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PUREX PROCESS ENGINEERING STUDY
Purex Aqueous Discharge

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PUREX PROCESS ENGINEERING STUDY
Purex Aqueous Discharge

K. L. Engelhardt

Purex Process Engineering
Engineering Department
Production and Waste Management Division

May 6, 1977

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PUREX PROCESS ENGINEERING STUDY
PUREX AQUEOUS DISCHARGE

INTRODUCTION

Effective control and monitoring of the Purex aqueous discharges are an extremely important phase of plant operation. Protection of the surrounding environment from radioactive contamination has to be of paramount importance. All possible safety measures need to be utilized and systems in place which provide effective treatment, isolation and monitoring of the discharged streams. Continual evaluation of the discharge systems is necessary to insure effective treatment and control utilizing technically up-to-date methods that will insure minimal contamination release.

Presented herein is an evaluation of Purex aqueous discharge treatment, control and monitoring capabilities and comparison with ERDA Manual Chapter 0511, 0513 and 0524 requirements. Where applicable, recommendations are submitted to accomplish those requirements.

SUMMARY

The ERDA manual requires effective aqueous discharge treatment and control, preclusion of radioactive discharge in excess of established values, and qualitative and quantitative characterization of the stream discharge. Each of the seven Purex aqueous discharge streams has been evaluated for flow measurement/totalizing, sampling, radiation monitoring and diversion capabilities and for effectiveness of discharge treatment and control. Table I shows the capabilities of the present discharge systems.

System improvements have been made to the plant since shutdown in 1972. However, several areas need immediate attention in order to attain the positive treatment, control and monitoring prescribed by the ERDA manual.

RECOMMENDATIONS

Evaluation of the Purex aqueous discharge systems indicates several areas which need immediate attention. The following recommendations, in order of decreasing priority, are submitted:

1. Radiation monitoring instrumentation on all systems needs to be redundant and failsafe.
2. Radiation monitoring capability is needed on the process condensate and chemical sewer streams.

TABLE I

Discharge Stream	Present System Capability/Description				
	Flow Measurement	Sampling	Diversion	Radiation Monitoring	Emergency Sampling
Cooling Water (CWL to 216-A-25)	1) Weir 2) Dip Tube 3) Flow Integrator/ Totalizer	1) EMV Sampler 2) Tank Drain Sample	Retention Basin (Automatic)	Single Probe (non-redundant) (non-failsafe)	None
Chemical Sewer (CSL to 216-A-3)	None	1) Jap Prop. Sampler 2) Jug Pour Sample	Inline Dikes (Manual)	None	None
Steam Condensate (SCD to 216-A-30)	1) Magnetic Flowmeter 2) Integrator/ Totalizer	1) EMV Sampler 2) Jug Pour Sample		Single Probe (non-redundant) (non-failsafe)	None
Process Condensate (PDD to 216-A-10)	Sample Tank Volume	1) Weir Sampler 100-25 2) Tank Bulk Dip Sample	None	None	None
Ammonia Scrubber Waste Condensate (ASW to 216-A-36B)	None	1) Timed Sampler 2) Tank Drain Sample	None	Single Probe (non-redundant) (non-failsafe)	Isolation/ Drainback
203A Discharge (PTD to 216-A-3)	None	1) P-Tank Condensate Line Sample 2) Sump Sample	None	None	None
A11 A12 French A14 Drains A15 A22 A26B	None	None	None	None	None

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3. Improved sampling and sample collection capability is needed on the chemical sewer, 203A area, and steam, process, and ammonia scrubber waste condensate streams.
4. Flow measurement/totalizing capability is needed on the process and ammonia scrubber waste condensate and chemical sewer streams.
5. French drains with contamination potential need to be eliminated.
6. The 203A area discharge needs capability to route all waste to the chemical sewer or back into the 202A Building for rework. Elimination of the 216-A3 crib is necessary due to a partially blocked header in the crib.
7. Improved radiation monitoring capability is needed on the cooling water and ammonia scrubber waste condensate streams.
8. More positive primary and backup treatment and handling system are needed for the process and the ammonia scrubber waste condensate streams. These streams presently have the greatest potential for uncontrolled contamination release to the environs.
9. Diversion and rework capability is needed for the process and ammonia scrubber waste condensate and the chemical sewer streams.
10. Improved flow measurement/totalizing capability is needed on the cooling water stream.
11. Verification sampling capability, when above limit conditions are detected, is needed on all continuously discharge streams.

SYSTEM DESCRIPTION

Aqueous discharge from the Purex Plant is segregated into the following seven categories: cooling water (CWL), chemical sewer (CSL), steam condensate (SCD), process condensate (PDD), ammonia scrubber waste condensate (ASD), 203A Area discharge (PTD) and french drains. A brief description of each system is presented below.

Cooling Water

This system collects cooling water discharge from concentrator condensers, low-risk vessel cooling coils and dissolver off-gas condenser tube bundles. These streams are collected in Header 8823, located on the south side of the Purex Building and drain to the 201 Pump Pit where stream sampling and monitoring are performed. The cooling water flows from the 201 Pump Pit

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through a diversion box with capability for emergency diversion to a covered, lined trench. The stream then flows to a second diversion box where flow can be directed either to the Gable Mountain Pond, 216-A-25, or to the "B" Pond; 216-B3. Normal flow at the present time is to 216-A25.

Chemical Sewer

This system collects AMU waste, non-contaminated floor drains and vessel coil waste, overflow from TK-U8, vacuum fractionator and non-process steam condensate. These streams are collected in Header 8819, located on the north side of the Purex Building and drain to 216-B3 via the 216-A29 ditch. Stream sampling is performed at the header discharge to the 216-A29 ditch.

Steam Condensate

This system collects steam condensate from concentrator tube bundles, cooling water from high-risk vessel coils, and the slug storage basin overflow and jetout. These streams are collected by headers 8824W and 8824R, located on the south side of the Purex Building and drain into a catch tank located approximately center between 8824W and 8824R. Stream sampling and monitoring are performed in conjunction with pumpout of the catch tank via Header 8824D to Crib 216-A30. Auxiliary sampling capability exists at the crib. Header 8824E provides overflow routing to the 216-A30 crib.

Process Condensate

This system collects process condensate from the E-K4 concentrator and overflow from the J8 and H4 sample pots. These streams are collected in Header 7717 located on the south side of the Purex Building and drain to the 216-A10 crib. Stream sampling is performed at the A5 sample pit.

Ammonia Scrubber Waste Condensate

This system collects condensate discharge from the E-F11 concentrator and drains to the 216-A36B crib via line T034. Stream sampling and monitoring are performed at the A36B sample station.

203A Area Discharge

This system collects sump waste, P Tank heating coil condensate, overflow from TK-15 (UO₃ recovered acid storage), cooling water and steam condensate from TK-P6. These streams are collected in separate headers and, except for TK-P6 discharge which is routed to the chemical sewer, are routed to the 216-A3 crib located north of the 203A area. Stream sampling is performed on the P-Tank condensate and on each sump prior to transfer.

French Drains

This system consists of six separate units which collect drainage from Trap Pit #1, Trap Pit #3, cleaner and blower pit, A5 sample pit, UNH truck apron and the fan control house. No sampling or monitoring are performed.

EVALUATION BASES

The primary concern of the study reported herein was to determine whether equipment and methods are available and in-place to evaluate the effectiveness of the Purex aqueous discharge treatment systems and control mechanisms, to preclude radioactive discharge in excess of established values, and to provide qualitative and quantitative data for stream characterization.

The following ERDAMC requirements are addressed in this evaluation:

- . Quantitative evaluation of stream discharge - volume and content measurement capability (ERDAMC 0513);
- . Preclusion of contaminated discharge - stream monitoring, diversion, collection and rework capability (ERDAMC 0511);
- . Qualitative evaluation of stream discharge - sufficient capability to evaluate the efficiency and control of treatment systems and environmental protection (ERDAMC 0513); and
- . The disposition of aqueous waste in such a manner as to insure discharges are as low as economically and technically practical, not exceeding limits established in ERDAMC 0524 appendix, Parts I and II. (ERDAMC 0511)

In order to accomplish the desired objectives outlined above, the Purex aqueous discharge systems were evaluated under the following criteria:

1. Flow/Volume Measurement

- a. Continuous discharge systems have accurate flow rate and volume totalizing capability.
- b. Batch discharge systems have capability for volume determination.

2. Sampling

- a. Continuous discharge systems have proportional sampling capability.
- b. Batch discharge systems have adequate facility for bulk sampling.
- c. Each system has capability for collection of samples representative of the discharge.
- d. Each system has the capability for separate verification sampling when above limit conditions are detected.

3. Radiation Monitoring and Diversion

- a. Continuous discharge systems have adequate monitoring capability based on stream characterization.
- b. Continuous discharge systems have redundant, failsafe and appropriately interlocked instrumentation which will detect above limit conditions and activate diversion or quick equipment shutdown.
- c. Each system has either diversion capability or can be quickly shut down to preclude further adverse discharge.

4. Effectiveness of Discharge Control

Stream discharge in compliance with ARH-220 requirements with emphasis on meeting Table II limits.

DISCHARGE STREAM EVALUATION

Aqueous discharge streams in 1972 were in compliance with ARH-220, Standard No. 5 as then published (See Table II). Since that time, discharge criteria have been changed. Presently, the criteria eliminate the use of soil columns as treatment systems. Also, greater emphasis has been placed on adhering to ERDAMC 0524, Table II discharge limits.

Continual effort to reduce discharge stream contamination has resulted in several modifications to the Plant since shutdown/standby in 1972. Two modifications, the steam condensate bypass and the cooling water and steam condensate diversion projects will provide greater flexibility in discharge control. Two other modifications, the condensate recycle and the ammonia scrubber waste treatment projects are expected to significantly reduce discharge contamination. (See Table II)

TABLE II

ARH-CD-962

Disch. Stream	Year	Volume (Liters)	Average Concentration (uc/ml)	Total Disch. (c)	Compliance					
					1972			1978		
					ARH 220 Std #5	0524 Tble I	0524 Tble II	ARH 220 Std #5	0524 Tble I	0524 Tble II
Process Cond. (PDD)	1972	4.0x10 ⁷	Tβ 3.3x10 ⁻³	131	Y	N	N			
			Pu 4.25x10 ⁻⁵	1.6	Y	N	N			
	1978	2.3x10 ⁷	Tβ 1x10 ⁻⁵					Y	Y	P
			Pu 1x10 ⁻⁷					Y	Y	Y
Steam Cond. (SCD)	1972	2.3x10 ⁸	Tβ 7.2x10 ⁻⁵	17	Y	N	N			
			Pu 5.2x10 ⁻⁷	0.3	Y	Y	Y			
	1978	5.5x10 ⁸	Tβ 1x10 ⁻⁵					Y	Y	P
			Pu 1x10 ⁻⁷					Y	Y	Y
Ammonia Scrubber Waste Cond(ASD)	1972	2.9x10 ⁷	Tβ 1.49x10 ⁻¹	4400	Y	N	N			
			Pu 1.34x10 ⁻⁴	3.9	N	N	N			
	1978	4.2x10 ⁷	Tβ 1x10 ⁻⁵					Y	Y	P
			Pu 1x10 ⁻⁷					Y	Y	Y
Cooling Water (CWL)	1972	1.1x10 ¹⁰	Tβ 1.46x10 ⁻⁶	16.3	Y	Y	Y			
			Pu 3.18x10 ⁻⁸	0.035	Y	Y	Y			
	1978	1.0x10 ¹⁰	Tβ 1.0x10 ⁻⁷					Y	Y	Y
			Pu 4x10 ⁻⁸					Y	Y	Y
Chem. Sewer (CSL)	1972	3.1x10 ⁸	Tβ 4.3x10 ⁻⁶	1.3	Y	Y	N			
			Pu 5.1x10 ⁻⁷	0.16	Y	Y	Y			
	1978	7x10 ⁷	Tβ 1x10 ⁻⁷					Y	Y	Y
			Pu 5x10 ⁻⁸					Y	Y	Y

Y - Actual or anticipated discharges below referenced limits.

N - Actual discharges not below referenced limits.

P - Anticipated discharges expected to be at or below but may exceed referenced limits.

The steam condensate bypass project eliminates a portion of the stream piping known to be leaking due to corrosion damage. The steam condensate is now collected in a catch tank and pumped to the disposal site. No major change in discharge contamination is anticipated.

The cooling water and steam condensate diversion project permits diversion of these streams to a covered retention basin when above limit conditions are encountered.

Two condensate streams, the acid absorber condensate (AAD) and the first cycle uranium concentrator condensate (IUD), were successfully recycled without serious adverse effect on product quality prior to plant shutdown in 1972. The condensate recycle project adds the backcycle concentrator condensate (3WD) and the acid fractionator condensate (AFD) to the recycle capability and further allows use of recycled condensate as makeup water for the HA column scrub stream (HAS), and the IC and 2E column strip streams (ICX and 2EX respectively). The final uranium concentrator condensate (2UD) remains the only process condensate stream which exits the process. A significant reduction in discharge contamination is anticipated with this modification. However, the overflow from the E-H4 and E-J8 concentrator condensate sample tanks (SPLPH4 and SPLPJ8) are still routed to the process condensate system. This creates a potential for contamination release during startup/shutdown and unplanned upset conditions which may exceed discharge limits.

The ammonia scrubber waste project permits the aqueous waste from the dissolver off gas condenser tower and the dissolver and E Cell ammonia scrubbers to be collected and treated by concentration in the E-F11 concentrator. The resulting condensate (ASD), containing nearly all the ammonia and ~1% of the contamination, is discharged to subsurface disposal. The remaining concentrated solution, containing ~99% of the contamination will be routed to underground storage awaiting further treatment. A major reduction in discharge contamination is anticipated with this modification.

The cooling water, chemical sewer, steam condensate and 203A area discharge streams have no direct contact with process solution or gas streams and therefore do not require treatment systems. Diversion and rework capability, however, must be provided to insure isolation when contamination is present. Presently, only the cooling water and steam condensate have this capability. Diversion and rework capability need to be provided for the chemical sewer and 203A area discharge streams.

With the elimination of the use of soil columns for treatment, discharge contamination control of the process and ammonia scrubber waste condensates is dependent strictly on the respective concentrator operation. It is questionable at this time whether these discharges will meet Table II limits. Further evaluation and possible backup system consideration is necessary to insure that capability is available to comply with Table II discharge limits.

Diversion and rework capability need to be provided, regardless of treatment system requirements.

French drain control and monitoring is nonexistent. Provision for this capability would be extremely difficult and, as mentioned above, use of soil column treatment systems has been eliminated. Use of french drains needs to be discontinued.

Anticipated operational discharge when the plant is restarted is shown in Table II. All discharge streams are anticipated to be at or below Table II limits. However, considerable effort must be made to insure that adequate administrative control (in terms of specifications, operating limits, job performance aids and training) is in force and appropriately addressed.

SYSTEM EVALUATION

Modifications in each discharge system are needed to adhere to ERDA Manual requirements and to provide more effective control and monitoring capability. Each system is addressed as applicable below.

Cooling Water

No changes are presently anticipated with the collection, routing, or discharge capabilities of this system. Adequate administrative control needs to be established concerning diversion and rework sequencing. Consideration should be given to placing many heat exchanger cooling water streams on automatic temperature control to decrease cooling water usage.

The major problem with this system is inadequate instrumentation. The accuracy of the flow measurement/totalizing capability needs re-evaluation as historical data do not support this as an accurate measurement system.

The basic sampling and sample collection system is considered adequate. Provision needs to be made for obtaining a verification sample in the event above limit conditions are detected.

The monitoring system is not considered to be adequate. The stream needs documented characterization and further evaluation for adequate monitoring capability. The monitoring system needs redundant failsafe instrumentation to assure continuous coverage and to preclude diversion except in real contamination release.

Chemical Sewer

The chemical sewer still has several potential sources for contamination: 203A area discharge, acid fractionator condenser cooling water and steam condensate, TK-U8 overflow, and P&O gallery floor drainage if internal building diversion fails.

This system presently has no flow measurement or totalizing capability. Design for this capability was completed in August 1975, but lack of funds has prevented installation. Further consideration should be given to placement of the instrument readout in Central Control rather than at the measurement site as designed. The system needs to have environmental sampling capability similar to the cooling water system and provision is needed for obtaining a verification sample in the event above limit conditions are detected. The system must have radiation monitoring capability with redundant failsafe instrumentation. Diversion capability needs to be provided.

Steam Condensate

No changes are presently anticipated with the collection, routing or discharge capabilities of this system. Adequate administrative control needs to be established concerning diversion and rework sequencing due to the potential for high contamination levels in the steam condensate in the event of a major tube bundle failure.

The 8824 collection header remains slightly contaminated and needs to be decontaminated prior to plant startup in order to assure a "clean" system when the plant is started up. Continuous water flow is provided presently only in the 8824W header. Similar capability should be added to the 8824R header.

The steam condensate caisson needs better ventilation control capability to preclude dust infiltration and provide a more positive controlled air flow through the caisson.

This system basically provides the desired effluent discharge monitoring capability. However, the sampling system needs better sample collection capability and capability to obtain a verification sample in the event above limit conditions are detected. The monitoring system needs to have redundant failsafe instrumentation to assure continuous coverage and to preclude diversion except in a real case situation.

Process Condensate

No changes are anticipated with the collection, routing, or discharge capabilities of this system until it has been operability tested. The condensate recycle project, mentioned in Section V, has eliminated all but the

2UD stream; however, overflow from the condensate sample pots for the E-H4 and E-J8 concentrators are still routed to this system. Problems with the overflow containing substantial contamination are most likely during startup/shutdown activities. Close administrative control needs to be established concerning operation of the recycle system, particularly during startup/shutdown activities to minimize overflow. The E-K4 concentrator is the final treatment system for the process condensate and careful monitoring of the 2UD stream and sample pot overflow will be necessary to minimize contamination release to the 216-A10 crib.

This system presently has no primary means to determine discharge flowrate or volume and no means for radiation monitoring. Sampling is accomplished by means of an inline weir sampler from which a dip sample is taken from an agitated collection tank.

This system needs flow measurement and volume totalizing capability. It needs a proportional sampler, a sample collection system and capability to obtain a verification sample in the event above limit conditions are detected. The system must have adequate radiation monitoring with failsafe, redundant instrumentation and provision for stream diversion in the event above limit conditions are detected.

Ammonia Scrubber Waste Condensate

This system is presently undergoing a major change in the off-gas handling system. Until completion of the above and of operability testing, no further process changes are envisioned.

This system needs flowrate and volume totalizing capability. It needs proportional sampling capability. It has an adequate sample collection system and needs better verification sampling capability. It has a basic radiation monitoring system, but needs to be modified for redundant failsafe instrumentation. Provision must be made for stream diversion or, alternately, rapid shutdown in the event above limit conditions are detected.

203A Area

Discharge systems in this area are presently under evaluation. Recommendations have been submitted to eliminate discharge to 216-A3 crib and for batch discharge of all aqueous waste to the Chemical Sewer if discharge criteria are met or rerouting into 202A for reprocessing, if not.

French Drains

Provision must be made for the elimination of discharge to french drains under present criteria for elimination of soil columns.

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