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POWER REACTORS

TITLE	REPORT NO.
FEASIBILITY STUDY FOR TRA MODULAR EVAPORATOR SYSTEM	PR-T-79-008

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SUMMARY

The objective of this feasibility study was to evaluate the potential for adapting the ECF modular evaporator system to meet TRA requirements. System sizes, locations, and costs were considered. System sizes and estimated costs were evaluated on a worst case basis.

The study determined that a modular evaporator could be utilized to fill TRA requirements at a much lower cost than previous evaporator installation estimates. The estimated cost for the system is $1.14 million and the yearly operating costs are estimated at $212 thousand. The capital equipment payback when compared to resin disposal is 2.4 years.

It is therefore recommended that a single module be set up as a pilot plant operation and when successfully proven on TRA wastes, proceed with the design and installation of the entire system.

1.0 INTRODUCTION

The original concepts for reduction of radioactive liquid effluents at TRA presumed that intermediate level wastes not usable for recycle would be shipped by tank truck to CPP for evaporation and disposal.

In 1978, a study by Allied Chemical (Ref. 1) indicated that CPP could not receive TRA wastes containing Na(OH) and/or $Na_2(SO_4)$. These are the chemicals contained in TRA cleanup demineralizer regenerants which comprise 75 percent of the anticipated disposable wastes. As a result of this limitation TRA is faced with two alternatives:

1. Dispose of regenerant wastes at TRA.
2. Do not regenerate ion exchange resins and dispose of the resin when it becomes saturated.

The feasibility and cost comparisons of resin disposal vs evaporation and solidification of regenerant solutions by commercial methods have been evaluated (Ref. 2). Both choices, however, have distinct disadvantages and studies were continued in search of a more viable solution. One method which appeared promising was the use of a modular type evaporator in which the waste is evaporated to dryness.

1.1 Modular Disposal Method

Intermediate level liquid wastes are stored in tanks which feed a disposable evaporator. The liquid is evaporated by hot air which, together with the clean water vapor it has absorbed, is exhausted to the atmosphere through stack exhaust. The dissolved and suspended residue remains in the shielded unit as a dry cake. When the unit becomes full it is sealed and sent to the RWMC.

1.2 Advantages and Disadvantages

The primary advantages of the module disposal method are simplicity of operation, low cost, and ease of disposal.

The primary disadvantages are the slow rate of liquid evaporation and the limited capacity of solids in the module.

2.0 TRA HOT WASTE SOURCES AND VOLUMES

2.1 ATR Sources

The current waste sources at ATR are primarily generated by loop decontamination and other infrequent flushes to the hot drain system.

The bypass demineralizer regenerant solutions are not currently sent to the hot drain system. In the future, if the bypass demineralizer regenerant and the warm waste demineralizer regenerants are routed to hot waste they would account for over 97% of the ATR hot waste. Table I shows the anticipated sources and volumes of ATR hot waste. A detailed breakdown of volumes generated by specific regeneration steps is contained in Reference 3.

2.2 ETR Sources

ETR hot waste volume, which is presently very small, would consist of bypass demineralizer regenerant and after Phase II also warm waste demineralizer regenerant. In the event that ETR operating time increased, the bypass demineralizer effluent would increase proportionately. Table I shows the anticipated sources and volumes for ETR hot waste. Additional detailed breakdowns are discussed in Reference 3.

2.3 MTR Hot Cell and Lab Sources

A third and final source of hot liquid waste is generated at TRA by the hot cells and chem labs. Although the activity concentration from these sources varies greatly, Table I assumes no ability to decay and discharge the waste.

2.4 Minimum Volumes

The waste volume basis for this study was assumed to be 384,000 gal/yr. However, studies are currently underway to reduce that total. Shipment of non-sodium waste to CPP and reduction of ion exchange bed regenerations could reduce the volume of effluent by one half. If programs for reducing the effluant are successful, overall operating costs would also be reduced proportionately.

3.0 ECF EVAPORATOR SYSTEM

The Expended Core Facility at NRF is currently operating a system which may , on a larger scale, prove adaptable for disposal of TRA hot waste.

The ECF evaporator unit consists of a concrete encased steel tank containing evaporation trays. The unit is filled with radioactive waste

TABLE I

TRA HOT WASTE SOURCES

	Operating Unit	Volume	Frequency	Composition	Total gal/yr
After Phase I					
	ATR Bypass Demineralizer (Anion)	2500 gal	1/6 days	~ 2.5% Na OH	115,000
	ATR Warm Waste Demineralizer	6700 gal	1/14 days 1/35 days**	~ 1.1% Na_2SO_4	175,000
	ETR Bypass Demineralizer (Anion)	1400 gal	1/10 days	~ 2.5% Na OH	6,000
	Misc. Sources	N/A	N/A	Variable	88,000
				TOTAL	384,000
After Phase II					
	ETR Warm Waste Demineralizer	2700 gal	1/14 days 1/40 days**	~ 1.1% Na_2SO_4	30,000
	ETR Bypass Demineralizer	1400 gal	1/10 days	~ 2.5% Na OH	6,000
	ATR Bypass Demineralizer	2500 gal	1/6 days	~ 2.5% Na OH	115,000
	ATR Warm Waste Demineralizer	6700 gal	1/35 days	~ 1.1% Na_2SO_4	74,000
	Misc. Sources	N/A	N/A	Variable	44,000
				TOTAL	269,000

** Shutdown requirements

water which is recirculated over the trays with a self contained pump. Heated air is drawn through the unit by a dual blower system. After passing through the evaporator the air is drawn through an absolute filter, monitored for activity and exhausted to a larger air stream discharging up the exhaust stack.

When the unit becomes full, the reusable components are removed, the top of the module filled with concrete and the unit shipped to the burial ground. (See Figure 1.)

4.0 SYSTEM DESCRIPTION

4.1 System Requirements

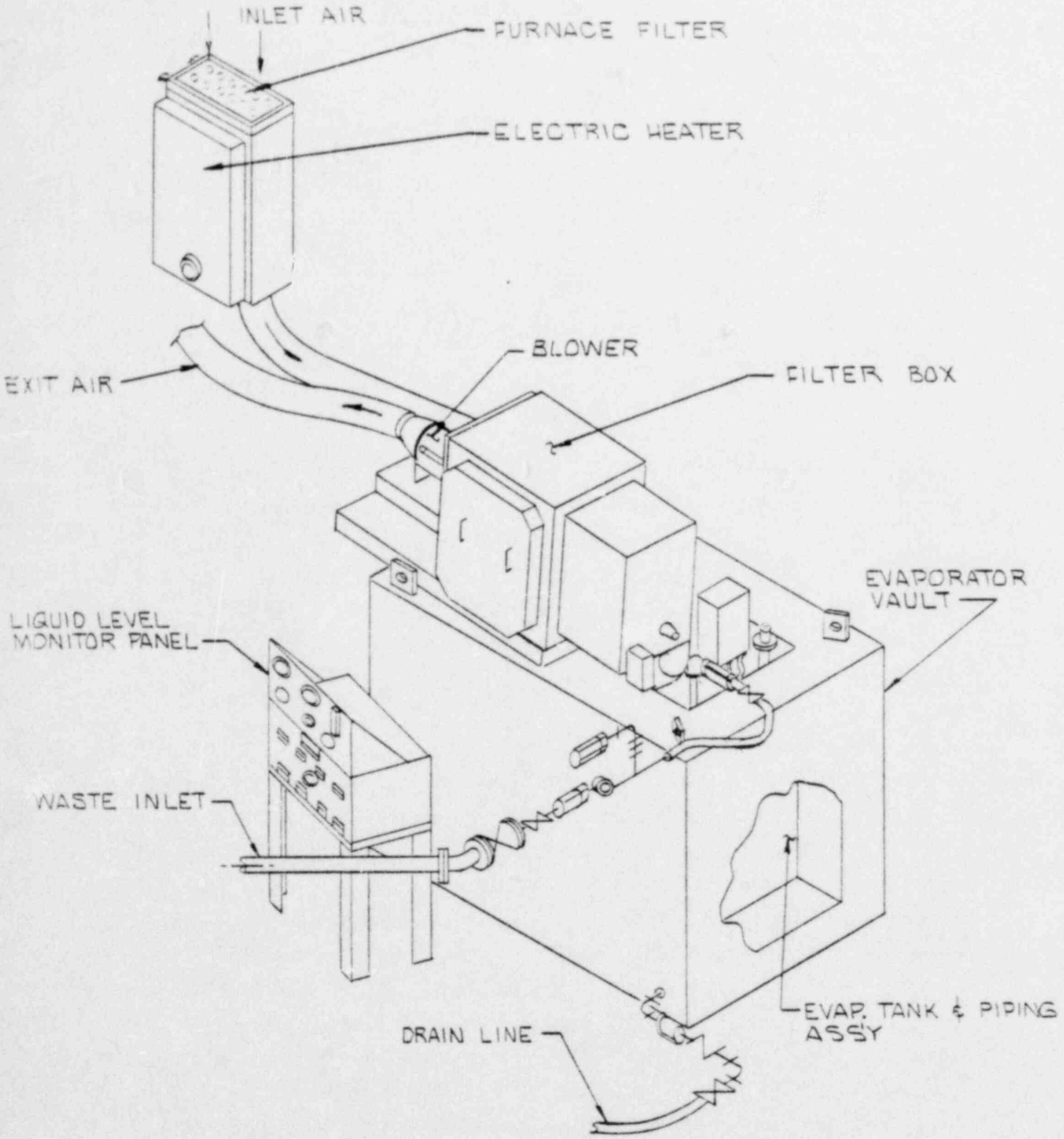
The system considered for TRA utilization would be of modular construction. With the exception of a common feed tank, a common return air header, and a common feed line each unit would be operational on an individual basis. The modular concept, while more expensive for initial installation, would be very versatile for handling varying amount of hot waste. The smaller disposal units would also facilitate handling and shipping with conventional equipment. The specifications for the system modules and the total capability are shown in Table II.

4.2 System Location

There are two potential locations for the system. Both locations are in building MTR 605. The most promising location from a size standpoint is the second floor evaporator room in MTR 605. Use of this room would require removal and disposal of the MTR process evaporators and covering of several holes left in the floor by the demolition. The layout for this area is shown in Figure 2. A second and somewhat smaller area considered was the MTR 605 basement beneath the seal tank room. Utilization of this area would require penetration of the basement wall for access. Use of this area would only be required if other circumstances prohibit utilization of the evaporator room.

4.3 Energy Requirements

The energy requirements for the system would be dependent upon the number of modules operating. Each module would consume approximately

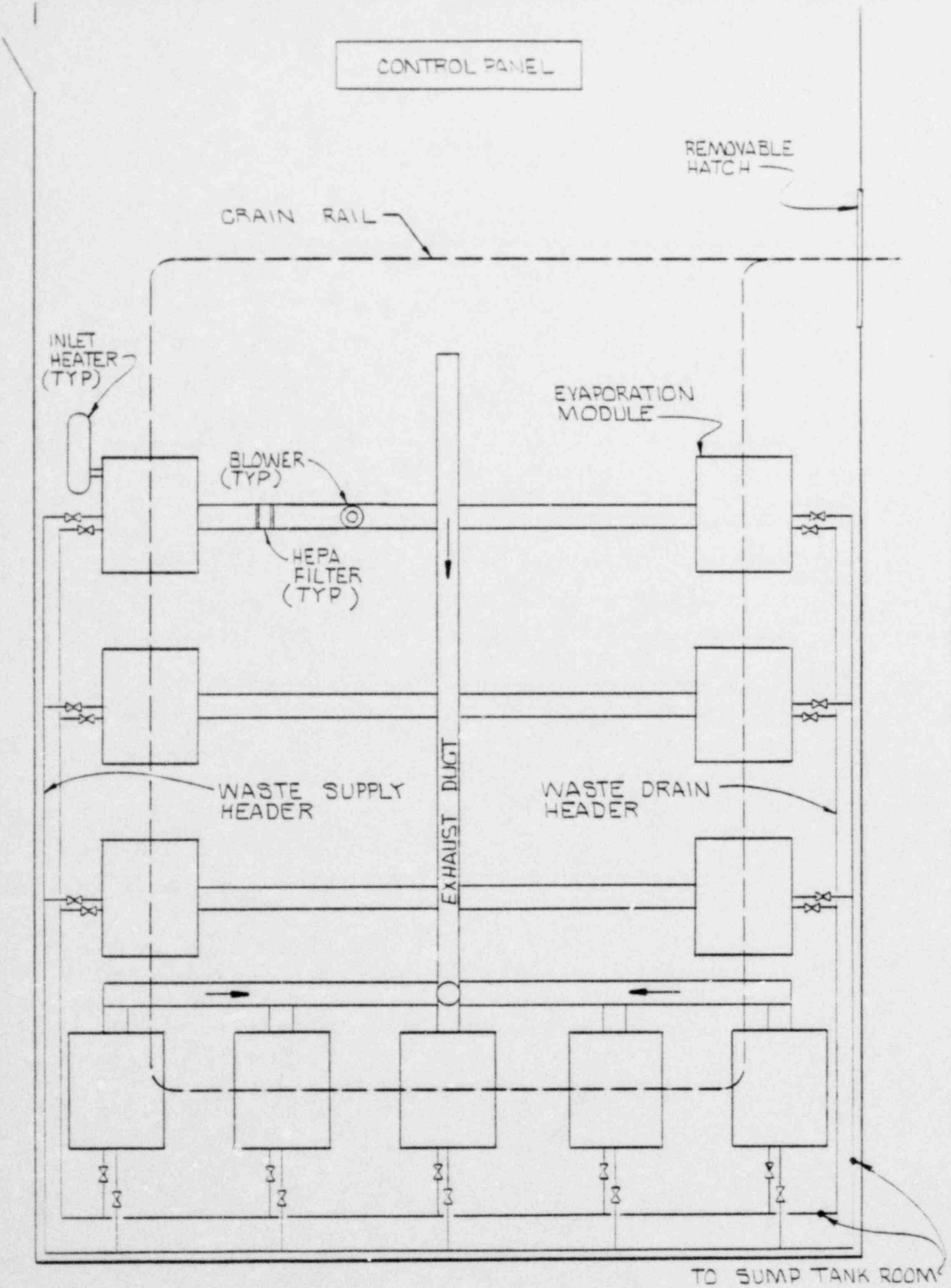


E C F
EVAPORATOR
FIG. 1

TABLE II

EVAPORATOR REQUIREMENTS

Yearly gallons to evaporate	384,000 gal
Estimated total volume of solid	281 ft^3
Approximate size of single module	7.5' x 5.5' x 4'
Approximate weight of single module	21,000#
Solid Capacity of single module	25 ft^3
Evaporation rate for single module	100 gal/day
Air flow through single module	500 SCFM
Energy requirements for single module	30 kWh/hr
Maximum number of units	11 units
Total yearly disposal volume for burial	1815 ft^3



MTR 605 EVAP. ROOM
FIG 2

720 kWh per day if 100 gallons of liquid were evaporated. At maximum capacity 7920 kWh would be used per day. The yearly energy costs in 1979 dollars are shown in Table III.

5.0 OPERATIONAL REQUIREMENTS

5.1 Operator Time

The operator time required for filling units and surveillance is estimated at 3 man-hours per day or approximately .5 man-years. Operating problems, record keeping, disposal, etc. may add an additional .5 man-years for a total operator time of 1 man-year.

5.2 Radiation Hazards

The concrete shielding around the modules is designed to allow radiation levels of <5 mR/hr. With proper placement of manual fill valves the operator exposures are estimated at less than 1 man Rem per year for the total system. Remote operated valves would reduce the exposure even more.

6.0 MAINTENANCE REQUIREMENTS

6.1 Installation and Disposal

The installation of a new module would require the use of equipment operators, pipe fitters and mechanics. Estimated installation time required is 5 man-days.

The disposal of a unit would require considerably more effort since the unit would need to be filled with concrete. The estimated time required to remove and ship a unit is 8 man-days.

6.2 Preventative Maintenance and Operating Maintenance

PM work on instrumentation would be done a semi annual basis and operating maintenance as required. The time for both categories is estimated at 1 man-year.

6.3 Radiation Exposures

The majority of radiation exposure to maintenance personnel would occur during module disposal. The estimated exposure for disposal of 11 units is 2.1 man Rem per year.

In addition, the mechanical and instrument maintenance exposure which would be accumulated during the year on all units is estimated at 660 mr.

TABLE III

1979 BASELINE COSTS FOR EVAPORATOR SYSTEM

	Initial Capital Cost 1979$	Yearly Energy Cost	Yearly Operator & Maint. Cost	Yearly Material Cost	Yearly Shipping Cost	Yearly Burial Cost	Yearly Cost
Individual Module	35 K	4.2 K	8.3 K	5 K	1.4 K	.45 K	19.35 K
Demolition Support Equipment	63.1 K	NA	NA	NA	NA	NA	
Maximum 11 Module System	389.2 K	46.3 K	91.3 K	55 K	15.5 K	5 K	212.1 K
Total Capital Expenditure	1.1377 M				Total Yearly Operating		212.1 K

This gives a total maintenance radiation exposure estimate of 2.76 man Rem per year.

7.0 COST SUMMARY

The costs involved for the system under consideration have been placed in three categories: 1) fabrication and initial installation costs, 2) operating costs and 3) disposal costs. The installation costs include all construction costs such as engineering, project management, indirects, and contingency. This summary is shown in Table IV. Table III shows a breakdown of capital and operating costs for the modular evaporator system. Costs are shown for an individual module and for the maximum eleven module system. The individual module costs are shown since if the waste volume was lower than 384,000 gal/yr the yearly operating costs would be proportional to the number of modules required.

Table V shows the estimated baseline costs for resin disposal. The evaporator costs were compared against resin disposal costs following Phase II completion.

The economic evaluation shown in Table VI was performed according to the Office of Management and Budget Circular, A-94, Guidelines. The results indicate a capital payback in 2.25 to 2.4 years depending upon the resin escalation rate chosen.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Figure 1 shows that the MTR 605 evaporator room would provide a very ideal location for the system under consideration.

It also appears that, based on ECF operating data, the system could meet the requirements listed in Table II. This area is not well defined, however, since exact concentrations and isotope inventories for ECF waste are not the same as those at TRA.

The economic analysis shown in Table VI indicates a favorable capital payback time.

Based on the above information it is recommended that a single pilot module be installed to determine the exact characteristics of TRA hot wastes. If successful pilot plant operation is achieved, the entire system may be designed and installed.

TABLE IV

COST ESTIMATE SUMMARY

Project: TRA MODULE EVAPORATOR   Date: 6-1-79

Location: TRA 605   Type of Estimate: Feasibility

Prepared By: ____   Chk'd./Appr'd. By: ____

	UNESCALATED	ESCALATION		
ENGINEERING, DESIGN & INSPECTION SUB-TOTAL:				151,698
Title I Design	48,135			
Title II Design	96,270			
Title III Inspection	7,293			
CONSTRUCTION COSTS SUB-TOTAL:				665,140
Direct Costs;			452,292	
4000 Improvement to Land	-	0		
5000 Bldg./Structures	-	0		
6000 Utilities	7,483	0		
7000 Equipment	425,395	0		
8000 Demolition & Removal	19,414	0		
Indirect Costs; 29%	131,164	0	131,164	
Construction Manager (CM)	81,684	0	81,684	
GOVERNMENT FURNISHED EQUIP'T./MAT'LS. SUB-TOTAL:				0
Purchased By - (CM) -	0	0		
Purchased By - ____	0	0		
PROJECT ADMINISTRATION COSTS SUB-TOTAL:				58,345
Project Management	35,007	0		
Construction Coordination	11,669	0		
Cost/Schedule Control	2,917	0		
Health - Safety	5,835	0		
Quality Engineering	2,917	0		
Procurement	0	0		
CONTINGENCY SUB-TOTAL:				262,555
TOTAL PROJECT COST:				1,137,738

ESCALATION: (Included in Above) ____

No escalation included since cost comparison analysis is made with 1979 costs.

TABLE V

BASELINE COSTS FOR RESIN DISPOSAL - 1979

	Yearly Resin Replacement Cost	Yearly Shipping and Burial Cost	Yearly Operator Cost	Yearly Subtotals
ATR Anion Units	358.8 K	127.7[illegible] K	71.85 K	558.43 K
ATR Warm Waste Units	*171.6 K ** 72.6 K	*72.23 K **30.56 K	*40.6 K **17.18 K	*284.43 K **120.34 K
ETR Anion Units	14.4 K	11.11 K	6.25 K	31.76 K
ETR/MTR Warm Waste Units	** 47.85 K	**39.56 K	**17.18 K	**104.59 K
Totals *	544.8 K	211.12 K	118.7 K	874.62 K
**	493.65 K	209.01 K	112.46 K	815.12 K

*Prior to Phase II Completion

**Following Phase II Completion

TABLE VI

ECONOMIC ANALYSIS

RESIN DISPOSAL VERSUS MODULAR EVAPORATOR INSTALLATION AND OPERATION

Resin Cost Escalation	Years to Reach Capital Equipment Payback	Total Cumulative Savings in Twenty Years $\$ \times 10^3$	Twenty Years Savings to Investment Ratio
2%	2.40	5596	4.47
4%	2.33	6462	5.16
6%	2.26	7538	6.02
8%	2.20	8881	7.10

9.0 REFERENCES

1. Alternatives for Managing Intermediate Level Wastes, by S. S. Bodner, Allied Chemical Company, Attachment to HL-137-78.
2. Evaluation of TRA Radioactive Resin Disposal vs Evaporation and Solidification of Regenerant Solutions, by R. N. Beatty.
3. Technical Report Number RE-E-149 Revision B, Conceptual Design Report for TRA Liquid Radioactive Waste Cleanup System, Phase II.