radius 90° elbow

st45i := 1 3" standard radius 45° elbow

The total line length is given by the sum of all the line segments

$$linetot := linea + lineb + linec + lined + linee + linef + lineg + lineh + linei$$

$$linetot = 1.45 \cdot 10^{3} \cdot ft$$

Now to determine the equivalent length of the fittings, the number of each type fitting is multiplied by the equivalent length in pipe diameters (L/D) from Crane Technical Paper # 410 "Flow of Fluids through Valves Fittings, and Pipe".

First for the PUREX type connectors (assumed to have equivalent pressure drop as in an angle valve), LDcon := 145 pipe diameters. Hence for a 3" pipe $Lcon := LDcon \cdot D$ $Lcon = 37.072 \cdot ft$

For a ball valve with flow through run the equivalent length in pipe diameters is
$LDtwvt := 44$ pipe diameters. Hence for 3" pipe $Ltwvt := LDtwvt \cdot D Ltwvt = 11.249 \cdot ft$

For a ball valve with flow through branch the equivalent length in pipe diameters is
$LDtwvb := 140$ pipe diameters. Hence for 3" pipe $Ltwvb := LDtwvb \cdot D\, Ltwvb = 35.793 \cdot ft$

For a ball valve the equivalent length in pipe diameters
$LDblvlv := 18$ pipe diameters. Hence for 3" pipe $Lblvlv := LDblvlv \cdot DLblvlv = 4.602 \cdot ft$

For long radius 90° elbow, the equivalent length is $LDlg90 := 20$ Pipe diameters. Hence for 3" pipe,
$Llg90 := LDlg90 \cdot D\ Llg90 = 5.113 \cdot ft$

For a standard radius 90° elbow, the equivalent length is $LDst90 := 30$ pipe diameters. Hence for 3" pipe,
$Lst90 := LDst90 \cdot D\ Lst90 = 7.67 \cdot ft$

For standard radius 45° elbows, the equivalent length is $LDst45 := 16$ pipe diameters. Hence for 3" pipe,
$Lst45 := LDst45 \cdot D\ Lst45 = 4.091 \cdot ft$

Now, we calculate the eqivalent length of the fittings. First for the PUREX connectors

$$ELcon := (conecta + conectc + conecte + conectg + conecti) \cdot Lcon$$

$$ELcon = 630.218 \cdot ft$$

Next the three way ball valves with flow through run

$$ELtwvt := (twvta + twvtc + twvte + twvtg + twvti) \cdot Ltwvt$$

$$ELtwvt = 78.745 \cdot ft$$

Next the three way ball valves with flow through branch

$$ELtwvb := (twvbc + twvbg) \cdot Ltwvb$$

$$ELtwvb = 178.967 \cdot ft$$

Next the long radius 90° elbows

$$ELlg90 := (lg90a + lg90b + lg90c + lg90d + lg90e + lg90f + lg90g + lg90h + lg90i) \cdot Llg90$$

$$ELlg90 = 286.347 \cdot ft$$

Next the standard radius 90° elbows

$$ELst90 := (st90g + st90i) \cdot Lst90 \quad ELst90 = 15.34 \cdot ft$$

Finally, the standard radius 45o elbow

$ELst45 := (st45i) \cdot Lst45 \quad ELst45 = 4.091 \cdot ft$

Now we can calculate the total equivalent length of all the fittings

$ELftot := ELcon + ELtwvt + ELtwvb + ELlg90 + ELst90 + ELst45$

$ELftot = 1.194 \cdot 10^3 \cdot ft$

Now the total effective pipe length is the sum of the pipe length and the equivalent length of all the fittings

$ELtot := linetot + ELftot + 40 \cdot ft$

$ELtot = 2.684 \cdot 10^3 \cdot ft$

The additional 40 ft is added to account for the length of the discharge pipe in the tank.
The total estimated head losses for each of the three temperatures can now be calculated

$Loss25 := hfL25 \cdot ELtot \quad Loss25 = 149.651 \cdot ft$

$Loss45 := hfL45 \cdot ELtot \quad Loss45 = 139.279 \cdot ft$

$Loss65 := hfL65 \cdot ELtot \quad Loss65 = 128.611 \cdot ft$

In addition to the pressure drop, there is a 41 ft gain in the transfer from the bottom Tank 241-AW-101 to the top of Tank 241-AP-102. Therefore, assuming a temperature of 25°C, if the fluid being transferred were water, the pump would need deliver a minimum head of approximately 191 ft. Since the density of the solution is 1.34, the minimum discharge head required is 255 ft or 111 psi.

Schedule (Thickness) of Steel Pipe Used in Obtaining Resistance Of Valves and Fittings of Various Pressure Classes by Test*

Valve or Fitting ANSI Pressure Classification — Steam Rating		Cold Rating	Schedule No. of Pipe Thickness
250-Pound and Lower		500 psig	Schedule 40
300-Pound to 600-Pound		1440 psig	Schedule 80
900-Pound		2160 psig	Schedule 120
1500-Pound		3600 psig	Schedule 160
2500-Pound	½ to 6"	6000 psig	xx (Double Extra Strong)
2500-Pound	8" and larger	3600 psig	Schedule 160

*These schedule numbers have been arbitrarily selected only for the purpose of identifying the various pressure classes of valves and fittings with specific pipe dimensions for the interpretation of flow test data; they should not be construed as a recommendation for installation purposes.

Representative Equivalent Length‡ in Pipe Diameters (L/D) Of Various Valves and Fittings

Description of Product				Equivalent Length In Pipe Diameters (L/D)
Globe Valves	Stem Perpendicular to Run	With no obstruction in flat, bevel, or plug type seat	Fully open	340
		With wing or pin guided disc	Fully open	450
	Y-Pattern	(No obstruction in flat, bevel, or plug type seat) — With stem 60 degrees from run of pipe line	Fully open	175
		— With stem 45 degrees from run of pipe line	Fully open	145
Angle Valves		With no obstruction in flat, bevel, or plug type seat	Fully open	145 (PUREX CONNECTOR)
		With wing or pin guided disc	Fully open	200
Gate Valves	Wedge, Disc, Double Disc, or Plug Disc		Fully open	13
			Three-quarters open	35
			One-half open	160
			One-quarter open	900
	Pulp Stock		Fully open	17
			Three-quarters open	50
			One-half open	260
			One-quarter open	1200
Conduit Pipe Line Gate, Ball, and Plug Valves			Fully open	3**
Check Valves	Conventional Swing		0.5†...Fully open	135
	Clearway Swing		0.5†...Fully open	50
	Globe Lift or Stop; Stem Perpendicular to Run or Y-Pattern		2.0†...Fully open	Same as Globe
	Angle Lift or Stop		2.0†...Fully open	Same as Angle
	In-Line Ball		2.5 vertical and 0.25 horizontal†...Fully open	150
Foot Valves with Strainer		With poppet lift-type disc	0.3†...Fully open	420
		With leather-hinged disc	0.4†...Fully open	75
Butterfly Valves (8-inch and larger)			Fully open	40
Cocks	Straight-Through	Rectangular plug port area equal to 100% of pipe area	Fully open	18 (BALL VALVES)
	Three-Way	Rectangular plug port area equal to 80% of pipe area (fully open)	Flow straight through	44
			Flow through branch	140
Fittings	90 Degree Standard Elbow			30 (90° ELBOWS)
	45 Degree Standard Elbow			16
	90 Degree Long Radius Elbow			20
	90 Degree Street Elbow			50
	45 Degree Street Elbow			26
	Square Corner Elbow			57
	Standard Tee	With flow through run		20
		With flow through branch		60
	Close Pattern Return Bend			50
Pipe	90 Degree Pipe Bends			See Page A-27
	Miter Bends			See Page A-27
	Sudden Enlargements and Contractions			See Page A-26
	Entrance and Exit Losses			See Page A-26

**Exact equivalent length is equal to the length between flange faces or welding ends

†Minimum calculated pressure drop (psi) across valve to provide sufficient flow to lift disc fully.

‡For limitations, see page 2-11. For effect of end connections, see page 2-10.

For resistance factor "K", equivalent length in feet of pipe, and equivalent flow coefficient "C_v", see pages A-31 and A-32.

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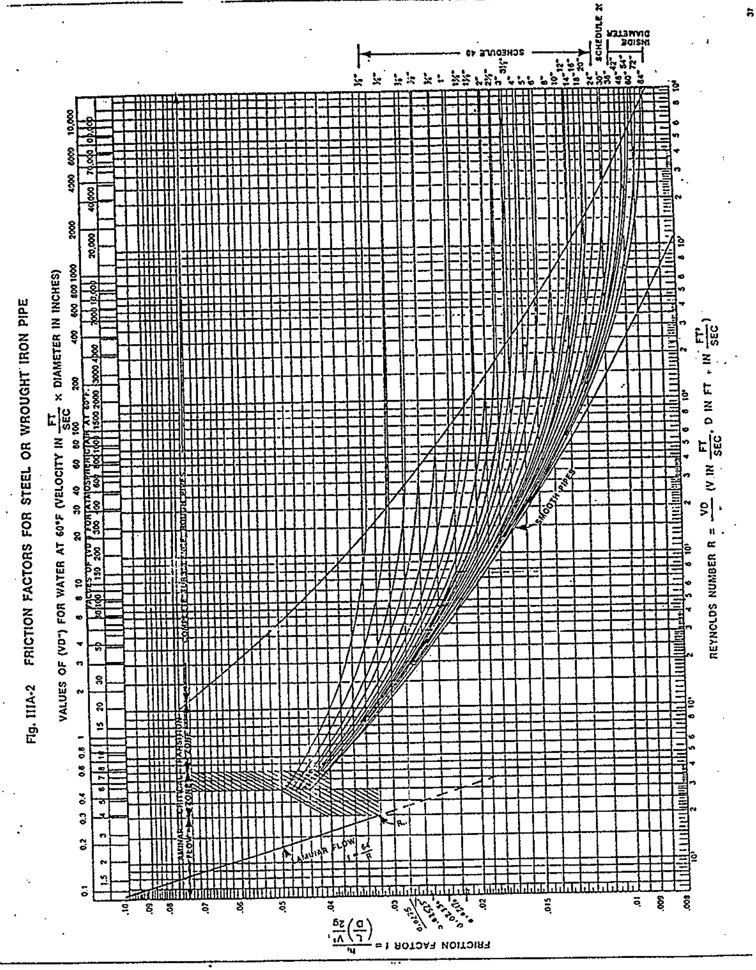
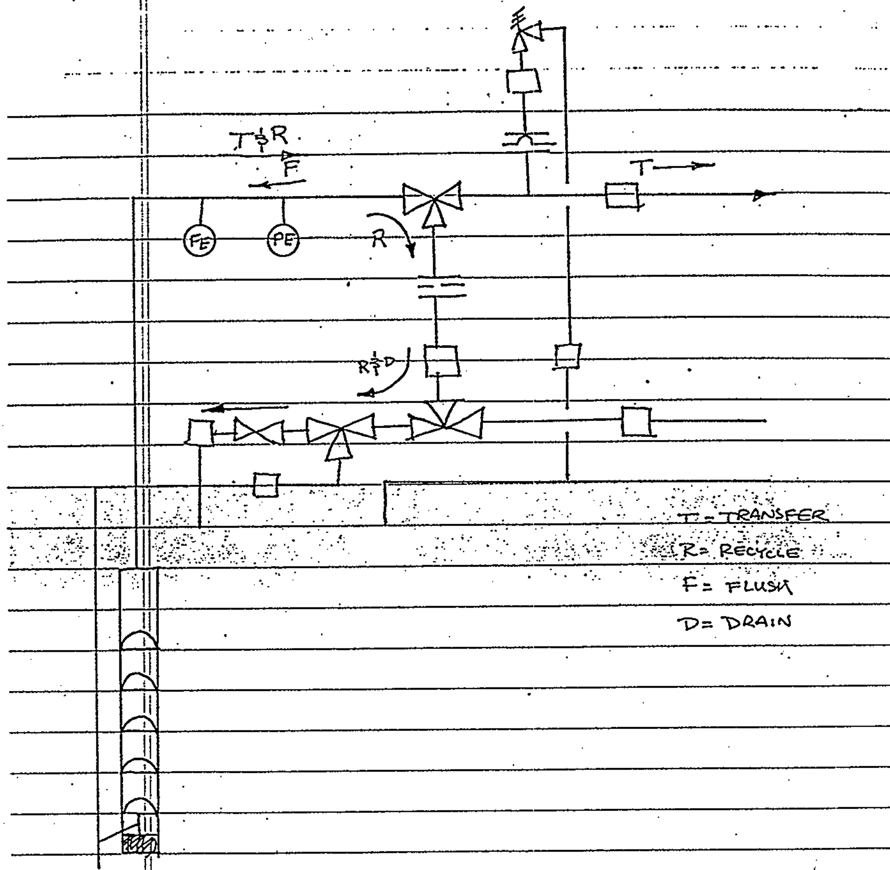


Fig. IIIA-2 FRICTION FACTORS FOR STEEL OR WROUGHT IRON PIPE

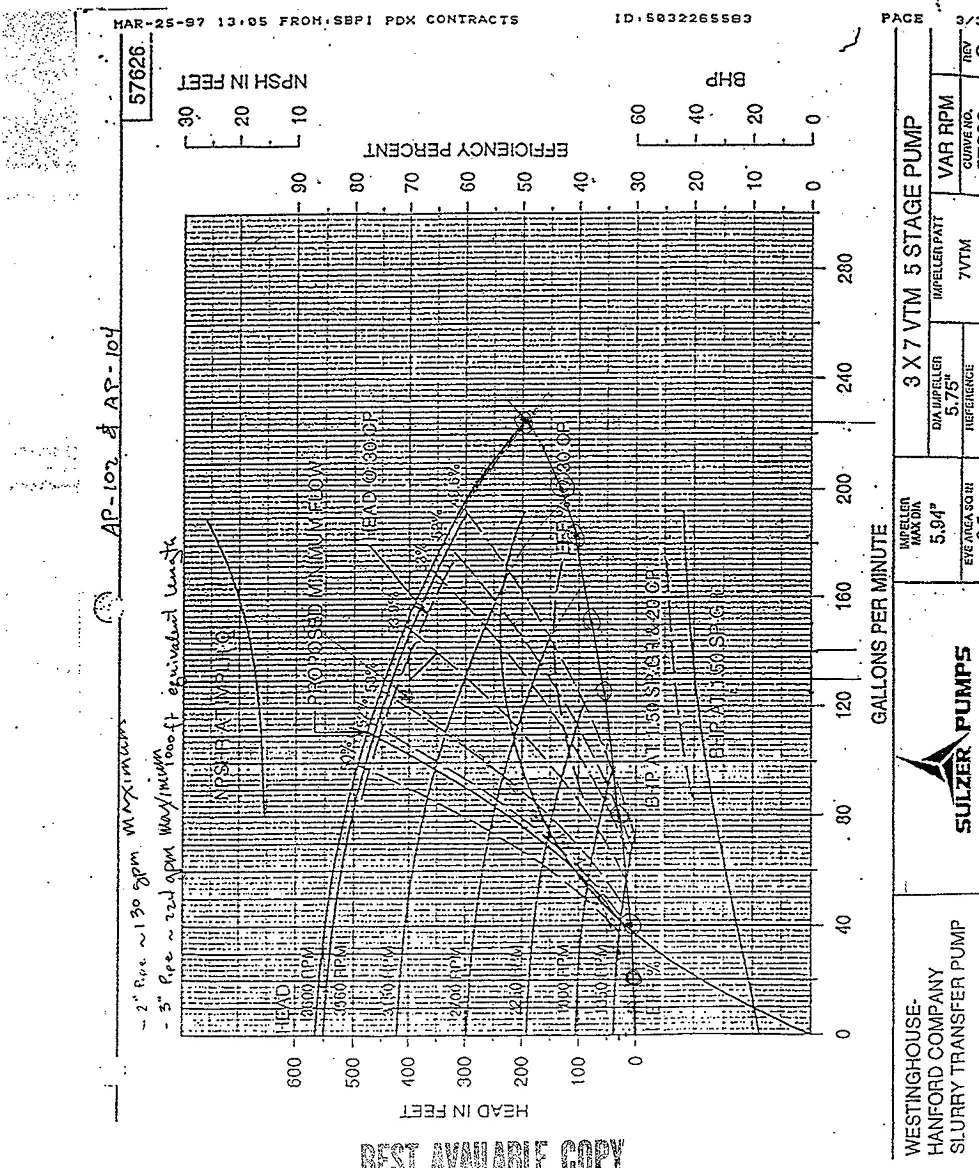

T & R
F
T
FE
PE
R
R & D
T = TRANSFER
R = RECYCLE
F = FLUSH
D = DRAIN

For 2" Pipe Lengths of feet

Flow Rate (Gpm)	1000	2000	3000	4000	5000	60000	7000	8000	9000	10000
	Total Pressure drops (feet of water)									
0	0	0	0	0	0	0	0	0	0	0
5										
10	3.74	7.47	11.21	14.95	18.69	224.22	26.16	29.90	33.63	37.37
15	7.75	15.50	23.25	31.00	38.75	465.05	54.26	62.01	69.76	77.51
20	12.99	25.97	38.96	51.95	64.94	779.24	90.91	103.90	116.89	129.87
25	19.42	38.85	58.27	77.69	97.12	1165.40	135.96	155.39	174.81	194.23
30	27.22	54.44	81.66	108.88	136.10	1633.22	190.54	217.76	244.98	272.20
35	36.45	72.89	109.34	145.79	182.24	2186.85	255.13	291.58	328.03	364.47
40	46.83	93.66	140.48	187.31	234.14	2809.69	327.80	374.62	421.45	468.28
45	57.90	115.80	173.70	231.60	289.50	3474.04	405.31	463.21	521.11	579.01
50	70.36	140.71	211.07	281.43	351.79	4221.45	492.50	562.86	633.22	703.57
55										
60	99.42	198.85	298.27	397.69	497.12	5965.39	695.96	795.39	894.81	994.23
65										
70	132.87	265.74	398.62	531.49	664.36	7972.31	930.10	1062.97	1195.85	1328.72
75										
80	172.09	344.17	516.26	688.35	860.44	10325.25	1204.61	1376.70	1548.79	1720.87
85										
90	214.53	429.07	643.60	858.13	1072.66	12871.96	1501.73	1716.26	1930.79	2145.33
95										
100	262.98	525.95	788.93	1051.90	1314.88	15778.53	1840.83	2103.80	2366.78	2629.76
105										
110										
115										
120										
125	406.00	811.99	1217.99	1623.99	2029.99	24359.84	2841.98	3247.98	3653.98	4059.97
130										
135										
140										
145										
150	579.01	1158.01	1737.02	2316.03	2895.04	34740.45	4053.05	4632.06	5211.07	5790.07
155										
160										
165										
170										
175	772.78	1545.56	2318.34	3091.12	3863.89	46366.73	5409.45	6182.23	6955.01	7727.79
180										
185										
190										
195										
200	996.54	1993.08	2989.62	3986.16	4982.69	59792.33	6975.77	7972.31	8968.85	9965.39
205										
210										
215										
220										
225										

For 3" Pipe Lengths of feet

Flow Rate (Gpm)	1000	2000	3000	4000	5000	60000	7000	8000	9000	10000
	Total Pressure drops (feet of water)									
0	0	0	0	0	0	0	0	0	0	0
5										
10										
15										
20	1.937714	3.875429	5.813143	7.750857	9.688571	116.2629	13.564	15.50171	17.43943	19.37714
25	2.883503	5.767007	8.65051	11.53401	14.41752	173.0102	20.18452	23.06803	25.95153	28.83503
30	3.944633	7.889265	11.8339	15.77853	19.72316	236.678	27.61243	31.55706	35.50169	39.44633
35	5.236442	10.47288	15.70933	20.94577	26.18221	314.1865	36.6551	41.89154	47.12798	52.36442
40	6.643592	13.28718	19.93078	26.57437	33.21796	398.6155	46.50514	53.14873	59.79233	66.43592
45	8.281422	16.56284	24.84427	33.12569	41.40711	496.8853	57.96995	66.25137	74.5328	82.81422
50	9.965388	19.93078	29.89616	39.86155	49.82694	597.9233	69.75771	79.7231	89.68849	99.65388
55										
60	14.04843	28.09686	42.14529	56.19371	70.24214	842.9057	98.339	112.3874	126.4359	140.4843
65										
70	18.6851	37.3702	56.05531	74.74041	93.42551	1121.106	130.7957	149.4808	168.1659	186.851
75										
80	23.76007	47.52014	71.2802	95.04027	118.8003	1425.604	166.3205	190.0805	213.8406	237.6007
85										
90	29.75776	59.51551	89.27327	119.031	148.7888	1785.465	208.3043	238.062	267.8198	297.5776
95										
100	36.44748	72.89497	109.3424	145.7899	182.2374	2186.849	255.1324	291.5799	328.0273	364.4748
105										
110										
115										
120										
125	55.82463	111.6493	167.4739	223.2985	279.1231	3349.478	390.7724	446.597	502.4216	558.2463
130										
135										
140										
145										
150	77.50857	155.0171	232.5257	310.0343	387.5429	4650.514	542.56	620.0686	697.5771	775.0857
155										
160										
165										
170										
175	103.8061	207.6122	311.4184	415.2245	519.0306	6228.367	726.6429	830.449	934.2551	1038.061
180										
185										
190										
195										
200	133.7946	267.5891	401.3837	535.1782	668.9728	8027.673	936.5619	1070.356	1204.151	1337.946
205										
210										
215										
220										
225	167.2432	334.4864	501.7296	668.9728	836.216	10034.59	1170.702	1337.946	1505.189	1672.432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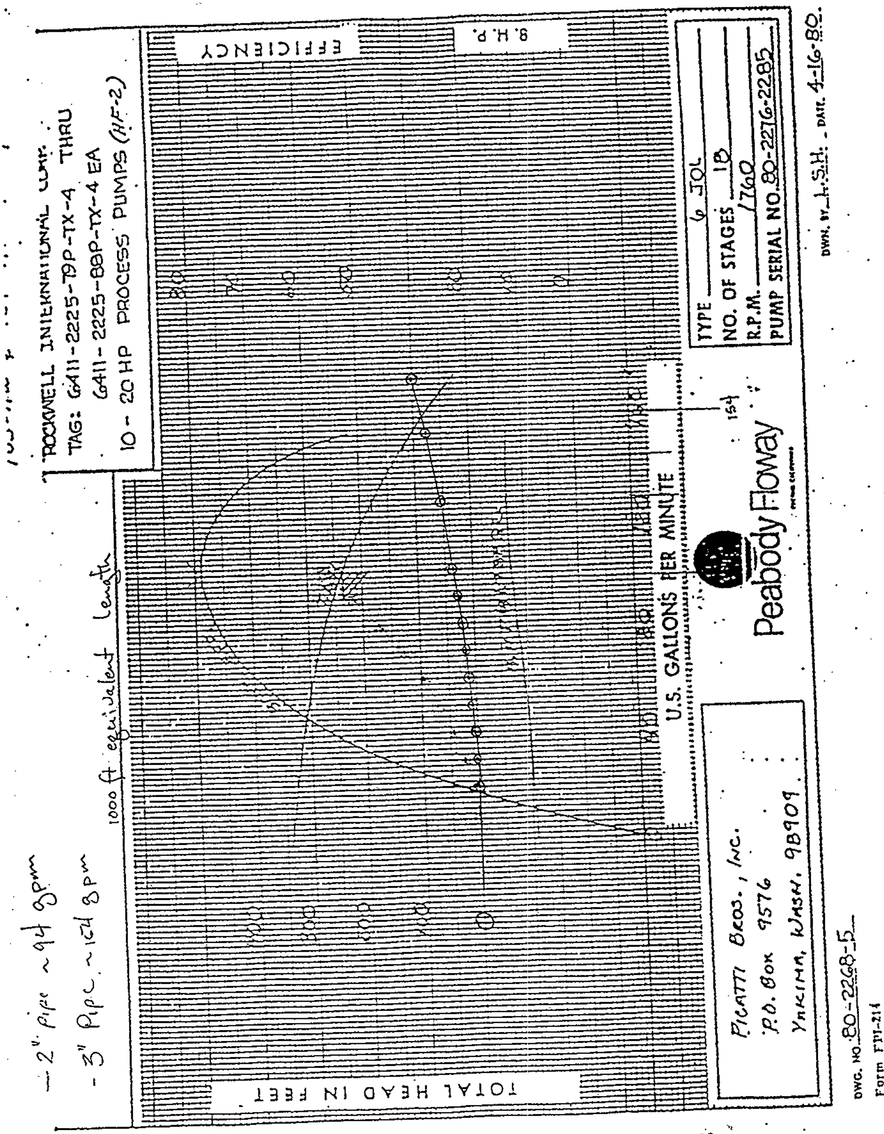
PAGE 3/3
57626
AP-102 & AP-104
- 2" Pipe ~ 130 gpm maximum
- 3" Pipe ~ 221 gpm maximum 1000 ft equivalent length
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
B.H.P AT 1.50 SP.GR.
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER PATT
7VTM
DIA IMPELLER
5.75"
IMPELLER MAX DIA
5.94"
SULZER PUMPS
WESTINGHOUSE-
HANFORD COMPANY
SLURRY TRANSFER PUMP

01/19/98 09:19 FAX 509 373 0171 ∅02



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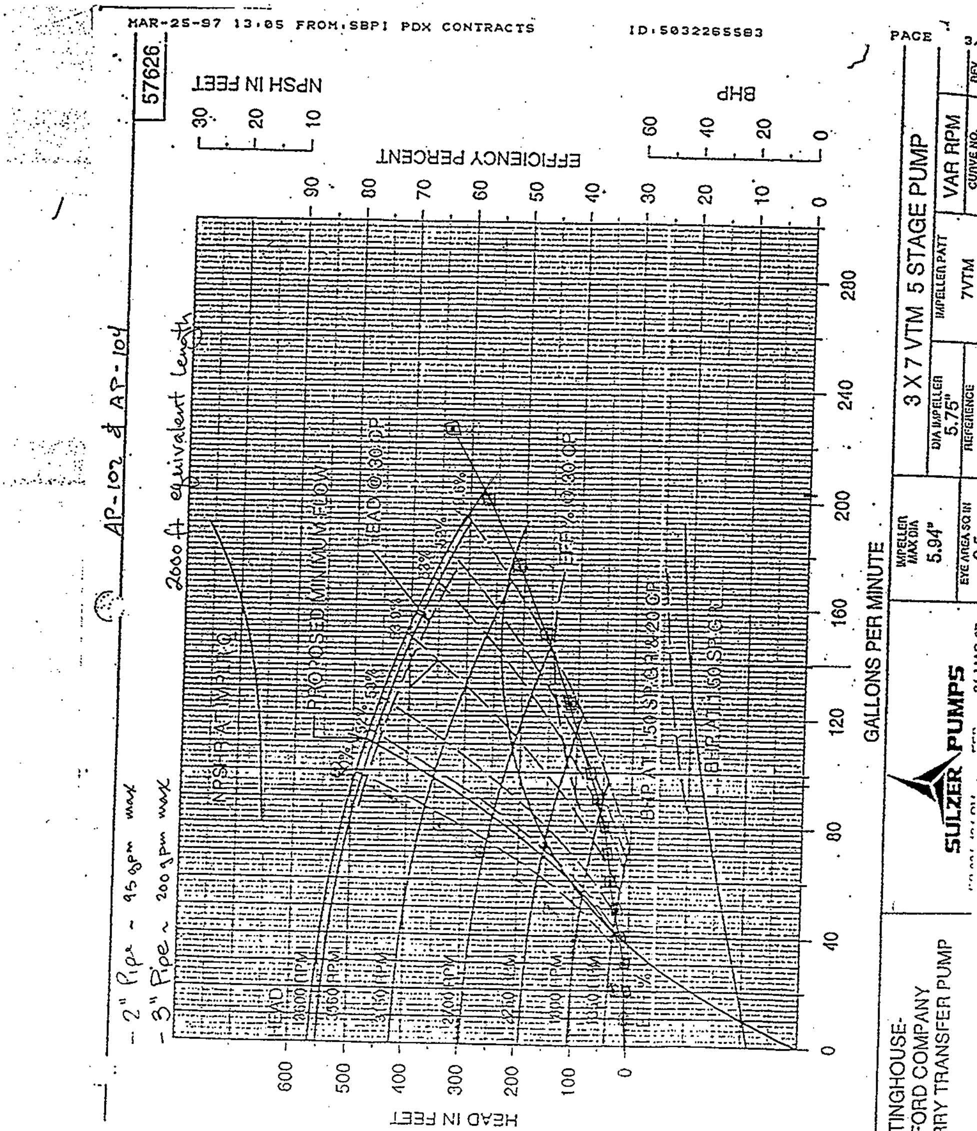
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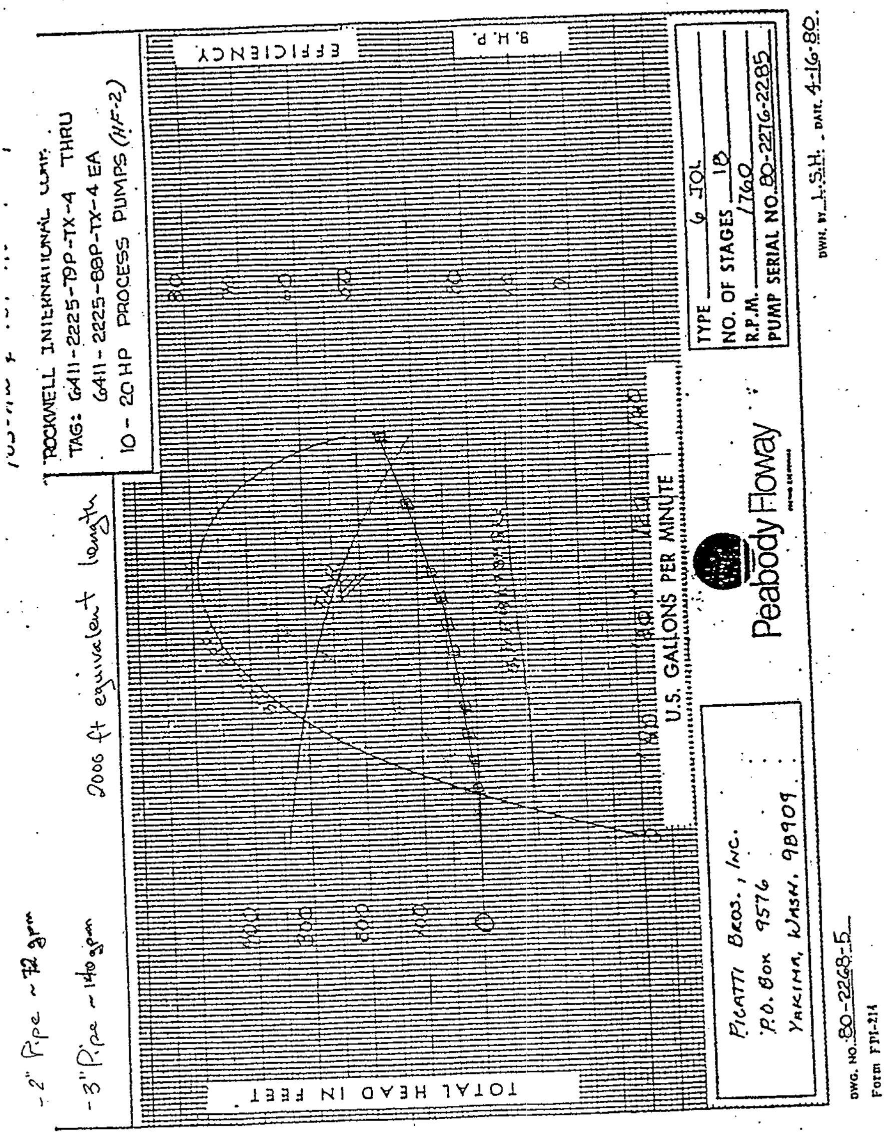
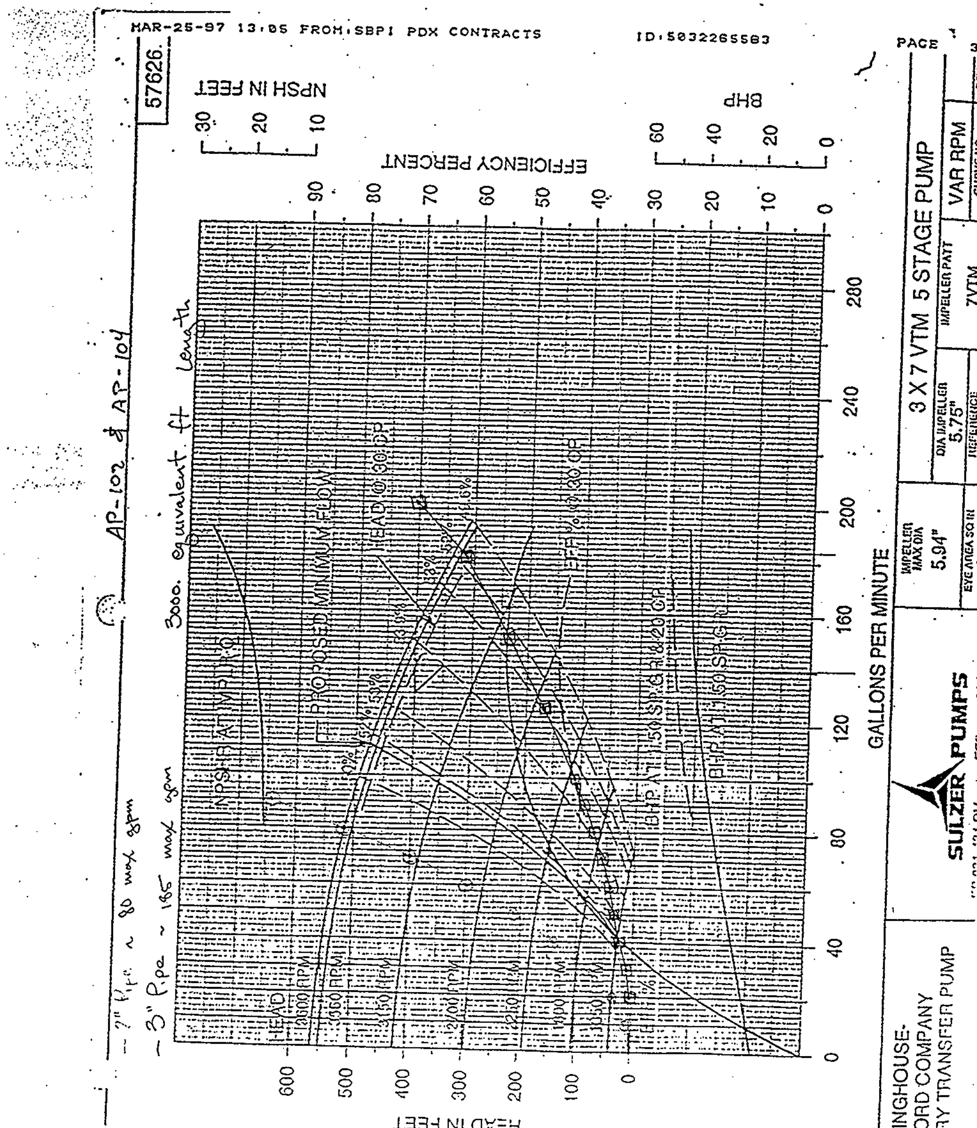
ID:5032265583
PAGE 3
57626
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
AP-102 & AP-104
2000 ft equivalent length
- 2" Pipe ~ 95 gpm max
- 3" Pipe ~ 200 gpm max
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER PATT
7VTM
DIA IMPELLER
5.75"
IMPELLER MAX DIA
5.94"
REFERENCE
EYE AREA SQ IN
CURVE NO.
SULZER PUMPS
WESTINGHOUSE-
HANFORD COMPANY
SLURRY TRANSFER PUMP

01/19/98 09:19 FAX 509 373 0171 ⊘02

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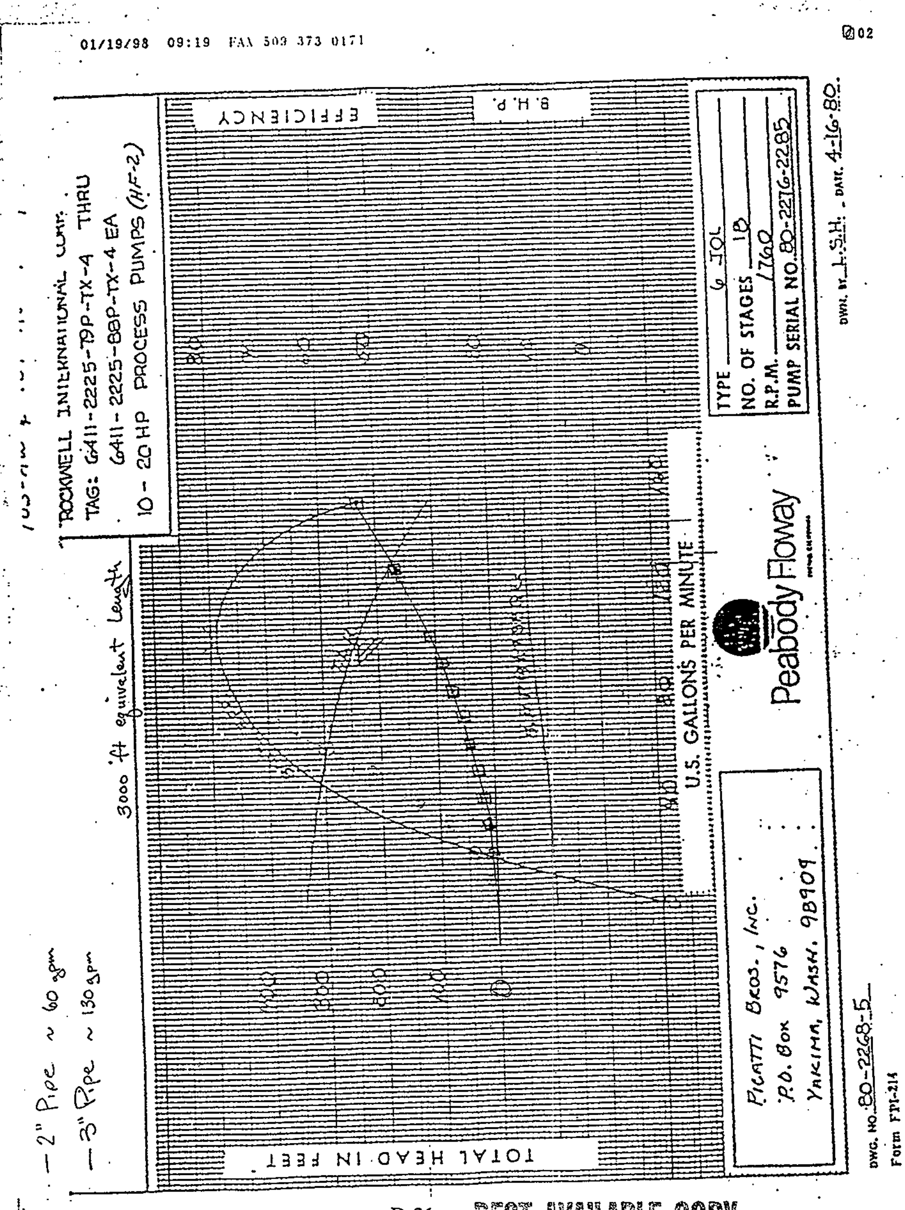
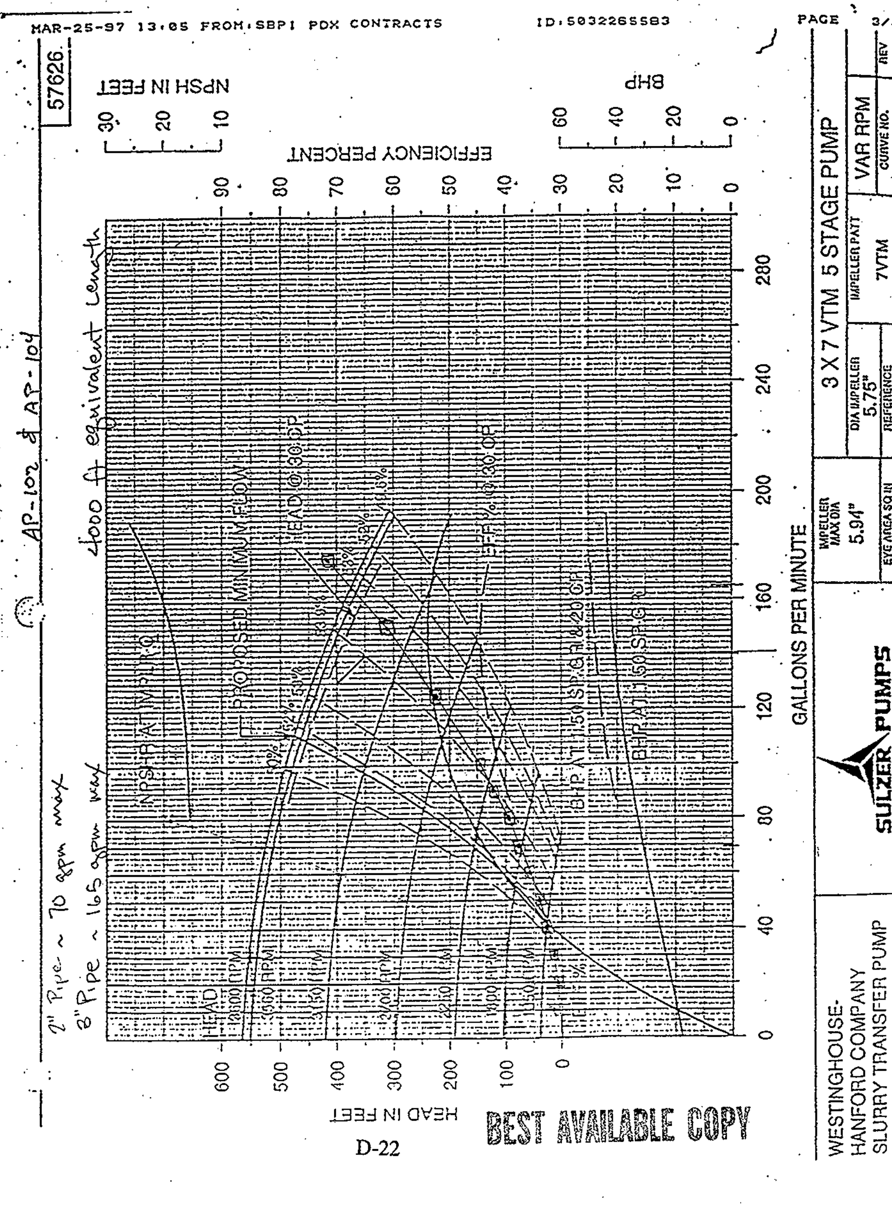
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
AP-102 & AP-104
3000. equivalent ft length
~ 2" Pipe ~ 80 max gpm
~ 3" Pipe ~ 185 max gpm
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF. @ 30 CP
BHP AT 1.50 SP.GR. & 20 CP
BHP AT 1.50 SP.GR.
NPSHR AT MAX RPM
3600 RPM
3360 RPM
3150 RPM
2700 RPM
2400 RPM
1900 RPM
1550 RPM
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER MAX DIA 5.94"
DIA IMPELLER 5.75"
IMPELLER PATT 7VTM
EYE AREA SQ IN
REFERENCE
SULZER PUMPS
WESTINGHOUSE-
HANFORD COMPANY
SLURRY TRANSFER PUMP


01/19/98 09:19 FAX 503 373 0171
002
ROCKWELL INTERNATIONAL CORP.
TAG: G411-2225-T9P-TX-4 THRU
G411-2225-88P-TX-4 EA
10 - 20 HP PROCESS PUMPS (HF-2)
3000 ft equivalent Length
— 2" Pipe ~ 60 gpm
— 3" Pipe ~ 130 gpm
EFFICIENCY
B. H. P.
TOTAL HEAD IN FEET
U.S. GALLONS PER MINUTE
TYPE 6 JOL
NO. OF STAGES 18
R.P.M. 1760
PUMP SERIAL NO. 80-2276-2285
DWG. BY L.S.H. DATE 4-16-80
Peabody Floway
Picatti Bros., Inc.
P.O. Box 9576
Yakima, Wash. 98909
DWG. NO. 80-2268-5
Form FPI-214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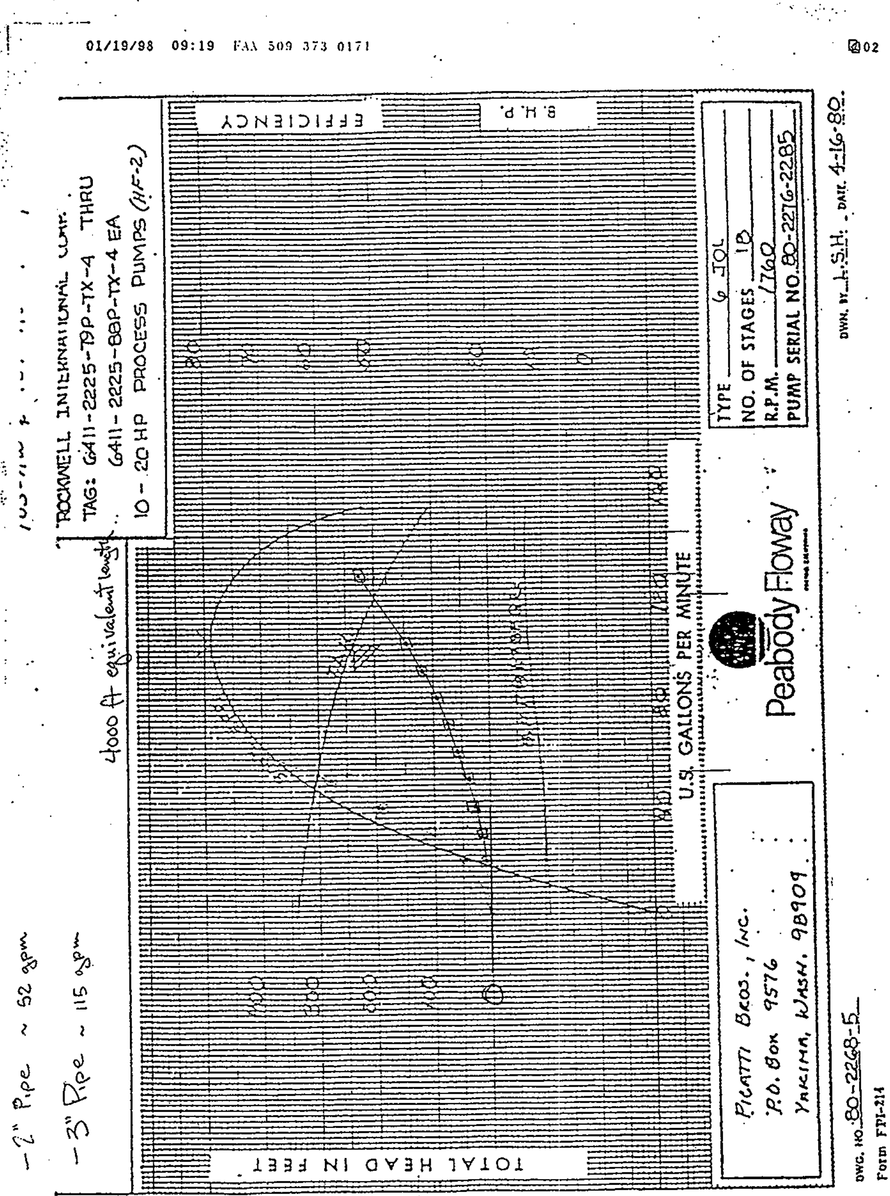
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER PAT
7VTM
DIA IMPELLER
5.75"
IMPELLER MAX DIA
5.94"
SULZER PUMPS
WESTINGHOUSE-
HANFORD COMPANY
SLURRY TRANSFER PUMP
AP-102 & AP-104
4000 ft equivalent Length
2" Pipe ~ 70 gpm max
3" Pipe ~ 165 gpm max



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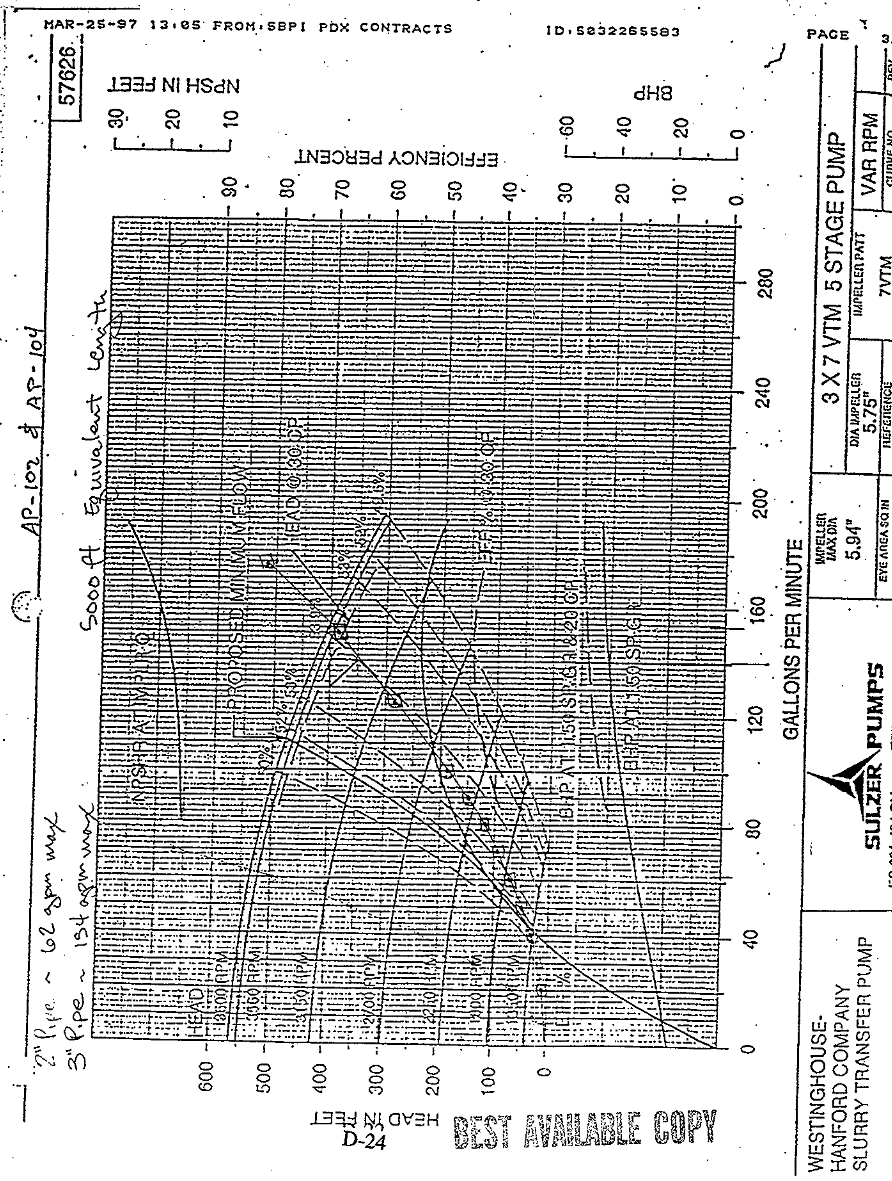
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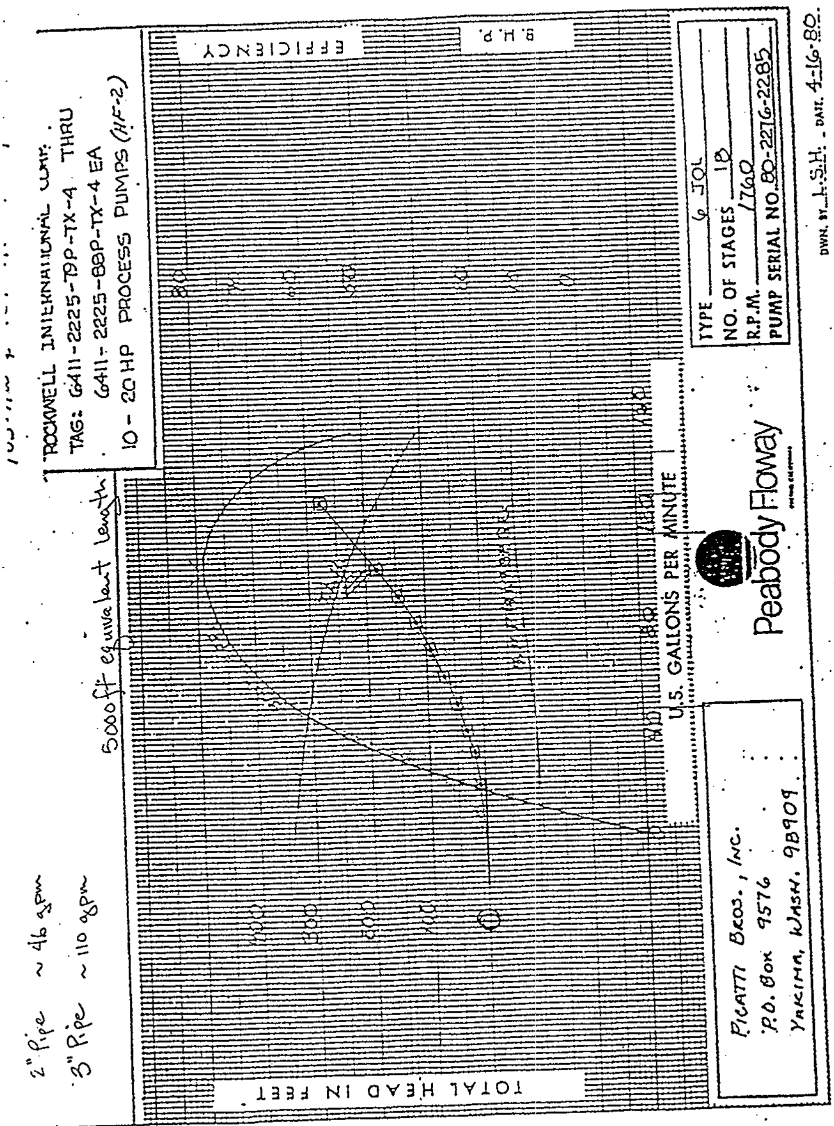
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
NPSH R AT MAX R.Q.
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF % @ 30 CP
B.H.P. AT 1.50 SP.GR. & 20 CP
B.H.P. AT 1.50 SP.G.
HEAD 3600 RPM
3360 RPM
3150 RPM
2700 RPM
2210 RPM
AP-102 & AP-104
5000 ft Equivalent Length
2" Pipe ~ 62 gpm max
3" Pipe ~ 154 gpm max
WESTINGHOUSE-HANFORD COMPANY
SLURRY TRANSFER PUMP
SULZER PUMPS
IMPELLER MAX DIA 5.94"
EYE AREA SQ IN
DIA IMPELLER 5.75"
REFERENCE
3 X 7 VTM 5 STAGE PUMP
IMPELLER PATT 7VTM
VAR RPM
CURVE NO.
BEST AVAILABLE COPY

01/19/98 09:19 FAX 509 373 0171 ☒02



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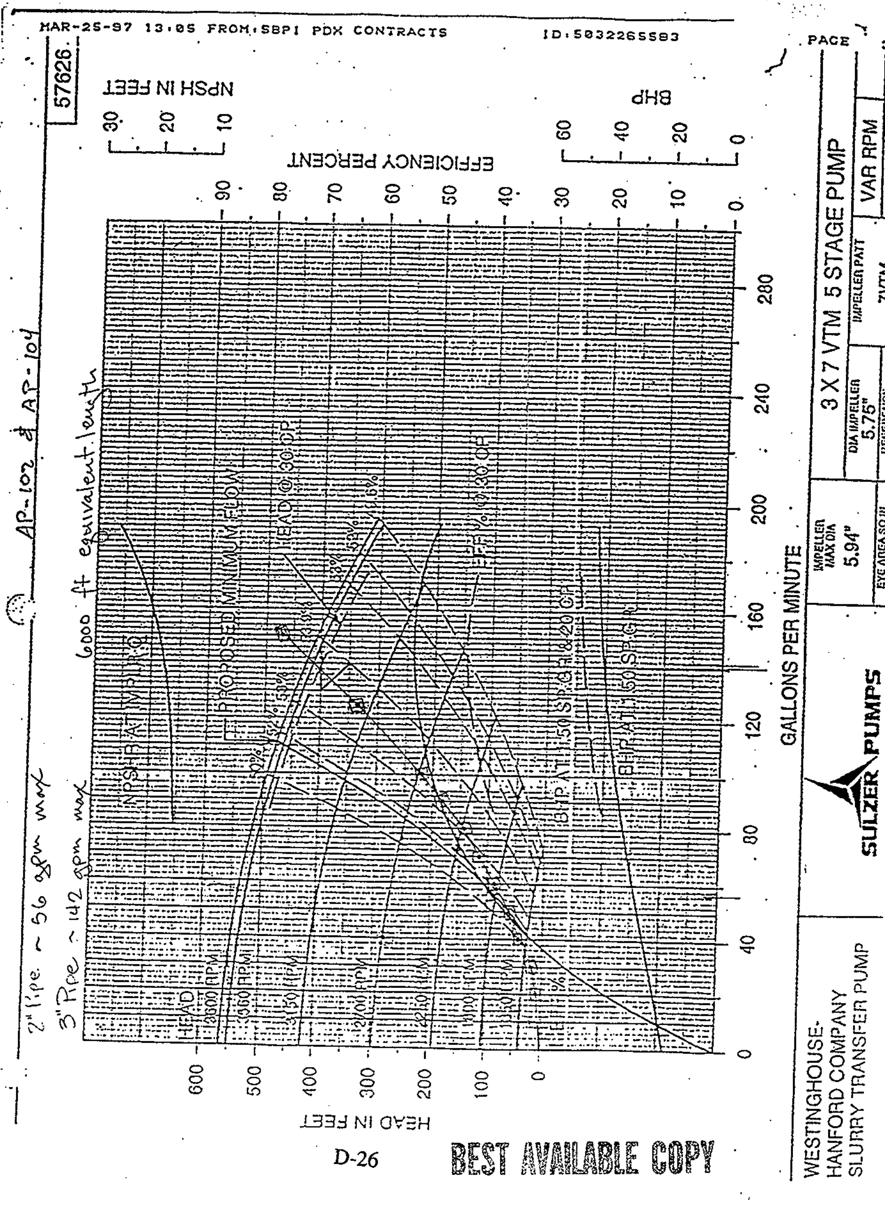
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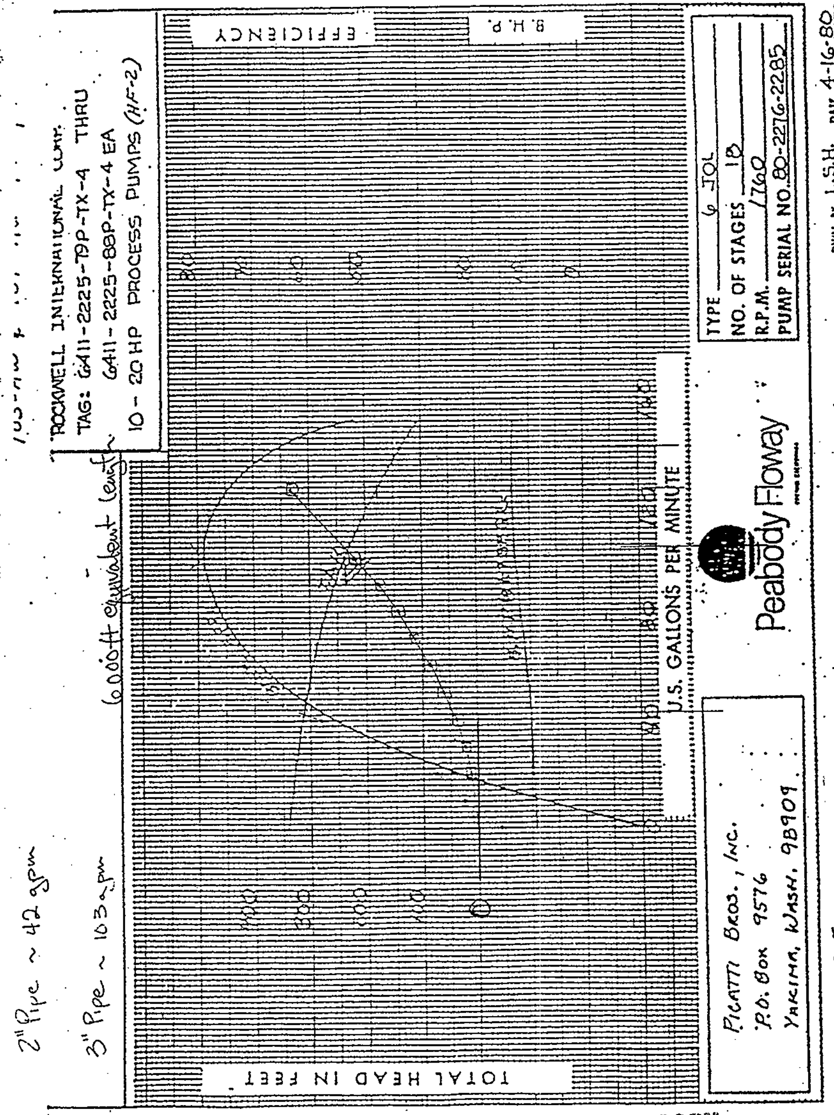
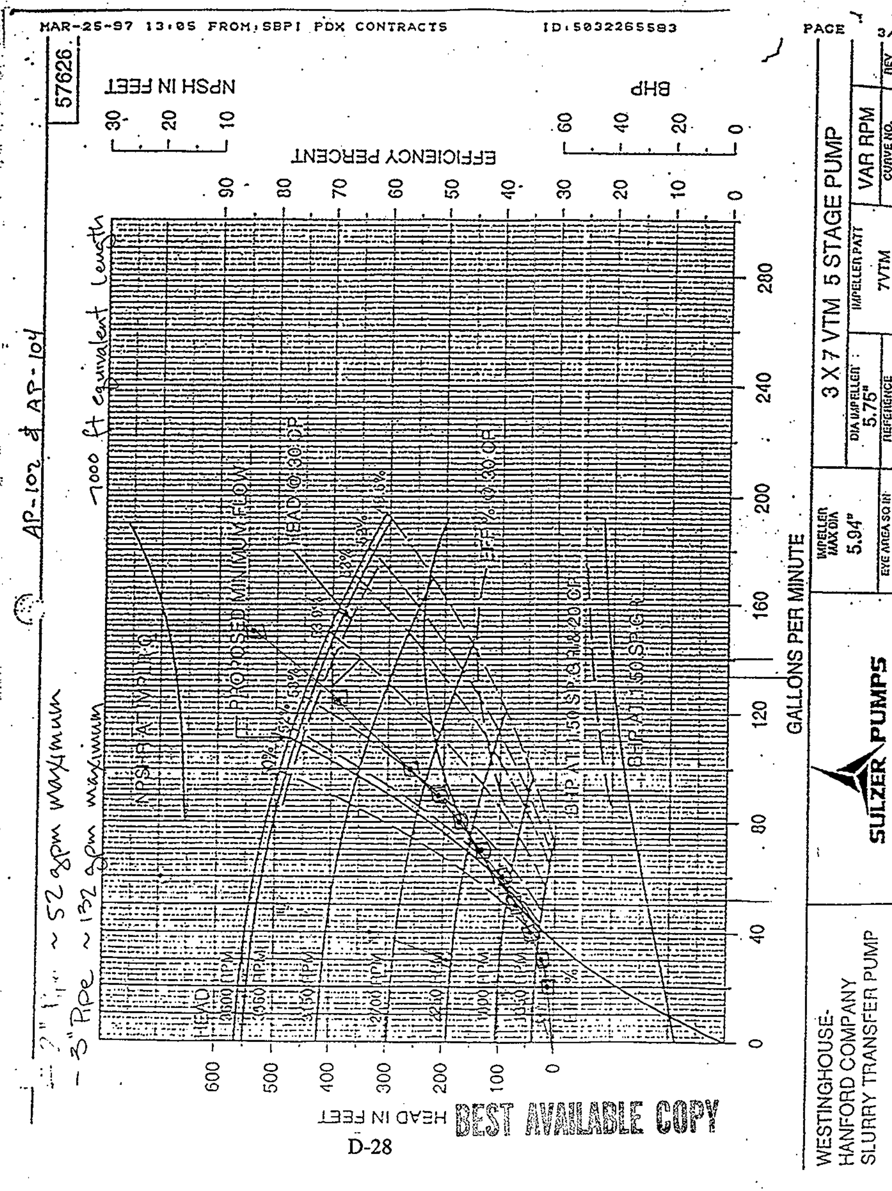
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
NPSHR AT MAX RPM
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF. @ 30 CP
B.H.P. AT 1.50 SP.GR. & 20 CP
BHP AT 1.50 SP.GR.
HEAD 3600 RPM
3360 RPM
3150 RPM
2700 RPM
2210 RPM
1800 RPM
1330 RPM
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER MAX DIA 5.94"
DIA IMPELLER 5.75"
SULZER PUMPS
WESTINGHOUSE-HANFORD COMPANY
SLURRY TRANSFER PUMP
AP-102 & AP-104
6000 ft equivalent length
2" Pipe ~ 56 gpm max
3" Pipe ~ 142 gpm max

01/19/98 09:19 FAX 509 373 0171 002

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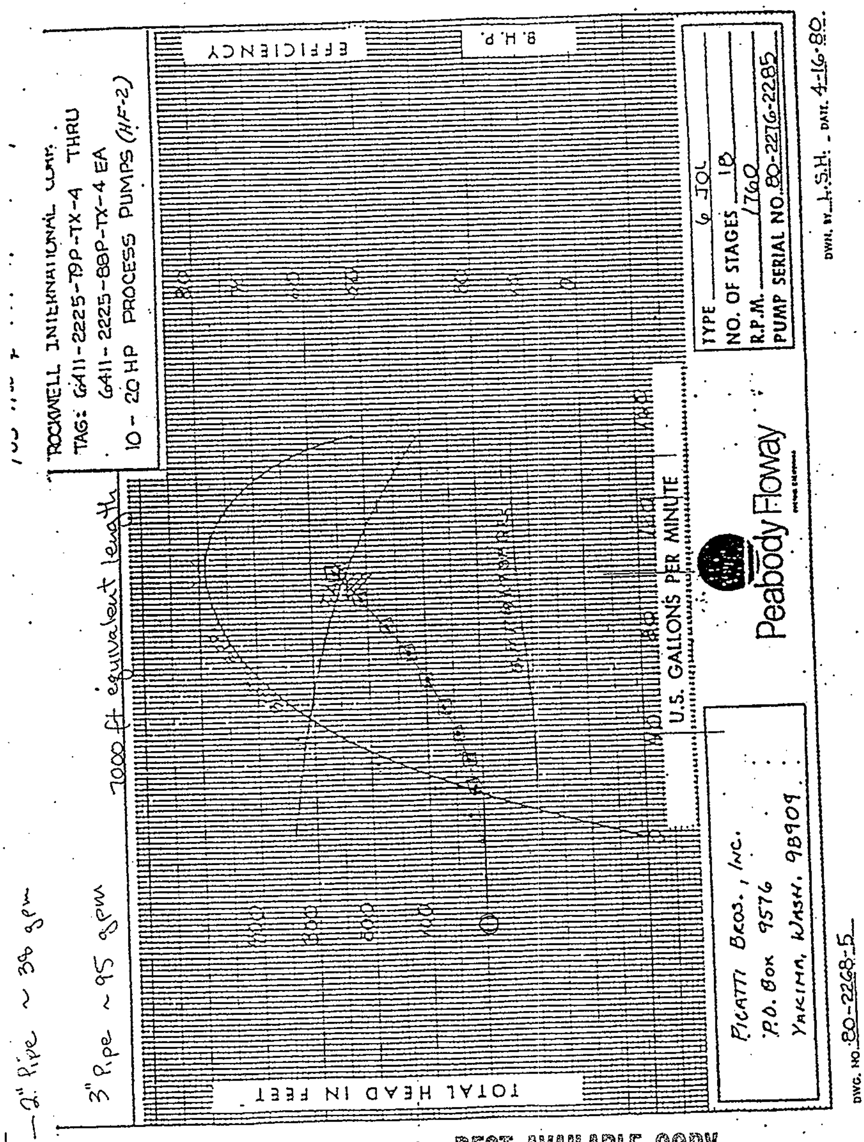
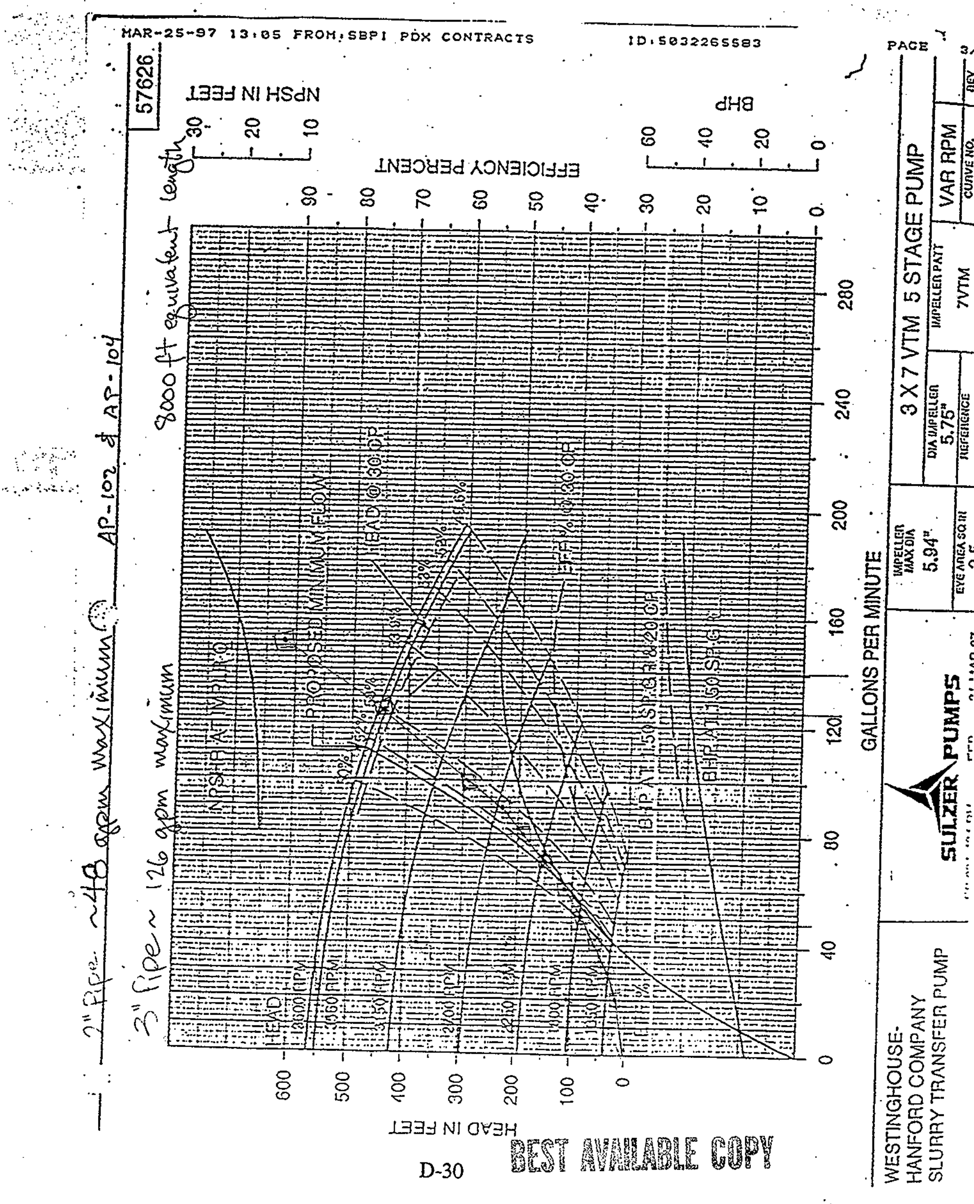
57626.
AP-102 & AP-104
7000 ft equivalent Length
2" Pipe ~ 52 gpm maximum
3" Pipe ~ 132 gpm maximum
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF. @ 30 CP
BHP AT 1.50 SP.GR. & 20 CP
BHP AT 1.50 SP.GR.
3 X 7 VTM 5 STAGE PUMP
VAR RPM
CURVE NO.
REV
DIA IMPELLER 5.75"
IMPELLER PATT 7VTM
REFERENCE
IMPELLER MAX DIA 5.94"
EYE AREA SQ IN
SULZER PUMPS
WESTINGHOUSE-HANFORD COMPANY
SLURRY TRANSFER PUMP

01/19/98 09:19 FAX 509 373 0171 002

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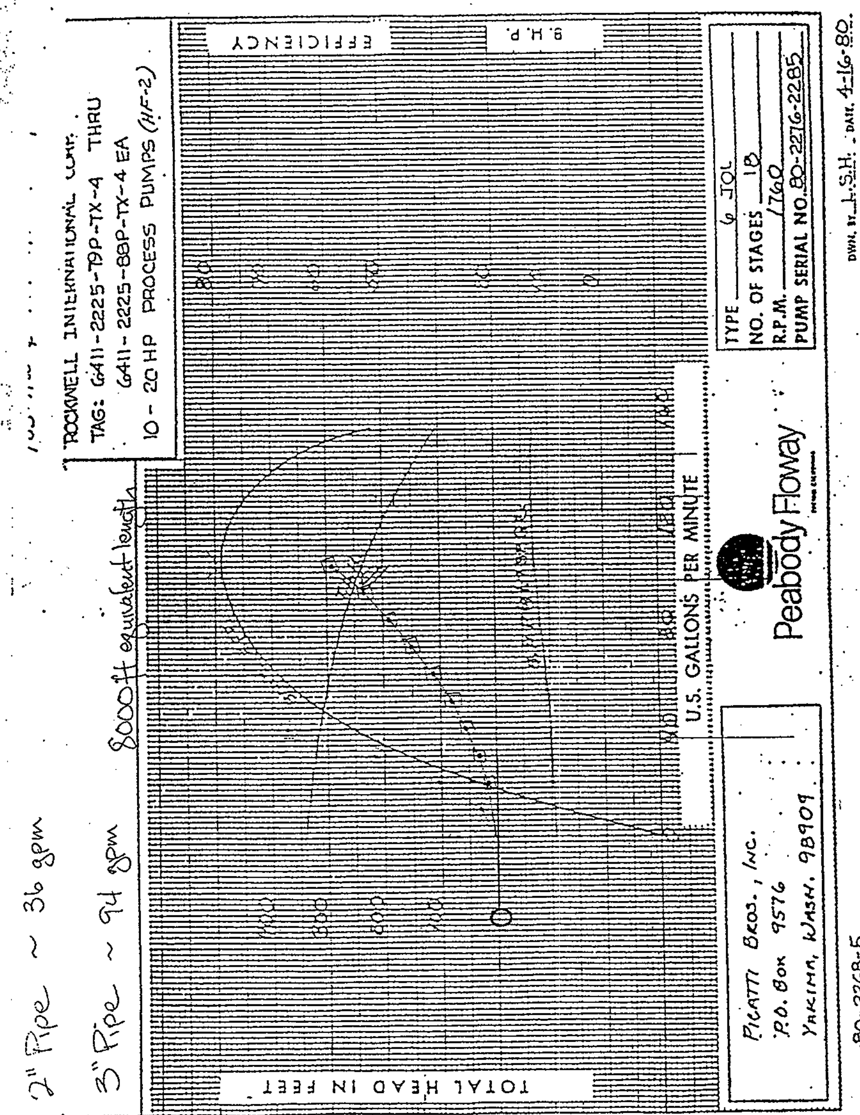
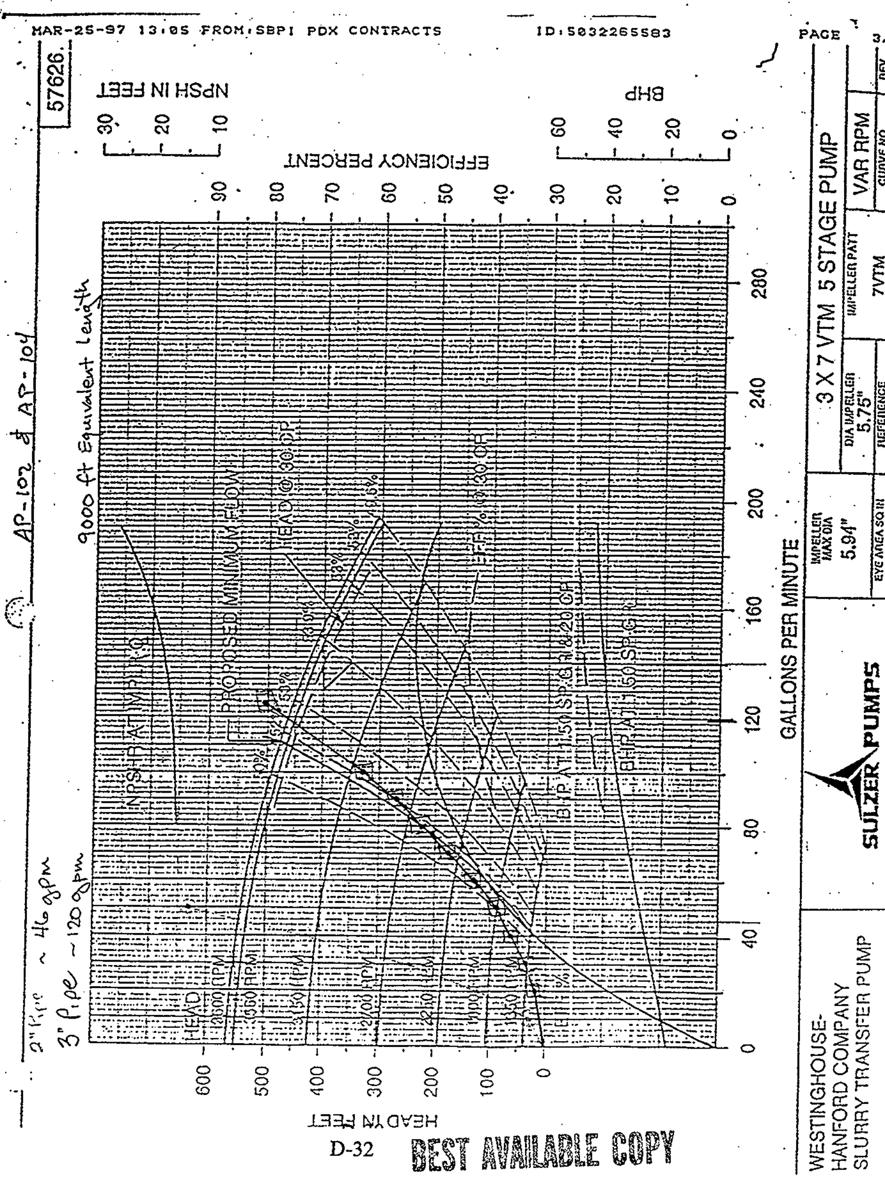
57626
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF % @ 30 CP
B.H.P. AT 1.50 SP.G. & 20 CP
B.H.P. AT 1.50 SP.G.
NPSH AT N.P.R.O.
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER MAX DIA 5.94"
DIA IMPELLER 5.75"
IMPELLER PATT 7VTM
SULZER PUMPS
WESTINGHOUSE-HANFORD COMPANY
SLURRY TRANSFER PUMP
2" Pipe ~48 gpm maximum
3" Pipe ~ 126 gpm maximum
AP-102 & AP-104
8000 ft equivalent length

01/19/98 09:19 FAX 509 373 0171 02

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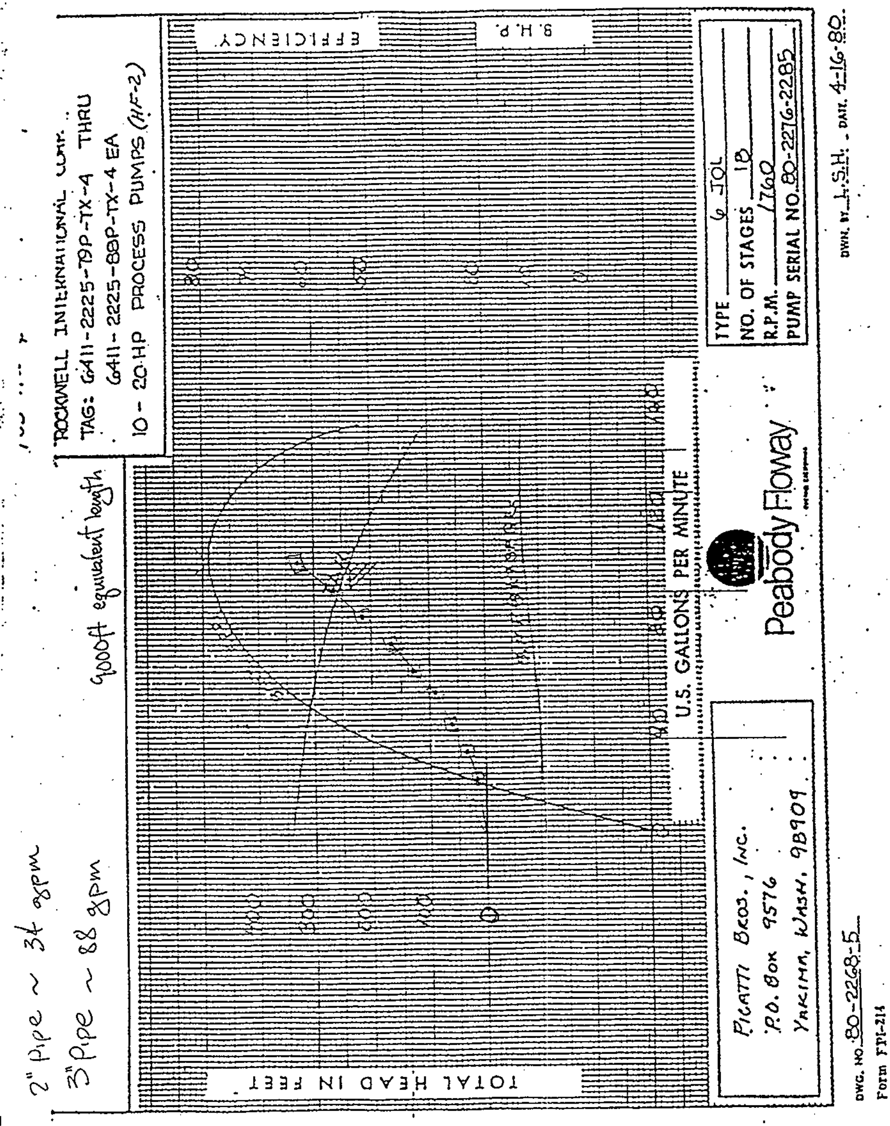
57626.
AP-102 & AP-104
9000 ft Equivalent Length
2" Pipe ~ 46 gpm
3" Pipe ~ 120 gpm
NPSH IN FEET
BHP
EFFICIENCY PERCENT
HEAD IN FEET
GALLONS PER MINUTE
PROPOSED MINIMUM FLOW
3 X 7 VTM 5 STAGE PUMP
VAR RPM
IMPELLER PATT 7VTM
DIA IMPELLER 5.75"
IMPELLER MAX DIA 5.94"
SULZER PUMPS
WESTINGHOUSE-
HANFORD COMPANY
SLURRY TRANSFER PUMP

01/19/98 09:19 FAX 509 373 0171 02



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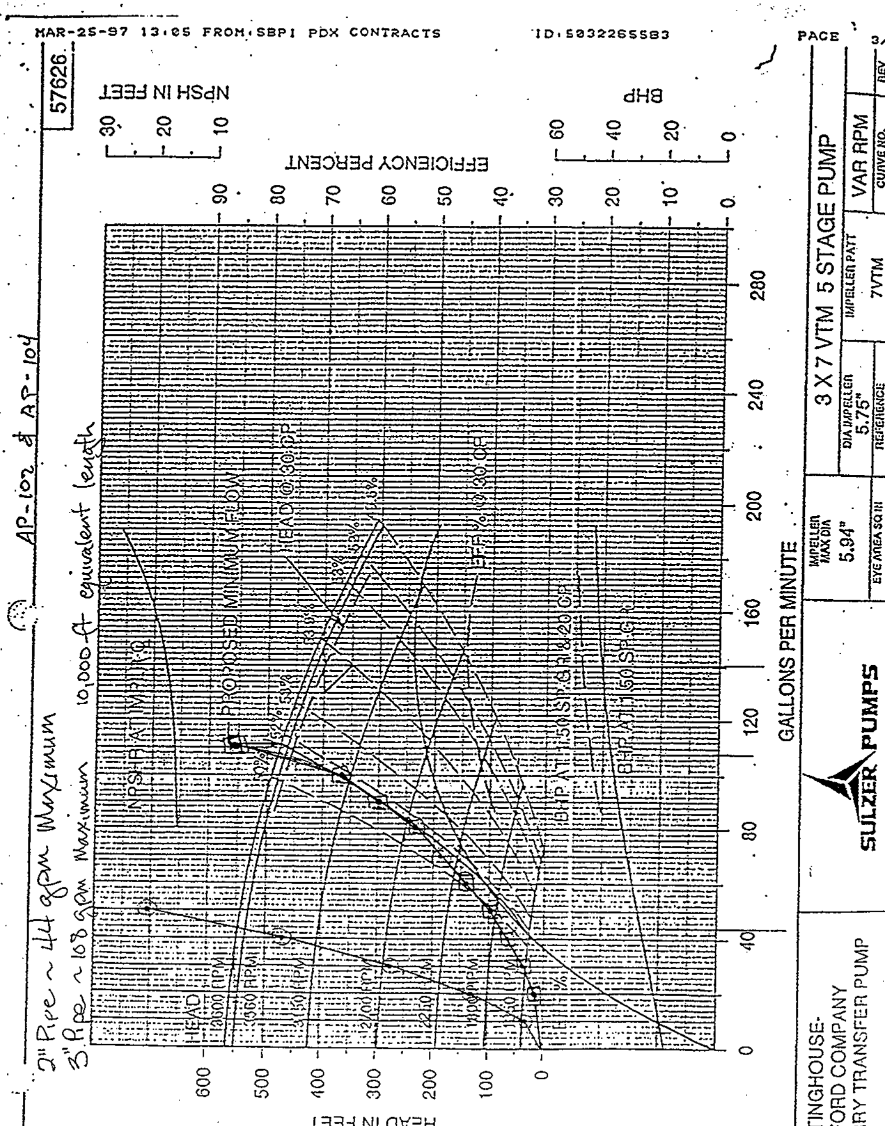
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57626
NPSH IN FEET
BHP
EFFICIENCY PERCENT
GALLONS PER MINUTE
HEAD IN FEET
PROPOSED MINIMUM FLOW
HEAD @ 30 CP
EFF. @ 30 CP
BHP AT 1.50 SP.GR.& 20 CP
BHP AT 1.50 SP.GR.
3 X 7 VTM 5 STAGE PUMP
VAR RPM
DIA IMPELLER 5.75"
IMPELLER PATT 7VTM
IMPELLER MAX DIA 5.94"
SULZER PUMPS
WESTINGHOUSE-HANFORD COMPANY
SLURRY TRANSFER PUMP
AP-102 & AP-104
10,000 ft equivalent length
2" Pipe ~ 44 gpm Maximum
3" Pipe ~ 108 gpm Maximum

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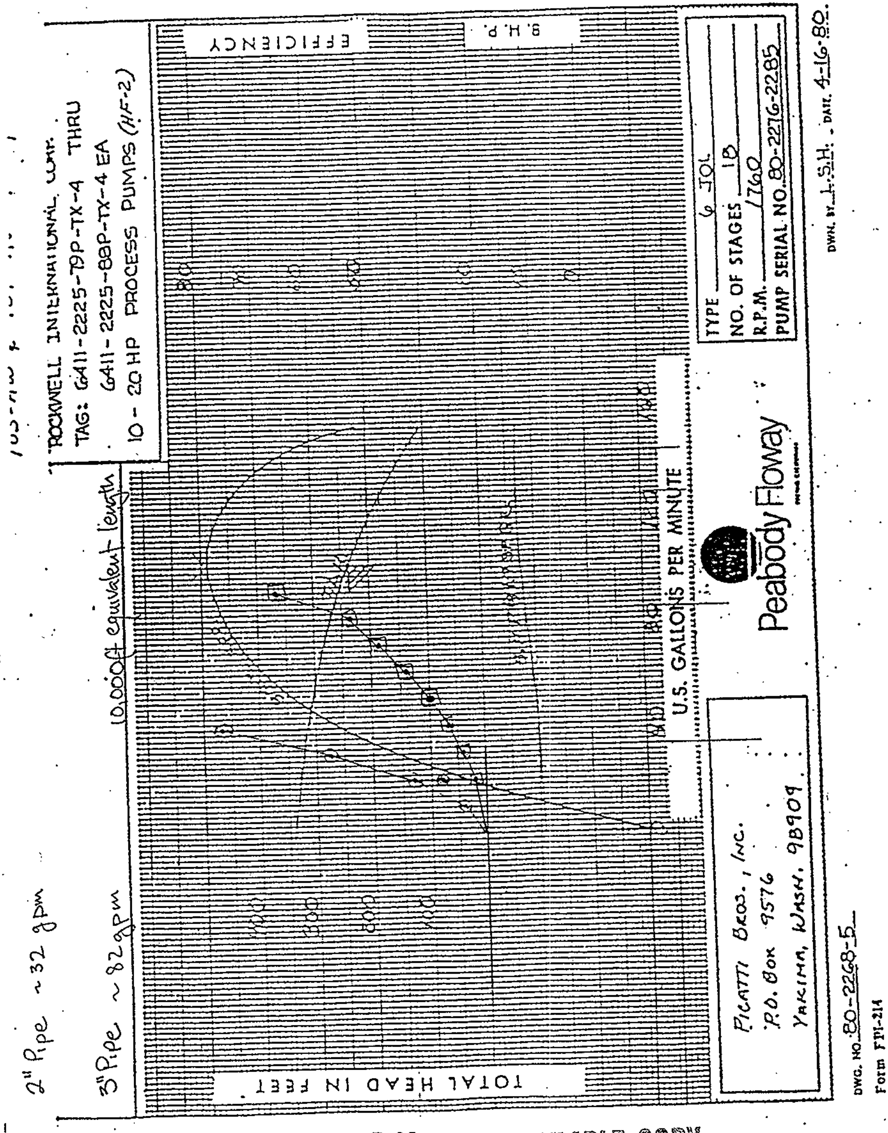
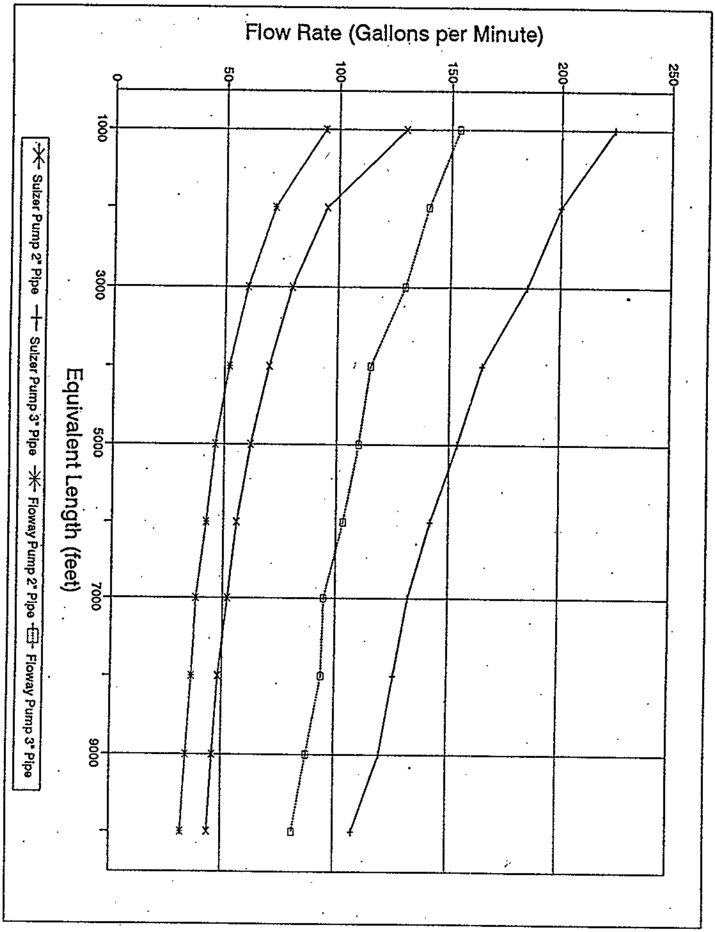
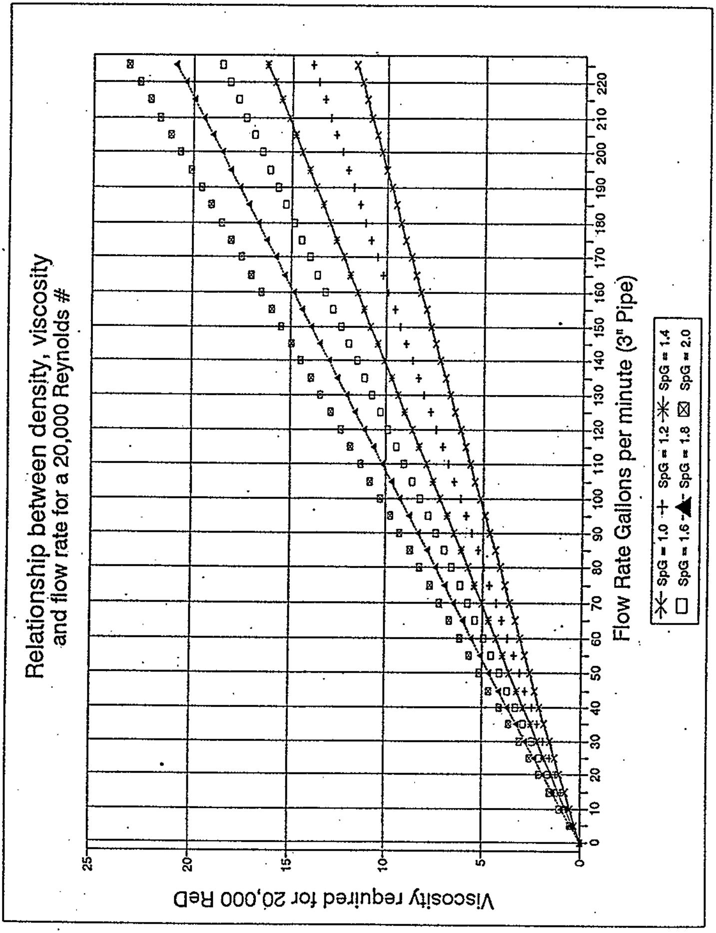



Flow Rate (Gallons per Minute)
0
50
100
150
200
250
Equivalent Length (feet)
1000
3000
5000
7000
9000
Sulzer Pump 2" Pipe
Sulzer Pump 3" Pipe
Floway Pump 2" Pipe
Floway Pump 3" Pipe


Relationship between density, viscosity
and flow rate for a 20,000 Reynolds #
Viscosity required for 20,000 ReD
Flow Rate Gallons per minute (3" Pipe)
SpG = 1.0
SpG = 1.2
SpG = 1.4
SpG = 1.6
SpG = 1.8
SpG = 2.0

```
$MODEL
GENTANKW
LAB
GEOCHEM
SPECIAL
$STREAM AW-101
SAMPLE AW-101
UNITS       USER    CALORI GMOLE  HOUR   CENTIG ATMOSP METER  LITER  MOLALI
TEMP           36.000
PRES           1.0000
H2O                .555087E+02
ALOH3              .157617E+01
BIOH3              .180626E-02
CAOH2              .444188E-01
CROH3              .431140E-02
CSOH               .613922E-04
FEIIIOH3           .196278E+00
H2CO3              .610405E+00
H2CRO4             .231633E-02
H4SIO4             .143158E-01
H6F6               .119977E-01
HCL                .246648E+00
HGOH2              .328700E-04
HNO2               .337513E+01
HNO3               .534342E+01
LAOH3              .237333E-04
MNOH2              .256533E-01
NA6SO42CO3         .186174E-01
NAFPO4             .124097E+00
NAOH               .156537E+02
NIOH2              .269153E-01
PBOH2              .202066E-02
PUIVOH4            .224284E-04
UCL6               .166649E-02
ZROH4              .522224E-02
K2O                .811563E+00
SCALE NA4SIO4PPT          .137039E+19
SCALE NA3PO4.6H2O         .122021E+06   343.150   394.150   EXCL TR
SCALE PUIVOH4PPT          .100002E+01
SCALE FEOOHPPT            .100000E+01
SCALE NIOH2PPT            .100000E+01
SCALE BI2O3PPT            .100000E+01
SCALE KALSIO4PPT          .100000E+01
SCALE NAFPO4.19H2O        .100000E+01   288.150   348.150
SCALE KNO3PPT             .100000E+01   273.150   383.150
SCALE LAOH3PPT            .100000E+01
SCALE CA5OHPO43PPT        .999999E+00
SCALE NA2U2O7PPT          .999996E+00
SCALE PBOH2PPT            .999996E+00   273.150   333.150
SCALE ZRO2PPT             .999985E+00
SCALE NA2CO3.1H2O         .936826E+00   308.520   382.150
SCALE NANO3PPT            .923637E+00   273.150   453.150
SCALE NAFPPT              .659095E+00   273.150   373.150
SCALE ALOOHPPT            .630184E+00   373.250   523.150   EXCL TR
SCALE NA3PO4.8H2O         .491001E+00   313.160   343.150   EXCL TR
SCALE LAPO4.2H2O          .427236E+00
SCALE NA2CO3PPT           .371623E+00   382.150   473.150   EXCL TR
SCALE ALOH3PPT            .366789E+00   273.150   373.150
SCALE NANO2PPT            .352236E+00   273.150   401.150
SCALE NA6SO42CO3PPT       .311425E+00   303.150   423.150
SCALE NA2SO4PPT           .257197E+00   305.550   514.150
SCALE CAOH2PPT            .234871E+00
SCALE MNOH2PPT            .210350E+00
SCALE NAPHOH.12H2O        .166815E+00   273.150   313.150
SCALE NACLPPT             .157304E+00   273.150   623.150
SCALE KNO2PPT             .152800E+00   273.150   393.150
SCALE CROH3PPT            .111181E+00
SCALE NA2CO3.7H2O         .540235E-01   305.150   308.520   EXCL TR
SCALE NIOPPT              .502681E-01
SCALE NAALO2.3H2O         .483655E-01
SCALE HGOPPT              .391181E-01
```

AW-101.smp

What is % dilution?

H_2O IN

40.716 kg	68.06
57.73	84.62
74.74	101.6
91.75	118.9
↑ survey	↑ approx volume

```
SCALE NAALSIO4PPT              .356196E-01
SCALE KCLPPT                   .339694E-01  273.150  473.150
SCALE NA2CO3.10H2O             .157802E-01  273.150  305.150  EXCL TR
SCALE NA2UO4PPT                .116540E-01
END
$SAMPLE AW-101
DESC 2-Sep-97 Single RecElec NoRecpH
UNITS     USER    CALORI GMOLE  HOUR    CENTIG ATMOSP METER  LITER
TEMP 36.000
PRES 1.0000
AMT  1.0
DENS 1490.0          1433.8
PH   0.0             15.273
RECELEC  Make Up Ion Method using -.5759 mg/l of OHION
EQUIL  LAB  BALANCE           OHION               OHION
CONCENTRATION mg/l.
AL+3                25800.         25800.
BI+3                229.00         229.00
CA+2                1080.0         1080.0
CRIII+3             136.00         136.00
CS+1                4.9500         4.9500
FEIII+3             6650.0         6650.0
HG+2                4.0000         4.0000
K+1                 38500.         38500.
LA+3                2.0000         2.0000
MN+2                855.00         855.00
NA+1                2.3200E+05     2.3200E+05
NI+2                958.00         958.00
PB+2                254.00         254.00
PUIV+4              3.3200         3.3200
UO2+2               273.00         273.00
ZR+4                289.00         289.00
OH-1                1.2947E+05     1.2947E+05
CL-1                5520.0         5520.0
CO3-2               22900.         22900.
CRO4-2              163.00         163.00
F-1                 2260.0         2260.0
H3SIO4-1            826.00         826.00
NO2-1               94200.         94200.
NO3-1               2.0100E+05     2.0100E+05
PO4-3               14300.         14300.
SO4-2               2170.0         2170.0
SOL SCALING
NA4SIO4PPT              .137039E+19
NA3PO4.6H2O             .122021E+06  343.150  394.150  EXCL TR
PUIVOH4PPT              .100002E+01
FEOOHPPT                .100000E+01
NIOH2PPT                .100000E+01
BI2O3PPT                .100000E+01
KALSIO4PPT              .100000E+01
NAFPO4.19H2O            .100000E+01  288.150  348.150
KNO3PPT                 .100000E+01  273.150  383.150
LAOH3PPT                .100000E+01
CA5OHPO43PPT            .999999E+00
NA2U2O7PPT              .999996E+00
PBOH2PPT                .999996E+00  273.150  333.150
ZRO2PPT                 .999985E+00
NA2CO3.1H2O             .936826E+00  308.520  382.150
NANO3PPT                .923637E+00  273.150  453.150
NAFPPT                  .659095E+00  273.150  373.150
ALOOHPPT                .630184E+00  373.250  523.150  EXCL TR
NA3PO4.8H2O             .491001E+00  313.160  343.150  EXCL TR
LAPO4.2H2O              .427236E+00
NA2CO3PPT               .371623E+00  382.150  473.150  EXCL TR
ALOH3PPT                .366789E+00  273.150  373.150
NANO2PPT                .352236E+00  273.150  401.150
NA6SO42CO3PPT           .311425E+00  303.150  423.150
NA2SO4PPT               .257197E+00  305.550  514.150
CAOH2PPT                .234871E+00
MNOH2PPT                .210350E+00
NAPHOH.12H2O            .166815E+00  273.150  313.150
```

NACLPPT	.157304E+00	273.150	623.150	
KNO2PPT	.152800E+00	273.150	393.150	
CROH3PPT	.111181E+00			
NA2CO3.7H2O	.540235E-01	305.150	308.520	EXCL TR
NIOPPT	.502681E-01			
NAALO2.3H2O	.483655E-01			
HGOPPT	.391181E-01			
NAALSIO4PPT	.356196E-01			
KCLPPT	.339694E-01	273.150	473.150	
NA2CO3.10H2O	.157802E-01	273.150	305.150	EXCL TR
NA2UO4PPT	.116540E-01			
END				

```
================================================================================

        O  O  O          L                  I I I I
     O           O       L                     I
   O               O     L                     I
  O                  O   L                     I
  O                  O   L                     I
  O                  O   L                     I
   O               O     L                     I
     O           O       L                     I
        O  O  O          L L L L L L L      I I I I
```

E N V I R O N M E N T A L   S I M U L A T I O N   P R O G R A M

V - 5.4   March 1, 1997

SURVEY: AW-101

CHEMISTRY MODEL: gentank

THIS FILE NAME: AW-101.~~LIS~~ sum

DATE: 3-Oct-97

==

This survey was done at 45 °C. Most of the ppt is $NaFPO_4 \cdot 19H_2O$. ~~This~~ About 2/3 dissolves by 75% dilution.

Also, $Mn(OH)_2$ begins to form at 25% dilution. KNO_3 is almost at saturation as is $Na_2CO_3 \cdot H_2O$.

This survey was done on a composite of AW-101.

Initial solids 3.47 Kg/100 g composite
3.29 Kg @ 25% dilution
2.32 Kg @ 50% dilution
2.05 Kg @ 75% dilution

TABLE OF CONTENTS

ESP V-5.4 SURVEY-VARIABLES 3-Oct-97 PAGE 2

H2OIN	DENSITY	VOLLIQ		NAFPO4.19H2O	MNOH2PPT
kg	kg/L	L/hr		kg	kg
40.72	1.418	68.06	1.24	2.310	.0000E+00
57.73	1.344	84.62		2.117	.1497E-01
74.74	1.291	101.6	1.49	1.593	.6187E-01
91.75	1.253	118.9	1.75	.8127	.7710E-01

ESP V-5.4 STREAM:AW-101 3-Oct-97 PAGE 1

STREAM: AW-101
POINT : 1

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	45.000	45.000	45.000	45.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	14.965			
Total mol/hr	3984.3	13.591	0.0	0.0
------------------	kg/hr	kg/hr	kg/hr	kg/hr
H2O	46.740	0.0	0.0	0.0
ALOH3	1.0116E-09	0.0	0.0	0.0
BIOH3	5.3175E-07	0.0	0.0	0.0
CASO4	6.2444E-12	0.0	0.0	0.0
CO2	5.0653E-17	0.0	0.0	0.0
CSCL	9.5039E-06	0.0	0.0	0.0
CSNO3	1.0914E-04	0.0	0.0	0.0
FEIIIOH3	3.3155E-12	0.0	0.0	0.0
H3PO4	5.4868E-28	0.0	0.0	0.0
HGCL2	7.5737E-17	0.0	0.0	0.0
HGOH2	5.9210E-06	0.0	0.0	0.0
HNO2	4.6374E-13	0.0	0.0	0.0
KCL	1.5841E-03	0.0	0.0	0.0
LAF3	2.3651E-28	0.0	0.0	0.0
LAOH3	5.6414E-13	0.0	0.0	0.0
MNNO32	1.8800E-15	0.0	0.0	0.0
MNOH2	1.5323E-08	0.0	0.0	0.0
NAF	2.9393E-02	0.0	0.0	0.0
NAHCO3	3.9673E-07	0.0	0.0	0.0
NANO3	.13858	0.0	0.0	0.0
NIOH2	2.7905E-09	.10094	0.0	0.0
PBNO22	1.3004E-16	0.0	0.0	0.0
PBO	5.6297E-09	0.0	0.0	0.0
PUIVOH4	1.0653E-09	2.8494E-04	0.0	0.0
SIO2	1.0561E-12	0.0	0.0	0.0
ZROH4	4.5314E-13	0.0	0.0	0.0
OHION	3.7738	0.0	0.0	0.0
ALOH2ION	6.6265E-19	0.0	0.0	0.0
ALOH4ION	6.0421	0.0	0.0	0.0
ALOHION	9.6400E-30	0.0	0.0	0.0
BIOH4ION	5.8109E-03	0.0	0.0	0.0
CAFION	1.4056E-11	0.0	0.0	0.0
CAHCO3ION	6.7663E-17	0.0	0.0	0.0
CAION	1.6289E-08	0.0	0.0	0.0
CAOHION	5.9904E-07	0.0	0.0	0.0
CAPO4ION	1.8154E-05	0.0	0.0	0.0
CLION	.36971	0.0	0.0	0.0
CO3ION	1.0625	0.0	0.0	0.0
CR2O7ION	1.8635E-21	0.0	0.0	0.0
CRO4ION	1.0939E-02	0.0	0.0	0.0
CROH4ION	2.1070E-02	0.0	0.0	0.0
CSION	2.5002E-04	0.0	0.0	0.0
CSSO4ION	4.4884E-07	0.0	0.0	0.0
FEIIIOH2ION	2.2086E-21	0.0	0.0	0.0
FEIIIOH4ION	5.6430E-05	0.0	0.0	0.0
FEIIIOHION	2.1492E-32	0.0	0.0	0.0
FION	1.5004E-02	0.0	0.0	0.0
H2PO4ION	1.6723E-13	0.0	0.0	0.0
H3SIO4ION	3.8707E-06	0.0	0.0	0.0
HCO3ION	9.4094E-07	0.0	0.0	0.0
HCRO4ION	1.2969E-12	0.0	0.0	0.0
HGCL3ION	7.5187E-15	0.0	0.0	0.0
HGCL4ION	2.7273E-13	0.0	0.0	0.0
HGCLION	9.6762E-22	0.0	0.0	0.0
HGFION	5.0694E-29	0.0	0.0	0.0
HGION	3.4690E-28	0.0	0.0	0.0
HGOH3ION	3.3039E-04	0.0	0.0	0.0
HGOHION	6.6107E-17	0.0	0.0	0.0
HION	2.2344E-17	0.0	0.0	0.0

HP2O7ION	1.0786E-20	0.0	0.0	0.0
HPBO2ION	4.8218E-04	0.0	0.0	0.0
HPO4ION	2.4717E-04	0.0	0.0	0.0
HSO4ION	3.1187E-17	0.0	0.0	0.0
KION	2.5581	0.0	0.0	0.0
KSO4ION	7.4324E-03	0.0	0.0	0.0
LACO3ION	1.6877E-25	0.0	0.0	0.0
LAF2ION	3.2754E-27	0.0	0.0	0.0
LAF4ION	1.5884E-27	0.0	0.0	0.0
LAFION	7.6862E-28	0.0	0.0	0.0
LAION	1.1487E-29	0.0	0.0	0.0
LANO3ION	9.8310E-31	0.0	0.0	0.0
LAOH2ION	7.4631E-18	0.0	0.0	0.0
LAOH4ION	4.6157E-09	0.0	0.0	0.0
LAOHION	2.0081E-24	0.0	0.0	0.0
MNCLION	2.1998E-15	0.0	0.0	0.0
MNION	1.1299E-13	0.0	0.0	0.0
MNNO3ION	2.4623E-15	0.0	0.0	0.0
MNOH3ION	1.6674E-04	0.0	0.0	0.0
MNOH4ION	.12824	0.0	0.0	0.0
MNOHION	6.6469E-11	0.0	0.0	0.0
NA2FION	.21121	0.0	0.0	0.0
NACO3ION	.65615	0.0	0.0	0.0
NAION	14.661	0.0	0.0	0.0
NASO4ION	7.7574E-03	0.0	0.0	0.0
NIION	1.2518E-17	0.0	0.0	0.0
NIOH3ION	7.5122E-04	0.0	0.0	0.0
NIOHION	2.5525E-14	0.0	0.0	0.0
NO2ION	6.3220	0.0	0.0	0.0
NO3ION	13.389	0.0	0.0	0.0
P2O7ION	8.5167E-13	0.0	0.0	0.0
PBION	1.2191E-17	0.0	0.0	0.0
PBNO23ION	4.0440E-14	0.0	0.0	0.0
PBNO2ION	1.4068E-17	0.0	0.0	0.0
PBOHION	3.7626E-14	0.0	0.0	0.0
PO4ION	.24027	0.0	0.0	0.0
PUIVOH3ION	3.5966E-19	0.0	0.0	0.0
SO4ION	.13409	0.0	0.0	0.0
UO2CO32ION	1.1641E-19	0.0	0.0	0.0
UO2CO33ION	1.6055E-12	0.0	0.0	0.0
ZROH3ION	1.1768E-22	0.0	0.0	0.0
ZROH5ION	5.7781E-03	0.0	0.0	0.0
BI2O3	0.0	1.2247E-02	0.0	0.0
CA5OHPO43	0.0	.18168	0.0	0.0
FEOOH	0.0	.71005	0.0	0.0
KALSIO4	0.0	9.2184E-02	0.0	0.0
LAPO4.2H2O	0.0	2.6081E-04	0.0	0.0
NA2U2O7	0.0	2.1510E-02	0.0	0.0
PBOH2	0.0	1.9362E-02	0.0	0.0
ZRO2	0.0	2.2166E-02	0.0	0.0
NAFPO4.19H2O	0.0	2.3099	0.0	0.0
	============	============	============	============
Total kg/hr	96.534	3.4706	0.0	0.0
Volume, L/hr	68.057	.29070	0.0	0.0
Enthalpy, cal/hr	-2.7260E+08	-9.8946E+06	0.0	0.0
Density, kg/L	1.4184	11.939		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	992.91			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.34362			
E-Con, cm2/ohm-mol	20.688			
Ionic Strength	15.709			

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STREAM: AW-101
POINT : 2

Phases------------->	Aqueous	Solid	Vapor	Organic
Temperature, C	45.000	45.000	45.000	45.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	14.542			
Total mol/hr	4938.2	13.495	0.0	0.0
------------------	kg/hr	kg/hr	kg/hr	kg/hr
H2O	63.843	0.0	0.0	0.0
ALOH3	4.2144E-09	0.0	0.0	0.0
BIOH3	1.7787E-06	0.0	0.0	0.0
CASO4	2.5355E-11	0.0	0.0	0.0
CO2	7.6558E-16	0.0	0.0	0.0
CSCL	7.1278E-06	0.0	0.0	0.0
CSNO3	1.1721E-04	0.0	0.0	0.0
FEIIIOH3	1.0023E-11	0.0	0.0	0.0
H3PO4	1.6141E-26	0.0	0.0	0.0
HGCL2	3.9301E-16	0.0	0.0	0.0
HGOH2	2.2609E-05	0.0	0.0	0.0
HNO2	2.1372E-12	0.0	0.0	0.0
KCL	1.3906E-03	0.0	0.0	0.0
LAF3	1.1153E-27	0.0	0.0	0.0
LAOH3	1.4316E-13	0.0	0.0	0.0
MNNO32	4.2093E-14	0.0	0.0	0.0
MNOH2	1.2313E-07	1.4969E-02	0.0	0.0
NAF	5.6600E-02	0.0	0.0	0.0
NAHCO3	1.3322E-06	0.0	0.0	0.0
NANO3	.16818	0.0	0.0	0.0
NIOH2	6.8909E-09	.10118	0.0	0.0
PBNO22	7.4627E-16	0.0	0.0	0.0
PBO	1.1355E-08	0.0	0.0	0.0
PUIVOH4	2.6307E-09	2.8494E-04	0.0	0.0
SIO2	7.5974E-12	0.0	0.0	0.0
ZROH4	1.6771E-12	0.0	0.0	0.0
OHION	3.7797	0.0	0.0	0.0
ALOH2ION	4.1807E-18	0.0	0.0	0.0
ALOH4ION	6.0421	0.0	0.0	0.0
ALOHION	3.4270E-28	0.0	0.0	0.0
BIOH4ION	4.8146E-03	0.0	0.0	0.0
CAFION	3.8921E-11	0.0	0.0	0.0
CAHCO3ION	3.2875E-16	0.0	0.0	0.0
CAION	4.0821E-08	0.0	0.0	0.0
CAOHION	7.5841E-07	0.0	0.0	0.0
CAPO4ION	2.3467E-05	0.0	0.0	0.0
CLION	.36981	0.0	0.0	0.0
CO3ION	1.0901	0.0	0.0	0.0
CR2O7ION	6.8651E-21	0.0	0.0	0.0
CRIIIION	3.5246E-32	0.0	0.0	0.0
CRO4ION	1.0939E-02	0.0	0.0	0.0
CROH4ION	2.1070E-02	0.0	0.0	0.0
CSION	2.4645E-04	0.0	0.0	0.0
CSSO4ION	3.6134E-07	0.0	0.0	0.0
FEIIIOH2ION	9.7897E-21	0.0	0.0	0.0
FEIIIOH4ION	4.2257E-05	0.0	0.0	0.0
FEIIIOHION	4.6930E-31	0.0	0.0	0.0
FION	2.8987E-02	0.0	0.0	0.0
H2PO4ION	8.5623E-13	0.0	0.0	0.0
H3SIO4ION	8.4440E-06	0.0	0.0	0.0
HCO3ION	2.8406E-06	0.0	0.0	0.0
HCRO4ION	4.3248E-12	0.0	0.0	0.0
HGCL3ION	1.1266E-14	0.0	0.0	0.0
HGCL4ION	2.0037E-13	0.0	0.0	0.0
HGCLION	5.6382E-21	0.0	0.0	0.0
HGFION	6.6684E-28	0.0	0.0	0.0
HGION	5.5676E-27	0.0	0.0	0.0
HGOH3ION	3.1249E-04	0.0	0.0	0.0
HGOHION	3.3010E-16	0.0	0.0	0.0

HION	1.1626E-16	0.0	0.0	0.0
HP2O7ION	2.5774E-19	0.0	0.0	0.0
HPBO2ION	3.3393E-04	0.0	0.0	0.0
HPO4ION	4.0402E-04	0.0	0.0	0.0
HSO4ION	1.6922E-16	0.0	0.0	0.0
KION	2.5582	0.0	0.0	0.0
KSO4ION	7.2470E-03	0.0	0.0	0.0
LACO3ION	2.1032E-25	0.0	0.0	0.0
LAF2ION	7.5843E-27	0.0	0.0	0.0
LAF4ION	4.9145E-27	0.0	0.0	0.0
LAFION	2.0831E-27	0.0	0.0	0.0
LAION	4.8298E-29	0.0	0.0	0.0
LANO3ION	2.9362E-30	0.0	0.0	0.0
LAOH2ION	2.7745E-18	0.0	0.0	0.0
LAOH4ION	2.9014E-10	0.0	0.0	0.0
LAOHION	3.7451E-24	0.0	0.0	0.0
MNCLION	2.6974E-14	0.0	0.0	0.0
MNION	1.6026E-12	0.0	0.0	0.0
MNNO3ION	4.8167E-14	0.0	0.0	0.0
MNOH3ION	3.3188E-04	0.0	0.0	0.0
MNOH4ION	.10736	0.0	0.0	0.0
MNOHION	7.8311E-10	0.0	0.0	0.0
NA2FION	.13892	0.0	0.0	0.0
NACO3ION	.61791	0.0	0.0	0.0
NAION	14.743	0.0	0.0	0.0
NASO4ION	8.3129E-03	0.0	0.0	0.0
NIION	6.0938E-17	0.0	0.0	0.0
NIOH3ION	4.5950E-04	0.0	0.0	0.0
NIOHION	9.2419E-14	0.0	0.0	0.0
NO2ION	6.3220	0.0	0.0	0.0
NO3ION	13.367	0.0	0.0	0.0
P2O7ION	1.1305E-11	0.0	0.0	0.0
PBION	1.7962E-17	0.0	0.0	0.0
PBNO23ION	8.7635E-14	0.0	0.0	0.0
PBNO2ION	7.4082E-17	0.0	0.0	0.0
PBOHION	1.4649E-13	0.0	0.0	0.0
PO4ION	.29165	0.0	0.0	0.0
PUIVOH3ION	1.1601E-18	0.0	0.0	0.0
SO4ION	.13377	0.0	0.0	0.0
UO2CO32ION	1.9612E-18	0.0	0.0	0.0
UO2CO33ION	1.4954E-11	0.0	0.0	0.0
ZROH3ION	6.3802E-22	0.0	0.0	0.0
ZROH5ION	5.2971E-03	0.0	0.0	0.0
BI2O3	0.0	1.3084E-02	0.0	0.0
CA5OHPO43	0.0	.18167	0.0	0.0
FEOOH	0.0	.71006	0.0	0.0
KALSIO4	0.0	9.2177E-02	0.0	0.0
LAPO4.2H2O	0.0	2.6081E-04	0.0	0.0
NA2U2O7	0.0	2.1510E-02	0.0	0.0
PBOH2	0.0	1.9511E-02	0.0	0.0
ZRO2	0.0	2.2496E-02	0.0	0.0
NAFPO4.19H2O	0.0	2.1167	0.0	0.0
	============	============	============	============
Total kg/hr	113.72	3.2939	0.0	0.0
Volume, L/hr	84.623	.29543	0.0	0.0
Enthalpy, cal/hr	-3.3755E+08	-9.2774E+06	0.0	0.0
Density, kg/L	1.3439	11.149		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	681.49			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.37609			
E-Con, cm2/ohm-mol	28.152			
Ionic Strength	11.569			

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STREAM: AW-101
POINT : 3

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	45.000	45.000	45.000	45.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	14.263			
Total mol/hr	5905.2	13.292	0.0	0.0
------------------	kg/hr---------	kg/hr---------	kg/hr---------	kg/hr---------
H2O	81.105	0.0	0.0	0.0
ALOH3	1.0129E-08	0.0	0.0	0.0
BIOH3	3.7280E-06	0.0	0.0	0.0
CASO4	5.3198E-11	0.0	0.0	0.0
CO2	4.4536E-15	0.0	0.0	0.0
CSCL	5.6424E-06	0.0	0.0	0.0
CSNO3	1.1741E-04	0.0	0.0	0.0
FEIIIOH3	1.9878E-11	0.0	0.0	0.0
H3PO4	2.0271E-25	0.0	0.0	0.0
HGCL2	1.0595E-15	0.0	0.0	0.0
HGOH2	4.9961E-05	0.0	0.0	0.0
HNO2	5.5555E-12	0.0	0.0	0.0
KCL	1.2151E-03	0.0	0.0	0.0
LAF3	2.0202E-27	0.0	0.0	0.0
LAOH3	4.0145E-14	0.0	0.0	0.0
MNNO32	1.4600E-13	0.0	0.0	0.0
MNOH2	2.1865E-07	6.1873E-02	0.0	0.0
NAF	7.9763E-02	0.0	0.0	0.0
NAHCO3	2.8102E-06	0.0	0.0	0.0
NANO3	.17786	0.0	0.0	0.0
NIOH2	1.2236E-08	.10129	0.0	0.0
PBNO22	2.2766E-15	0.0	0.0	0.0
PBO	1.8054E-08	0.0	0.0	0.0
PUIVOH4	4.6715E-09	2.8494E-04	0.0	0.0
SIO2	2.7909E-11	0.0	0.0	0.0
ZROH4	3.7148E-12	0.0	0.0	0.0
OHION	3.7978	0.0	0.0	0.0
ALOH2ION	1.4183E-17	0.0	0.0	0.0
ALOH4ION	6.0421	0.0	0.0	0.0
ALOHION	3.5153E-27	0.0	0.0	0.0
BIOH4ION	4.1379E-03	0.0	0.0	0.0
CAFION	6.2067E-11	0.0	0.0	0.0
CAHCO3ION	7.8780E-16	0.0	0.0	0.0
CAION	6.1891E-08	0.0	0.0	0.0
CAOHION	7.3130E-07	0.0	0.0	0.0
CAPO4ION	3.2726E-05	0.0	0.0	0.0
CLION	.36989	0.0	0.0	0.0
CO3ION	1.1100	0.0	0.0	0.0
CR2O7ION	1.6449E-20	0.0	0.0	0.0
CRIIIION	6.9072E-31	0.0	0.0	0.0
CRO4ION	1.0939E-02	0.0	0.0	0.0
CROH4ION	2.1070E-02	0.0	0.0	0.0
CSION	2.4750E-04	0.0	0.0	0.0
CSSO4ION	3.3257E-07	0.0	0.0	0.0
FEIIIOH2ION	2.6673E-20	0.0	0.0	0.0
FEIIIOH4ION	3.4365E-05	0.0	0.0	0.0
FEIIIOHION	3.5934E-30	0.0	0.0	0.0
FION	4.4144E-02	0.0	0.0	0.0
H2PO4ION	3.5255E-12	0.0	0.0	0.0
H3SIO4ION	1.4206E-05	0.0	0.0	0.0
HCO3ION	6.0243E-06	0.0	0.0	0.0
HCRO4ION	9.7423E-12	0.0	0.0	0.0
HGCL3ION	1.3755E-14	0.0	0.0	0.0
HGCL4ION	1.4732E-13	0.0	0.0	0.0
HGCLION	1.7664E-20	0.0	0.0	0.0
HGFION	3.5076E-27	0.0	0.0	0.0
HGION	3.4046E-26	0.0	0.0	0.0
HGOH3ION	2.8316E-04	0.0	0.0	0.0
HGOHION	9.3566E-16	0.0	0.0	0.0

HION	3.5093E-16	0.0	0.0	0.0
HP2O7ION	3.7287E-18	0.0	0.0	0.0
HPBO2ION	2.6858E-04	0.0	0.0	0.0
HPO4ION	7.7212E-04	0.0	0.0	0.0
HSO4ION	5.4372E-16	0.0	0.0	0.0
KION	2.5582	0.0	0.0	0.0
KSO4ION	7.5292E-03	0.0	0.0	0.0
LACO3ION	1.8822E-25	0.0	0.0	0.0
LAF2ION	9.4280E-27	0.0	0.0	0.0
LAF4ION	6.7979E-27	0.0	0.0	0.0
LAFION	2.9129E-27	0.0	0.0	0.0
LAION	8.9481E-29	0.0	0.0	0.0
LANO3ION	4.3921E-30	0.0	0.0	0.0
LAOH2ION	1.0765E-18	0.0	0.0	0.0
LAOH4ION	3.3361E-11	0.0	0.0	0.0
LAOHION	4.1470E-24	0.0	0.0	0.0
MNCLION	6.7908E-14	0.0	0.0	0.0
MNION	4.4121E-12	0.0	0.0	0.0
MNNO3ION	1.6463E-13	0.0	0.0	0.0
MNOH3ION	2.4166E-04	0.0	0.0	0.0
MNOH4ION	4.2623E-02	0.0	0.0	0.0
MNOHION	1.9103E-09	0.0	0.0	0.0
NA2FION	9.9050E-02	0.0	0.0	0.0
NACO3ION	.59039	0.0	0.0	0.0
NAION	14.882	0.0	0.0	0.0
NASO4ION	9.0007E-03	0.0	0.0	0.0
NIION	1.8083E-16	0.0	0.0	0.0
NIOH3ION	3.3458E-04	0.0	0.0	0.0
NIOHION	2.2545E-13	0.0	0.0	0.0
NO2ION	6.3220	0.0	0.0	0.0
NO3ION	13.360	0.0	0.0	0.0
P2O7ION	9.8595E-11	0.0	0.0	0.0
PBION	2.8839E-17	0.0	0.0	0.0
PBNO23ION	1.4368E-13	0.0	0.0	0.0
PBNO2ION	2.3116E-16	0.0	0.0	0.0
PBOHION	3.7470E-13	0.0	0.0	0.0
PO4ION	.43106	0.0	0.0	0.0
PUIVOH3ION	2.6262E-18	0.0	0.0	0.0
SO4ION	.13302	0.0	0.0	0.0
UO2CO32ION	1.3438E-17	0.0	0.0	0.0
UO2CO33ION	6.5455E-11	0.0	0.0	0.0
UO2ION	2.7528E-32	0.0	0.0	0.0
ZROH2ION	2.7200E-32	0.0	0.0	0.0
ZROH3ION	1.9518E-21	0.0	0.0	0.0
ZROH5ION	4.8112E-03	0.0	0.0	0.0
BI2O3	0.0	1.3651E-02	0.0	0.0
CA5OHPO43	0.0	.18166	0.0	0.0
FEOOH	0.0	.71007	0.0	0.0
KALSIO4	0.0	9.2167E-02	0.0	0.0
LAPO4.2H2O	0.0	2.6081E-04	0.0	0.0
NA2U2O7	0.0	2.1510E-02	0.0	0.0
PBOH2	0.0	1.9576E-02	0.0	0.0
ZRO2	0.0	2.2836E-02	0.0	0.0
NAFPO4.19H2O	0.0	1.5926	0.0	0.0
	============	============	============	============
Total kg/hr	131.21	2.8178	0.0	0.0
Volume, L/hr	101.63	.30992	0.0	0.0
Enthalpy, cal/hr	-4.0347E+08	-7.6126E+06	0.0	0.0
Density, kg/L	1.2910	9.0919		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	510.90			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.38417			
E-Con, cm2/ohm-mol	34.530			
Ionic Strength	9.2256			

STREAM: AW-101
POINT : 4

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	45.000	45.000	45.000	45.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	14.061			
Total mol/hr	6881.7	12.372	0.0	0.0
------------------	kg/hr	kg/hr	kg/hr	kg/hr
H2O	98.490	0.0	0.0	0.0
ALOH3	1.8689E-08	0.0	0.0	0.0
BIOH3	6.2207E-06	0.0	0.0	0.0
CASO4	8.3705E-11	0.0	0.0	0.0
CO2	1.5688E-14	0.0	0.0	0.0
CSCL	4.6735E-06	0.0	0.0	0.0
CSNO3	1.1466E-04	0.0	0.0	0.0
FEIIIOH3	3.2049E-11	0.0	0.0	0.0
H3PO4	1.4456E-24	0.0	0.0	0.0
HGCL2	2.0140E-15	0.0	0.0	0.0
HGOH2	8.2346E-05	0.0	0.0	0.0
HNO2	1.0818E-11	0.0	0.0	0.0
KCL	1.0768E-03	0.0	0.0	0.0
LAF3	2.8099E-27	0.0	0.0	0.0
LAOH3	1.3661E-14	0.0	0.0	0.0
MNNO32	3.5236E-13	0.0	0.0	0.0
MNOH2	3.2911E-07	7.7096E-02	0.0	0.0
NAF	.10131	0.0	0.0	0.0
NAHCO3	4.7095E-06	0.0	0.0	0.0
NANO3	.17890	0.0	0.0	0.0
NIOH2	1.8418E-08	.10134	0.0	0.0
PBNO22	4.9981E-15	0.0	0.0	0.0
PBO	2.5371E-08	0.0	0.0	0.0
PUIVOH4	7.0315E-09	2.8493E-04	0.0	0.0
SIO2	7.1723E-11	0.0	0.0	0.0
ZROH4	6.4153E-12	0.0	0.0	0.0
OHION	3.8039	0.0	0.0	0.0
ALOH2ION	3.4705E-17	0.0	0.0	0.0
ALOH4ION	6.0421	0.0	0.0	0.0
ALOHION	1.8683E-26	0.0	0.0	0.0
BIOH4ION	3.6753E-03	0.0	0.0	0.0
CAFION	8.2245E-11	0.0	0.0	0.0
CAHCO3ION	1.3811E-15	0.0	0.0	0.0
CAION	7.6938E-08	0.0	0.0	0.0
CAOHION	6.5573E-07	0.0	0.0	0.0
CAPO4ION	4.4985E-05	0.0	0.0	0.0
CLION	.36996	0.0	0.0	0.0
CO3ION	1.1260	0.0	0.0	0.0
CR2O7ION	3.1235E-20	0.0	0.0	0.0
CRIIIION	5.6572E-30	0.0	0.0	0.0
CRO4ION	1.0939E-02	0.0	0.0	0.0
CROH4ION	2.1070E-02	0.0	0.0	0.0
CSION	2.5015E-04	0.0	0.0	0.0
CSSO4ION	3.2072E-07	0.0	0.0	0.0
FEIIIOH2ION	5.5723E-20	0.0	0.0	0.0
FEIIIOH4ION	2.9492E-05	0.0	0.0	0.0
FEIIIOHION	1.5640E-29	0.0	0.0	0.0
FION	6.1370E-02	0.0	0.0	0.0
H2PO4ION	1.1476E-11	0.0	0.0	0.0
H3SIO4ION	2.0815E-05	0.0	0.0	0.0
HCO3ION	1.0499E-05	0.0	0.0	0.0
HCRO4ION	1.7675E-11	0.0	0.0	0.0
HGCL3ION	1.4948E-14	0.0	0.0	0.0
HGCL4ION	1.0892E-13	0.0	0.0	0.0
HGCLION	3.8808E-20	0.0	0.0	0.0
HGFION	1.1437E-26	0.0	0.0	0.0
HGION	1.2148E-25	0.0	0.0	0.0
HGOH3ION	2.4842E-04	0.0	0.0	0.0
HGOHION	1.9129E-15	0.0	0.0	0.0

HION	7.8566E-16	0.0	0.0	0.0
HP2O7ION	3.2714E-17	0.0	0.0	0.0
HPBO2ION	2.3217E-04	0.0	0.0	0.0
HPO4ION	1.4330E-03	0.0	0.0	0.0
HSO4ION	1.2868E-15	0.0	0.0	0.0
KION	2.5582	0.0	0.0	0.0
KSO4ION	7.8914E-03	0.0	0.0	0.0
LACO3ION	1.5612E-25	0.0	0.0	0.0
LAF2ION	1.0148E-26	0.0	0.0	0.0
LAF4ION	8.0474E-27	0.0	0.0	0.0
LAFION	3.3390E-27	0.0	0.0	0.0
LAION	1.2172E-28	0.0	0.0	0.0
LANO3ION	5.0871E-30	0.0	0.0	0.0
LAOH2ION	4.7972E-19	0.0	0.0	0.0
LAOH4ION	6.0430E-12	0.0	0.0	0.0
LAOHION	3.9042E-24	0.0	0.0	0.0
MNCLION	1.3625E-13	0.0	0.0	0.0
MNION	9.4198E-12	0.0	0.0	0.0
MNNO3ION	4.0911E-13	0.0	0.0	0.0
MNOH3ION	1.9362E-04	0.0	0.0	0.0
MNOH4ION	2.1634E-02	0.0	0.0	0.0
MNOHION	3.7258E-09	0.0	0.0	0.0
NA2FION	7.7951E-02	0.0	0.0	0.0
NACO3ION	.56822	0.0	0.0	0.0
NAION	15.067	0.0	0.0	0.0
NASO4ION	9.6467E-03	0.0	0.0	0.0
NIION	4.0725E-16	0.0	0.0	0.0
NIOH3ION	2.6807E-04	0.0	0.0	0.0
NIOHION	4.3973E-13	0.0	0.0	0.0
NO2ION	6.3220	0.0	0.0	0.0
NO3ION	13.359	0.0	0.0	0.0
P2O7ION	5.4173E-10	0.0	0.0	0.0
PBION	4.5171E-17	0.0	0.0	0.0
PBNO23ION	2.0279E-13	0.0	0.0	0.0
PBNO2ION	5.3769E-16	0.0	0.0	0.0
PBOHION	7.5552E-13	0.0	0.0	0.0
PO4ION	.63842	0.0	0.0	0.0
PUIVOH3ION	4.8552E-18	0.0	0.0	0.0
SO4ION	.13224	0.0	0.0	0.0
UO2CO32ION	5.5573E-17	0.0	0.0	0.0
UO2CO33ION	1.8939E-10	0.0	0.0	0.0
UO2ION	2.3942E-31	0.0	0.0	0.0
ZROH2ION	1.2743E-31	0.0	0.0	0.0
ZROH3ION	4.4029E-21	0.0	0.0	0.0
ZROH5ION	4.4227E-03	0.0	0.0	0.0
BI2O3	0.0	1.4038E-02	0.0	0.0
CA5OHPO43	0.0	.18165	0.0	0.0
FEOOH	0.0	.71007	0.0	0.0
KALSIO4	0.0	9.2156E-02	0.0	0.0
LAPO4.2H2O	0.0	2.6081E-04	0.0	0.0
NA2U2O7	0.0	2.1510E-02	0.0	0.0
PBOH2	0.0	1.9613E-02	0.0	0.0
ZRO2	0.0	2.3107E-02	0.0	0.0
NAFPO4.19H2O	0.0	.81267	0.0	0.0
	============	============	============	============
Total kg/hr	148.98	2.0538	0.0	0.0
Volume, L/hr	118.92	.31466	0.0	0.0
Enthalpy, cal/hr	-4.7029E+08	-5.0325E+06	0.0	0.0
Density, kg/L	1.2528	6.5272		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	405.01			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.39186			
E-Con, cm2/ohm-mol	41.178			
Ionic Strength	7.7431			

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    E N V I R O N M E N T A L   S I M U L A T I O N   P R O G R A M

                    V - 5.4   March 1, 1997

                        SURVEY: AP-101
               CHEMISTRY MODEL: gentank
                THIS FILE NAME: AP-101.LIS
                          DATE:  6-Feb-98

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ESP V-5.4 STREAM:ap-101 6-Feb-98 PAGE 1

STREAM: ap-101
POINT : 1

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	18.000	18.000	18.000	18.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	15.050			
Total mol/hr	4588.7	9.4329	0.0	0.0
------------------	kg/hr---------	kg/hr---------	kg/hr---------	kg/hr---------
H2O	65.693	0.0	0.0	0.0
ALOH3	2.1422E-09	0.0	0.0	0.0
CAC2O4	2.2794E-09	0.0	0.0	0.0
CASO4	8.7417E-10	0.0	0.0	0.0
CO2	3.7944E-16	0.0	0.0	0.0
CSCL	6.3317E-07	0.0	0.0	0.0
CSNO3	4.4922E-05	0.0	0.0	0.0
FEIIIOH3	3.2229E-12	0.0	0.0	0.0
H3PO4	2.0772E-28	0.0	0.0	0.0
HNO2	8.1685E-13	0.0	0.0	0.0
KCL	1.8641E-04	0.0	0.0	0.0
NAF	.14410	0.0	0.0	0.0
NAHCO3	4.6464E-07	0.0	0.0	0.0
NANO3	.14170	0.0	0.0	0.0
NIC2O4	1.9518E-15	0.0	0.0	0.0
NIOH2	1.1809E-08	5.0565E-04	0.0	0.0
PBC2O4	9.4086E-18	0.0	0.0	0.0
PBNO22	1.7445E-16	0.0	0.0	0.0
PBO	5.2231E-09	0.0	0.0	0.0
SIO2	4.0924E-12	0.0	0.0	0.0
OHION	2.8307	0.0	0.0	0.0
ALOH2ION	2.1420E-18	0.0	0.0	0.0
ALOH4ION	2.5289	0.0	0.0	0.0
ALOHION	5.6882E-28	0.0	0.0	0.0
CAFION	9.3803E-11	0.0	0.0	0.0
CAHCO3ION	1.8406E-15	0.0	0.0	0.0
CAION	3.2741E-07	0.0	0.0	0.0
CAOHION	2.3320E-06	0.0	0.0	0.0
CAPO4ION	1.2649E-05	0.0	0.0	0.0
CLION	.10181	0.0	0.0	0.0
CO3ION	1.1852	0.0	0.0	0.0
CR2O7ION	3.8254E-21	0.0	0.0	0.0
CRO4ION	2.6541E-02	0.0	0.0	0.0
CSION	1.1692E-04	0.0	0.0	0.0
CSSO4ION	3.9955E-07	0.0	0.0	0.0
FEIIIOH2ION	2.0173E-21	0.0	0.0	0.0
FEIIIOH4ION	2.9127E-06	0.0	0.0	0.0
FEIIIOHION	1.6076E-31	0.0	0.0	0.0
FION	7.2407E-02	0.0	0.0	0.0
H2PO4ION	2.4331E-14	0.0	0.0	0.0
H3SIO4ION	3.0989E-06	0.0	0.0	0.0
HCO3ION	1.8006E-06	0.0	0.0	0.0
HCRO4ION	3.3776E-12	0.0	0.0	0.0
HION	5.5236E-17	0.0	0.0	0.0
HOXALATION	1.0221E-14	0.0	0.0	0.0
HP2O7ION	6.6816E-22	0.0	0.0	0.0
HPBO2ION	1.1103E-04	0.0	0.0	0.0
HPO4ION	2.6198E-05	0.0	0.0	0.0
HSO4ION	1.3254E-16	0.0	0.0	0.0
KION	1.9439	0.0	0.0	0.0
KSO4ION	1.7669E-02	0.0	0.0	0.0
NA2FION	8.3336E-02	0.0	0.0	0.0
NACO3ION	1.1796	0.0	0.0	0.0

NAION	9.8751	0.0	0.0	0.0
NASO4ION	1.9055E-02	0.0	0.0	0.0
NIC2O42ION	9.6651E-17	0.0	0.0	0.0
NIION	5.9940E-17	0.0	0.0	0.0
NIOH3ION	6.9677E-04	0.0	0.0	0.0
NIOHION	8.1288E-14	0.0	0.0	0.0
NO2ION	2.9355	0.0	0.0	0.0
NO3ION	9.6305	0.0	0.0	0.0
OXALATION	2.3627E-02	0.0	0.0	0.0
P2O7ION	1.1996E-13	0.0	0.0	0.0
PBION	1.2854E-17	0.0	0.0	0.0
PBNO23ION	1.0991E-14	0.0	0.0	0.0
PBNO2ION	2.9734E-17	0.0	0.0	0.0
PBOHION	5.8210E-14	0.0	0.0	0.0
PO4ION	7.0712E-02	0.0	0.0	0.0
SO4ION	.21313	0.0	0.0	0.0
UO2CO32ION	6.2669E-19	0.0	0.0	0.0
UO2CO33ION	1.4665E-11	0.0	0.0	0.0
CA5OHPO43	0.0	1.0680E-02	0.0	0.0
FEOOH	0.0	6.7063E-04	0.0	0.0
KALSIO4	0.0	5.1846E-02	0.0	0.0
NA2C2O4	0.0	1.2144	0.0	0.0
NA2U2O7	0.0	4.5622E-03	0.0	0.0
PBOH2	0.0	2.8688E-04	0.0	0.0
	============	============	============	============
Total kg/hr	98.718	1.2829	0.0	0.0
Volume, L/hr	76.076	.55889	0.0	0.0
Enthalpy, kJ/hr	-1.3113E+06	-1.2870E+04	0.0	0.0
Density, kg/L	1.2976	2.2955		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	405.51			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.21462			
E-Con, cm2/ohm-mol	21.169			
Ionic Strength	7.6910			

ESP V-5.4 STREAM:ap-101 6-Feb-98 PAGE 2

STREAM: ap-101
POINT : 2

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	15.000	15.000	15.000	15.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	15.172			
Total mol/hr	4587.7	10.633	0.0	0.0
------------------	kg/hr---------	kg/hr---------	kg/hr---------	kg/hr---------
H2O	65.693	0.0	0.0	0.0
ALOH3	1.7337E-09	9.1835E-02	0.0	0.0
CAC2O4	1.8179E-09	0.0	0.0	0.0
CASO4	9.4584E-10	0.0	0.0	0.0
CO2	2.3895E-16	0.0	0.0	0.0
CSCL	6.1612E-07	0.0	0.0	0.0
CSNO3	4.4195E-05	0.0	0.0	0.0
FEIIIOH3	2.6830E-12	0.0	0.0	0.0
H3PO4	9.5616E-29	0.0	0.0	0.0
HNO2	6.6011E-13	0.0	0.0	0.0
KCL	1.7432E-04	0.0	0.0	0.0
NAF	.14734	0.0	0.0	0.0
NAHCO3	3.4569E-07	0.0	0.0	0.0
NANO3	.14489	0.0	0.0	0.0
NIC2O4	1.4128E-15	0.0	0.0	0.0
NIOH2	1.1668E-08	4.2140E-04	0.0	0.0
PBC2O4	5.6062E-18	0.0	0.0	0.0
PBNO22	1.2320E-16	0.0	0.0	0.0
PBO	4.0680E-09	0.0	0.0	0.0
SIO2	3.0678E-12	0.0	0.0	0.0
OHION	2.8507	0.0	0.0	0.0
ALOH2ION	1.6136E-18	0.0	0.0	0.0
ALOH4ION	2.4171	0.0	0.0	0.0
ALOHION	3.9778E-28	0.0	0.0	0.0
CAFION	7.9416E-11	0.0	0.0	0.0
CAHCO3ION	1.5870E-15	0.0	0.0	0.0
CAION	3.4593E-07	0.0	0.0	0.0
CAOHION	2.4512E-06	0.0	0.0	0.0
CAPO4ION	1.2256E-05	0.0	0.0	0.0
CLION	.10182	0.0	0.0	0.0
CO3ION	1.1369	0.0	0.0	0.0
CR2O7ION	2.3468E-21	0.0	0.0	0.0
CRO4ION	2.6541E-02	0.0	0.0	0.0
CSION	1.1743E-04	0.0	0.0	0.0
CSSO4ION	4.0596E-07	0.0	0.0	0.0
FEIIIOH2ION	1.3582E-21	0.0	0.0	0.0
FEIIIOH4ION	2.2649E-06	0.0	0.0	0.0
FEIIIOHION	9.7221E-32	0.0	0.0	0.0
FION	7.1291E-02	0.0	0.0	0.0
H2PO4ION	1.5347E-14	0.0	0.0	0.0
H3SIO4ION	2.5614E-06	0.0	0.0	0.0
HCO3ION	1.3996E-06	0.0	0.0	0.0
HCRO4ION	2.5276E-12	0.0	0.0	0.0
HION	4.1532E-17	0.0	0.0	0.0
HOXALATION	7.2608E-15	0.0	0.0	0.0
HP2O7ION	3.0287E-22	0.0	0.0	0.0
HPBO2ION	9.4270E-05	0.0	0.0	0.0
HPO4ION	2.1285E-05	0.0	0.0	0.0
HSO4ION	9.5217E-17	0.0	0.0	0.0
KION	1.9438	0.0	0.0	0.0
KSO4ION	1.8107E-02	0.0	0.0	0.0
NA2FION	8.2144E-02	0.0	0.0	0.0
NACO3ION	1.2464	0.0	0.0	0.0

NAION	9.8536	0.0	0.0	0.0
NASO4ION	1.9300E-02	0.0	0.0	0.0
NIC2O42ION	7.0442E-17	0.0	0.0	0.0
NIION	4.9001E-17	0.0	0.0	0.0
NIOH3ION	7.9648E-04	0.0	0.0	0.0
NIOHION	6.9175E-14	0.0	0.0	0.0
NO2ION	2.9355	0.0	0.0	0.0
NO3ION	9.6281	0.0	0.0	0.0
OXALATION	2.1518E-02	0.0	0.0	0.0
P2O7ION	7.1937E-14	0.0	0.0	0.0
PBION	9.4388E-18	0.0	0.0	0.0
PBNO23ION	8.5690E-15	0.0	0.0	0.0
PBNO2ION	2.0809E-17	0.0	0.0	0.0
PBOHION	3.9980E-14	0.0	0.0	0.0
PO4ION	7.0718E-02	0.0	0.0	0.0
SO4ION	.21262	0.0	0.0	0.0
UO2CO32ION	3.3743E-19	0.0	0.0	0.0
UO2CO33ION	8.9839E-12	0.0	0.0	0.0
CA5OHPO43	0.0	1.0680E-02	0.0	0.0
FEOOH	0.0	6.7109E-04	0.0	0.0
KALSIO4	0.0	5.1847E-02	0.0	0.0
NA2C2O4	0.0	1.2176	0.0	0.0
NA2U2O7	0.0	4.5622E-03	0.0	0.0
PBOH2	0.0	3.0372E-04	0.0	0.0
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Total kg/hr	98.623	1.3779	0.0	0.0
Volume, L/hr	75.728	.59791	0.0	0.0
Enthalpy, kJ/hr	-1.3106E+06	-1.4428E+04	0.0	0.0
Density, kg/L	1.3023	2.3045		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	405.33			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.19809			
E-Con, cm2/ohm-mol	19.480			
Ionic Strength	7.6638			

STREAM: ap-101
POINT : 3

Phases----------->	Aqueous	Solid	Vapor	Organic
Temperature, C	12.000	12.000	12.000	12.000
Pressure, atm	1.0000	1.0000	1.0000	1.0000
pH	15.299			
Total mol/hr	4584.2	12.705	0.0	0.0
------------------	kg/hr---------	kg/hr---------	kg/hr---------	kg/hr---------
H2O	65.660	0.0	0.0	0.0
ALOH3	1.3440E-09	.23690	0.0	0.0
CAC2O4	1.5885E-09	0.0	0.0	0.0
CASO4	1.1346E-09	0.0	0.0	0.0
CO2	1.4785E-16	0.0	0.0	0.0
CSCL	6.0049E-07	0.0	0.0	0.0
CSNO3	4.3549E-05	0.0	0.0	0.0
FEIIIOH3	2.2460E-12	0.0	0.0	0.0
H3PO4	3.5810E-29	0.0	0.0	0.0
HNO2	5.2809E-13	0.0	0.0	0.0
KCL	1.6295E-04	0.0	0.0	0.0
NAF	.14910	0.0	0.0	0.0
NAHCO3	2.5502E-07	0.0	0.0	0.0
NANO3	.14835	0.0	0.0	0.0
NIC2O4	9.9866E-16	0.0	0.0	0.0
NIOH2	1.1480E-08	3.2465E-04	0.0	0.0
PBC2O4	3.1834E-18	0.0	0.0	0.0
PBNO22	8.4063E-17	0.0	0.0	0.0
PBO	3.0789E-09	0.0	0.0	0.0
SIO2	2.3464E-12	0.0	0.0	0.0
OHION	2.8818	0.0	0.0	0.0
ALOH2ION	1.1584E-18	0.0	0.0	0.0
ALOH4ION	2.2404	0.0	0.0	0.0
ALOHION	2.6354E-28	0.0	0.0	0.0
CAFION	7.3188E-11	0.0	0.0	0.0
CAHCO3ION	1.4998E-15	0.0	0.0	0.0
CAION	4.0405E-07	0.0	0.0	0.0
CAOHION	2.8702E-06	0.0	0.0	0.0
CAPO4ION	1.0997E-05	0.0	0.0	0.0
CLION	.10182	0.0	0.0	0.0
CO3ION	1.0843	0.0	0.0	0.0
CR2O7ION	1.4175E-21	0.0	0.0	0.0
CRO4ION	2.6541E-02	0.0	0.0	0.0
CSION	1.1788E-04	0.0	0.0	0.0
CSSO4ION	4.1376E-07	0.0	0.0	0.0
FEIIIOH2ION	8.9284E-22	0.0	0.0	0.0
FEIIIOH4ION	1.7546E-06	0.0	0.0	0.0
FEIIIOHION	5.6937E-32	0.0	0.0	0.0
FION	6.9254E-02	0.0	0.0	0.0
H2PO4ION	7.9656E-15	0.0	0.0	0.0
H3SIO4ION	2.1703E-06	0.0	0.0	0.0
HCO3ION	1.0750E-06	0.0	0.0	0.0
HCRO4ION	1.8782E-12	0.0	0.0	0.0
HION	3.0897E-17	0.0	0.0	0.0
HOXALATION	5.0876E-15	0.0	0.0	0.0
HP2O7ION	9.3584E-23	0.0	0.0	0.0
HPBO2ION	7.8238E-05	0.0	0.0	0.0
HPO4ION	1.4340E-05	0.0	0.0	0.0
HSO4ION	6.7716E-17	0.0	0.0	0.0
KION	1.9437	0.0	0.0	0.0
KSO4ION	1.8614E-02	0.0	0.0	0.0
NA2FION	8.0254E-02	0.0	0.0	0.0
NACO3ION	1.3191	0.0	0.0	0.0

NAION	9.8205	0.0	0.0	0.0
NASO4ION	1.9547E-02	0.0	0.0	0.0
NIC2O42ION	5.0053E-17	0.0	0.0	0.0
NIION	3.9482E-17	0.0	0.0	0.0
NIOH3ION	9.1098E-04	0.0	0.0	0.0
NIOHION	5.8217E-14	0.0	0.0	0.0
NO2ION	2.9355	0.0	0.0	0.0
NO3ION	9.6256	0.0	0.0	0.0
OXALATION	1.9458E-02	0.0	0.0	0.0
P2O7ION	2.9626E-14	0.0	0.0	0.0
PBION	6.7012E-18	0.0	0.0	0.0
PBNO23ION	6.4829E-15	0.0	0.0	0.0
PBNO2ION	1.4017E-17	0.0	0.0	0.0
PBOHION	2.6494E-14	0.0	0.0	0.0
PO4ION	5.9011E-02	0.0	0.0	0.0
SO4ION	.21206	0.0	0.0	0.0
UO2CO32ION	1.7802E-19	0.0	0.0	0.0
UO2CO33ION	5.3698E-12	0.0	0.0	0.0
CA5OHPO43	0.0	5.9328E-03	0.0	0.0
CAF2	0.0	3.6891E-03	0.0	0.0
FEOOH	0.0	6.7146E-04	0.0	0.0
KALSIO4	0.0	5.1848E-02	0.0	0.0
NA2C2O4	0.0	1.2207	0.0	0.0
NA2U2O7	0.0	4.5622E-03	0.0	0.0
NAPHOH.12H2O	0.0	5.9180E-02	0.0	0.0
PBOH2	0.0	3.1982E-04	0.0	0.0
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Total kg/hr	98.416	1.5841	0.0	0.0
Volume, L/hr	75.300	.65837	0.0	0.0
Enthalpy, kJ/hr	-1.3082E+06	-1.7718E+04	0.0	0.0
Density, kg/L	1.3070	2.4062		
Vapor fraction	0.0	0.0	0.0	0.0
Solid fraction	0.0	1.0000	0.0	0.0
Organic fraction	0.0	0.0	0.0	0.0
Osmotic Pres, atm	405.77			
Redox Pot, volts	0.0			
E-Con, 1/ohm-cm	.18111			
E-Con, cm2/ohm-mol	17.757			
Ionic Strength	7.6258			

STREAM: ap-101
POINT : 1

Solid	Scale Tend.	Temperature Range		
NA4SIO4PPT	6.83475E+14			
NA3PO4.6H2O	2.27903E+14	70.000	121.000	EXCL TR
NA3PO4.8H2O	4.06615E+00	40.010	70.000	EXCL TR
FEOOHPPT	1.00000E+00			
NA2U2O7PPT	1.00000E+00			
NIOH2PPT	1.00000E+00			
PBOH2PPT	1.00000E+00	.000	60.000	
NA2C2O4PPT	1.00000E+00	.000	100.000	
CA5OHPO43PPT	1.00000E+00			
KALSIO4PPT	9.99996E-01			
ALOH3PPT	9.66424E-01	.000	100.000	
NAFPPT	8.42113E-01	.000	100.000	
ALOOHPPT	8.41044E-01	100.100	250.000	EXCL TR
CAF2PPT	6.97683E-01			
NAPHOH.12H2O	5.89761E-01	.000	40.000	
KNO3PPT	4.97677E-01	.000	110.000	
NA2CO3.10H2O	3.25864E-01	.000	32.000	
NANO3PPT	2.83843E-01	.000	180.000	
NAFPO4.19H2O	2.23997E-01	15.000	75.000	
NA2CO3.7H2O	2.08747E-01	32.000	35.370	EXCL TR
NA2CO3.1H2O	1.85034E-01	35.370	109.000	EXCL TR
NA2SO4PPT	7.31470E-02	32.400	241.000	EXCL TR
NAALO2.3H2O	6.25180E-02			
NANO2PPT	5.46422E-02	.000	128.000	
CAOH2PPT	4.17342E-02			
KNO2PPT	2.67638E-02	.000	120.000	
NA2SO4.10H2O	2.66190E-02	.000	32.400	
NA2CO3PPT	2.53170E-02	109.000	200.000	EXCL TR
NIOPPT	2.24117E-02			
CACO3PPT	1.39812E-02			
NAALSIO4PPT	1.31107E-02			
NACLPPT	6.07030E-03	.000	350.000	
K2SO4PPT	4.92616E-03	9.700	292.000	
K2SO4.1H2O	4.19841E-03	.000	9.700	EXCL TR
NA6SO42CO3PPT	3.47474E-03	30.000	150.000	EXCL TR
KCLPPT	2.60293E-03	.000	200.000	
AL2O3PPT	1.37494E-03			
KOH.2H2O	7.48265E-04	.000	33.000	
NAOH.1H2O	7.05176E-04	20.000	55.000	EXCL TR
NA2CRO4.6H2O	5.93527E-04	19.500	25.900	EXCL TR
NA2CRO4.4H2O	5.84408E-04	25.910	60.000	EXCL TR
NA2CRO4.10H2O	5.48071E-04	.000	19.500	
NA2CRO4PPT	5.16414E-04	65.010	260.000	EXCL TR
K2C2O4PPT	4.44247E-04			
NA2UO4PPT	3.96756E-04			
CAC2O4.1H2O	3.45861E-04	.000	95.000	
K3NASO42PPT	3.17569E-04	35.000	150.000	EXCL TR
NA2OPPT	1.74660E-04			
KF.4H2O	1.14303E-04	.000	17.700	EXCL TR
NAALO2PPT	9.18293E-05			
KOH.1H2O	8.26056E-05	33.000	143.000	EXCL TR
FEIIIOH3PPT	7.43521E-05	.000	100.000	
K2C2O4.1H2O	6.43977E-05	.000	150.000	
CSNO3PPT	3.91151E-05	.000	106.200	
PBOPPT	3.54941E-05			
K2CRO4PPT	3.00077E-05	.000	300.000	
KF.2H2O	2.54645E-05	17.700	40.200	

CA3PO42PPT	9.61707E-06			
NA2HPO4.12H2O	7.91163E-06	.000	34.700	
KFPPT	6.77461E-06	40.200	80.000	EXCL TR
NA2HPO4.7H2O	4.84816E-06	35.400	48.100	EXCL TR
NA2HPO4.2H2O	3.84030E-06	48.100	95.100	EXCL TR
NAHCO3PPT	3.09615E-06	.000	200.000	
NAALSIO32PPT	2.42279E-06			
NAOHPPT	2.05119E-06	300.000	300.000	EXCL TR
K2OPPT	2.02294E-06			
K2CO3.1.5H2O	1.15269E-06	.000	80.000	
NA3PO4.1H2O	8.67114E-07	121.000	215.000	EXCL TR
CAC2O4PPT	6.99304E-07			
NAALSI2O6.1H2O	3.75197E-07			
CSNO2PPT	3.45163E-07			
CASO4PPT	6.13917E-08	100.000	250.000	EXCL TR
CASO4.2H2O	5.46712E-08	.000	100.000	
KHCO3PPT	5.41320E-08	.000	70.000	
K3PO4PPT	4.91778E-08			
CSCLPPT	2.75314E-08	.000	119.400	
K2CO3PPT	2.07183E-08			
CACRO4PPT	9.59166E-09			
K3PO4.7H2O	6.62908E-09	.000	45.600	
CAHPO4PPT	2.78286E-09			
K2HPO4PPT	2.68315E-09	48.300	99.400	EXCL TR
SIO2PPT	2.19330E-09			
K2HPO4.6H2O	1.67722E-09	.000	14.700	EXCL TR
CAHPO4.2H2O	1.31467E-09			
K2HPO4.3H2O	1.30659E-09	14.700	48.300	
UO2OH2PPT	4.59154E-10			
K3PO4.3H2O	2.14811E-10	52.000	60.000	EXCL TR
NA2SI2O5PPT	1.18090E-10			
PBCO3PPT	1.03808E-10	.000	300.000	
CSOHPPT	6.44408E-11	15.000	30.000	
CANO22.4H2O	2.97139E-11	.000	34.600	
CANO32.4H2O	2.64051E-11	.000	42.500	
CSOH.1H2O	2.35544E-11			
KOHPPT	2.22686E-11			
KFELDSPARPPT	1.04121E-11			
CANO32.3H2O	7.53830E-12	42.500	51.100	EXCL TR
NIC2O4.2H2O	7.50161E-12	.000	25.000	
NAALSI2O6PPT	7.30875E-12			
CANO22.1H2O	3.72121E-12	34.600	115.000	EXCL TR
CANO22PPT	3.03750E-12	500.000	500.000	EXCL TR
CAOPPT	2.32867E-12			
NIC2O4PPT	1.23781E-12			
CSF.1H2O	1.10395E-12			
KALSI3O8PPT	5.90119E-13			
CS2CRO4PPT	3.60863E-13			
K2SI2O5PPT	2.76819E-13			
NICO3PPT	8.45734E-14			
CANO32PPT	1.70565E-14	55.000	151.000	EXCL TR
PBC2O4PPT	1.19653E-14			
CS2SO4PPT	9.34531E-15	.000	108.600	
CSFPPT	5.51472E-15			
NAH2PO4.2H2O	1.23086E-15	.000	40.000	
NAH2PO4.1H2O	1.20735E-15	41.000	58.000	EXCL TR
NAH2PO4PPT	9.32903E-16	60.000	100.000	EXCL TR
KH2PO4PPT	8.85356E-16	.000	90.000	
CACL2.6H2O	3.26207E-16	.000	30.100	
NINO32.2H2O	9.85736E-17	85.400	119.800	EXCL TR
CACL2.4H2O	2.97089E-17	30.100	45.100	EXCL TR
CS2CO3.3.5H2O	2.59275E-17			
PBF2PPT	1.64429E-17	.000	26.600	
PBSO4PPT	7.49073E-18	.000	40.000	
KHSO4PPT	3.25839E-18			

NAHSO4PPT	3.45946E-19				
P4O10PPT	1.91834E-19				
CACL2.1H2O	1.16975E-19	175.500	260.000	EXCL TR	
NIF2.4H2O	9.22250E-20	.000	90.000		
PBCL2PPT	4.14121E-20	.000	287.000		
NINO32.4H2O	3.98116E-20	54.000	85.400	EXCL TR	
NINO32.6H2O	3.05151E-20	.000	54.000		
NA3HSO42PPT	1.13384E-20	.000	82.500		
PBNO32PPT	1.10121E-20	.000	100.000		
NISO4PPT	7.80640E-21	500.000	500.000	EXCL TR	
CACL2.2H2O	6.40735E-21	45.100	175.500	EXCL TR	
NISO4.6H2O	1.96542E-21	31.200	100.000	EXCL TR	
NISO4.7H2O	1.56782E-21	.000	31.200		
CSH2PO4PPT	2.35040E-22				
NA2CR2O7.2H2O	1.09934E-22	.000	60.000		
NA2HPO4PPT	1.08407E-22	95.100	120.000	EXCL TR	
ALPO4PPT	8.10196E-23				
K2CR2O7PPT	6.09846E-23	.000	150.000		
CS2CO3PPT	2.33104E-23				
NINO32PPT	2.17867E-23				
CACL2PPT	1.95982E-23				
FEIIIPO4.2H2O	5.53438E-24				
NICL2.6H2O	5.01814E-24	.000	28.800		
NICL2.4H2O	2.60801E-24	28.800	64.300	EXCL TR	
NICL2.2H2O	1.68274E-24	64.300	117.900	EXCL TR	
ALF3.3H2O	1.43922E-24	.000	90.000		
NA2CR2O7PPT	1.13096E-26	84.600	100.000	EXCL TR	
KAL3SULFATPPT	3.18233E-29				
OXALAC.2H2O	3.02031E-29	.000	90.200		
OXALACPPT	2.40290E-29				
PB3PO42PPT	1.17364E-29				
UO2C2O4.3H2O	7.19683E-30	.000	100.000		
FEIIIPO4PPT	6.68346E-30				
UO2F2PPT	1.97094E-30				
UO2F2.3H2O	1.97033E-31				
NI3PO42PPT	3.42895E-35				
UO2SO4.3H2O	2.03828E-35	.000	153.600		
UO2SO4PPT	1.00000E-35				^@^@^@^@^@
UVIF6PPT	1.00000E-35				^@^@^@^@^@
ALNO33.8H2O	1.00000E-35	80.000	107.000	EXCL TR	^@^@^@^@^@
ALNO33.9H2O	1.00000E-35	.000	80.000		^@^@^@^@^@
CAH2PO42.1H2O	1.00000E-35				^@^@^@^@^@
FE2SO43PPT	1.00000E-35				^@^@^@^@^@
FECL3.2.5H2O	1.00000E-35	50.000	55.000	EXCL TR	^@^@^@^@^@
FECL3.2H2O	1.00000E-35	55.000	73.500	EXCL TR	^@^@^@^@^@
NA3PO4PPT	1.00000E-35	215.000	350.000	EXCL TR	^@^@^@^@^@
FECL3.6H2O	1.00000E-35	.000	37.000		^@^@^@^@^@
FECL3PPT	1.00000E-35	75.000	100.000	EXCL TR	^@^@^@^@^@
FEIIIF3PPT	1.00000E-35				^@^@^@^@^@
FEIIINO33.9H2O	1.00000E-35	.000	40.000		^@^@^@^@^@
UCL6PPT	1.00000E-35				^@^@^@^@^@
UO22P2O7PPT	1.00000E-35				^@^@^@^@^@
UO23PO42.4H2O	1.00000E-35				^@^@^@^@^@
UO23PO42PPT	1.00000E-35				^@^@^@^@^@
CAH2PO42PPT	1.00000E-35				^@^@^@^@^@
UO2CL2.3H2O	1.00000E-35				^@^@^@^@^@
UO2CL2.H2O	1.00000E-35				^@^@^@^@^@
UO2CL2PPT	1.00000E-35				^@^@^@^@^@
ALCL3.6H2O	1.00000E-35	.000	98.000		^@^@^@^@^@
ALNO33.6H2O	1.00000E-35	107.000	129.000	EXCL TR	^@^@^@^@^@
UO2NO32.2H2O	1.00000E-35	113.000	184.000	EXCL TR	^@^@^@^@^@
UO2NO32.3H2O	1.00000E-35	58.600	113.000	EXCL TR	^@^@^@^@^@
UO2NO32.6H2O	1.00000E-35	.000	58.600		^@^@^@^@^@
UO2NO32PPT	1.00000E-35				^@^@^@^@^@
ALSO4.16H2O	1.00000E-35	.000	88.000		^@^@^@^@^@

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POINT : 2

Solid	Scale Tend.	Temperature Range		
NA3PO4.6H2O	6.14093E+16	70.000	121.000	EXCL TR
NA4SIO4PPT	9.50012E+14			
NA3PO4.8H2O	8.45744E+00	40.010	70.000	EXCL TR
ALOH3PPT	1.00000E+00	.000	100.000	
NIOH2PPT	1.00000E+00			
PBOH2PPT	1.00000E+00	.000	60.000	
KALSIO4PPT	1.00000E+00			
NA2C2O4PPT	1.00000E+00	.000	100.000	
CA5OHPO43PPT	1.00000E+00			
NA2U2O7PPT	9.99992E-01			
FEOOHPPT	9.99992E-01			
NAFPPT	8.66321E-01	.000	100.000	
NAPHOH.12H2O	8.35926E-01	.000	40.000	
ALOOHPPT	8.26936E-01	100.100	250.000	EXCL TR
CAF2PPT	8.01501E-01			
KNO3PPT	5.46808E-01	.000	110.000	
NA2CO3.10H2O	4.31328E-01	.000	32.000	
NANO3PPT	3.04475E-01	.000	180.000	
NA2CO3.7H2O	2.26912E-01	32.000	35.370	EXCL TR
NA2CO3.1H2O	1.76963E-01	35.370	109.000	EXCL TR
NAFPO4.19H2O	1.61064E-01	15.000	75.000	
NAALO2.3H2O	9.61527E-02			
NA2SO4PPT	7.02071E-02	32.400	241.000	EXCL TR
NANO2PPT	5.83178E-02	.000	128.000	
CAOH2PPT	4.43754E-02			
NA2SO4.10H2O	3.52299E-02	.000	32.400	
KNO2PPT	2.70402E-02	.000	120.000	
NA2CO3PPT	2.11401E-02	109.000	200.000	EXCL TR
NIOPPT	2.07978E-02			
CACO3PPT	1.37136E-02			
NAALSIO4PPT	1.18827E-02			
NACLPPT	6.15160E-03	.000	350.000	
K2SO4PPT	5.55035E-03	9.700	292.000	
K2SO4.1H2O	4.70802E-03	.000	9.700	EXCL TR
NA6SO42CO3PPT	3.15855E-03	30.000	150.000	EXCL TR
KCLPPT	2.75987E-03	.000	200.000	
AL2O3PPT	1.17707E-03			
KOH.2H2O	8.01995E-04	.000	33.000	
NAOH.1H2O	7.09190E-04	20.000	55.000	EXCL TR
NA2CRO4.6H2O	6.49874E-04	19.500	25.900	EXCL TR
NA2CRO4.10H2O	6.46860E-04	.000	19.500	
NA2CRO4.4H2O	6.29797E-04	25.910	60.000	EXCL TR
NA2CRO4PPT	6.19367E-04	65.010	260.000	EXCL TR
K2C2O4PPT	4.60855E-04			
NA2UO4PPT	3.67421E-04			
CAC2O4.1H2O	3.54878E-04	.000	95.000	
K3NASO42PPT	3.40659E-04	35.000	150.000	EXCL TR
NA2OPPT	1.59218E-04			
KF.4H2O	1.26195E-04	.000	17.700	
KOH.1H2O	8.62175E-05	33.000	143.000	EXCL TR
NAALO2PPT	7.82524E-05			
FEIIIOH3PPT	7.36531E-05	.000	100.000	
K2C2O4.1H2O	6.30634E-05	.000	150.000	
CSNO3PPT	4.66396E-05	.000	106.200	
PBOPPT	3.19009E-05			
K2CRO4PPT	3.05818E-05	.000	300.000	
KF.2H2O	2.64904E-05	17.700	40.200	EXCL TR

KFPPT	1.30447E-05	40.200	80.000	EXCL TR
NA2HPO4.12H2O	9.66313E-06	.000	34.700	
CA3PO42PPT	8.19878E-06			
NA2HPO4.7H2O	4.46798E-06	35.400	48.100	EXCL TR
NA2HPO4.2H2O	3.16166E-06	48.100	95.100	EXCL TR
NAHCO3PPT	2.64906E-06	.000	200.000	
NAALSIO32PPT	2.05143E-06			
NAOHPPT	1.79015E-06	300.000	300.000	EXCL TR
K2OPPT	1.77880E-06			
K2CO3.1.5H2O	1.11977E-06	.000	80.000	
NA3PO4.1H2O	7.21089E-07	121.000	215.000	EXCL TR
CAC2O4PPT	6.65541E-07			
CSNO2PPT	3.76064E-07			
NAALSI2O6.1H2O	3.15578E-07			
CASO4PPT	6.49236E-08	100.000	250.000	EXCL TR
CASO4.2H2O	6.06333E-08	.000	100.000	
KHCO3PPT	4.52665E-08	.000	70.000	
K3PO4PPT	4.13695E-08			
CSCLPPT	2.82148E-08	.000	119.400	
K2CO3PPT	1.79142E-08			
CACRO4PPT	9.77733E-09			
K3PO4.7H2O	7.44320E-09	.000	45.600	
K2HPO4PPT	3.42254E-09	48.300	99.400	EXCL TR
CAHPO4PPT	2.22246E-09			
SIO2PPT	1.81665E-09			
K2HPO4.6H2O	1.44846E-09	.000	14.700	EXCL TR
CAHPO4.2H2O	1.12605E-09			
K2HPO4.3H2O	1.09913E-09	14.700	48.300	
UO2OH2PPT	3.89447E-10			
K3PO4.3H2O	2.27346E-10	52.000	60.000	EXCL TR
NA2SI2O5PPT	9.57032E-11			
PBCO3PPT	7.49625E-11	.000	300.000	
CSOHPPT	4.89890E-11	15.000	30.000	
CANO22.4H2O	3.57109E-11	.000	34.600	
CANO32.4H2O	3.00486E-11	.000	42.500	
CSOH.1H2O	2.24707E-11			
KOHPPT	1.80850E-11			
NIC2O4.2H2O	9.76170E-12	.000	25.000	
KFELDSPARPPT	8.43890E-12			
CANO32.3H2O	8.27939E-12	42.500	51.100	EXCL TR
NAALSI2O6PPT	5.41406E-12			
CANO22.1H2O	3.82741E-12	34.600	115.000	EXCL TR
CANO22PPT	3.16709E-12	500.000	500.000	EXCL TR
CAOPPT	1.87606E-12			
CSF.1H2O	1.03130E-12			
NIC2O4PPT	8.51947E-13			
KALSI3O8PPT	4.56324E-13			
CS2CRO4PPT	4.22812E-13			
K2SI2O5PPT	2.31871E-13			
NICO3PPT	5.80310E-14			
CANO32PPT	1.69060E-14	55.000	151.000	EXCL TR
CS2SO4PPT	9.84805E-15	.000	108.600	
PBC2O4PPT	8.84020E-15			
CSFPPT	4.70330E-15			
NAH2PO4.2H2O	8.19202E-16	.000	40.000	
NAH2PO4.1H2O	7.94968E-16	41.000	58.000	EXCL TR
NAH2PO4PPT	6.05324E-16	60.000	100.000	EXCL TR
KH2PO4PPT	5.98080E-16	.000	90.000	
CACL2.6H2O	3.93359E-16	.000	30.100	
NINO32.2H2O	2.56436E-16	85.400	119.800	EXCL TR
CACL2.4H2O	4.45793E-17	30.100	45.100	EXCL TR
CS2CO3.3.5H2O	2.68975E-17			
PBF2PPT	1.14826E-17	.000	26.600	
PBSO4PPT	5.87284E-18	.000	40.000	
KHSO4PPT	2.58737E-18			

NAHSO4PPT	2.57913E-19			
P4O10PPT	1.17260E-19			
CACL2.1H2O	1.00848E-19	175.500	260.000	EXCL TR
NIF2.4H2O	7.23833E-20	.000	90.000	
NINO32.4H2O	3.94378E-20	54.000	85.400	EXCL TR
PBCL2PPT	3.20974E-20	.000	287.000	
NINO32.6H2O	2.61724E-20	.000	54.000	
NA3HSO42PPT	1.08408E-20	.000	82.500	
PBNO32PPT	7.75476E-21	.000	100.000	
NISO4PPT	6.00174E-21	500.000	500.000	EXCL TR
CACL2.2H2O	5.54233E-21	45.100	175.500	EXCL TR
NISO4.6H2O	1.70215E-21	31.200	100.000	EXCL TR
NISO4.7H2O	1.35512E-21	.000	31.200	
CSH2PO4PPT	1.55136E-22			
NA2CR2O7.2H2O	7.22359E-23	.000	60.000	
K2CR2O7PPT	5.85071E-23	.000	150.000	
ALPO4PPT	4.07941E-23			
CS2CO3PPT	1.79441E-23			
CACL2PPT	1.50266E-23			
NINO32PPT	1.45803E-23			
NICL2.6H2O	4.36903E-24	.000	28.800	
FEIIIPO4.2H2O	3.05374E-24			
NICL2.4H2O	2.05860E-24	28.800	64.300	EXCL TR
NICL2.2H2O	1.40819E-24	64.300	117.900	EXCL TR
NA2HPO4PPT	1.07426E-24	95.100	120.000	EXCL TR
ALF3.3H2O	9.32226E-25	.000	90.000	
NA2CR2O7PPT	7.82985E-27	84.600	100.000	EXCL TR
KAL3SULFATPPT	2.38051E-29			
OXALAC.2H2O	1.85666E-29	.000	90.200	
OXALACPPT	1.30061E-29			
PB3PO42PPT	4.50225E-30			
UO2C2O4.3H2O	4.32545E-30	.000	100.000	
FEIIIPO4PPT	3.41712E-30			
UO2F2PPT	1.03001E-30			
UO2F2.3H2O	1.12923E-31			
UO2SO4.3H2O	1.24338E-35	.000	153.600	
NI3PO42PPT	1.24226E-35			
UO2SO4PPT	1.00000E-35			
UVIF6PPT	1.00000E-35			
ALNO33.8H2O	1.00000E-35	80.000	107.000	EXCL TR
ALNO33.9H2O	1.00000E-35	.000	80.000	
CAH2PO42.1H2O	1.00000E-35			
FE2SO43PPT	1.00000E-35			
FECL3.2.5H2O	1.00000E-35	50.000	55.000	EXCL TR
FECL3.2H2O	1.00000E-35	55.000	73.500	EXCL TR
NA3PO4PPT	1.00000E-35	215.000	350.000	EXCL TR
FECL3.6H2O	1.00000E-35	.000	37.000	
FECL3PPT	1.00000E-35	75.000	100.000	EXCL TR
FEIIIF3PPT	1.00000E-35			
FEIIINO33.9H2O	1.00000E-35	.000	40.000	
UCL6PPT	1.00000E-35			
UO22P2O7PPT	1.00000E-35			
UO23PO42.4H2O	1.00000E-35			
UO23PO42PPT	1.00000E-35			
CAH2PO42PPT	1.00000E-35			
UO2CL2.3H2O	1.00000E-35			
UO2CL2.H2O	1.00000E-35			
UO2CL2PPT	1.00000E-35			
ALCL3.6H2O	1.00000E-35	.000	98.000	
ALNO33.6H2O	1.00000E-35	107.000	129.000	EXCL TR
UO2NO32.2H2O	1.00000E-35	113.000	184.000	EXCL TR
UO2NO32.3H2O	1.00000E-35	58.600	113.000	EXCL TR
UO2NO32.6H2O	1.00000E-35	.000	58.600	
UO2NO32PPT	1.00000E-35			
ALSO4.16H2O	1.00000E-35	.000	88.000	

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STREAM: ap-101
POINT : 3

Solid	Scale Tend.	Temperature Range		
NA3PO4.6H2O	2.43036E+19	70.000	121.000	EXCL TR
NA4SIO4PPT	1.40279E+15			
NA3PO4.8H2O	1.52625E+01	40.010	70.000	EXCL TR
KALSIO4PPT	1.00002E+00			
FEOOHPPT	1.00000E+00			
NA2U2O7PPT	1.00000E+00			
NIOH2PPT	1.00000E+00			
PBOH2PPT	1.00000E+00	.000	60.000	
ALOH3PPT	1.00000E+00	.000	100.000	
NA2C2O4PPT	1.00000E+00	.000	100.000	
CA5OHPO43PPT	1.00000E+00			
CAF2PPT	1.00000E+00			
NAPHOH.12H2O	9.99999E-01	.000	40.000	
NAFPPT	8.82565E-01	.000	100.000	
ALOOHPPT	7.85616E-01	100.100	250.000	EXCL TR
KNO3PPT	6.06806E-01	.000	110.000	
NA2CO3.10H2O	5.74093E-01	.000	32.000	
NANO3PPT	3.27493E-01	.000	180.000	
NA2CO3.7H2O	2.46451E-01	32.000	35.370	EXCL TR
NA2CO3.1H2O	1.68475E-01	35.370	109.000	EXCL TR
NAALO2.3H2O	1.49348E-01			
NAFPO4.19H2O	6.96978E-02	15.000	75.000	EXCL TR
NA2SO4PPT	6.74393E-02	32.400	241.000	EXCL TR
NANO2PPT	6.23485E-02	.000	128.000	
CAOH2PPT	5.28236E-02			
NA2SO4.10H2O	4.80410E-02	.000	32.400	
KNO2PPT	2.73677E-02	.000	120.000	
NIOPPT	1.92810E-02			
NA2CO3PPT	1.74498E-02	109.000	200.000	EXCL TR
CACO3PPT	1.48995E-02			
NAALSIO4PPT	1.07462E-02			
K2SO4PPT	6.29827E-03	9.700	292.000	
NACLPPT	6.24189E-03	.000	350.000	
K2SO4.1H2O	5.28933E-03	.000	9.700	EXCL TR
KCLPPT	2.93570E-03	.000	200.000	
NA6SO42CO3PPT	2.89077E-03	30.000	150.000	EXCL TR
AL2O3PPT	9.38874E-04			
KOH.2H2O	8.61825E-04	.000	33.000	
NA2CRO4.10H2O	7.77443E-04	.000	19.500	
NA2CRO4.6H2O	7.63747E-04	19.500	25.900	EXCL TR
NA2CRO4PPT	7.55031E-04	65.010	260.000	EXCL TR
NAOH.1H2O	7.21646E-04	20.000	55.000	EXCL TR
NA2CRO4.4H2O	6.80948E-04	25.910	60.000	EXCL TR
K2C2O4PPT	4.80697E-04			
CAC2O4.1H2O	4.02965E-04	.000	95.000	
K3NASO42PPT	3.67845E-04	35.000	150.000	EXCL TR
NA2UO4PPT	3.42252E-04			
NA2OPPT	1.45047E-04			
KF.4H2O	1.35015E-04	.000	17.700	
KOH.1H2O	9.04249E-05	33.000	143.000	EXCL TR
FEIIIOH3PPT	7.29964E-05	.000	100.000	
NAALO2PPT	6.47030E-05			
K2C2O4.1H2O	6.15732E-05	.000	150.000	
CSNO3PPT	5.62365E-05	.000	106.200	
K2CRO4PPT	3.12442E-05	.000	300.000	
PBOPPT	2.80495E-05			
KFPPT	2.80291E-05	40.200	80.000	EXCL TR

KF.2H2O	2.72066E-05	17.700	40.200	EXCL TR
NA2HPO4.12H2O	9.88044E-06	.000	34.700	
CA3PO42PPT	6.70253E-06			
NA2HPO4.7H2O	3.43183E-06	35.400	48.100	EXCL TR
NAHCO3PPT	2.26022E-06	.000	200.000	
NA2HPO4.2H2O	2.16038E-06	48.100	95.100	EXCL TR
NAALSIO32PPT	1.78012E-06			
NAOHPPT	1.56818E-06	300.000	300.000	EXCL TR
K2OPPT	1.56205E-06			
K2CO3.1.5H2O	1.08402E-06	.000	80.000	
CAC2O4PPT	7.01309E-07			
NA3PO4.1H2O	5.01864E-07	121.000	215.000	EXCL TR
CSNO2PPT	4.12444E-07			
NAALSI2O6.1H2O	2.71822E-07			
CASO4PPT	7.63834E-08	100.000	250.000	EXCL TR
CASO4.2H2O	7.47701E-08	.000	100.000	
KHCO3PPT	3.75626E-08	.000	70.000	
K3PO4PPT	2.93800E-08			
CSCLPPT	2.90299E-08	.000	119.400	
K2CO3PPT	1.55136E-08			
CACRO4PPT	1.10995E-08			
K3PO4.7H2O	6.99964E-09	.000	45.600	
K2HPO4PPT	3.86443E-09	48.300	99.400	EXCL TR
CAHPO4PPT	1.63858E-09			
SIO2PPT	1.53965E-09			
K2HPO4.6H2O	1.04531E-09	.000	14.700	
CAHPO4.2H2O	8.90448E-10			
K2HPO4.3H2O	7.69052E-10	14.700	48.300	EXCL TR
UO2OH2PPT	3.27233E-10			
K3PO4.3H2O	2.02270E-10	52.000	60.000	EXCL TR
NA2SI2O5PPT	8.26720E-11			
PBCO3PPT	5.21393E-11	.000	300.000	
CANO22.4H2O	4.73369E-11	.000	34.600	
CANO32.4H2O	3.79450E-11	.000	42.500	
CSOHPPT	3.71998E-11	15.000	30.000	EXCL TR
CSOH.1H2O	2.15633E-11			
KOHPPT	1.47267E-11			
NIC2O4.2H2O	1.25791E-11	.000	25.000	
CANO32.3H2O	1.02672E-11	42.500	51.100	EXCL TR
KFELDSPARPPT	7.20044E-12			
CANO22.1H2O	4.33146E-12	34.600	115.000	EXCL TR
NAALSI2O6PPT	4.09882E-12			
CANO22PPT	3.67704E-12	500.000	500.000	EXCL TR
CAOPPT	1.68305E-12			
CSF.1H2O	9.52919E-13			
NIC2O4PPT	5.74319E-13			
CS2CRO4PPT	5.02087E-13			
KALSI3O8PPT	3.71198E-13			
K2SI2O5PPT	2.07336E-13			
NICO3PPT	3.91673E-14			
CANO32PPT	1.86293E-14	55.000	151.000	EXCL TR
CS2SO4PPT	1.04284E-14	.000	108.600	
PBC2O4PPT	6.30471E-15			
CSFPPT	3.96334E-15			
NINO32.2H2O	7.24332E-16	85.400	119.800	EXCL TR
CACL2.6H2O	5.20915E-16	.000	30.100	
NAH2PO4.2H2O	4.49837E-16	.000	40.000	
NAH2PO4.1H2O	4.31447E-16	41.000	58.000	EXCL TR
KH2PO4PPT	3.34333E-16	.000	90.000	
NAH2PO4PPT	3.24077E-16	60.000	100.000	EXCL TR
CACL2.4H2O	8.09417E-17	30.100	45.100	EXCL TR
CS2CO3.3.5H2O	2.80106E-17			
PBF2PPT	7.49045E-18	.000	26.600	
PBSO4PPT	4.44813E-18	.000	40.000	
KHSO4PPT	2.04028E-18			

NAHSO4PPT	1.90913E-19			
CACL2.1H2O	9.62441E-20	175.500	260.000	EXCL TR
P4O10PPT	6.58178E-20			
NIF2.4H2O	5.44954E-20	.000	90.000	
NINO32.4H2O	3.93926E-20	54.000	85.400	EXCL TR
PBCL2PPT	2.40814E-20	.000	287.000	
NINO32.6H2O	2.21256E-20	.000	54.000	
NA3HSO42PPT	9.89913E-21	.000	82.500	
CACL2.2H2O	5.30516E-21	45.100	175.500	EXCL TR
PBNO32PPT	5.29153E-21	.000	100.000	
NISO4PPT	4.56162E-21	500.000	500.000	EXCL TR
NISO4.6H2O	1.45295E-21	31.200	100.000	EXCL TR
NISO4.7H2O	1.15215E-21	.000	31.200	
CSH2PO4PPT	8.47227E-23			
K2CR2O7PPT	5.56726E-23	.000	150.000	
NA2CR2O7.2H2O	4.68532E-23	.000	60.000	
ALPO4PPT	1.62463E-23			
CS2CO3PPT	1.38186E-23			
CACL2PPT	1.27328E-23			
NINO32PPT	9.63122E-24			
NICL2.6H2O	3.69469E-24	.000	28.800	
NICL2.4H2O	1.59155E-24	28.800	64.300	EXCL TR
FEIIIPO4.2H2O	1.37984E-24			
NICL2.2H2O	1.16397E-24	64.300	117.900	EXCL TR
ALF3.3H2O	5.49969E-25	.000	90.000	
NA2HPO4PPT	6.12180E-27	95.100	120.000	EXCL TR
NA2CR2O7PPT	5.44152E-27	84.600	100.000	EXCL TR
KAL3SULFATPPT	1.59041E-29			
OXALAC.2H2O	1.12226E-29	.000	90.200	
OXALACPPT	6.88090E-30			
UO2C2O4.3H2O	2.51747E-30	.000	100.000	
FEIIIPO4PPT	1.43062E-30			
PB3PO42PPT	1.09602E-30			
UO2F2PPT	5.10824E-31			
UO2F2.3H2O	6.13987E-32			
ALCL3.6H2O	1.00000E-35	.000	98.000	
UO2SO4.3H2O	1.00000E-35	.000	153.600	
UO2SO4PPT	1.00000E-35			
UVIF6PPT	1.00000E-35			
ALNO33.6H2O	1.00000E-35	107.000	129.000	EXCL TR
ALSO4.16H2O	1.00000E-35	.000	88.000	
ALSO4PPT	1.00000E-35			
ALNO33.8H2O	1.00000E-35	80.000	107.000	EXCL TR
ALNO33.9H2O	1.00000E-35	.000	80.000	
CAH2PO42.1H2O	1.00000E-35			
NI3PO42PPT	1.00000E-35			
FE2SO43PPT	1.00000E-35			
FECL3.2.5H2O	1.00000E-35	50.000	55.000	EXCL TR
FECL3.2H2O	1.00000E-35	55.000	73.500	EXCL TR
NA3PO4PPT	1.00000E-35	215.000	350.000	EXCL TR
FECL3.6H2O	1.00000E-35	.000	37.000	
FECL3PPT	1.00000E-35	75.000	100.000	EXCL TR
UCL6PPT	1.00000E-35			
UO22P2O7PPT	1.00000E-35			
UO23PO42.4H2O	1.00000E-35			
UO23PO42PPT	1.00000E-35			
FEIIIF3PPT	1.00000E-35			
UO2CL2.3H2O	1.00000E-35			
UO2CL2.H2O	1.00000E-35			
UO2CL2PPT	1.00000E-35			
FEIIINO33.9H2O	1.00000E-35	.000	40.000	
CAH2PO42PPT	1.00000E-35			
UO2NO32.2H2O	1.00000E-35	113.000	184.000	EXCL TR
UO2NO32.3H2O	1.00000E-35	58.600	113.000	EXCL TR
UO2NO32.6H2O	1.00000E-35	.000	58.600	

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APPENDIX E

241-AW PROJECT REQUIREMENTS AND BASIS

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APPENDIX E
241-AW PROJECT REQUIREMENTS AND BASIS

1. Purpose

Initially, only the transfer system was included in the evaluation of the 241-AW Tank Farm. It is clear from the evaluation that some work scope is needed to address system deficiencies. In order to ensure those issues with all of the systems are addressed by any new work scope, all of the systems need to be evaluated. As part of the W-314 Project definition, other systems in the 241-AW Tank Farm were evaluated in fiscal year 1995 in a system condition assessment survey. A number of issues and system deficiencies were identified and documented during the system condition assessment survey. The purpose of this attachment is to present a preconceptual project scope for the 241-AW Tank Farm. A number of system deficiencies were identified in the course of this evaluation. Many of the deficiencies can be remedied by repair or replacement in kind. Only a few of the deficiencies will require new project work scope to remedy. The tables below identify issues that need to be addressed. Solutions for five issues should be included in new work scope, namely the AW-A and AW-B Valve Pit jumper modifications (see Table E-2a for the nozzle connections); the AW Stack modification necessary to provide National Emission Standards for Hazardous Air Pollutants (NESHAP) compliant continuous emissions monitoring; replacement of the transfer pump in tank 241-AW-104; connecting line LIQW-702 directly to line SN-220; and installation of flow meters in tank 241-AW-101 primary ventilation exhaust ducting. Preconceptual design work to address all of these issues is being developed. The other issues listed in the tables and in the body of this document need to be addressed and remedied. At the time of this writing however it is apparent that the best way to address most of these issues is through maintenance activities, negotiation with regulators, or other work scope which is not project related.

This list of issues was developed using the system condition assessment survey, and the evaluation of the transfer system done for this document. This issues list is intended to be modified over time as new issues are identified or clearer definition of requirements and basis becomes available. Systems included in this evaluation are: ventilation system, transfer system, electrical system, monitor and control system, utilities systems, and sampling systems. The attempt here is to identify issues (system inadequacies) with all of the systems, reference requirements not met by current system configuration, and state the basis for the requirement. Each of the systems has its own issues table. It is important to note that some of this work may already be included as project scope. Part of this evaluation is to determine the value added to combining all of the 241-AW Tank Farm system deficiencies into a single project. This evaluation will provide input to assist in making that decision.

2. Ventilation system

In assessing the tank ventilation system, *Initial Assessment Report HVAC Systems*, WHC-SD-W314-ES-022 (Kriskovich 1996) was used as the basis for the evaluation.

The performance requirements for the ventilation system are as follows: LCO 3.2.1 of TSR-006 requires that "the active primary ventilation system shall be operable." The electrical system repairs listed in the condition assessment item 1 in Table E-1 should be addressed by maintenance activities. The ventilation system will also need to meet environmental permit requirements. The stack upgrades listed in Item 2 in Table E-1 should be addressed by project work scope. Finally, Item 3 in Table E-1 requires further evaluation.

In addition to the issues listed in Table E-1 below, the Heating, Ventilation, and Air Conditioning (HVAC) system will need to be capable of removing heat added to the tank by operation of two mixer pumps. The HVAC system will need to remove sufficient heat such that the temperature of the waste does not exceed 90.6 °C (195 °F). Although the temperature of the waste is expected to rise during operation of the mixer pumps, the amount of time necessary to reach 90.6 °C (195 °F) is on the order of days. The time required to operate the mixer pumps to achieve the desired dissolution is expected to be on the order of hours (see Attachment 1). The temperature limitation of the waste is therefore not considered to be an issue even with operation of the mixer pumps. Mixer pump operation in tank 241-AW-101 will be modeled (hydraulic/chemical) to provide a basis for the required duration of mixer pump operation. The operations concept and procedures will need to be written to consider the mixer pump operation time limitations.

Table E-1. Ventilation System. (2 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
1. Electrical supply and control circuits to the primary fans are in poor condition and jeopardize the reliability of the system (wire terminations are not properly supported and control circuits are not fully functional).	Repair or replace electrical components in the HVAC system. Specific components are identified in the Condition Assessment Survey (WHC-SD-W314-ES-020).	LCO 3.2.1 Technical Safety Requirements (BIO) requires that the active primary ventilation system shall be operable. The basis for this requirement is the need to prevent flammable gases from accumulating in the tank headspace.	Write a work package to confirm condition of electrical supply and control circuits. Document specific components requiring repair or replacement

Table E-1. Ventilation System. (2 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
2. The 241-AW primary ventilation stack will likely be redesignated from a minor to a major stack. Permitting, monitoring, and potentially treatment requirements will change.	Upgrade the 241-AW ventilation system to be compliant with NESHAP. This is likely to require changes to the effluent monitoring system. A fully NESHAP - compliant ventilation stack system has been developed under Project W-420. The estimated project cost for a single stack is approximately $200,000.	A criterion for designation of an effluent discharge stack as minor or major is whether the potential for unabated discharges results in an off-site exposure of 1×10^{-3} mSv/yr (0.1 mrem/yr). Air modeling requirements have recently changed by a factor of 1.5. This increased factor causes the current 241-AW primary stack to exceed 6×10^{-4} mSv/yr (0.06 mrem/yr) unabated releases under current conditions. Increased releases are likely due to mixer pump operation.	This is project work scope. The design for changes to the 241-AW primary ventilation stack will be similar to the design done for the W-420 Project (see Attachment 2).
3. The HVAC system does not have the capability of removing toxic pollutants from off-gas. This issue is particularly important during a Gas Release Event (GRE). The concentrations of volatile toxic pollutants in the tank waste are not well characterized. Release limits are not currently defined.	Install or provide expansion capability for an activated carbon filter and dry scrubber system in the HVAC system to reduce or eliminate toxic pollutants from the off-gas stream.	Toxic constituents are present in off-gas from the tanks potentially at concentrations which will require abatement. This follows the recommendation made in WHC-SD-W314-ES-022.	Adding the capability of toxic constituent removal to the HVAC systems is currently planned for W-314. Development of a basis for this requirement will require vapor space sampling of target Double-shell tanks (DSTs) with analysis for Tanks Advisory Panel (TAPs).
4. There currently is no direct method to measure the primary ventilation airflow from tank 241-AW-101. The filtered inlet air flowrate is monitored but this doesn't account for inleakage through pump pits, etc.	Install flow meters in tank 241-AW-101 primary ventilation exhaust ducting. See *Double-Shell Tank Primary Ventilation Exhaust Flow Monitor System Design Description*, HNF-SD-WM-SDD-074 for conceptual design information.	Flow monitoring in conjunction with hydrogen monitoring equipment already installed, will allow for determination of the overall hydrogen generation and release rates. This information will be necessary for controlling the waste degassing operation. See *Technical Basis for Installation of the Double-Shell Tank Exhaust Flow Monitoring Systems*, HNF-SD-WM-ER-629 for a detailed basis.	Issue work package to install flow monitoring system on the 241-AW-101 tank exhaust header and connect the output signals to TMACS.

3. Transfer System

The evaluation of the transfer system is documented in this report. The Tank Waste Remediation System Operation and Utilization Plan (TWRSO&UP) (Kirkbride et al. 1997) transfer list was used as the starting point. All of the transfers originating or ending in 241-AW were extracted from the transfer list, and paths were defined for each of the different tank to tank transfers. All of the transfer equipment in the different transfer paths was considered.

Issue 1 in Table E-2 is the broken transfer pump in tank 241-AW-104. Although repair or replacement of a transfer pump is a major effort, the work is replacement in kind (most likely with an existing spare). It is recommended that if used the existing spare transfer pump should be shortened. An existing turbine pump such as the spare for the 241-AW-104 transfer pump can be shortened by replacing one or more shaft section(s) and transfer pipe section(s) with shorter pieces. These shorter pieces are available from the pump manufacturer. Even given the pump shortening, this work scope should be considered as replacement in kind.

Issue 2 and Issue 6 in Table E-2 are the jumper modifications needed in the AW-A and AW-B Valve Pits, and the 102-A central Pump Pit. Table E-2a lists the nozzles in each pits that need to be connected to support the identified transfers. A preconceptual design for the jumper configurations in each pit is included in Figure 1. Figure 1a shows an alternate manifold system that may add flexibility by including the 2-in. lines. Figure 2 shows the jumper recommended in the 241-AW-102 02A central pump pit. Figure 3 shows the recommended jumper configuration for the 241-AW-103 and -106 tanks and for the 241-AN-106 tank. Issues 4 and 5 establish requirements that new jumper designs will need to meet. These issues will be addressed during the conceptual design of the jumper system.

Issue 3 in Table E-2 requires a field evaluation to determine what if any damage was done to the piping, valve pits, and monitoring equipment in the valve pit. The field evaluation should pressure test the transfer lines between the AW-A and AW-B valve pits and should visually inspect the valve pits for any signs of damage caused by acid leakage.

Several potential issues were evaluated and determined not to constitute significant problems; what follows is a brief discussion of those potential issues.

In December of 1984, a submersible pump was being used to transfer waste from tank 241-AW-101. The discharge line from the pump (5.1×10^{-2} m [2-in.] rubber hose) had come loose from the discharge flange. The weight of the line caused the pump to rotate on its support cables and prevented the pump from being withdrawn from the tank. Support cables to the pump were cut and the pump was allowed to fall back into the tank. The pump is currently resting on the bottom of the tank. The potential issue is the possibility that the pump could either block the mixer or transfer pump intake or be thrown into the tank wall or instrumentation by the mixer pump outflow. A thrown transfer pump has the potential to damage an instrument tree, air lift circulator, or otherwise damage the tank structure.

Noting that this issue is not limited to a transfer pump in tank 241-AW-101 is important, other (perhaps all) tanks contain debris that could affect mixer or transfer pump operation. Debris in tank 241-SY-101 was addressed in the *Los Alamos National Laboratory Safety Assessment (LANL) for the 241-SY-101 Mixer Pump*, LA-UR-92-3196, Appendix D. The conclusions of the analysis were that none of the debris in tank 241-SY-101 is a credible threat to the structural integrity of the tank; that no permanent damage to instrument trees was anticipated to occur; and that entrapment of debris by the mixer pump was unlikely to occur. Operation of the mixer pump in tank 241-SY-101 has occurred without such an incident occurring since 1993. The mixer pump design and the transfer pumps have a screened intake that would likely prevent ingestion of debris. The safety assessment determined that this potential issue is not a significant problem.

Another potential issue is the Net Positive Suction Head (NPSH) required to operate the mixer and transfer pumps versus the NPSH available from the system. If the NPSH required is greater than the NPSH available, the pump will experience a cavitation on the suction side of the pump. A cavitation on either suction or discharge will lead to pump damage and early failure. In an evaluation by M.A. Przybylski, it was determined that the mixer pumps can be operated at full speed with a submergence (level difference between the impellers and the liquid level) of approximately 5.5 m (18 ft) (dependant upon the temperature of the liquid, 5.5 m [18 ft] at 100 °C [212°F], 1.2 m [4 ft] at 60 °C [140°F]). The mixer pump can be run at slow speed (58 percent of full speed) with a submergence of 1.1 m (3.5 ft) for a waste temperature of 88 °C (190°F).

Drawing the waste in the tanks down to 0.25 m (10-in.) is desirable. The NPSH required by the transfer pump (W-211 Sulzer Pump) is 5.5 m (18 ft). With the impeller located approximately 0.69 m (27-in.) from the bottom of the tank, the waste can be drawn down to 0.25 m (10-in.) provided the temperature of the waste is less than 60 °C (140°F). At a temperature of 91 °C (195°F), the submergence of the pump will need to be 3.4 m (11 ft) based on a SpG of 1.41 to prevent a cavitation. These calculations are included as Attachment 3. The temperature dependance of the pump submergence requirement will need to be factored into operating procedures to be developed for the tank retrieval activities.

Table E-2. Transfer System. (2 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
1. Tank 241-AW-104 does not have a functional transfer pump (the existing pump has a broken coupling in the shaft).	Install a new or spare pump into the Tank 241-AW-104 Central Pump Pit 04-A to provide the means to transfer waste from the tank.	The TWRSO&UP has identified two supernate transfers of 2000 m^3 (540,000 gal) and 620 m^3 (164,000 gal) scheduled to occur in October of 1998. As part of changes made during the readiness to proceed effort, tank 241-AW-104 is currently scheduled to be a waste feed delivery tank with transfers to 241-AP-102 and 241-AP-104 in June 2004 (batch 5). The Waste Feed Delivery (WFD) transfer will be supernate only.	Although the pump will likely be replaced with an existing spare, the pump replacement should be project work scope due to the cost and complexity involved with the removal and disposal of the existing pump.
1.a) Piping from pump to the pit wall should use existing pipe nozzles and jumpers to the extent possible.	The pump shall connect to wall nozzle A, and tank return nozzle G in the 241-AW-04A Central Pump Pit.	Use of Existing piping systems is required to reduce costs, to minimize disruption of operations, and to eliminate the need of excavation in the tank farms (Reference Drawing # H-14-020802 sh.3, for existing piping system).	
1.b) The existing pump (if functional) would not meet system flow and head requirements.	The pump shall provide a minimum flow of 0.53 m^3/min (140 gal/min), and a maximum head of 116 m (379 ft).	The lowest pressure rating in the piping systems is 1.6 MPa (230 psi) in the 3-in. SN-220 line. A specific gravity of 1.41 and a maximum allowable operating pressure of 1.6 MPa (230 psi) suggest that the maximum allowable dead head pressure is 116 m (379 ft). The minimum flow rate requirement is based on transferring 3790 m^3 (1,000,000 gal) over a five day period (Best Engineering Judgement) (calculations shown in Attachment 4).	The basis for the flowrate will require that a definition and flow requirements for "supernate" transfers be developed. Awaiting work plan and cost estimate from Pacific Northwest National Laboratory (PNNL).
1.c) The existing pump in tank 241-AW-104 (a stick type pump) intake is approximately 2.5 m (100-in.) below the nominal sludge/liquid interface.	Install a supernate pump (flex and float or a shorter stick-type pump), such that the pump intake is above the sludge level in the tank.	All of the transfers currently identified from tank 241-AW-104 are supernate only.	

Table E-2. Transfer System. (2 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
2. The current valve pit jumper configuration will not support the planned transfers.	The system shall be designed such that the nozzles identified in the Table E-2a below can be connected.	Transfers identified in the TWRSO&UP and updated to reflect the readiness to proceed baselines, routes identified in Appendix A.	Installation of a new jumper system is project work scope. A manifold sketch is included as Figure 1. Fluor Daniel Northwest to develop detailed drawings.
3. In 1984 or 1985, an acid transfer from PUREX damaged 2-in. SL-161 and potentially other equipment.	The AW-A and AW-B Valve Pits and transfer lines between these valve pits shall be evaluated (pressure tested). Damaged equipment shall be repaired or replaced.	Existing equipment will need to be maintained or repaired to support continued operations through Phase 1 privatization. Additionally, equipment will also likely be used through the end of Phase 2 privatization.	Develop a work package to visually inspect the condition of the AW-A and AW-B Valve Pits and to pressure test the SN-271 line between the two Valve Pits.
4. Pump and Valve Pit modifications need to be designed so that they are controlled by existing and planned equipment.	System shall be integrated with both existing control system and system to be installed by Projects W-314 and W-211.	The current control strategy is to control transfers from a central control room (valve positions shown on read out board).	Specific I&C integration requirements will be developed by Vista Research.
5. Systems need to meet RCRA (dangerous waste rules)	Pipe systems shall have leak detection and shall be self draining.	The system needs to comply with WAC-173-303.	Compliance issues are being negotiated with regulators.
6. The current system only allows transfers out of 241-AW-102 to the 242-A evaporator but the capability is required to also pump from 241-AW-102 to 241-AW-106.	Provide a jumper connection from nozzle K to nozzle A in the 02-A central pump pit. Retain connection from nozzle K to nozzle G. See Figure 2.	To make the transfers listed in the TWRSO&UP, (241-AW-102 to 241-AW-106) a routing through the 02-A central pump pit is needed.	Installation of a new jumper system is project work scope. Fluor Daniel Northwest to develop detailed drawings.
7. The proposed new W-314 line does not require the use of Valve Pit 241-A-A excepting waste transferred from 204-AR. A route from 204-AR to 241-AW that bypasses Valve Pit 241-A-A would allow this valve pit to be abandoned.	Connect line LIQW-702 directly to line SN-220, bypassing the 241-A-A Valve Pit.	Line LIQW-702 is required for receipt of misc. Waste into the DST system via the 204-AR vault. Bypassing the 241-A-A Valve Pit allows it to be abandoned.	Fluor Daniel Northwest to develop detailed drawings.

Table E-2a. Valve Pit connections and dates.

Valve pit 241-AW-A connections	Need dates	Valve pit 241-AW-B connections	Need dates
nozzles L-1 to L-2	6/15/98 - 4/4/11 (exists)	nozzles R-1 to R-14	10/10/98 - 12/1/10
nozzles L-1 to L-14	8/6/98 - single use	nozzles R-1 to R-15	6/3/98 - single use (exists)
nozzles L-1 to L-15	10/6/00 - 4/2/06	nozzles R-3 to R-9	now (exists)
nozzles L-1 to L-16	1/9/03 - 1/14/03	nozzles R-14 to R-15	4/5/99 - 10/12/99
nozzles L-2 to L-14	1/17/05 - single use	nozzles R-14 to R-19	1/17/05 - single use
nozzles L-2 to L-15	10/10/00 - 4/2/06	nozzles R-15 to R-16	10/28/98 - 9/22/99
nozzles L-2 to L-19	7/20/99 - 1/17/05	nozzles R-15 to R-19	7/20/99 - 7/1/11
nozzles L-16 to L-19	7/20/99 - single use		

Additionally, in the 02-A central Pump Pit, Nozzle K shall connect to nozzle A to allow a transfer from tank 241-AW-102 to tank 241-AW-106 without having the waste go through the 242-A Evaporator. This connection is needed for two transfers scheduled to occur 10/28/98 and 9/22/99.

4. Electrical System

Three issues are identified with the electrical system. The first two are derived from previously performed Condition Assessment Survey (CAS) inspections. The issues identified here from the Condition Assessment Survey should be resolved through the corrective maintenance process. Deficiencies documented during the 1995 CAS performance are, however, dated. Establishing baseline information that accurately describes the physical condition of waste transfer system components is important. This can be accomplished via employing the formal DOE CAS methodology or by means of a similar assessment/inspection system. Knowledge of the current condition of equipment/systems is essential to determining reliability, repair, and replacement needs. The third issue deals with the capacity of the electrical system. Work to resolve the third issue is currently underway.

Table E-3. Electrical System.

Issue	Process needs	Basis	Suggested scope of work to address issue
1. A 1995-system assessment survey found many deficiencies with MCC-241-AW	Electrical system must be repaired.	System will be operational through the end of Phase 1 Privatization.	Develop a work package to confirm condition of MCC-241-AW. Document specific components requiring repair or replacement.
2. 1995 system assessment for HVAC identified electrical issues with the HVAC systems	See Ventilation System Issue 1.	See Ventilation System Issue 1.	See Ventilation System Issue 1.
3. It is not clear that new loads that will be installed under project W-211 have been fully evaluated and compared with excess capacity in the system.	Upgrade electrical system - TBD	Electrical Transmission systems may need to be upgraded to account for the new loads.	Develop a work package to review the electrical system capability and availability versus use and document.

5. Monitor and Control System

Two issues are identified with the monitor and control system. The first issue comes from previously performed Condition Assessment Survey (CAS) inspections. The issues identified here from the CAS should be resolved through the corrective maintenance process. Deficiencies documented during the 1995 CAS performance are, however, dated. Establishing baseline information that accurately describes the physical condition of waste transfer system components is important. This can be accomplished via employing the formal DOE CAS methodology or by means of a similar assessment/inspection system. Knowledge of the current condition of equipment/systems is essential to determining reliability, repair, and replacement needs.

The second issue comes from the fact that some new monitor and control systems are expected to be installed under Projects W-211 and W-314. These instrument systems will need to integrate with existing instrumentation in the Tank Farms. The design work for the new instrumentation is not yet complete. When the design media become available, the integration issue listed here can be addressed.

Table E-4. Monitor and Control System.

Issue	Process needs	Basis	Suggested scope of work to address issue
1. Maintenance issues were identified in '95 assessment.	TBD (the primary issue was the weather tightness of the enclosures)	WHC-SD-W314-ES-018, '95 assessment will be updated to verify requirements	Develop a work package to assess the condition of the 241-AW monitor and control system. Document specific components requiring repair or replacement.
2. Existing monitor and control systems need to interface with new systems.	Systems need to work in a coordinated way per the operations Monitor and Control (M&C) concept.	Existing and new monitoring and control systems will be operated by TWRS personnel for efficiency, all of the farms should be similar (best engineering practice).	Specific M&C integration requirements will be developed by Vista Research

6. Utilities Systems

Two issues associated with the utilities systems were identified. The first issue is the need to provide flush and dilution/dissolution water to the 241-AW Tank Farm. The current system provides only 0.23 m^3/min (60 gal/min). A flush rate of 0.23 m^3/min (60 gal/min) is likely sufficient to meet all flushing requirements except the waste retrieval transfers from 241-AW-101, but is unlikely sufficient for dilution/dissolution needs.

The other issue is the need to prevent the frequent cycling of the air compressors. Compressed air is used for instrumentation and air lift circulators. The current compressed air receiver tank may be undersized or the system has leaks, causing the compressors to cycle on and off every 30 to 50 seconds. The compressors are experiencing early failures and increased maintenance costs due to the frequent cycling. The reliability of the instrumentation is based on the reliability of the compressed air system.

Table E-5. Utilities Systems.

Issue	Process needs	Basis	Suggested scope of work to address issue
1. Need to provide water for flush and dilution/dissolution.	Provide water for 241-AW-101 for dilution/dissolution and line flushing, and to the remaining tanks for line flushing. Line flushing requirements 0 to 100% of flow rate (0 to 0.57 m^3/min [0 to 150 gal/min], 1.83 m/sec [6 ft/sec] in 3-in. line) for 241-AW-101. TBD gal/min for remaining tanks.	Tank 241-AW-101 is a source tank for Envelope A and as such will require dilution/dissolution water. Other tanks require line flushes following transfers. Current flush system capable of approximately 0.23 m^3/min [60 gal/min], new system to be installed by W-211 is expected to provide up to 0.57 m^3/min (150 gal/min).	A defensible basis for the flowrate will require a review of solids resuspension models and potentially pipe loop pumping studies. A Work plan and cost estimate for these activities are currently being developed by PNNL.
2. Compressors cycle every 30 to 50 seconds and experience early failures.	Determine the cause of the frequent cycling of the air compressors, and plan and execute a solution.	Reliability of some instrumentation is based on the reliability of the compressed air system. The Compressed Air system is needed to support existing and future operations.	Develop a work package to assess the compressed air system and determine the cause of the frequent cycling. After the cause of the cycling has been determined, a scoping study of alternatives is needed to develop a project requirement. Alternatives might include repair or replacement of buried air lines if leaking or larger compressed air receiver tanks.

7. Sampling Systems

No issues were identified with the existing sampling system, the requirements given below attempt to address necessary new capabilities that will be required for the feed delivery system.

Table E-6. Sampling Systems.

Issue	Process needs	Basis	Suggested scope of work to address issue
1. No issues were identified with the current sampling system.	Any changes to the 241-AW system shall not preclude the ability to obtain grab samples from two risers in each tank.	Transfers in and out of DSTs in 241-AW will require grab samples to confirm waste compatibility. Tank 241-AW-101 may also require process control grab samples during waste feed staging.	None
2.	Provide tank viscosity data to support transfer analysis.	Process need, waste pumpability is a function of viscosity. Viscosity data does not exist for all waste types.	None
3.	Provide "Boil Down" data to support 242-A Evaporator operation.	This requirement meets a 242-A Evaporator process need.	None
4. Samples will need to be drawn from 241-AW-101 after mixing but before settling.	Provide sample analysis of homogenized feed delivery tanks (241-AW-101) to support immobilization operations	Private contract stipulation of waste constituents.	None

8. Additional issues associated with tank 241-AW-101

Beyond the issues identified in the tables above, additional issues are associated with tank 241-AW-101 because it is scheduled to be retrieved and delivered to the private contractors during Phase 1.

The 241-AW-101 tank is a flammable gas watch list tank. The 241-AW-101 tank has a crust of solid material on top of the waste, a layer of liquid waste, and a layer of settled solids or sludge on the tank bottom. Hydrogen and other flammable gasses are continuously generated by the decay processes of the radioactive constituents in the waste. These flammable gasses are trapped by the sludge and crust layers. It is assumed that the tank will require a degassing step before retrieval to control the release of the flammable gasses. The planned degassing process is to gently mix the waste with mixer pumps. There are currently no mixer pumps installed in tank 241-AW-101. A new transfer pump is also needed in tank 241-AW-101 to meet the required flow rate of 0.53 m^3/min (140 gal/min).

The waste in tank 241-AW-101 requires dilution to ensure that waste transferred from the tank will not form solids and plug the transfer line during the transfer. The waste also requires dissolution to deliver as much as possible of the tank waste. The requirement for delivery of flush/dilution/dissolution water volume flow is given in the *Performance Requirements for Phase 1 Waste feed Delivery Components,* HNF-1985 (Claghorn 1998). The flow requirement is to provide from 0 to 100 percent of the delivery flow or up to 0.53 m^3/min (140 gal/min). The current flush system in the 241-AW Tank Farm can deliver only approximately 0.23 m^3/min (60 gal/min). The reason for the low flow rate is that the flush system is delivered through 3.8 cm (1½-in.) pipe. Because the 241-AW-101 tank is full of waste, at least initially, the dilution water will need to be added to the pump intake. On the other Envelope A tanks, providing the dilution water through the 2-in. slurry lines is possible. The 2-in. slurry line from the AW-A valve Pit to the 241-AW-101 tank was damaged and can no longer be used. The initial dilution water to be added at the pump intake will need to be delivered to the 01-A central pump pit through an alternate route. As one option, running the flush line overground from the 241-AP Tank Farm flush/dilution/dissolution system and into the 01-A central pump pit may be possible. If an overground line were run, backflow prevention would need to be installed in the 01-A Central Pump Pit.

The waste in tank 241-AW-101 has been evaluated, and addition of caustic to the tank is not beneficial either from a stand point of aided dissolution, or from a standpoint of maintaining the tank within the corrosion concentration limitations (refer to Attachment 5). There may be a benefit from the standpoint of corrosion prevention in the transfer piping to having the capability to flush with inhibited water (0.01 MNaOH).

Noting that the issues listed above will all be addressed by the W-211 Project is important. The 241-AW-101 tank is planned to be included in the scope of project W-211. Definitive design for tank 241-AW-101 is scheduled to begin early in FY 1999. Construction activities are scheduled to be completed by June 2002. As mentioned in Appendix B of this document, it is likely that a reliability benefit would be gained by having the 241-AW-101 tank ready to transfer waste at the beginning of Phase 1.

Table E-7. Additional Tank 241-AW-101 Issues. (3 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
1. 241-AW-101 has no means to mobilize solids	Install two mixer pumps to mobilize solids	*Decision Document, Phase I Intermediate Waste Feed Staging System Design Requirements* (Galbraith and Daling 1997). Mixer pumps were the most cost-effective alternative for waste mobilization and mixing	none

Table E-7. Additional Tank 241-AW-101 Issues. (3 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
2. Sodium salts in 241-AW-101 must be dissolved prior to delivery to the privatization vendor. Saturated salt solutions can cool and form precipitates during transfer.	LAW transfer pump shall have capability to inject water or aqueous solutions of NaOH at the pump suction bell.	Dilution of waste with water or dilute caustic solutions is required to dissolve solids and prevent precipitation during transfer	none
3. Transfer velocity should be sufficient to avoid line pluggage.	241-AW-101 transfer pump shall deliver waste feeds at TBD ft/s	Required transfer velocity is dependent on whether "supernate" or "slurry" transfers are being performed.	The basis for the flowrate will require that a definition and flow requirements for "supernate" and "slurry" transfers be developed. Awaiting work plan and cost estimate from PNNL.
4. Sodium salts in 241-AW-101 must be dissolved prior to delivery to the privatization vendor.	System shall have capability to add up to 3790 m^3 (1,000,000 gal) water to tank 241-AW-101.	Preliminary results for 241-AN-105 indicate that the settled solids will require approximately a 1:1 dilution for solids dissolution.	Complete 241-AW-101 flowsheet ESP model runs to estimate water volume requirements
5. Dilution water is needed to dissolve the waste solids. The mixer pump intake is near the tank bottom beneath 2.7 m (9 ft) of compact settled sludge. Start up of the mixer pump will require addition of water.	System shall have capability to add dilution water to 241-AW-101 at or near the mixer pump intake. The dilution water capacity shall be 0.27 m^3/min (70 gal/min).	Dilution water is needed near the mixer pump intakes to provide a pumpable fluid at the pump intake for startup. Addition to the mixer pump intake is also the best way to provide fast, thorough mixing of the dilution water with the waste solids. The dilution system capacity is 0.53 m^3/min (140 gal/min) added to two mixer pumps.	none
6. The 241-AW-101 instrumentation does not currently provide a means to accurately locate the solid/liquid interface as solids settle.	Provide AW-101 tank instrumentation capable of monitoring solids settling and identifying a solid/liquid interface in a tank with settled solids	Monitoring of slurry density at different depths is needed to monitor solids settling and establish the location of the liquid/settled solids interface for controlling supernate decanting.	It is expected that this instrumentation will consist of an ENRAF gauge with the densitometer upgrade. This is the instrument specified for the W-320 project.

Table E-7. Additional Tank 241-AW-101 Issues. (3 Sheets)

Issue	Process needs	Basis	Suggested scope of work to address issue
7. To prolong pump life the transfer pumps should be sized to prevent pump cavitation under planned operating conditions.2	241-AW-101 transfer pump shall have a NPSHR of 5.5 m (18 ft) or less	At 60 °C, no cavitation should occur at -43 cm (-17 in.) of submergence (see attachment 3). This allows a decant pump (assumed impeller location 68 cm (27 in.) above the tank bottom) to pump the tank down to a 25 cm (10 in.) heel.	None
8. A new transfer pump is required in 241-AW-101.	241-AW-101 transfer pump shall have a maximum developed head of 379 ft (230 psi and 1.41 g/ml)	The maximum developed pressure should not exceed the piping design pressure.	Document logic and source of design pressure
9. The current retrieval scenario requires that clarified supernate be transferred to the staging tanks. This will require an adjustable intake pump to complete the retrieval.	241-AW-101 transfer pump inlet shall be adjustable from 10 m to 0.25 m above the tank bottom	Best engineering judgement. There are alternative retrieval scenarios which would utilize 1 or 2 fixed inlet pumps.	The appropriate transfer pump configuration needs to be determined. This is has a number of impacts on process reliability and will require an alternatives evaluation.
10. Addition of cool water to the waste could result in precipitation of solids. It is also desirable to warm transfer lines prior to transferring waste to reduce potential for solids precipitation.	Temperature of water added to tank 241-AW-101 and the 241-AW-101 transfer pump shall be adjustable from ambient-60 °C (140 °F) while delivering the maximum flowrate (cooling capability not required).	The maximum allowable waste temperature is 90 °C (195 °F). A maximum temperature of 60 °C (140 °F) allows the transfer pump to empty the tank without cavitation (see Attachment 3).	Provide heating capability in dilution water system for tank 241-AW-101.
11. No need was identified for addition of NaOH to 241-AW-101.	Remove caustic addition requirement from W-211 scope for tank 241-AW-101.	There are no plans to add caustic to the waste in tank 241-AW-101. The 241-AW-101 waste is within corrosion specification and will remain in spec after addition of dilution water. See Attachment 5.	none

Figure 1. AW-A and AW-B Manifold Layout Sketch.

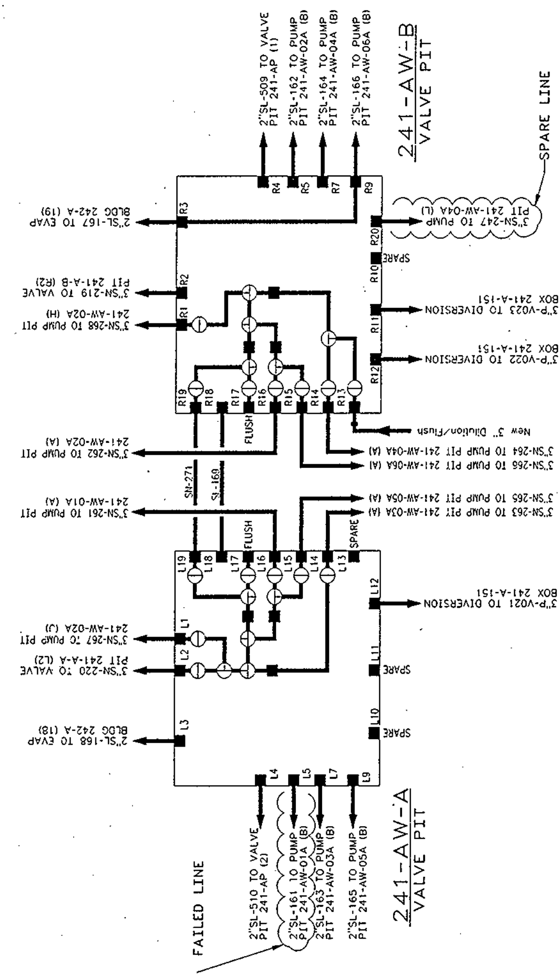


Figure 1a. Alternate AW-A and AW-B Manifold Layout Sketch.

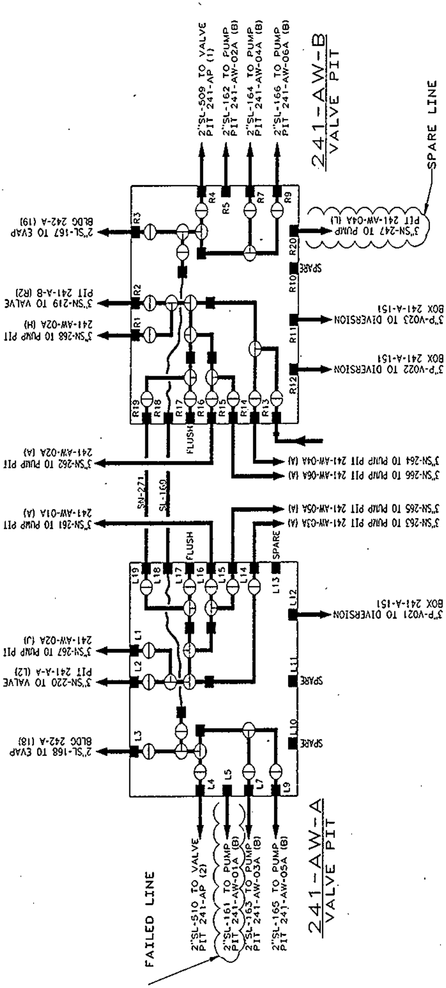


Figure 2. Tank 241-AW-102 Central Pump Pit Jumper Layout Sketch.

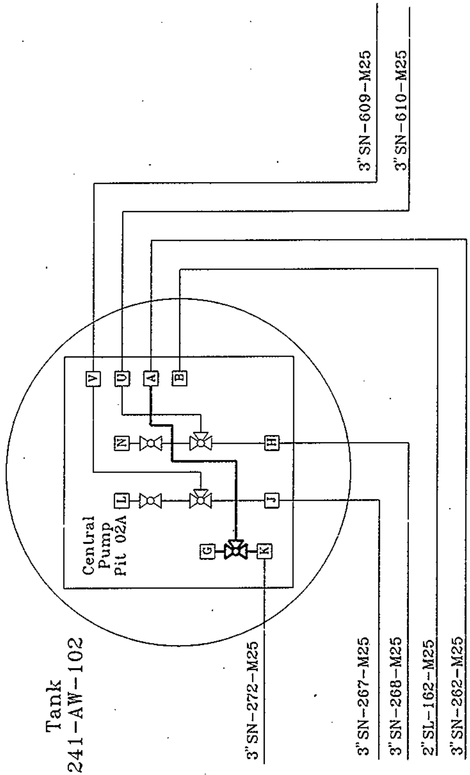
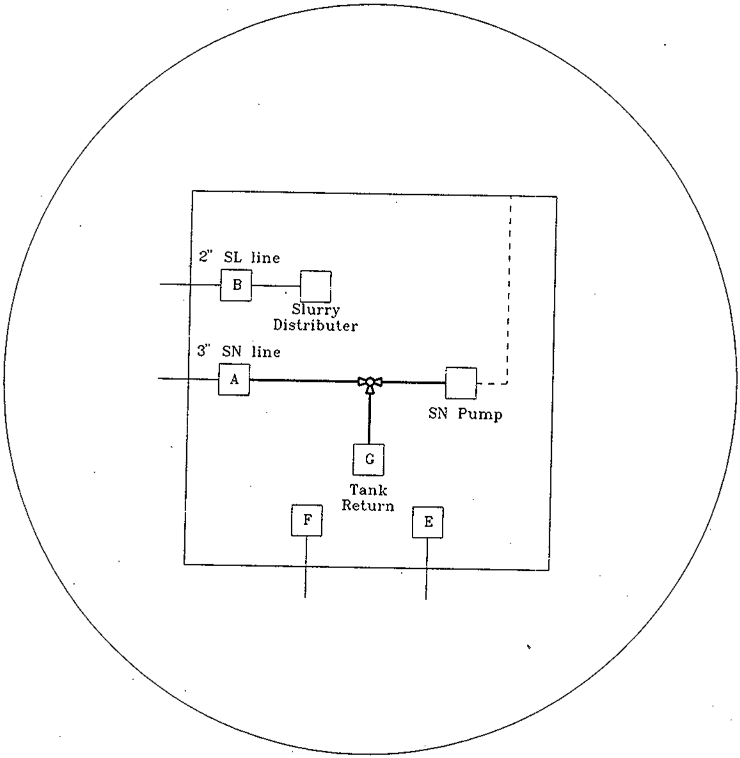


Figure 3. Central Pump Pit Configuration Sketch.



Attachment 1 (Sheet 1 of 2)

CALCULATION SHEET

Page 1 of 1
Revision No. 0
Task No. 350
Date: May 12, 1998
By: BB Peters
Checked By: WLWillis

SUBJECT: Calculation of maximum heatup rate from operation of two mixer pumps

Assumptions: 1) 100% of energy goes to heatup waste
2) each mixer pump is 300 hp (600 hp total)
3) waste heat capacity is same as water (1 BTU/lb°F)
4) initial waste temperature is 117°F (47°C)
- this is maximum temp in AN-104 sludge
- the average temp in AW-101 is ~108 °F
5) average density of waste is 1.4 g/ml

A) Calculate Heatup rate and time to reach 140°F and 195°F for a tank with 1 million gallons

$$\frac{600\ \text{hp}}{} \left| \frac{42.4356\ \text{BTU/min}}{\text{hp}} \right| \frac{60\ \text{min}}{\text{hr}} \left| \frac{\text{lb}\ °\text{F}}{1\ \text{BTU}} \right| \frac{453.6\ \text{g}}{\text{lb}} \left| \frac{\text{gal}}{3785\ \text{ml}} \right| \frac{\text{ml}}{1.4\ \text{g}} \left| \frac{}{1 \times 10^6\ \text{gal}} \right.$$

$= 0.13\ °\text{F/hr}$

$$\frac{(140-117)\ °\text{F}}{0.13\ °\text{F/hr}} = 177\ \text{hr}\ (7.4\ \text{days})\ \text{to reach}\ 140°\text{F}$$

$$\frac{(195-117)\ °\text{F}}{0.13\ °\text{F/hr}} = 600\ \text{hr}\ (25\ \text{days})\ \text{to reach}\ 195°\text{F}$$

Attachment 1 (Sheet 2 of 2)

Author: "Onishi; Yasuo" <yasuo.onishi@pnl.gov> at ~EXCHANGE
Date: 4/20/98 1:57 PM
TO: Brian B Peters at ~HANFORD21E
Subject: RE: Status of DST mixing/waste transfer modeling work
------------------------------ Message Contents ------------------------------
Brian:

We completed AP-102 and AP-104 pump jet mixing modeling. We assumed that there will be no yield strength of the disturbed mixture of AN-105 solids and diluents. We selected for test cases; 25% and 180% dilution by water with and without solid dissolution effects as starting conditions. For the 25% dilution case, the mixing was predicted to be very quick , within tens of minutes. For 180% case, **it will take a little over one hour to fully mix the waste.** We made these simulation results into video tapes and John Van Beek has a copy. If you are interested in, I will show you the video tape. We may repeat these cases when we get a yield strength value of this disturbed mixture of AN-105 solid and diluent in the later part of FY98.

We are now setting up our chemical model as a part of the AN-105 pump jet mixing. After confirming our chemical model results, we will conduct pump jet mixing modeling of AN-105 tank with chemical reactions occurring during the mixing. I am assuming that (i) gas is already removed from AN-105 salt cake, and (ii) the supernatant liquid of AN-105 is decanted and the tank was filled back with water, as a starting condition for the AN-105 pump jet mixing.

I was not asked to conduct degas modeling with pump jet mixing, so I assume the degas process will be assessed in some other ways. One way to degas would be to use short bursts of jets to mobilize only a portion of the salt cake at a time to avoid a large gas release. It will take a long time for the solids resuspended during the degas process to settle down so the supernate can be decanted, I suspect.

Yasuo

Attachment 2 (Sheet 1 of 15)

Requirement Basis
241-AW Primary Ventilation Stack Effluent Monitoring Upgrade

Issue Description:

The 241-AW primary ventilation stack (296-A-27) is currently designated as a minor stack under the site air permit thus it has not been required to meet NESHAP requirements (40 CFR 61, subpart H) for continuous emissions monitoring. The environmental permit groups from both LMH and WMH agree that under a review such as part of a Notice Of Construction (NOC), this stack is likely to be redesignated as a major stack. The current stack would not be compliant with NESHAP monitoring requirements.

The criterion for designation of an effluent discharge stack as minor or major is whether the potential for unabated discharges could result in an off-site exposure of 0.1 mrem/yr. Previous modeling for 241-AW's current designation as a minor stack identified an exposure potential of 0.04 mrem/yr. Recent and ongoing changes to the air standards would probably revise the current 241-AW primary stack calculations to exceed 0.06 mrem/yr under current conditions. The consensus among the environmental permitting groups is that the Department of Health is very likely to consider the 241-AW primary stack as a major stack even under the current conditions (safe storage & evaporator support). Increased activities, such as mixer pump operation and WFD transfers, would provide additional rationale for a major stack designation.

As a major stack, the monitoring requirements will be increased. There are a number of existing projects which could include the scope to upgrade this stack but none appear to have identified it explicitly. Project W-314 will be replacing the entire 241-AW ventilation system during phase 2 of that project. The W-314 CDR shows the schedule for completion of all phase 2 AW farm upgrades as 12/2003. Tank AW-101 is scheduled for retrieval in 3/2003. Project W-211 will provide for modifications to AW-101, including installation of the mixer pumps, by 7/2002. The NOC for this aspect of Project W-211 will likely identify the potential ventilation emissions as exceeding 0.1 mrem/yr.

There is another project (W-420) which is installing fully NESHAP-compliant stacks on the ventilation systems for four DCRTs (244-A, 244-BX, 244-S, 244-TX), 244-CR Vault, 241-SX exhauster, and the exhauster for tanks C-104/C-105/C-106. Initial indications are that the design from this project could be readily applied to 241-AW. Based on cost estimates prepared for W-420, installation of a NESHAP-compliant stack at 241-AW would cost $100,000 to $250,000.

Project Ownership Issue:

There is a potential ownership issue (WFD/Operations) because current operations (safe storage, evaporator support) in 241-AW may result in the redesignation of the stack without considering impacts from WFD activities. However, upgrades to 241-AW in support of WFD will probably be the actions that trigger a formal redesignation of the stack, and even if ongoing operations did not exceed 0.1 mrem/yr, the additional WFD activities would probably cause this limit to be exceeded, albeit for a temporary period.

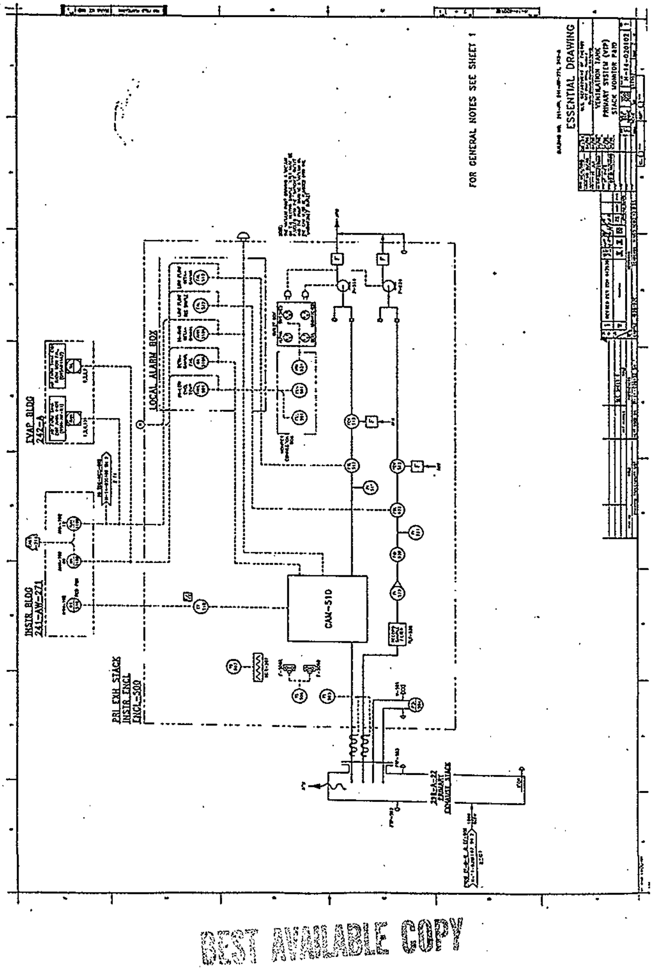
Attachment 2 (Sheet 2 of 15)

Timecycle/Schedule Issues:

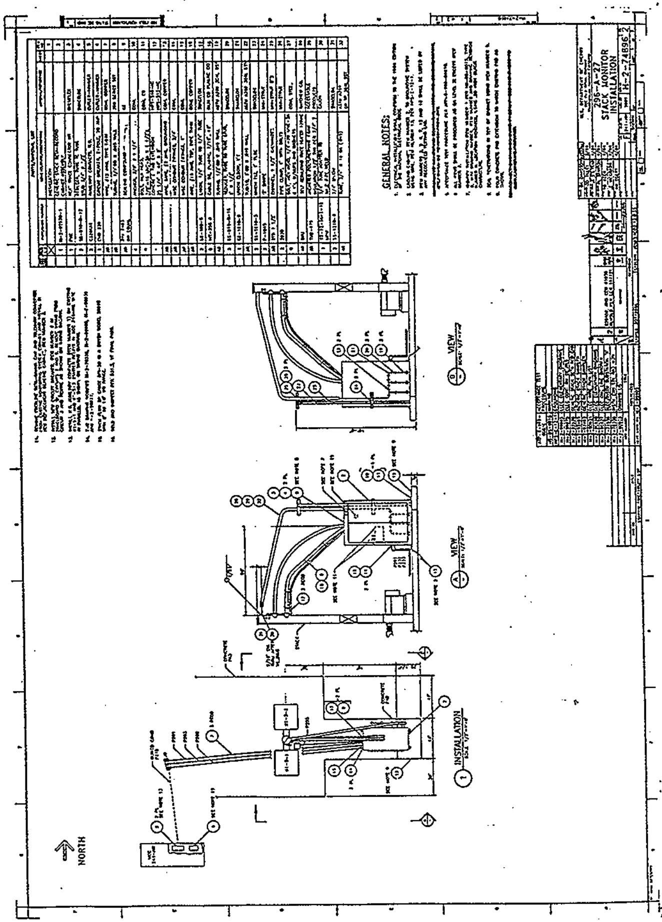
The time required to prepare an NOC and get it approved can take 6-9 months. Installing, testing and operation of new monitoring equipment could add 3-6 months to the upgrade and compliance process. The earliest need date depends on when the need for review and stack designation is triggered (e.g., by preparation of an NOC for changes to current system design or effluent sources). Project W-314 will be making upgrades to the AW valve pits early next FY. It is not clear whether the NOC for this work would trigger the ventilation system review. The next activity to trigger an NOC review is likely to be project W-211. The W-211 design for tank AW-101 is scheduled to start in 1999 with construction complete by 6/2002.

ATTACHMENTS
H-14-020102 *Ventilation Tank Primary System (VTP) Stack Monitor P&ID*
H-2-74896 *296-A-27 Stack Monitor Installation*
HNF-SD-W420-CDR-001, pages 4-14, *Conceptual Design Report for Project W-420, Stack Monitoring Upgrade,* Project Description

Attachment 2 (Sheet 3 of 15)



Attachment 2 (Sheet 4 of 15)



Attachment 2 (Sheet 5 of 15)

Table 1. Project W-420 Upgrade Overview

Facility	Remove Existing Monitor	Remove Existing Stack	Remove Existing Concrete Pad	Stack Modifications	Install Concrete Pads	Install Work Platform	Install New Monitor
244-A	Y	Y	Y	R	Y	Y	Y
244-BX	Y	Y	N	R	Y	Y	Y
244-CR	Y	N	Y	M	Y	Y	Y
244-S	Y	Y	N	R	Y	Y	Y
244-TX	Y	Y	N	R	Y	Y	Y
241-C	Y	Y	N	R	Y	Y	Y
241-SX	Y	Y	Y	R	Y	Y	Y

Y = yes
N = no

Notes: 1) M = modify existing,
2) R = replace

3.1 Gaseous Effluent Monitoring System

A GEMS will be installed at each exhaust stack to monitor and trend the concentration of radioactive materials released to the environment. The system will extract a representative sample; measure and totalize stack velocity and flow rate; measure, control, and totalize sample flow rates; and monitor the sample flow to determine air emissions. Each system shall contain the following equipment as required for the individual stack:

- Instrument Cabinets,
- Stack Flow Instrumentation,
- Sample Collection System,
- Particulate Record Sampler,
- Particulate Beta-Gamma Continuous Monitor,
- Particulate Alpha Continuous Monitor,
- Sample Flow Instrumentation,
- Data Collection System, and
- Vacuum System.

Design of the air monitoring and sampling systems for Project W-420 is based on specifications provided by WHC-S-0400, *Procurement Specification for the Gaseous Effluent Monitoring System* (White 1995). This specification establishes the requirements for design and fabrication of a generic GEMS and will be modified to meet stack-specific requirements for this project. The following provides a general overview of the equipment and details of the various components. In general, the GEMS consists of in-stack sample probes, three instrument cabinets that house associated electronics and sampling systems, and in-stack instrumentation (humidity, temperature, and flow).

3.1.1 Instrument Cabinets

The air sampling and monitoring system is provided in three separate cabinets: a sampler cabinet, an electronics cabinet, and a pump cabinet. The cabinets are weatherproof and maintain a controlled environment as required for equipment and instrumentation.

The electronics and pump cabinets contain the support equipment for the sampling system and are provided by the vendor on a 34 inch (86 cm) by 70 inch (178 cm) skid with a weather shield. The sampler cabinet contains the equipment to analyze the air sample taken from the stack and is mounted on a platform adjacent to the exhaust stack at the sample probe location. This location is based on locating the sampler cabinet as close to the sample source as practical to minimize the loss of sample particles in the sample transport line between the probe assembly and the record sampler. The electronics and pump cabinet skids are located as close as practical to the sampler cabinet.

The following data displays are provided on the local cabinets:

- Stack flow rate,
- Stack gas temperature,
- Individual sampler/monitor flow rate, and
- Other indications and readouts as determined appropriate by the vendor, with customer approval. An alarm for high radiation consisting of a ringing bell and rotating red beacon is located on top of the electronics cabinet.

3.1.2 Stack Flow Instrumentation

Airflow sensing probes are provided to monitor stack flow rate. The probes are mounted on removable flange assemblies to allow removal for inspection and maintenance. The sensing probes are positioned perpendicular to the direction of flow and are either self-averaging pitot or thermal anemometer type probes. If a pitot-type probe is used to measure flow rate, a temperature probe is also installed in the stack to provide temperature information necessary to interpret the flow rate. Design of the airflow sensing probes and temperature probes (if required) will be performed by the GEMS vendor, based on the stack-specific requirements in the procurement specification.

The airflow sensing probes are positioned in each stack in accordance with the appropriate 40 CFR 60, Appendix A method. Airflow sensing and sample probes are located in the same plane for Stacks 296-C-5, 296-S-15, and 296-P-16 as these stacks are greater than 12 inches in diameter. Stack velocity is measured downstream from the sample probes for Stacks 296-A-25, 296-T-18, 296-B-28, and 296-S-22 because these stacks are less than 12 inches in diameter and locating both probes in the same sample plane would block a significant portion of the cross section and could cause inaccurate measurements.

Calibration ports are necessary to allow periodic flow rate verification. The calibration ports are positioned in accordance with the appropriate 40 CFR 60, Appendix A method, to prevent encountering obstructions from other probes. Calibration ports will be provided on new Stacks 296-A-25, 296-S-15, 296-P-16, 296-B-28, 296-S-22, and 296-T-18. For stack 296-C-05, modifications to the existing stack will be made to add the necessary calibration ports.

3.1.3 Sample Collection System

The transport piping and sample collection probes for sampling particulate radionuclides are designed and fabricated by the GEMS vendor in accordance with the requirements of document WHC-SD-EN-TI-288, *Functional Requirements Document for Measuring Emissions of Airborne Radioactive Materials* (Criddle 1994) and the appropriate procurement specification. The probes are mounted on removable flange assemblies to allow for inspection and maintenance.

Sample collection probes are positioned in each stack in accordance with American National Standards Institute (ANSI) N13.1 and 40 CFR 60, Methods 1 and 1A. The sample extraction location will be qualified according to the performance criteria specified in WHC-SD-SD-WM-TI-288 (Criddle 1994). Qualification of the sample location for the new stacks can be done by mocking up the stack in the shop and performing the test prior to delivery. For the stacks being modified, the test will need to be performed after stack modifications have been performed.

The sampler cabinets are mounted directly on the work platforms adjacent to the exhaust stacks. This design is utilized to minimize the loss of particulates in the sample lines by assuring sample lines are as short as practical, the number of bends are minimized, and horizontal runs of sample lines are avoided. The size of the transport line for each stack will be determined by the vendor. The sampler cabinet is heated to maintain the electronics at the proper operating temperature and to prevent condensation from forming in the sample lines. In the sampler cabinet, the sample flow stream is split and one stream flows to the record sampler and the other flows to the continuous in-line beta-gamma sample head. The flow rate of each sample stream is controlled separately.

The sample transport lines are recombined in the Sampler cabinet and routed to the pump cabinet where the vacuum pumping sources are located. Sample return piping is provided from the pump cabinet to return the extracted sample to the stack. The size of the return line for each stack will be determined during final design (normally ½ inch).

Sample probe, sample transport piping, and sample return piping will be fabricated from type 316 stainless steel. All tubing is seamless construction with material composition per American Society for Testing and Materials (ASTM) A269.

3.1.4 Particulate Record Sampler

The particulate record sampler is located in the sampler cabinet. The particulate record sampler collects a sample of particles onto a standard 47 millimeter (mm) membrane filter paper for future radionuclide analysis at a laboratory. A record sampler is required to meet the requirements of 40 CFR 61 Subpart H which requires that "all radionuclides which could contribute greater than 10 percent of the potential effective dose equivalent for a release point shall be measured."

Performance of the particulate record sampler shall be verified and documented by (in order of preference): 1) a field acceptance test, 2) laboratory wind tunnel testing, or 3) the verified model (Criddle 1994). Performance requirements for the record sampler and sample probe are as specified in WHC-S-0400 (White 1995) and WHC-SD-W420-FDC-001 (Lott 1996).

3.1.5 Particulate Beta-Gamma Continuous Monitor

The particulate beta-gamma continuous monitor in-line sample head is located in the sampler cabinet. The counting electronics are located in the electronics cabinet. A local alarm on top of the electronics cabinet is provided for stack high radiation. The alarm includes a ringing bell and rotating red beacon. Auxiliary contacts are provided for two remote indicators, if desired; one for high radiation and one for continuous air monitor (CAM) failure.

The criteria for the need of a continuous on-line beta-gamma monitor is the graded approach to the application of sampling and monitoring outlined in WHC-SD-WM-TI-288 (Criddle 1994). This graded approach is reproduced below in Table 2 where it can be seen that real-time monitoring is required for Potential Effective Dose Equivalents (PEDE) greater than 1.0 mrem/yr.

Attachment 2 (Sheet 9 of 15)

Table 2. Graded Monitoring Approach

Potential Effective Dose Equivalent Category	Required Monitoring and Sampling Analysis Procedures	Potential Effective Dose Equivalent Range (mrem/yr)
1	Continuous extractive sampling for a record of emissions and in-line, real-time monitoring with alarm capability; consideration of separate accident monitoring system.	>1.0
2	Continuous extractive sampling for record of emissions, with retrospective, off-line periodic analysis.	>0.1 and ≤1
3	Periodic confirmatory extractive sampling and off-line analysis.	>0.001 and ≤0.1
4	Annual administrative review of facility used to confirm absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits.	≤0.0001

Six of the seven stacks within the scope of Project W-420 have PEDEs greater than 1.0 mrem/yr of which the majority are beta-gamma emitters. For this reason, a continuous beta-gamma monitor is required for the following stacks: 296-A-25, 296-B-28, 296-C-05, 296-P-16, 296-S-15, and 296-S-22. However, to provide flexibility for process changes such as the use of the DCRTs for retrieval, a continuous beta-gamma monitor is also recommended for Stack 296-T-18. Tables 3 through 9 contain information from WHC-SD-WM-EMP-031 (Crummel 1996) on the total PEDEs for the seven stacks and the individual radionuclides which provide greater than one percent of the total PEDE.

Attachment 2 (Sheet 10 of 15)

Table 3. PEDE for Stack 296-A-25

Stack 296-A-25			
Radionuclide	Emitter Type	% PEDE	PEDE (mrem/yr)
Cs-137	alpha	71.1%	3.97
Pu-239/240	alpha	23.5%	1.31
Am-241	alpha	2.8%	0.16
Pu-238	alpha	1.1%	0.06
Others (<1%)	N/A	1.5%	0.08
Total	N/A	100%	5.58

Table 4. PEDE for Stack 296-B-28

Stack 296-B-28			
Radionuclide	Emitter Types	% PEDE	PEDE (mrem/yr)
Cs-137	beta-gamma	37.6%	0.975
Am-241	alpha	37.4%	0.969
Pu-239/240	alpha	10.6%	0.275
Sr-89/90	beta-gamma	9.0%	0.233
I-129	beta-gamma	4.3%	0.111
Others (<1%)	N/A	1.1%	0.027
Total	N/A	100%	2.590

Attachment 2 (Sheet 11 of 15)

Table 5. PEDE for Stack 296-C-05

Stack 296-C-05			
Radionuclide	Emitter Type	%PEDE	PEDE (mrem/yr)
Sr-89/90	beta-gamma	82.3%	154.00
Am-241	alpha	10.6%	19.80
Pu-239/240	alpha	4.8%	8.93
Cs-137	beta-gamma	1.6%	2.92
Others (<1%)	N/A	0.7%	1.35
Total	N/A	100%	187.0

Table 6. PEDE for Stack 296-P-16

Stack 296-P-16			
Radionuclide	Emitter Type	%PEDE	PEDE (mrem/yr)
Pu-239/240	alpha	42.4%	0.71
Cs-137	beta-gamma	39.2%	0.66
Sr-89/90	beta-gamma	8.3%	0.14
Am-241	alpha	5.9%	0.10
I-129	beta-gamma	3.5%	0.06
Others (<1%)	N/A	0.7%	0.01
Total	N/A	100%	1.68

Table 7. PEDE for Stack 296-S-15

Stack 296-S-15			
Radionuclide	Emitter Type	%PEDE	PEDE (mrem/yr)
Am-241	alpha	99.4%	1.560
Sr-89/90	beta-gamma	0.4%	0.007
Others (<1%)	N/A	<0.2%	<0.004
Total	N/A	100%	1.570

Table 8. PEDE for Stack 296-S-22

Stack 296-S-22			
Radionuclide	Emitter Type	% PEDE	PEDE (mrem/yr)
Sr-89/90	beta-gamma	46.1%	31.98
Cs-137	beta-gamma	35.4%	24.57
Am-241	alpha	17.1%	11.84
Others (<1%)	N/A	1.4%	1.01
Total	N/A	100%	69.4

Table 9. PEDE for Stack 296-T-18

Stack 296-T-18			
Radionuclide	Emitter Type	% PEDE	PEDE (mrem/yr)
Pu-239/240	alpha	55.3%	0.21
Cs-137	beta-gamma	23.7%	0.09
Am-241	alpha	21.0%	0.08
Others (<1%)	N/A	<0.01%	<0.009
Total	N/A	100%	0.38

3.1.6 Particulate Alpha Continuous Monitor

It is recommended (but not required) that continuous alpha monitors be used on those stacks where >50 percent of the PEDE comes from alpha emitting radionuclides. A continuous alpha monitor would prevent a large, predominantly alpha emitter, release from going undetected until the periodic record sample is analyzed. Reviewing Tables 3 through 9, stacks 296-S-15 and 296-T-18 would be recommended for continuous alpha monitors. Stacks 296-S-22 and 296-T-18 are presently monitored continuously for particulate alpha activity while the others are not. There are provisions for installation of alpha monitors in the GEMS.

3.1.7 Sample Flow Instrumentation

Instrumentation is provided to record and control the record sampler and continuous monitor flow rates, including provisions for totalizing the flow between filter changes. An adjustable alarm set point for sample low flow rate is provided. Auxiliary contacts are provided for remote indication, if desired, when sample flow rate deviates beyond required tolerances.

3.1.8 Data Collection System

The Data Collection System shall have a standardized communications interface with the existing host computer for the transfer, on command, of recorded values.

The Data Collection System shall record and store stack flow rate, stack temperature, stack relative humidity, record sampler flow rate, total stack flow, and total record sampler flow since the last filter change-out. The beta-gamma monitor shall have its flow rate and readings stored periodically. The data storage shall have a method of data transfer for archival purposes. The transfer media shall be PC compatible.

The Data Collection System shall have a method of transferring data during filter change-out. The record sampler flow readings and total flow, the stack flow readings and total flow, and the date and time of the starting and ending data points shall be the minimum information transferred. The transfer media shall be PC compatible.

3.1.9 Vacuum System

A vacuum system is located in the pump cabinet. The system provides a steady, non-pulsing, vacuum source over a range of operating conditions from the maximum and minimum design values of the samplers based on the required collection efficiency. Two vacuum pumps are provided for redundancy.

Each particulate sampling line has its own flow regulation. The vacuum supply to each sample line is adjustable and automatically regulated so that individual sample flow rates are maintained. Components can be isolated individually by isolation valves provided.

The individual vacuum exhaust lines are combined in to a single return manifold. The combined return manifold is connected by field piping to the stack downstream of sampling and velocity probes.

3.2 Stacks

An analysis was performed to determine the ability of the existing stacks to accept the required probes. The decision to use an existing stack configuration or to replace or modify a stack is based on the ability to provide satisfactory locations for sample and flow sensing probes. The

Attachment 2 (Sheet 14 of 15)

locations for the sample extraction and flow sensing probes have been chosen in accordance with ANSI N13.1, the appropriate 40 CFR 60 Appendix A method, and WHC-SD-EN-TI-288 (Criddle 1994). An existing stack is used when the probe mounting location(s) satisfy the applicable criteria. New stack extensions, modifications to existing stacks, or replacement stacks are specified when the existing probe locations do not satisfy the applicable requirements. Appropriate modifications are described for each stack.

The locations for flow sensing probes were chosen to satisfy the requirements of the appropriate 40 CFR 60 method, Method 1 for stacks greater than 12 inches in diameter, and Method 1A for stacks less than 12 inches in diameter. Following installation in the field, an initial stack flow sensor verification test will be performed in accordance with 40 CFR 52 Appendix E. When practical, flow sensing probes are located in the same plane as the sample probes.

The locations for sample probes were chosen in accordance with the guidance of ANSI N13.1 and the requirements of the appropriate 40 CFR 60 Appendix A method. In general, these locations must not exhibit angular or cyclonic flow and must provide acceptable uniformity of contaminant mixing. Specific performance criteria for sample extraction locations is provided by WHC-SD-EN-TI-288 (Criddle 1994).

Testing (shop or field) will be performed to qualify the sample extraction locations according to the performance criteria of WHC-SD-EN-TI-288 (Criddle 1994). The velocity profile at the sample location will be measured in accordance with 40 CFR 60 Appendix A, Method 1, Section 2.4, "Verification of the Absence of Cyclonic Flow." Satisfactory contaminant mixing will be demonstrated in accordance with the methods described in WHC-SD-EN-TI-288 (Criddle 1994), Section 3.3, "Methods for Qualifying the Sample Extraction Location."

An assumption has been made that locating sample probes in accordance with the ANSI N13.1 and 40 CFR 60 Appendix A will result in sample locations that satisfy performance criteria of WHC-SD-EN-TI-288 (Criddle 1994). The validity of this assumption will be demonstrated by shop or field testing. When the existing sample locations are in accordance with ANSI N13.1 and 40 CFR 60 Appendix A, the sample location will be qualified by field testing after performance of any additional stack modifications.

Several of the existing stack designs utilize flow straightening vanes because the stacks have tangential inlets which tend to induce swirling. An assumption has been made that flow straightening vanes will not be required with the new stack extensions. However, removable spool pieces are provided to allow installation of flow vanes if testing indicates unacceptable flow conditions at the sample extraction location.

As mentioned previously, the decision to replace or modify a stack is based on the ability of the

Attachment 2 (Sheet 15 of 15)

stack to provide satisfactory probe locations. An assumption has been made that the existing stack heights provide adequate dilution and dispersion. It was not within the scope of Conceptual Design for Project W-420 to verify that existing stacks satisfy requirements for dilution and dispersion of contaminants. Therefore, the original stack height is used as the minimum height for new stack extensions. This should be confirmed early in Definitive Design or in a separate study.

Preliminary calculations indicate that several of the existing stacks have low stack discharge velocity that may result in extensive downwash along the stack. It is recommended that a separate study be performed prior to detailed design of new stack extensions to ensure the stack effluent escapes the air flow patterns surrounding adjacent buildings and provides adequate dilution and dispersion of contaminants to prevent an unacceptable situation when the effluent reaches the ground.

3.3 Utilities

Electrical power for the stack monitors will be provided from the same panel boards that supply the existing stack monitors. Existing conduit will be utilized to the maximum extent practical. All electrical materials and equipment shall be UL or FM tested, with labels attached, for the purpose intended, whenever such products are available. Installation methods shall be in accordance with manufacturer's instructions, NFPA 70, and with other applicable requirements. A 30 A, 120 VAC, single phase power supply is required for the stack monitors. The single feed connects with a power distribution panel in the pump cabinet supplied by the stack monitor vendor. Distribution from the pump cabinet to the sample cabinet and the electronics cabinet will be performed through short runs of galvanized rigid steel (or flexible seal tight) conduit.

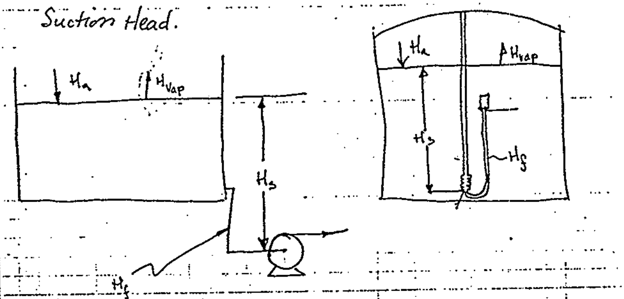
3.4 Work Platforms

Work platforms are provided for routine access to the sample cabinets which are located next to the sample probe location. The work platforms shall have guardrails and toe boards that conform to 29 CFR 1910.23(c), and ladders that conform to 29 CFR 1910.27. Conceptual Design allows for a 60 degree pitch for the ladders. A safety chain will be provided at the access to the platform.

Attachment 3 (Sheet 1 of 6)

Calculation Prepared by
Checked by 4/27/98

Evaluation of Required vs. Available Net Positive
Suction Head.



NPSHR : is net positive suction head required to prevent
pump from Cavitating

NPSHA : is NET POSITIVE suction Head Available

$NPSHA_{min} = NPSHR$

$NPSHA = H_s + H_a - H_{vap} - H_f$

Where : H_s : static Head
H_a : Atmospheric Pressure Head
H_{vap} : Vapor Pressure of Liquid
H_f : friction Loss in intake piping

We desire to draw the tanks down to a residual ~~head~~
of 10". We need to Calculate the static head minimum
requirement, where $NPSHA_{min} = NPSHR$
from above

$$NPSHR = H_{s(min)} + H_a - H_{vap} - H_f \qquad (1)$$

Attachment 3 (Sheet 2 of 6)

REARRANGING; $H_{s(min)} = NPSHR + H_{vap} + H_f - H_a$

from the attached pump curve NPSHR = 18 ft @ 140 gpm.

H_{vap}: Vapor Presure of simulated waste was measured in 1976 by G.S. Barney (ARH-ST-133) at temperatures of 20, 40, 60, and 80°C.

Using this data (simulant 5A), the vapor pressure at 90°C was extrapolated as 300 mm Hg.

converting to ft. H_2O

$$300 \text{ mm Hg} \times \frac{33.9 \text{ ft } H_2O}{760 \text{ mm Hg}} = 13.4 \text{ ft } H_2O$$

H_a: We need to adjust Atmospheric Pressure for both ELEVATION AND SLIGHT NEGATIVE PRESSURE in tank head space.

first adjusting for Elevation:

$$\frac{\rho_{air}}{\rho_{H_2O}} = \frac{\text{Height of Water Column}}{\text{Height of Air Column}}$$

at sea level standard pressure is 33.9 ft H_2O

$\rho_{air} = 0.0752 \text{ lb}_m/\text{ft}^3$

$\rho_{H_2O} = 62.4 \text{ lb}_m/\text{ft}^3$

$$\text{Height of Air Column} = \frac{(33.9 \text{ ft } H_2O)(62.4 \text{ lb}_m/(\text{ft}^3 \cdot H_2O))}{0.0752 \text{ lb}_m/\text{ft}^3 \text{ air}}$$

$$= 28{,}130 \text{ ft air}$$

(2)

Attachment 3 (Sheet 3 of 6)

Adjusting for Elevation (Max Elevation = 690 ft)

$28{,}130\,ft - 690\,ft = 27{,}440\,ft$

Converting to ft H_2O

$27{,}440\text{ ft air} \times \frac{33.9\text{ ft } H_2O}{28{,}130\text{ ft Air}} = 33.1\text{ ft } H_2O$

Adjusting for Negative tank pressure.
Assume tank pressure is −4 in WG

$H_A = 33.1\,ft - 4\,in$
$= 32.7\text{ ft } H_2O$

H_f: Per Senior Flexonics (Manufacturer of flex line) frictional loss in flex is ≃ 7 times that in similar sized pipe.

From "Flow of Fluid Through Valves, Fittings, and Pipe," The pressure drop is 1.99 psi/100 ft for three inch pipe at a flow rate of 140 gpm.

Since the flexible suction hose is 20 ft × 3 in stainless steel flex hose the Head loss is estimated as $\frac{1.99\,psi}{100\,ft} \times 20\,ft \times 7 \times \frac{33.9\text{ ft } H_2O}{14.7\,psi}$

$= 6.4\text{ ft } H_2O$

Hence

$H_{S(min)} = 18\text{ ft } H_2O + 13.4\text{ ft } H_2O + 6.4\text{ ft } H_2O - 32.7\text{ ft } H_2O$
$= 5.1\text{ ft}$

(3)

Attachment 3 (Sheet 4 of 6)

Adjusting for a SpG of 1.41 yields a minimum submergence of the impellers of

3.6 ft

Since the vapor pressure is a strong function of Temperature, to allow the tanks to be drawn down to 10" requires a maximum temperature limit

$H_{vap(max)} = H_s + H_a - H_f - NPSHR$

The impeller is located 27" from the bottom of the tank when H_s = -17 in there is a 10" heal left in the tank.

$-17 in = -1.42 ft\ H_2O$

$H_{vap(max)} = -1.42 ft\ H_2O + 32.7 ft\ H_2O - 6.4 ft\ H_2O - 18 ft\ H_2O$

$= 6.88 ft\ H_2O$

converting

$6.88 ft\ H_2O \times \frac{760\ mm\ Hg}{33.9 ft\ H_2O} = 154\ mmHg$

which corresponds to a temperature of ~ 70 °C

(4)

Attachment 3 (Sheet 5 of 6)

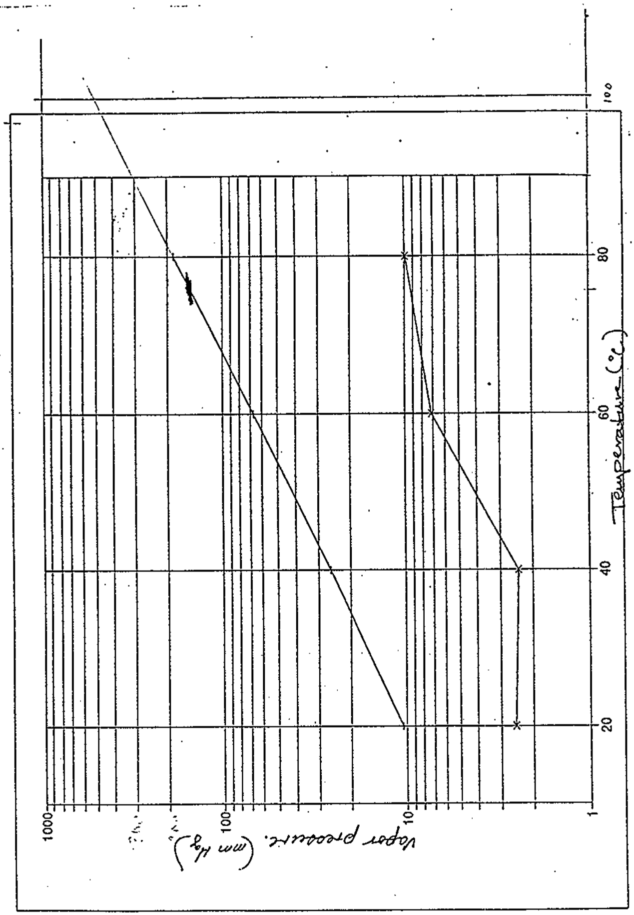
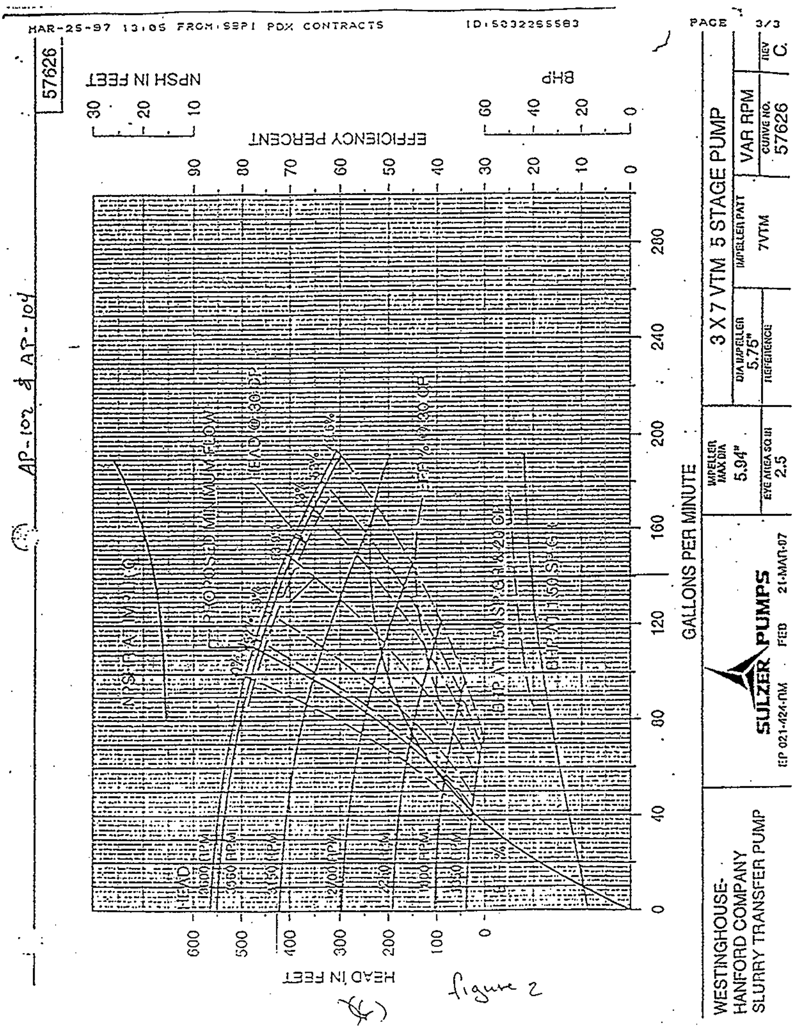


figure 1

(5)

Attachment 3 (Sheet 6 of 6)



CALCULATION SHEET Attachment 4 (Sheet 1 of 1)

Page 1 of 1
Revision No. 0
Task No. M98-350
Date: May 12, 1998
By: BB Peters
Checked By: WL Willis (wlw)

SUBJECT: Calculation of Maximum Head for AW-104 Pump

Assumptions: 1) maximum waste density is 1.4 g/ml
2) Line operating pressure is 230 psi
3) Set maximum head equal to line operating pressure

$$\frac{230\ lb}{in^2}\left|\frac{ml}{1.4\ g}\right|\frac{453.6\ g}{lb}\left|\frac{ft^3}{28316\ ml}\right|\frac{144\ in^2}{ft^2} = 379\ ft\ head$$

5/12/98

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CALCULATION SHEET

PAGE 1 of 3

May 19, 1998

By: W.L. Willis (wlw)
Checked By: B.B. Peters B.Peters

Subject: Comparison of Tank 241-AW-101 contents to the corrosion Specification for underground Storage tanks.

I. Corrosion Specification

for temperatures $T \le 212°F (100°C)$

A. if $[NO_3^-]$ concentration $\le 1.0\underline{M}$

$[OH^-]$ concentration $0.010\underline{M} \le [OH^-] \le 5.0\underline{M}$

$[NO_2^-]$ concentration $0.011\underline{M} \le [NO_2^-] \le 5.5\underline{M}$

$[NO_3^-]/([OH^-] + [NO_2^-]) < 2.5$

B. if $[NO_3^-]$ concentration $1.0\underline{M} < [NO_3^-] \le 3\underline{M}$

$[OH^-]$ concentration $0.1([NO_3^-]) \le [OH^-] < 10\underline{M}$

$[OH^-] + [NO_2^-]$ $\ge 0.4([NO_3^-])$

C. if $[NO_3^-]$ concentration $> 3.0\underline{M}$

$[OH^-]$ concentration $0.3\underline{M} \le [OH^-] < 10\underline{M}$

$[OH^-] + [NO_2^-]$ $\ge 1.2\underline{M}$

$[NO_3^-]$ $\le 5.5\underline{M}$

Comparison of Tank 241-AW-1Ø1 contents to the Corrosion Specification for underground storage tanks. (continued)

II. The water survey for Tank 241-AW-1Ø1 in Appendix D lists Kilogram quantities of ionic species for the waste. Undiluted waste and waste diluted with 25, 5Ø, and 75% are included in the water survey.

A. Undiluted Waste — Volume = 68.057 L/hr.

$OH^- = 3.7738$ kg/hr, $NO_2^- = 6.3220$ kg/hr, $NO_3^- = 13.389$ kg/hr

converting to molarity (Mol/L)

$$3.7738\,\frac{kg}{hr} \times \frac{mol}{17g} \times \frac{1000g}{kg} \times \frac{hr}{68.057L} = 3.2\,\frac{mol}{L} \qquad 3.2\,\underline{M}\ OH^-$$

$$6.3220\,\frac{kg}{hr} \times \frac{mol}{46g} \times \frac{1000g}{kg} \times \frac{hr}{68.057L} = 2.1\,\underline{M}\ NO_2^-$$

$$13.389\,\frac{kg}{hr} \times \frac{mol}{62g} \times \frac{1000g}{kg} \times \frac{hr}{68057L} = 3.2\,\underline{M}\ NO_3^-$$

Condition C is met with undiluted waste

B. 25% dilution — Volume = 84.623 L/hr

$OH^- = 3.7797$ kg/hr, $NO_2^- = 6.3220$ kg/hr, $NO_3^- = 13.367$ kg/hr

converting to molarity

$$3.7797\,\frac{kg}{hr} \times \frac{mol}{17g} \times \frac{1000g}{kg} \times \frac{hr}{84.623L} = 2.6\,\underline{M}\ OH^-$$

$$6.3220\,\frac{kg}{hr} \times \frac{mol}{46g} \times \frac{1000g}{kg} \times \frac{hr}{84.623L} = 1.6\,\underline{M}\ NO_2^-$$

$$13.367\,\frac{kg}{hr} \times \frac{mol}{62g} \times \frac{1000g}{kg} \times \frac{hr}{84.623L} = 2.5\,\underline{M}\ NO_3^-$$

Condition B is met with waste diluted by 25%

Comparison of Tank 241-AW-101 contents to the corrosion specification for underground storage tanks. (continued)

C. 50% dilution — Volume = 101.63 L/hr.

OH^- = 3.7978 Kg/hr, NO_2^- = 6.3220 kg/hr, NO_3^- = 13.360 kg/hr

converting to molarity

$3.7978 \frac{kg}{hr} \times \frac{mol}{17g} \times \frac{1000 g}{kg} \times \frac{hr}{101.63 L} = 2.2 \underline{M}\ OH^-$

$6.3220 \frac{kg}{hr} \times \frac{mol}{46g} \times \frac{1000 g}{kg} \times \frac{hr}{101.63 L} = 1.4 \underline{M}\ NO_2^-$

$13.360 \frac{kg}{hr} \times \frac{mol}{62g} \times \frac{1000 g}{kg} \times \frac{hr}{101.63 L} = 2.1 \underline{M}\ NO_3^-$

Condition B is met with waste diluted by 50%

D. 75% dilution — Volume = 118.92 L/hr.

converting to molarity OH^- = 3.8039 $\frac{kg}{hr}$, NO_2^- = 6.3220 $\frac{kg}{hr}$, NO_3^- = 13.359 $\frac{kg}{hr}$

$3.8039 \frac{kg}{hr.} \times \frac{mol}{17g} \times \frac{1000 g}{kg} \times \frac{hr}{118.92 L} = 1.9 \underline{M}\ OH^-$

$6.322 \frac{kg}{hr} \times \frac{mol}{46g} \times \frac{1000 g}{kg} \times \frac{hr}{118.92 L} = 1.2 \underline{M}\ NO_2^-$

$13.359 \frac{kg}{hr} \times \frac{mol}{62g} \times \frac{1000 g}{kg} \times \frac{hr}{118.92 L} = 1.8 \underline{M}\ NO_3^-$

Condition B is met with waste diluted by 75%

Attachment 5 (Sheet 4 of 4)

7.2 UNDERGROUND STORAGE TANKS SPECIFICATION

7.2.1 TANK COMPOSITION

7.2.1.A Temperatures ($T \leq 212°F$)

Variable	Specification Limit
For $[NO_3^-] \leq 1.0\underline{M}$:	
$[OH^-]$	$0.010\underline{M} \leq [OH^-] \leq 5.0\underline{M}$
$[NO_2^-]$	$0.011\underline{M} \leq [NO_2^-] \leq 5.5\underline{M}$
$[NO_3^-]/([OH^-] + [NO_2^-])$	<2.5
(for solutions below 167°F, the $[OH^-]$ limit is $8.0\underline{M}$)	
For $1.0\underline{M} < [NO_3^-] \leq 3.0\underline{M}$:	
$[OH^-]$	$0.1([NO_3^-]) \leq [OH^-] < 10\underline{M}$
$[OH^-] + [NO_2^-]$	$\geq 0.4([NO_3^-])$
For $[NO_3^-] > 3.0\underline{M}$:	
$[OH^-]$	$0.3\underline{M} \leq [OH^-] < 10\underline{M}$
$[OH^-] + [NO_2^-]$	$\geq 1.2\underline{M}$
$[NO_3^-]$	$\leq 5.5\underline{M}$

7.2.1.B For High Operating Temperatures ($T > 212°F$ for AY and AZ tanks) - section 7.2.1.A temperature limits apply with the exception that OH^- concentration must be $< 4\underline{M}$.

NOTE: LCO 3.3.2 restricts the waste temperature to 195° F for the upper 15 feet of waste and 215° F for waste below 15 feet.

7.2.1.C Section Deleted

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	TWRS Process Development	Date 5/22/98
Project Title/Work Order		EDT No. 622714
Evaluation of Tank Waste Transfers at 241-AW Tank Farm, HNF-2238, Rev. 0		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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DIMC	H6-15	X			
DOE Reading Room	H2-53	X			
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