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Waste Management Study-Process Development at Lawrence Livermore National Laboratory

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Arthur D. Little, Inc.

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DISCLAIMER

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.

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1.1 This report presents the results of an evaluation of the present Toxic Waste Control Operations at the Lawrence Livermore National Laboratory, evaluates the technologies most applicable to the treatment of toxic and hazardous wastes and presents conceptual designs of processes for the installation of a new decontamination and waste treatment facility (DWTF) for future treatment of these wastes. The findings and recommendations of this study are as follows:

1.1.1 LLNL generates a great diversity of hazardous wastes in small to medium quantities that require flexible equipment and knowledgeable personnel in order to meet governmental regulations.

1.1.2 The present Toxic Waste Control Facility uses well established technologies for decontamination and treatment; however, the facility is not capable of meeting RCRA regulations for a Hazardous Waste Management facility, is constrained in layout and size and needs improvement in operability.

1.1.3 The relatively large fraction of the Toxic Wastes that are currently shipped off-site means that LLNL must rely upon the performance of others who may not be as dedicated to handling those wastes in the most environmentally safe manner.

1.1.4 A new DWTF must not be treated as an independent entity for the sole purpose of ensuring that LLNL operates in an environmentally acceptable manner. Generators of wastes must understand their responsibilities in aiding LLNL to meet all established policies and regulations on its discharges.

1.1.5 The DWTF should be capable of meeting presently established rules and regulations and of being readily modified to meet future rules and regulations that will undoubtedly become increasingly stringent.

1.1.6 All treatment and disposal steps should be examined carefully for their risk to the environment and those with the lowest potential risk should be chosen.

1.1.7 The DWTF can be developed to provide three levels of treatment. Those levels should be:

1.1.7.1 Level I Meeting of Presently Established Regulations

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1.1.9 A Level II DWTF would include in addition to Level I:

1.1.9.1 -- Rotary-kiln Incinerator
1.1.9.2 -- Solvent Recovery

1.1.10 A Level III DWTF would include in addition to Levels I & II:

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allow incineration of all radioactivity contaminated organics

1.1.10.2 -- A Reactive Materials Treatment System

1.1.10.3 -- Evaporative Concentration of Inorganic Chemical in Water Streams

1.2 The results of progressing from Level I to Level III would be an increasing reduction in the potential risk to the environment by treatment at the LLNL site. The major accomplishments at each level would be as follows:

1.2.1 Level I.

1.2.1.1 The DWTF would attain compliance with the State of California's Department of Health Services Interim Status Document No. CA 2890012584 issued to LLNL on May 16, 1983.

1.2.1.2 Wastewater effluents would meet EPA Effluent Guidelines for Electroplating and Metal Finishing and ensure LLNL compliance with Ordinance 1134 of the City of Livermore for discharges into a publicly owned treatment works.

1.2.1.3 The present controlled air incinerator controls would meet RCRA requirements for Hazardous Waste Incineration; however, the incinerator could not destroy wastes differing from those presently burned.

1.2.1.4 The following would result when compared with present treatment.

Radioactive Waste

(a) No change in solids

(b) Reduction is total Dissolved Solids sent to Livermore POTW by approximately 85 percent.

(c) Increase by a factor of approximately 8 the liquids solidified for off-site disposal.

Nonradioactive Wastes

(a) Seventy-five percent reduction in brines sent to off-site disposal.

(b) Three times as much filter cake sent off-site.

(c) No change in untreated organic liquids, sludges and other residuals sent off-site.

I.2.1 Level II.

1.2.1.1 The DWTF would reduce the nonradioactive wastes solids and liquids containing organic hazardous waste to a form which would be largely inorganic with a concomitant reduction in the risks that occur over long-time periods.

1.2.1.2 The recovery and reuse of valuable materials such as solvents would be in accordance with RCRA legislation objectives.

1.2.1.3 The following would result when compared with present treatment.

Radioactive Wastes

(a) No change from Level I treatment.

Nonradioactive Wastes

(a) A 65 percent increase in the quantity of brines sent off-site.

(b) No change from Level I in filter cakes sent off-site.

(c) A 92 percent reduction in untreated organic liquids, sludges and other residuals sent off-site.

(d) Recovery of solvents for reuse.

1.2.3 Level III.

1.2.3.1 The DWTF would reduce to a minimum the off-site shipments of both radioactive and nonradioactive wastes and these would be in solidified form.

1.2.3.2 The following would result when compared with present treatment.

Radioactive Wastes

(a) Nearly a 50 percent reduction in radioactive solids wastes shipped off-site and these will contain no organics.

(b) Reduction in dissolved solids to POTW same as Level I.

(c) All radioactivity will be incorporated in most stable solid forms.

Nonradioactive Wastes

(a) No brines shipped off-site

(b) Filter cakes for off-site disposal same as Level I.

(c) A 92 percent reduction in untreated organic liquid sludges and others residuals sent off-site.

(d) Over 98 percent of dissolved inorganic materials from treatments will be disposed of as solids.

2. INTRODUCTION

This report represents the waste management study of the Lawrence Livermore National Laboratory (LLNL) and conceptual process designs required as part of a Conceptual Design Report. This report was prepared under a Holmes & Narver, Inc. Subcontract No. 1797-00-01 with Arthur D. Little, Inc.

3. OBJECTIVES

The objectives of this work were to study the present toxic waste and decontamination operations at LLNL and determine the best options for managing hazardous, mixed and low level radioactive waste at LLNL. From these determinations, conceptual designs of alternative treatment technologies and flowsheets were to be prepared that will permit selection of those alternatives best capable of meeting LLNL's objectives. The principal objectives of LLNL are to insure that handling, treatment and disposal of all hazardous and low-level radioactive waste meet applicable regulations and that the toxic waste control facilities have the capability of meeting future regulations which are expected to become increasingly stringent. Ideally, LLNL would like to minimize the types and quantities of hazardous and radioactive wastes that leave the laboratory ultimately destined for disposal at other sites such as EPA or State of California approved hazardous waste landfills or government-owned, low level radioactive waste burial sites.

4. METHOD OF APPROACH

In carrying out this assignment, Arthur D. Little personnel visited LLNL for the purpose of observing the present toxic waste control practices and to gather information on the types and quantities of waste generated. Utilizing these data we have prepared comments on the present methods and disposal practices, established a number of waste categories into which the many different waste sources could be placed,

utilized our experience and knowledge of waste treatment technologies to provide a ranking of the most applicable technologies, estimated the capacity likely to be required for the handling and treatment of these waste according to their different sources, prepared conceptual layouts of flowsheets and technologies for consideration in recommending those to be incorporated into a new DWTF facility and prepared preliminary process designs for incorporation into the Conceptual Design Report. In the following sections we discuss our findings, conclusions and recommendations.

5. ASSESSMENT OF PRESENT PRACTICES

There are a large number of chemical and physical methods employed by LLNL in its present toxic waste control facility. In order to understand these operations we prepared the simplified block diagrams shown in Figures G-1 through G-6 on which the symbol * designates the incoming and exiting steams to the present TWC. Although a number of different categories might be used to characterize the present TWC procedures, we have made our segregation into the six areas of:

- decontamination,
- liquid waste handling,
- liquid waste handling - solidification,
- liquid waste handling - precipitation,
- incineration, and
- size reduction,

This segregation will facilitate specific comments on the present toxic waste control practices.

5.1 General

The present toxic waste control facility utilizes a number of procedures, e.g., the removal of heavy metal ions from liquid streams by chemical treatment, that have proven capable of meeting effluent limitations established for discharge into the City of Livermore's

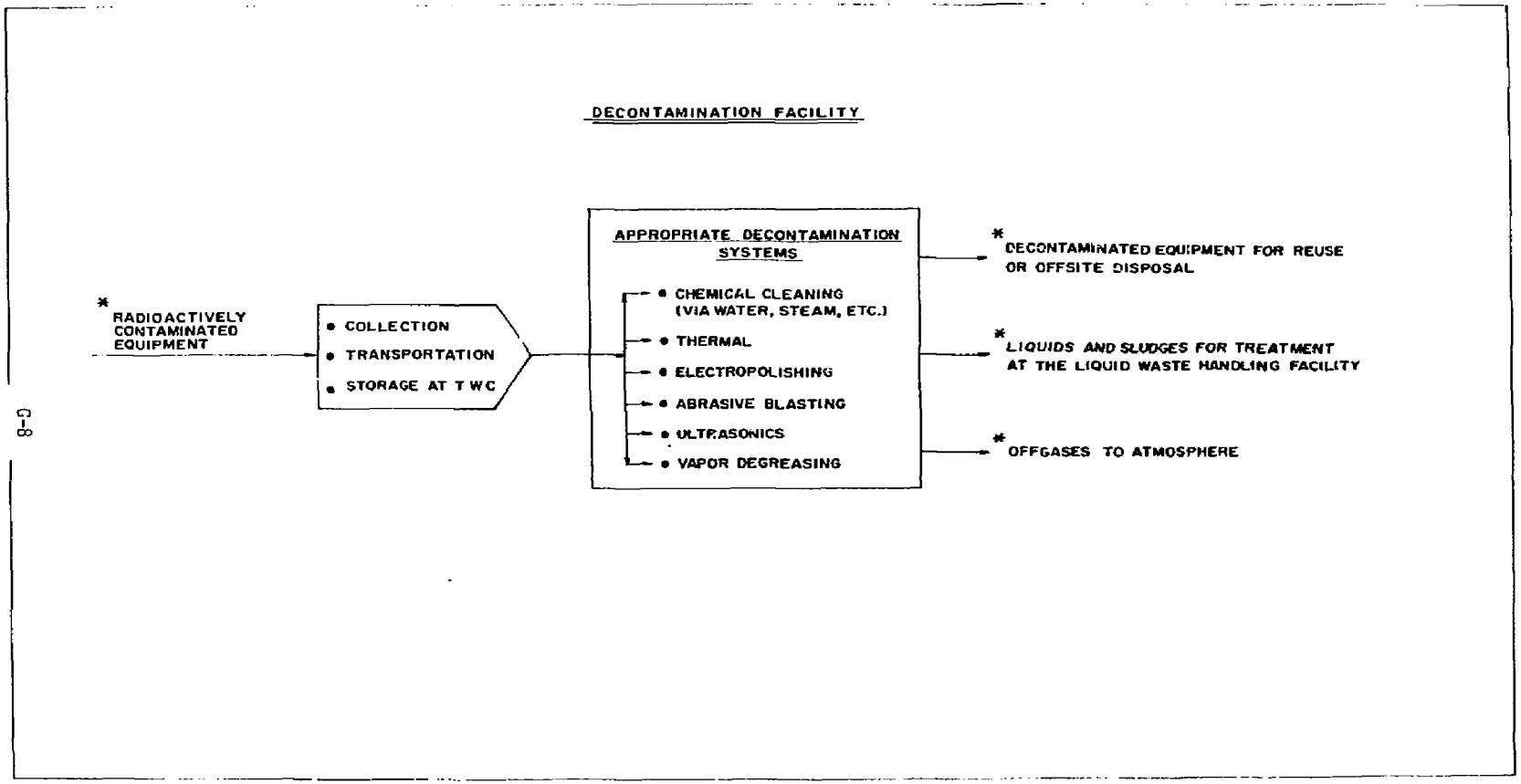

DECONTAMINATION FACILITY
* RADIOACTIVELY CONTAMINATED EQUIPMENT
• COLLECTION
• TRANSPORTATION
• STORAGE AT T W C
APPROPRIATE DECONTAMINATION SYSTEMS
• CHEMICAL CLEANING (VIA WATER, STEAM, ETC.)
• THERMAL
• ELECTROPOLISHING
• ABRASIVE BLASTING
• ULTRASONICS
• VAPOR DEGREASING
* DECONTAMINATED EQUIPMENT FOR REUSE OR OFFSITE DISPOSAL
* LIQUIDS AND SLUDGES FOR TREATMENT AT THE LIQUID WASTE HANDLING FACILITY
* OFFGASES TO ATMOSPHERE

FIGURE G-1

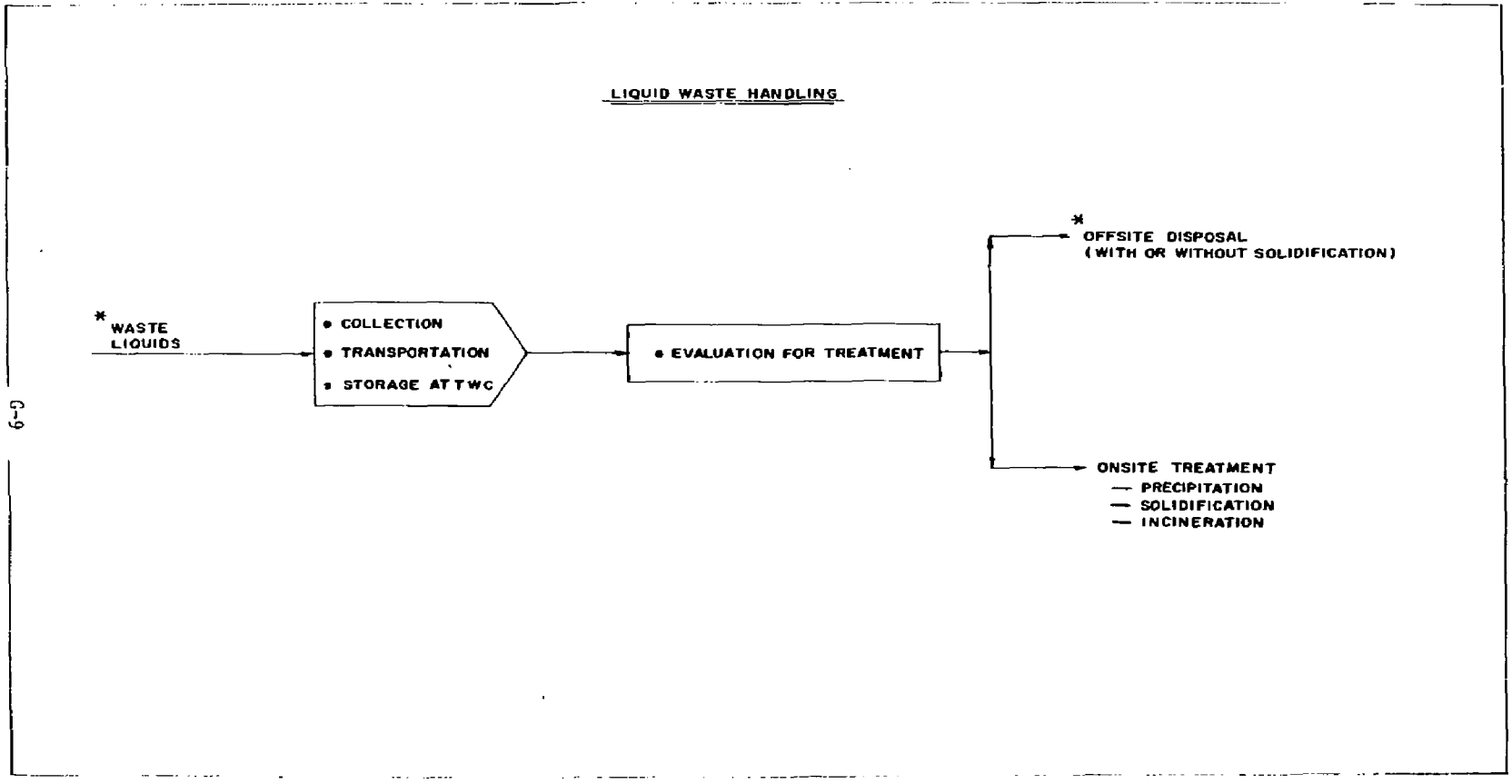

LIQUID WASTE HANDLING
* WASTE LIQUIDS
• COLLECTION
• TRANSPORTATION
• STORAGE AT TWC
• EVALUATION FOR TREATMENT
* OFFSITE DISPOSAL (WITH OR WITHOUT SOLIDIFICATION)
ONSITE TREATMENT
— PRECIPITATION
— SOLIDIFICATION
— INCINERATION

FIGURE G-2

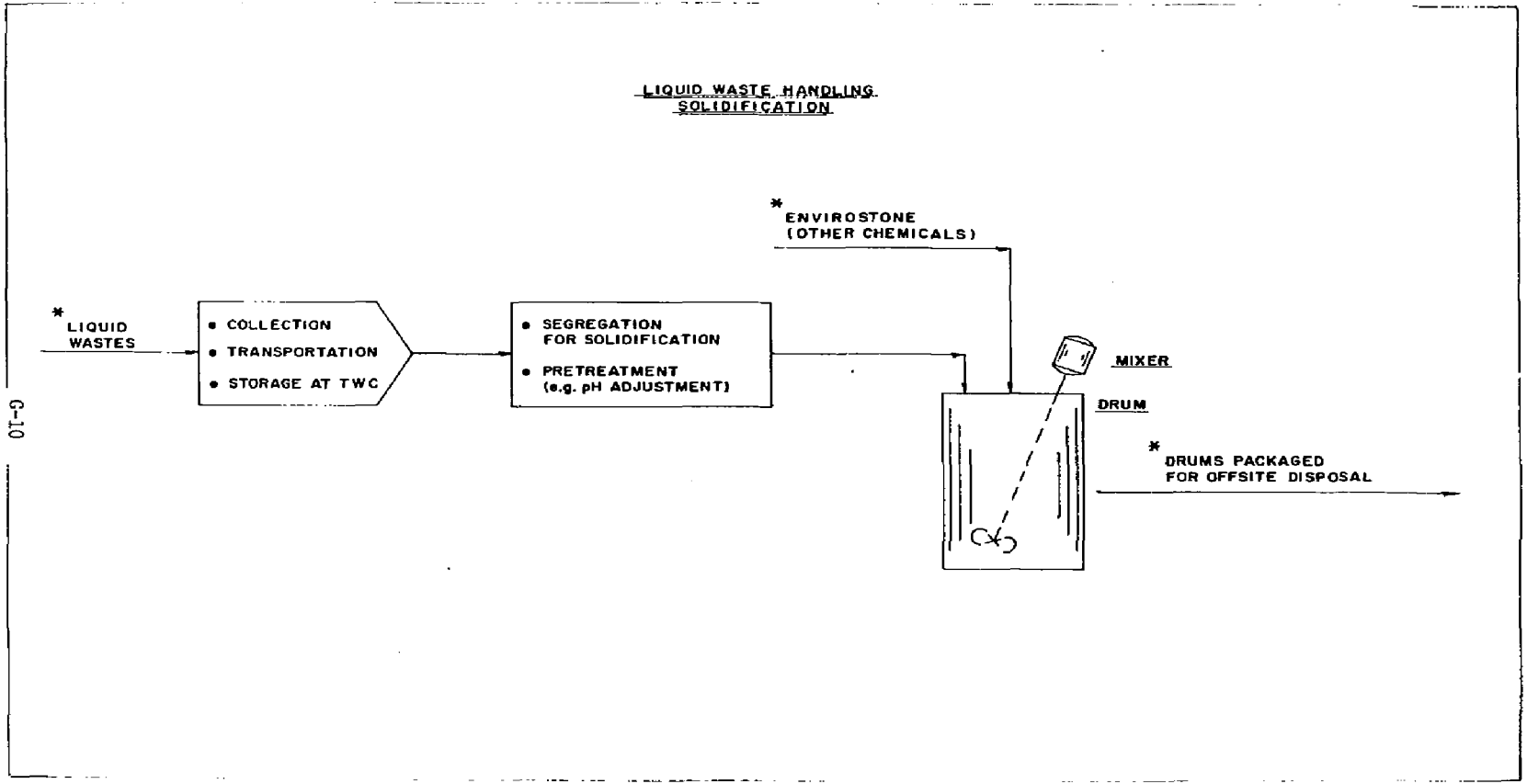

LIQUID WASTE HANDLING
SOLIDIFICATION
* ENVIROSTONE
(OTHER CHEMICALS)
* LIQUID WASTES
• COLLECTION
• TRANSPORTATION
• STORAGE AT TWC
• SEGREGATION FOR SOLIDIFICATION
• PRETREATMENT (e.g. pH ADJUSTMENT)
MIXER
DRUM
* DRUMS PACKAGED FOR OFFSITE DISPOSAL

FIGURE G-3

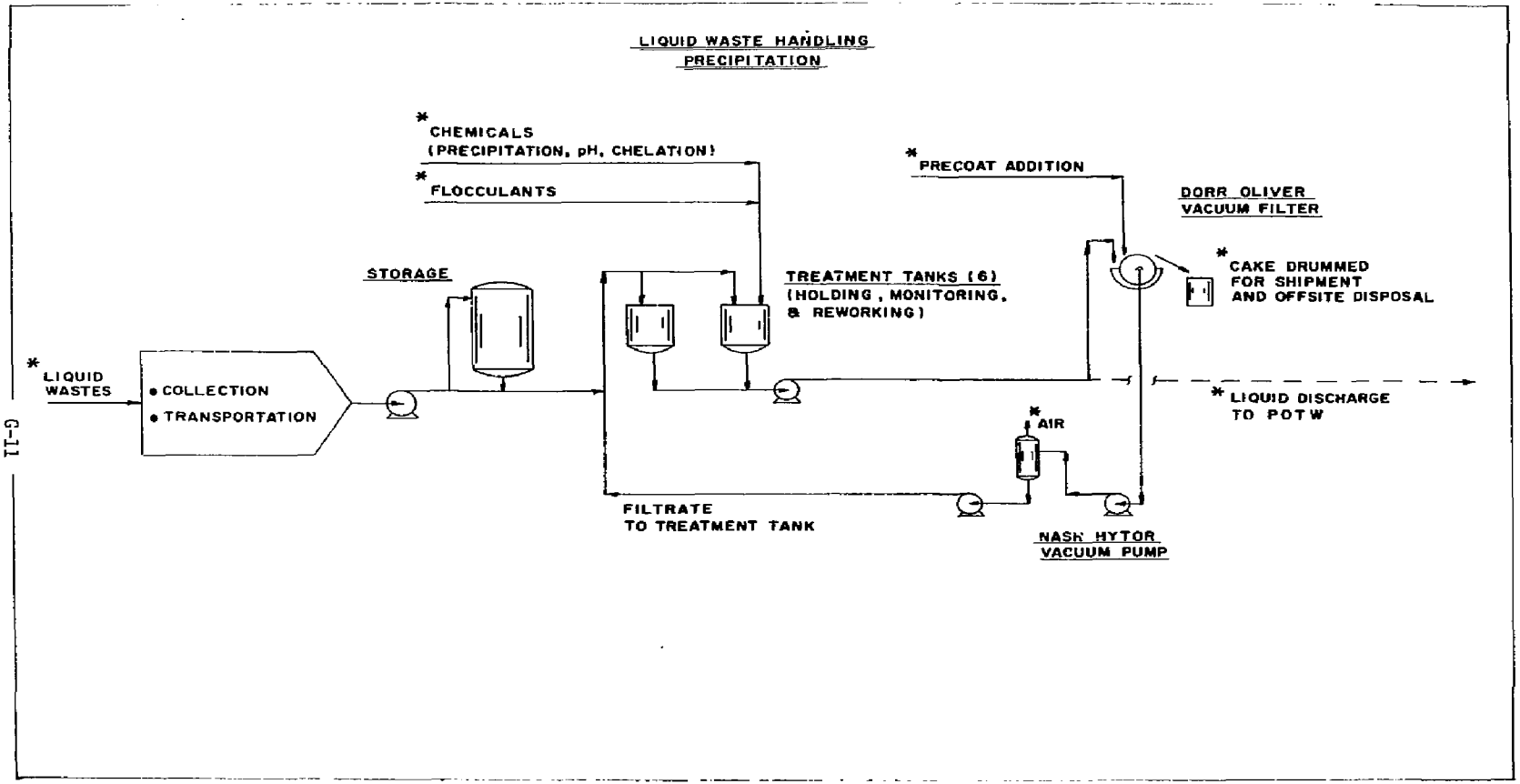

LIQUID WASTE HANDLING
PRECIPITATION
* CHEMICALS
(PRECIPITATION, pH, CHELATION)
* FLOCCULANTS
* PRECOAT ADDITION
DORR OLIVER
VACUUM FILTER
STORAGE
TREATMENT TANKS (6)
(HOLDING, MONITORING,
& REWORKING)
* CAKE DRUMMED
FOR SHIPMENT
AND OFFSITE DISPOSAL
* LIQUID
WASTES
• COLLECTION
• TRANSPORTATION
* LIQUID DISCHARGE
TO POTW
* AIR
FILTRATE
TO TREATMENT TANK
NASH HYTOR
VACUUM PUMP

FIGURE G-4

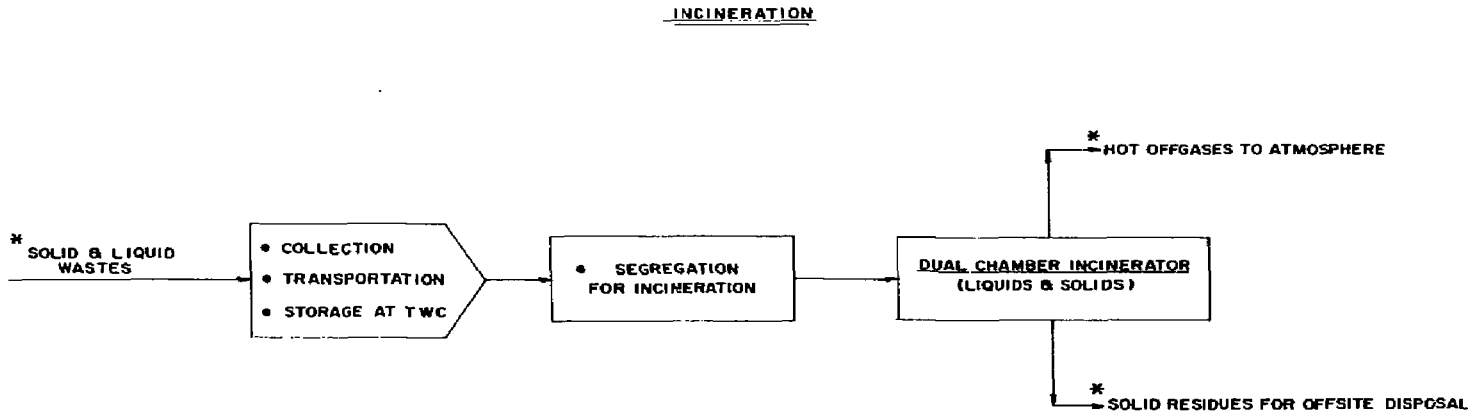

INCINERATION
* SOLID & LIQUID WASTES
• COLLECTION
• TRANSPORTATION
• STORAGE AT TWC
• SEGREGATION FOR INCINERATION
DUAL CHAMBER INCINERATOR (LIQUIDS & SOLIDS)
* HOT OFFGASES TO ATMOSPHERE
* SOLID RESIDUES FOR OFFSITE DISPOSAL

FIGURE G-5

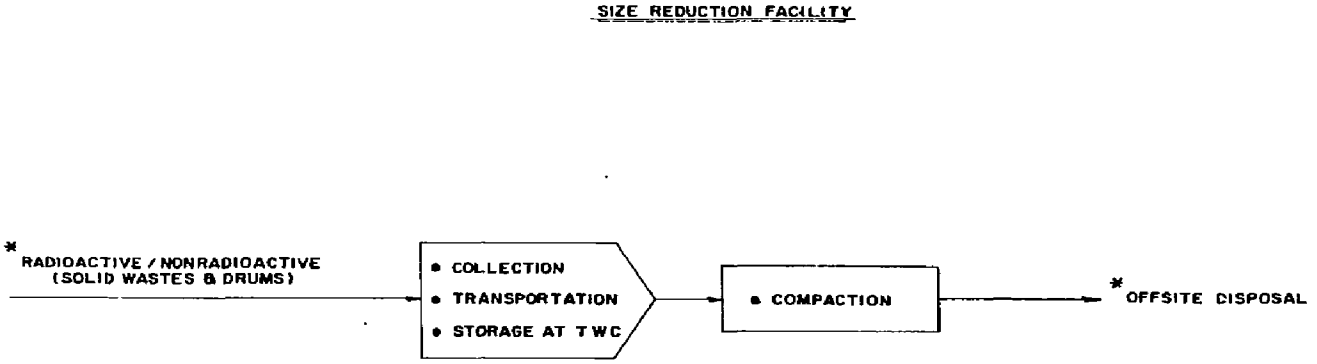

SIZE REDUCTION FACILITY
* RADIOACTIVE / NONRADIOACTIVE (SOLID WASTES & DRUMS)
• COLLECTION
• TRANSPORTATION
• STORAGE AT TWC
• COMPACTION
* OFFSITE DISPOSAL

FIGURE G-6

publicly-owned treatment works (POTW) when combined with other LLNL wastewaters (UCRL-50027-83). However, while meeting the limits established by present regulations, these treatment procedures are cumbersome and involve a high degree of personnel contact. The large amount of handling required in the present facilities compared with its limited space and difficulties of operating in an orderly manner contribute to the difficulties in achieving compliance with all the regulations that are required in the Interim Status Document (ISD) of the State of California. Although many of the areas of non-compliance with the ISD are procedural in nature, there are other areas where equipment and layout prevent achieving compliance. Based on our experience with the design and operations of toxic waste control facilities in industry, it is apparent that the present DWTF will have increasing difficulties in meeting the more stringent regulations LLNL is likely to face in the future and has very little potential capability for significantly reducing the types and quantities of toxic and hazardous wastes that must be shipped from the laboratory.

5.2 Decontamination

The techniques employed in the decontamination of equipment for reuse or to meet disposal limits are typical of those that have been demonstrated to be successful at many facilities handling radioactivity. Equipment for the utilization of these techniques, however, could be improved to make this operation more consistent with operator safety and the objectives of reducing to a minimum emissions to the environment. For example, while we recognize the efficacy of removing mercury from solid objects by heating, the apparent unknown effectiveness of its removal from air emitted to the environment could be improved with a better designed system. The operational difficulties of carrying out some of the decontamination operations as well as the physical limitations placed on the size of equipment that can be decontaminated are recognized. Overcoming these should be a principal objective of the DWTF.

5.3 Liquid Waste Handling

Because of the multiplicity of locations generating hazardous liquid waste, it is likely that the present collection and transportation system is the most cost effective method. However, the facilities for unloading at the present DWTF should be upgraded to provide containment for accidental spills and leaks.

5.3.1 Liquid Waste Handling - Precipitation

The oxidation, reduction and precipitation of metallic ions from liquid streams is based on well developed procedures taking into consideration the chemical nature of these metallic solutions. The selection of batch treatments will permit monitoring and reworking should the quality of the treated wastewater fail to meet discharge limitations and is an operationally flexible system. However, the procedures require long time to carry out and considerable manpower. The present system, while probably adequate to cope with the historical volume of wastewaters assigned to it, will not likely be capable of treating the larger volumes likely to result from future treatments scenarios. Furthermore, the system does not appear to meet criteria for containment of accidental spills and leaks and handling of rainwater that must be incorporated into a hazardous waste treatment facility.

5.3.2 Liquid Waste Handling - Solidification

Solidification of liquid waste for ultimate disposal into near surface landfills is not only required by regulations but is a well established technique for reducing the mobility of liquids in geological strata. It will undoubtedly continue to be an important technology in the management of hazardous waste. However, the present liquid waste solidification procedures could be improved significantly to reduce personnel exposure, direct handling and, probably, improve the quality of the solidified products. In particular, consideration should be given in the future operation of solidification procedures to meet expected increased limitations on the types of materials allowed to be

solidified, e.g., oils and organic compounds are likely to be facing regulations prohibiting introduction into landfills even though solidified.

5.4 Incineration

The batch, two-stage incinerator at LLNL is essentially a low capacity, manually operated unit that will not meet RCRA regulations for incineration of hazardous wastes. By virtue of knowledgeable and dedicated operators and close administrative control of the materials to be incinerated, it may be doing a satisfactory job of destroying hazardous components of the waste with a greater than 99.99 percent efficiency. However, even with the installation of continuous emission monitoring equipment and other controls now required under EPA regulations for incineration of hazardous wastes (See Report DCS 243-018-03 by Radian Corporation), the limited capacity of the present incinerator would restrict severely the future use of incineration as a method for effecting destruction of hazardous materials and reduction in volume of wastes going to off-site disposal.

5.5 Size Reduction

The crushing of drums and the compaction of voluminous solid wastes are procedures that will always be considered in a facility where significant volumes of waste must be transported either to a landfill or other treatment sites. The present operations, however, need to be improved in order to ensure against accidental emissions and improve the productivity of operating personnel.

6. ASSESSMENT OF TREATMENT TECHNOLOGIES

To develop a rational basis for the selection of hazardous waste treatment technologies at a site requires knowledge of the types of wastes and quantities to be treated. Various waste characteristic classifications schemes have been developed by regulatory agencies, such as the EPA's list of hazardous wastes, including such tests as ignitability,

corrosivity, reactivity and EP (Extraction Procedure) toxicity. Others, such as the University of California at Davis, have developed two and three digit waste categories into which wastes from a diversity of sources might be classified. These characterizations have been developed, usually, from the viewpoint of the regulators and not from the viewpoint of the operator of a hazardous waste management complex. Since the operator of a hazardous waste control facility is interested principally in selecting the treatment technologies most applicable to the wastes to be treated, we believe that a simplified waste characterization system is more useful. Inspection of the various waste classification systems and review of the waste source at LLNL has lead us to establish the list of principal classes of toxic and hazardous wastes shown in Table G-1. Class 13, halogenated organic residuals, includes polychlorinated biphenyl (PCB) contaminated wastes.

Taking into consideration the physical and chemical characteristics of these waste classes and the limitations these characteristics impose on various treatment processes, we next prepared a matrix comparing the relative merits of various waste treatment technologies for each waste class. The ratings shown in Table G-2 are based upon the utilization frequency throughout the hazardous waste management field which reflects the relative merits of the processes. In Table G-2 we have not considered land burial as a technology since it should be, in our opinion, a management choice only where the long-term potential risks to the environment from the land burial site are at a level acceptable to society. In other words, we have considered that the treatment technologies assessed in Table G-2 should be considered for their merit in (1) the recovery of valuable resources, (2) the reduction or destruction of wastes to their lowest degree of hazardousness or (3) preparation in a form which will have the least probable long-term risk of polluting the environment.

In Table G-2, we have indicated three levels of utilization - most frequently used, secondary level of utilization, and rarely used. Inspection of this table indicates that thermal processing - notably incineration - is a leading technology because high temperatures can

TABLE G-1

CLASSES OF HAZARDOUS WASTES

Class	Description
1	Organic sludges and still bottoms
2	Solvents and organic solutions
3	Oils and greases
4	Oil and water mixtures
5	Organic and oily wastes
6	Metal solutions and residuals
	a. Solutions b. Sludges and other residuals
7	Miscellaneous chemicals and products
8	Paint and organic residuals
9	Aqueous solutions with organics
10	Anion complexes
11	Inorganic sludges and residuals
12	Pesticides and herbicide wastes
13	Halogenated organic residuals
14	Clean-up residuals
15	Acids
16	Alkali
17	Waste waters not elsewhere classified

TABLE G-2

RANKING OF APPLICABILITY OF TECHNOLOGIES TO HAZARDOUS WASTE CATEGORIES

Legend

*** Most frequently used
** Secondary Level of Utilization
* Rarely used

	(1) Organic Sludges and Still Bottoms	(2) Solvents and Organic Solutions	(3) Oils and Grease	(4) Oil and Water Mixture	(5) Organic and Oily Wastes	(6A) Metal Solutions	(6B) Metal Sludges and Other Residuals	(7) Miscellaneous Chemicals and Products	(8) Paint and Organic Residuals	(9) Aqueous Solutions with Organics	(10) Anion Complexes	(11) Inorganic Sludges and Residuals	(12) Pesticides and Herbicides	(13) PCB Residuals	(14) Cleanup Residuals
Air Stripping										**					
Suspension Freezing							*								
Activated Carbon Adsorption				*	*	*				***	*		**		
Centrifugation				***	**		**					**			
Crushing/Grinding/Shredding													**		**
Cryogenics															
Dialysis						*					*				
Distillation		***		**	**			**		**					
Electrodialysis						*									
Electrophoresis						*				*					
Encapsulation	**		**		**		**		*.			**	**	**	**
Evaporation	**	**			*	***	**		*		**	**			
Filtration	*			*			**					**			
Flotation				***	*		*			*					
Freeze Crystallization		*				*		*		*					
Freeze Drying															
High Gradient Magnetic Separation							*								
Resin Ion Exchange						***					**				
Liquid Ion Exchange						*		*							
Steam Distillation	*	**			**			**		**					
Resin Adsorption										**			**	*	
Reverse Osmosis						**				**	**				
Sedimentation				***			*					*			
Liquid-Liquid, Liquid-Solid Extraction		**	**	**		**	*	**	*	*		*	*	*	
Ultrafiltration				***	**					*					
Zone Refining															
Thermal Processing [Calcination, Sintering; Incineration]	***	***	***	***	***		**	***	***	*	*		***	***	**
Catalytic Conversions								*		*	**		**	***	
Chlorinolysis		*			*			*	*				*		
Dissolution							*					**			
Electrolysis						**									
Microwave-Ultraviolet Discharges								*		*	*		*	*	
Neutralization						***					**				
Oxidation	*					***		**		**	***		**	**	
Ozonolysis				*		*		*		**	**		**	**	
Photolysis								*		*	*		*	*	
Precipitation						***									
Reduction						***					**				
Biological Process (Aerobic, Anaerobic)	*	*		**		*		*		***	*		**	**	

breakdown hazardous organic molecules into substances of less environmental concern. The effectiveness of oxidation, reduction and precipitation such as employed at LLNL place them among the leading technologies for treatment of water streams containing hazardous materials. As the level of utilization of technologies declines, it is found that the applicability becomes more narrowly focused so that specific conditions must prevail before they are used in hazardous waste management.

7. ESTIMATED WASTE GENERATION RATES

There are two compilations of waste stream sources and generation rates at the Lawrence Livermore National Laboratory site. The first compilation is a report by Richard A. Heckman, "A Preliminary Analysis of Toxic and Radioactive Hazardous Waste Streams Generated by LLNL", UCID-20209, September 23, 1984. The data in this report were collected from the logbooks of buildings 514 and 612 which are waste treatment facilities operated by the Toxic Waste Control Group (TWCG). The second compilation of waste stream data was tabulated in a May 1984 report by Radian Corporation and was based on the results of a building survey on waste material generation throughout the Livermore and Site 300 areas.

In UCID-20209 the information was taken from logbooks covering a six month period, February 1984 through July 1984. These records included a three month period, March through May, when all liquid streams were inventoried into the building 514 logs, i.e. information on those liquid waste streams not treated on the site but shipped offsite to commercial disposal sites was also logged. From the raw data, batches of similar wastes were aggregated and labelled with a stream identification number and an estimated annual rate of current generation. Stream identification numbers which contain the letter "R" identify radioactive waste strams. Projected annual rates of generation, over a five year period, were based on estimates by LLNL staff of the likely growth of various programs. Tables G-3 and G-4 are summaries of the current and projected rates of annual waste generation by class for radioactive and nonradioactive wastes respectively. A detailed discussion of the liquid waste stream data is found in Appendix G-A. Nonradioactive solid wastes generated at LLNL were placed in class 14 of Table G-4. Radioactive solids are not included in Table G-3; solid waste data is discussed and tabulated in Appendix G-B.

The Radian report gives the source of waste material by building, a general description of the type of waste, the quantity, and method of treatment, storage and disposal. Little information is given on waste composition and component concentrations. In Appendix G-C is a comparison of the Radian information with that of UCID-20209.

TABLE G-3

TOTAL RADIOACTIVE WASTE GENERATION RATES

BY CLASS AT THE LLNL SITE

	Waste Class	Current* Generation L/yr	Projected* Generation L/yr
1.	Organic Sludges/Still Bottoms	0	0
2.	Solvents and Organic Solutions	4,336	5,269
3.	Oils and Greases	77	90
4.	Oil and Water Mixtures	59,176	105,268
5.	Organic and Oily Wastes	0	0
6.	Metal Solutions and Residuals		
	a. Solutions	246,830	478,017
	b. Sludges and Residuals	0	0
7.	Miscellaneous Chemicals and Products	0	0
8.	Paint and Organic Residuals	0	0
9.	Aqueous Solutions with Organics	1,632	1,958
10.	Anion Complexes	0	0
11.	Inorganic Sludges and Residuals	0	0
12.	Pesticides and Herbicide Wastes	0	0
13.	Halogenated Organic Wastes	0	0
14.	Clean-up Residuals	**	**
15.	Acids	0	0
16.	Alkali	0	0
17.	Wastewaters not elsewhere classified	16,625	21,304

* These generation rates are consistent with the methodology used in UCID-20209, however, these should be considered approximations only.

** Not Available

TABLE G-4

TOTAL NONRADIOACTIVE WASTE GENERATION RATES

BY CLASS AT THE LLNL SITE

	Waste Class	Current* Generation L/yr	Projected* Generation L/yr
1.	Organic Sludges/Still Bottoms	6,592	9,888
2.	Solvents and Organic Solutions	42,728	104,323
3.	Oils and Greases	57,737	80,813
4.	Oil and Water Mixtures	1,263	2,273
5.	Organic and Oily Wastes	2,540	4,018
6.	Metal Solutions and Residuals		
	a. Solutions	7,632,557	12,406,657
	b. Sludges and Residuals	2,648	4,766
7.	Miscellaneous Chemicals and Products	19,932	34,186
8.	Paint and Organic Residuals	0	0
9.	Aqueous Solutions with Organics	59,010	110,004
10.	Anion Complexes	1,824	3,305
11.	Inorganic Sludges and Residuals	60	60
12.	Pesticides and Herbicide Wastes	0	0
13.	Halogenated Organic Wastes	15,183	21,586
14.	Clean-up Residuals	50,620[1]	100,745[1]
15.	Acids	376	450
16.	Alkali	326	439
17.	Wastewaters not elsewhere classified	24,368	28,912

[1] Rate in Kg yr.

*These generation rates are consistent with the methodology used in UCID-20209, however, these should be considered approximations only.

8. BASES FOR SELECTION AND DESIGN OF TREATMENT PROCESSES

8.1 Bases for Process Selection

The diversity of hazardous and low-level radioactive wastes to be disposed of at LLNL coupled with the relatively small quantities generated requires that the DWTF have maximum flexibility to treat these wastes for disposal. The treatments should ensure that all streams leaving the site meet regulatory limitations and reduce the potential for incurring contingent liability through the actions of others such as off-site disposers. Based on the estimated future quantities of wastes, (Table G-3 and G-4) it seemed apparent that the treatment equipment and processes should be selected on the basis of intermittent operations. This mode of operation will provide the greatest flexibility for handling the diversity of wastes generated at LLNL. Not only will this approach result in a facility with the flexibility of dealing with unanticipated wastes types or increased quantities but also it permits incremental installations of equipment to increase the degree of treatment to meet either increasingly stringent regulatory limits or revised laboratory policies. In the following paragraphs are described the technologies recommended for installations in a new toxic waste control facility and the bases for their selection.

In developing the conceptual process flow schemes (Drawing 53299-1 to -11) and selecting the types of treatment we were guided not only by our consideration of the applicability of generally available, proven technologies, but also by the broad guidelines that various levels of treatment should be considered for their future capability to meet expected increasingly stringent regulations for the disposal of toxic and hazardous wastes provide LLNL with the options of exercising maximum control of treatment at the LLNL site. Premises and assumptions made in the course in this work were as follows:

(1) As in the present TWC, no high-explosives solid wastes will be treated at the DWTF facility.

(2) Only those Site 300 wastes presently brought to the laboratory for treatment or introduction into the City of Livermore's POTW will be considered for treatment at the DWTF.

(3) The treatment or processing of radioactively contaminated wastes should be carried out separately from the non-radioactive wastes.

(4) The present discharges to the Livermore POTW are near the limits of total dissolved solids and future treatments in the DWTF should be capable of reducing these concentration levels.

(5) The discharges into the Livermore POTW from the treatment of metal containing streams at the DWTF should meet the concentration limits specified by the U.S. EPA in 40 CFR 433 for a Metal Finishing point source category and 40 CFR 413 for Electroplating point source category. Large volume streams from rinsing presently discharged to the POTW will not be handled in the DWTF as these can meet discharge limitations with minor improvement in operations. In addition, the LLNL discharges shall meet the sewer ordinance limits imposed by the City of Livermore.

(6) The principal control of tritium emission will not be the responsibility of the DWTF.

Upon considering the type of equipment for treatment of toxic and hazardous wastes at LLNL it became apparent that the leading technologies identified earlier could be installed in various combinations and at various times to accomplish different objectives. There are, however, certain technologies for decontamination and size reduction of radioactively contaminated equipment such as tools, glove-boxes, etc. that must be installed if LLNL is to meet DOE criteria for the management and disposal of low level radioactive waste. These are:

1. A facility for the reduction in size of glove-boxes removed from operation. This facility is needed to reduce glove boxes to sizes more compatible with requirements for shipment to a disposal site such as the Waste Isolation Pilot Plant (WIPP) in New Mexico and to minimize the volume required at the disposal site. These facilities can be based on the designs developed at Los Alamos National Laboratory and the Rocky Flats plant. Compaction of loose Low Specific Activity (LSA) and TRU wastes and crushing of radioactively contaminated drums for off-site shipment should be continued.

2. The decontamination facility should be based on the present technologies but with updated designs. The proposed technologies are (a) chemical/steam cleaning, (b) electropolishing, (c) grit blasting, (d) vapor degreasing and (e) ultrasonic cleaning. The present bake-out ovens for tritium and mercury removal should be installed at the facility handling the major sources of tritium.

3. A drum rinsing facility for nonradioactive toxic and hazardous wastes should be included in order to permit the reuse of drums.
The installation of treatment technologies for the toxic and hazardous waste streams coming from both radioactive and non-radioactive sources can be approached at several levels. The objectives of each ensuing level will be the capability to exercise increasing control over the treatment and destruction of toxic and hazardous wastes thereby reducing the dependency on outside contractors for disposal of LLNL wastes. The first level should ensure that the DWTF meet presently established RCRA regulations and meet the limitations imposed on air emissions and water effluents. Furthermore, the DWTF should be capable of handling specialized problems such as the conversion of stockpiled uranium metal into oxides for disposable. The course of action recommended for Level I is as follows:

a. Upgrading of controls for the presently installed controlled-air incinerator to meet EPA and state of California requirements for hazardous waste incinerators. This will not, however, permit the incineration of wastes not now approved for

this incinerator. Furthermore, incineration of tritium containing wastes should be restricted if every effort is to be made to reduce further the emissions of tritium. The major purpose of this action is to permit rapid compliance with RCRA regulations during the time required to carry out the design and construction of more up-to-date incinerators.

b. Chemical treatment and precipitation utilizing the well-established techniques for rad and non-rad liquids should be an important part of Level I treatment. Reverse-osmosis should be added for concentration of the liquid streams highest in total dissolved solids to ensure that effluent limitations for electroplating and metal finishing point sources are achieved and to meet the POTW limitations on total dissolved solids.

c. Ultrafiltration concentration of oily waste waters containing radioactive particulates was chosen to reduce the volume of the liquids requiring solidification prior to shipment to a low-level radioactive waste management site. A separate facility was not designed for treating nonradioactive oil/water mixtures because only very small quantities of these wastes are generated and it was assumed that they could be incinerated.

d. In anticipation of increasingly stringent limitations on the disposal of sludges and filter cakes, especially the assurance that liquids will not be expressed when put into a landfill, the use of high pressure filtration is recommended in order to produce filter cakes with low residual moisture contents.

e. The installation of a burn box for the oxidation of depleted uranium independent of the present incinerator to permit the work-off of stored materials.

f. An enlarged and operationally improved solidification facility to meet an anticipated need for greater future use of this technique.

g. The installation of an analytical laboratory under the control of the DWTF. This laboratory to be equipped to analyze the wastes coming into the DWTF for treatment, determine the composition of treated wastewater streams and develop the documentation necessary under RCRA.

For Level II, the technologies utilized and treatments carried out would reduce significantly the quantities and types of non-rad wastes leaving LLNL for treatment or disposal by others as well as increase the potential for recycle or reuse. In addition to the treatment systems installed at Level I, the following would be required.

a. A rotary kiln incinerator for the thermal destruction of hazardous, non-radioactive organic wastes. This incinerator to be equipped with a shredder capable of shredding metal drums that are now compacted and, often, combined with low-level radwastes destined for the NTS. The incinerator and its off-gas system to be designed to RCRA regulations for the thermal destruction of organic chlorides including halogenated organics.

b. The Recovery for Reuse of Spent Solvent.

Reclamation of spent solvents for reuse is widely employed in industry and equipment packages are available for easy installation. However, segregation of solvents would probably be required and a determination made of the economic viability of reclamation. If not reuseable, the solvents could be incinerated at Level II.

The highest level of treatment technologies, Level III, would encompass those treatments utilized at Levels I and II and, in addition, would be designed and operated in a manner which would ensure that any toxic and hazardous waste-related materials would leave LLNL in a form which has the minimum potential for entering the biosphere over several millennia. The Level III treatment would include:

a. A radioactive waste incinerator for the destruction of all organic substances prior to solidification of the remaining inorganic materials in a highly leach resistant form. Included with this incinerator would be an off-gas treatment system which will permit the destruction of halogenated organics and which can, on an intermittent basis, remove appreciable quantities of tritium from off-gases when destroying batches of wastes known to contain tritium.

b. Installation of a laundry for cleaning of radioactively contaminated clothing thereby reducing further the dependency upon outside contractors.

c. Evaporation, crystallization and solidification of the inorganic compounds generated or removed during the course of Level I and II treatments. These solidified forms would be expected to meet the most stringent limitations likely to be imposed.

8.2 Bases for Process Design

To establish bases for preliminary sizing of process equipment, we estimated the quantities of each class of waste to be treated by the waste treatment operations chosen for each of the three levels of treatment. Our initial estimates of the quantities of waste to be handled by the various methods of treatment are shown in Table G-5. The quantities shown in this table are based on the projected UCID-20209 stream rates shown in Tables G-3 and G-4 and the following rationale for treating these wastes.

- For organic sludges (Class 1), oils and greases (Class 3), miscellaneous chemicals (Class 7), and halogenated organic wastes (Class 13), Level I treatment represents the current level of waste treatment in which there is no onsite treatment. Level II and III treatment of such wastes would involve onsite destruction by incineration. Very small quantities of radwaste, 90 L/yr, falls into these classes. Radioactively contaminated oils are

TABLE G-5

ESTIMATE OF PROJECTED QUANTITIES FOR VARIOUS TREATMENT

	CHEMICAL TREATMENT OF LIQUIDS				INCINERATION				SOLVENT DISTILLATION		REVERSE OSMOSIS			
	RAD		NONRAD		RAD		NONRAD		RAD	NONRAD	RAD	NONRAD		
	Class	L/yr	Class	L/yr	Class	L/yr	Class	L/yr	Class L/yr	Class L/yr	Class L/yr	Class L/yr	Crystallization	Vapor Compression Evaporation
Level 1	(4)	102,772[1]	(6a)	918,975	(2)	4,872	(2)	34,307			6(a)	478,017	6(a) 2,943,358	
	(6a)	478,017	(16)	144			(5)	111						
					(9)	1,958	(9)	3,662						
					(14)	NA[3]	(14)	100,745[2]						
					(17)	12,124								
Level 2	(4)	105,268	(4)	2,273	(1)	0	(1)	9,888	(2) 0	(2) 19,310	6(1)	478,017	6(a) 2,943,358	
	(6a)	478,017	(6a)	918,975	(2)	4,872	(2)	85,013						
			(6b)	4,366			(3)	80,813						
			(10)	3,305			(5)	4,018						
			(15)	400	(7)	0	(7)	34,186						
			(16)	439	(9)	1,958	(9)	110,004						
							(33)	21,586						
					(14)	NA[3]	(14)	100,745[2]						
					(17)	12,124								
Level 3	----------Same classes as Level 2 (same quantities treated)----------										---------- Further treatment of waste streams (quantities depend on Level 2 treatment) ----------			

[1] An aggregate of some treated and untreated wastes.

[2] Rate in kg/yr.

[3] Labwide LSA wastes not described; most may be candidates for incineration.

incinerated at Level III only. Major nonrad waste streams that fall into these classes include waste sludges, epoxy resins and monomer from the plastic shop and building 443, waste oils from salvage, and halogenated organics contaminated oils also from salvage.

- Level I treatment of solvents/organic solutions, organic/oily wastes, and organic/water solutions represents the current treatment of Class 2, 5 and 9 wastes, i.e., nonhalogenated organic mixtures are incinerated. Level II and III treatment will allow for incineration of the chlorinated organics and freon wastes which are currently shipped offsite for disposal. The only radioactive wastes incinerated in Level I are those contaminated with tritium, C^{14}, and K^{32}. Level III allows for incineration of other radioactive wastes.

- The DWTF is envisaged to be capable of handling and treating nearly all Class 4 oil/water wastes at all levels of treatment. The separated or concentrated oils and aqueous liquids are then treated as Class 1 and 6a liquid, respectively. Amounts of oils to be disposed of offsite are difficult to determine because the oil water waste streams are aggregates of many streams containing from less than 2% oil to 99% oil.

- Levels I, II, and III are anticipated to be able to chemically treat nearly all aqueous wastes contaminated with heavy metals. Only very concentrated aqueous wastes e.g., concentrated nitric acid solutions, would be directly solidified. Levels I, II, and III treatment will incorporate reverse osmosis to reduce the volume and/or concentrate for chemical treatment the wastes currently shipped offsite for disposal. These streams include the large ion exchange regeneration wastes, spent solutions and rinse waters from plating, circuit board, and photochemical operations. Streams that are currently directly sewered remain untreated since it was assumed that these met Livermore POTW regulations as well as EPA and State of California effluent limitations. All filtrate streams

from liquid chemical treatment will be sent through the reverse osmosis unit; these numbers are included in the projected reverse osmosis rates.

- Levels I, II, and III treatment will incorporate chemical treatment of reactive anion solutions (Class 10) containing chemical species such as cyanide, and aqueous acids (Class 15) and bases (Class 16).

- Tritium contaminated wastes (Class 17) are incinerated at all treatment levels. Other Class 17 wastes are sewered.

Because some of the waste streams listed in UCID-20209 are expected to be dischargeable to the Livermore POTW following monitoring or sent off-site because of special considerations such as high solids contents, we have prepared Table G-6 which shows our estimate of the projected rates of untreated wastes by waste class at the current level of treatment versus that of Levels I, II and III treatment at the DWTF. The projected rates do not include the brine liquids from the reverse osmosis unit which are sent offsite. Tables G-7 and G-8 show the amounts of Class 6a liquids being sewered versus those being disposed of offsite. These figures include brine liquids being sent offsite. Because of more liquids being treated at a new Level I facility, there will be more liquids from the rad area going to solidification for off-site disposal than are now solidified. The sewered streams from Level I treatment, however, will be much lower in TDS. Figures G-7 and G-8 graphically show the distribution of liquids and solids in the various treatment options.

TABLE G-6

PROJECTED RATES OF UNTREATED WASTES[1]
(L/YR)

	Current		Level I		Level II		Level III	
	Rad	Nonrad	Rad	Nonrad	Rad	Nonrad	Rad	Nonrad
1	0	9,888	0	9,888	0	0	0	0
2	397	70,016	397	70,016	397	0	0	0
3	90	80,813	90	80,813	90	0	0	0
4[2]	2,496	2,273	0	0	0	0	0	0
5	0	3,907	0	3,907	0	0	0	0
6a	75,000	14,367,020	56,000	12,342,299	56,000	12,342,299	56,000	12,342,299
6b	0	4,766	0	0	0	0	0	0
7	0	34,186	0	34,186	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	106,342	0	106,342	0	0	0	0
10	0	3,305	0	0	0	0	0	0
11	0	60	0	60	0	60	0	60
12	0	0	0	0	0	0	0	0
13	0	21,586	0	21,586	0	0	0	0
14	NA	0	NA	0	NA	0	NA	0
15	0	400	0	0	0	0	0	0
16	0	295	0	0	0	0	0	0
17	9,180	28,912	9,180	28,912	9,180	28,912	9,180	28,912
Total	86,320	11,830,662	9,667	9,761,006	9,667	9,492,271	9,180	9,492,271

(1) Untreated wastes include those streams that are directly sewered, solidified, or sent offsite. The projected rates do not include the brine liquids from the reverse osmosis unit which are sent offsite.

(2) Oil water mixtures are concentrated by UF or separated. Separated nonrad oils are shipped offsite for Level 1 and 2 treatment.

TABLE G-7

PROJECTED RATES OF CLASS 6A
NONRAD LIQUIDS GOING OFFSITE
(Liters/Year)

Stream I.D. #	pH	Current		Level 1	
		To Sewer	Offsite Disposal	To Sewer	Offsite Disposal
L03TA	7	9,430,000		9,430,000	0
Retention Tank Liquids		2,879,000		2,879,000	0
L01TA	13.1		1,111,000	944,000	167,000
L01TB	12.4		163,000	139,000	24,000
S11TB	7.4	363,000		309,000	54,000
L06TD	5.4	33,000		28,000	5,000
L06TB	3		25,000	21,000	4,000
L06TBD	1.5		6,000	5,000	1,000
L04TA	1	349,000		300,000	49,000
L04TF	2	461,000		392,000	69,000
L17TA		109,000		93,000	16,000
L03TD	0.67		333,000[1]	283,000[1]	50,000[1]
15 Misc Streams			24,000	20,000	4,000
Total		13,624,000	1,662,000	14,843,000	443,000

[1] Assumed Value

TABLE G-8

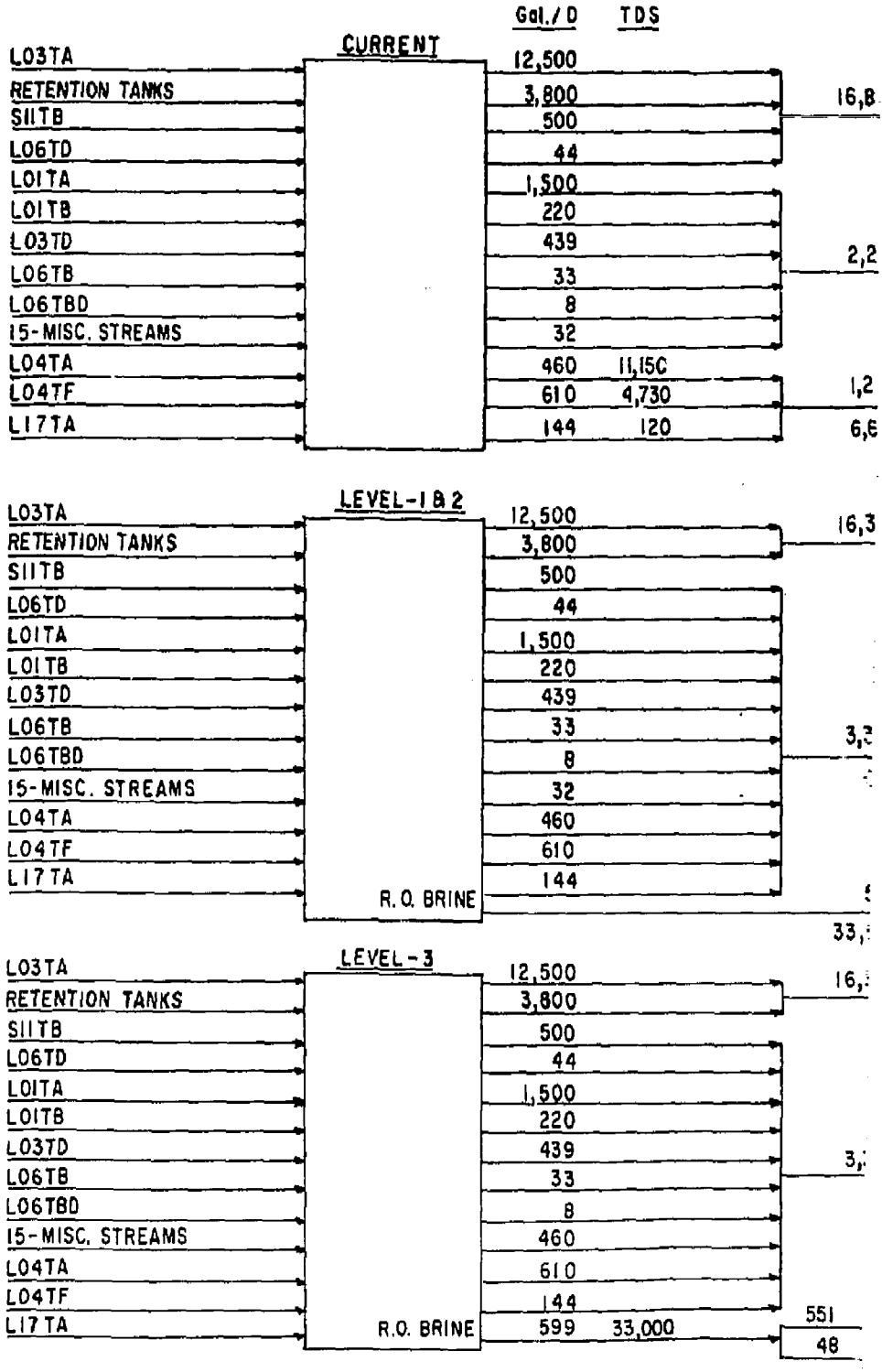
PROJECTED RATES OF CLASS 6A
RADIOACTIVE LIQUIDS GOING OFFSITE
(Liters/Year)

Stream I.D. #	pH	Current		Level 1	
		To Sewer	Offsite Disposal	To Sewer	Offsite Disposal
L01TRTA	1	65,000		55,000	10,000
L03TRC	1.7	39,000		33,000	6,000
L10TRF	1.7	136,000		116,000	20,000
L12TRAI	4	18,000		15,000	3,000
L13TRB	<1		56,000		56,000
L13TRG	<1-8.4	129,000		110,000	19,000
L17TRBA	6.2	15,000		13,000	2,000
12 Misc Streams		19,000[1]	19,000[1]	35,000[1]	3,000[1]
Total		421,000	75,000	377,000	119,000

[1] Assumed Value

FIGURE - G7

COMPARISON OF WASTE TREATMENT SCENAR
OF CLASS-6a NONRADIOACTIVE LIQUIDS



To convert from Gal/D to Liters/Yr multiply by 758.

IGURE – G7

-TE TREATMENT SCENARIOS

-NRADIOACTIVE LIQUIDS

S

16,844 Gal./D → DIRECTLY SEWERED

2,232 Gal./D → OFFSITE DISPOSAL

0
30
20

1,214 Gal./D
6,620 ppm → SEWERED AFTER PRECIPITATION

16,300 Gal./D → DIRECTLY SEWERED

3,391 Gal./D
400 ppm → SEWERED AFTER PRECIPITATION AND REVERSE OSMOSIS

599 Gal./D
33,000 ppm → OFFSITE DISPOSAL

16,300 Gal./D → DIRECTLY SEWERED

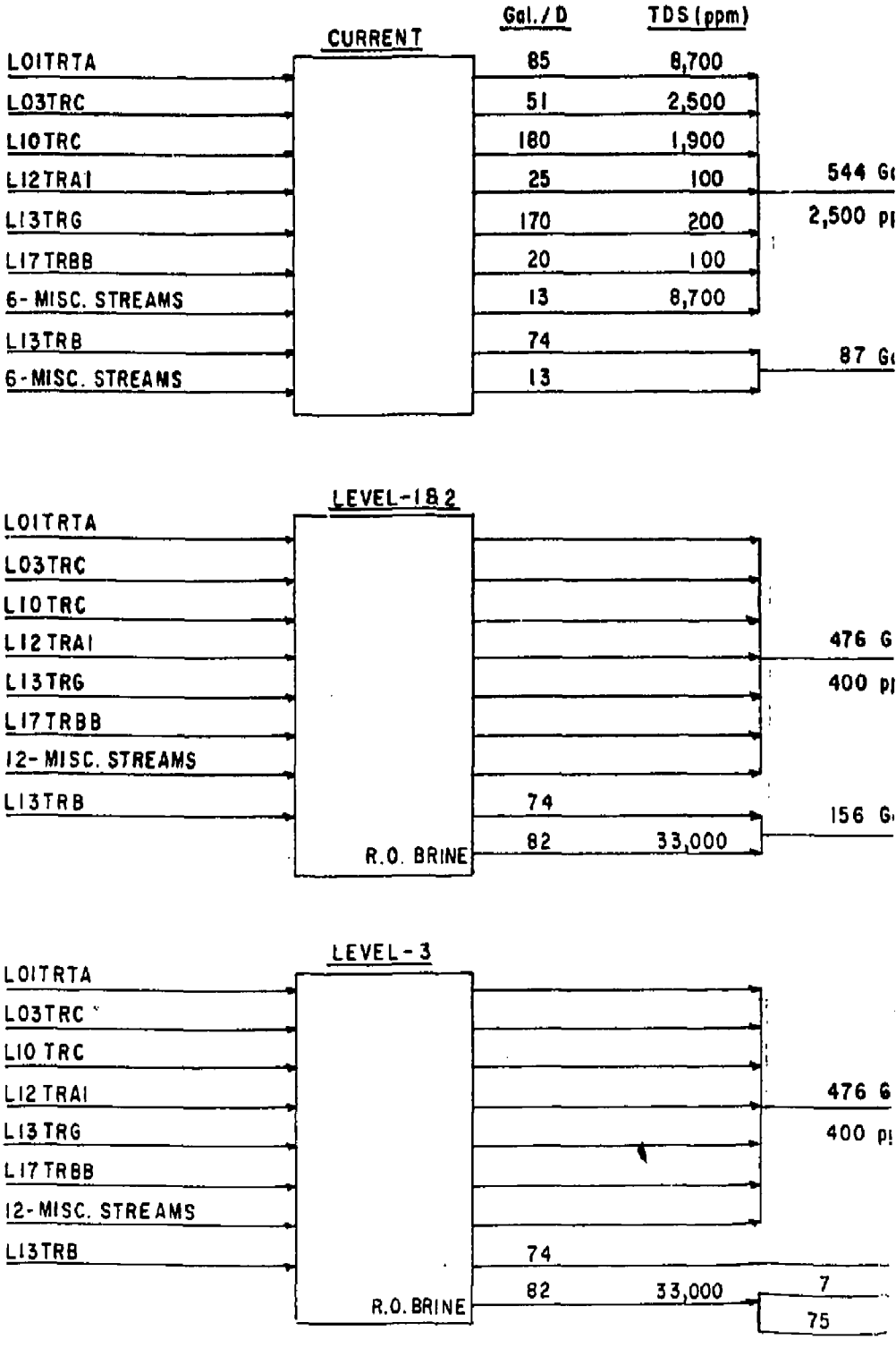
3,391 Gal./D
400 ppm → SEWERED AFTER PRECIPITATION AND REVERSE OSMOSIS

00

551 10
48 400,000 → SEWERED FROM EVAPORATION BRINE (OFFSITE DISPOSAL)

FIGURE - G8

COMPARISON OF WASTE TREATMENT S
OF CLASS-6a RADIOACTIVE LIC

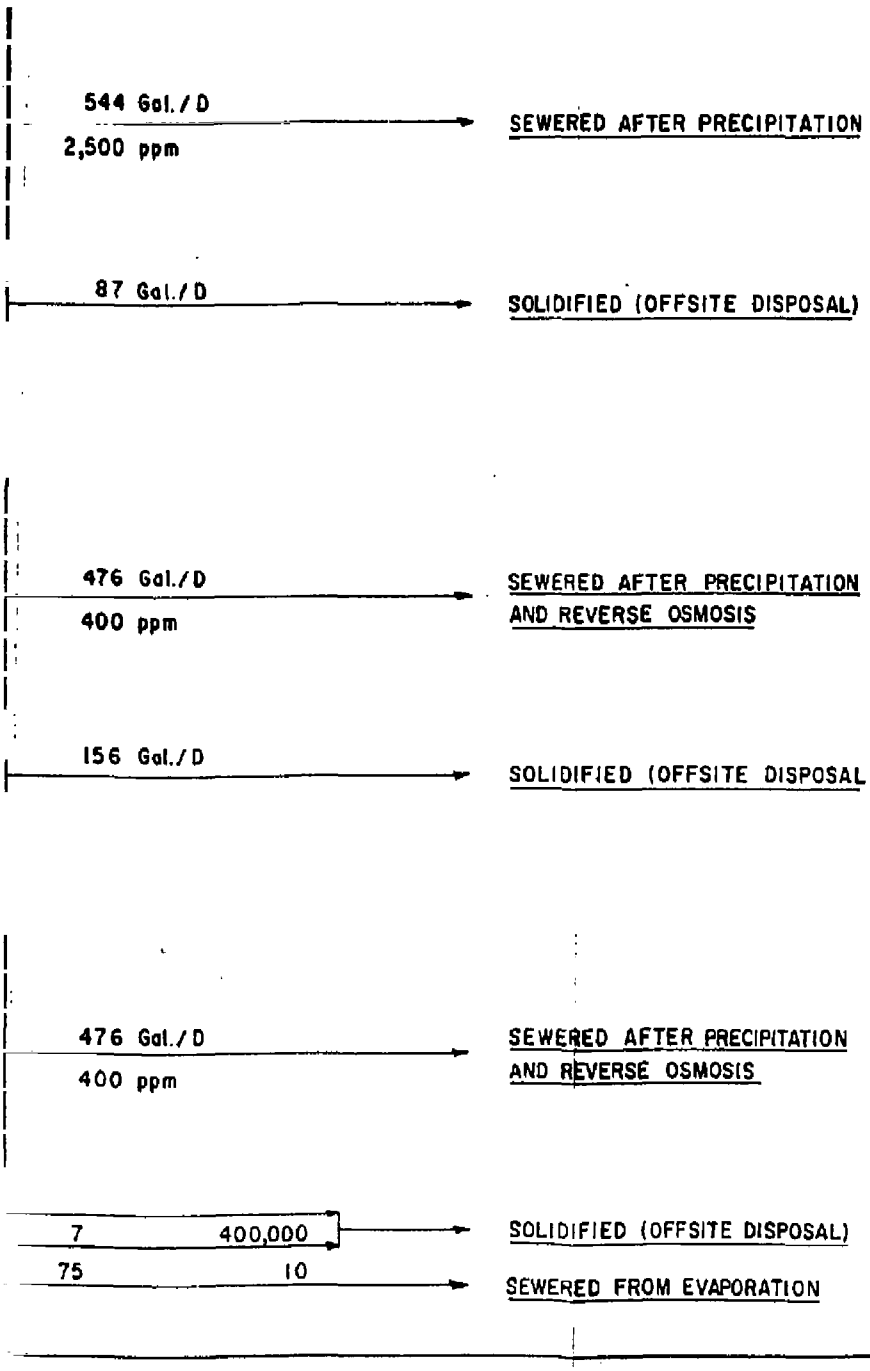


: To convert from Gal/D to Liters/Yr multiply by 758.

RE - G8

TREATMENT SCENARIOS

:OACTIVE LIQUIDS



9. CONCEPTUAL DESIGN FOR DWTF PROCESSES

The necessity for the DWTF to deal with low-levels of radioactive wastes as well as the many and varied wastes streams that are subject to RCRA regulations while ensuring that water effluents and air emissions meet the stringent State of California regulations requires not only a variety of process equipment but also a knowledgeable and dedicated staff to utilize the equipment.

9.1 Regulatory Bases

In developing the conceptual designs for the DWTF we were guided by the need to meet all or part of the following regulations when taking into consideration the February 22, 1984 "Memorandum of Understanding Between the U.S. Department of Energy and the U.S. Environmental Protection Agency for Hazardous Waste and Radioactive Mixed Waste Management."

State of California Administrative Code, Title 22, Chapter 30, Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes.

Interim Status Document Number CA 28 90012584 of May 16, 1983 granted to LLNL by the State of California Department of Health Services. This granted for Hazardous Waste Treatment, Storage and Disposal of Utilities - 40 CFR-265.

Hazardous Waste Treatment Storage and Disposal Facilities - 40 CFR-264; (Especially), Subpart J- Tank
Subpart O- Incineration, especially Section 264.343a which requires 99.99% Destruction Removal Ffficiency (DRE) for Principal Organic Hazardous Constructions (POHC)

Section 264.343b Limiting Emission of HCl to 1.8 Kilograms per hour or 1% of the HCl in the stack prior to cleaning.

Section 264.343c Limiting the emission of particulates to 180 mg/Dry Std Cubic Meter (0.089 grains/dry Std Cubic Foot).

California Health and Safety Code Division 26, Part 4, Chapter 3, Article 7 which recommends incineration of toxic waste materials.

Ordinance No. 1134 of the City of Livermore, CA Relating to Control and Operation of the Sewage Collection and Treatment System.

U.S. Environmental Protection Agency Effluent. Guideline and Standards for Metal Finishing 40 CFR 433 - October 3, 1983.

U.S. Environmental Protection Agency Effluent Guidelines for Standards for Electroplating, 40 CFR 413 - September 26, 1983.

U.S. Department of Energy Order - DOE 5820.2 - Radioactive Waste Management - February 2, 1980

San Francisco Operations Office - U.S. DOE, San MD No. 54801.A. CHX1 Requirements for Radiation Protection - March 21, 1983.

ibid - San MD No. 54802 - Hazardous and Radioactive Mixed Waste Management

9.2 Process Bases

Since the volumes and masses of toxic and hazardous wastes are not large when compared with manufacturing facilities in industry, the DWTF should rely predominantly upon batch treatment. Although continuously

operating equipment may seem a desirable goal, the operational problems encountered in small size equipment processing streams of highly variable compositions are likely to be severe. Obviously, some hazardous waste management techniques by their nature must be batch operations or handled in discrete, stepwise sequences, e.g., the size reduction of glove-boxes, the decontamination of tools, the compaction of refuse, and so on. In developing the conceptual flowsheet designs for the DWTF, we have utilized engineering judgement to select continuous operations where we perceived that these might offer advantages in reducing the number of operating personnel or where continuous operation increased flexibility to meet expected future goals or increasingly stringent regulations.

We based our estimates of equipment sizes, shown in Drawing 53299-1 through -11, and expected performance characteristics upon typical engineering data; however, before preparation of final designs for the purchase and erection of equipment additional data should be developed. In Appendix G-E we have outlined the most important areas where design data should be developed. Furthermore, some of the process equipment such as reverse osmosis, and vapor compression evaporation may be available as package units rather than the designated components shown on the flowsheets.

In the following sections we discuss the operational bases for the conceptual flowsheets developed.

9.2.1 Decontamination

This important operation will occupy significant space and, in the process of decontaminating equipment, will generate some liquid and solid wastes from the chemicals used in decontaminating equipment and rinsing of drums, as well as the other operations of grit blasting, ultrasonic cleaning, vapor decontamination and electro-polishing.

Although these operations are presently used by LLNL and are widespread throughout the nuclear industry, the DWTF equipment should incorporate improved handability for operating personnel and make provisions for ensuring maximum cleaning of any airborne emissions. Therefore, we have indicated (Drawing 53299-1) the installation of appropriate condensers, filters, liquid collection tanks and so on; however, no sizes have been indicated since in some instances these are dependent upon the size of the chamber, e.g., the number and size of HEPA filters will depend upon the frequency of air changes in a decontamination chamber. Likewise, liquid wastes from decontamination may be best transported to the radwaste liquid treatment facility on a batch basis rather than installing pumps for pipeline transfer. A more detailed presentation will be found in Appendix J of the Holmes & Narver report.

9.2.2 Rad Liquid Waste Treatment

It is proposed that the oily water liquid wastes containing radioactive substances be treated by acid and heated to break emulsions (Drawing 53299-2). Decantation of the lighter and heavier fractions into a receiving tank is envisioned followed by ultrafiltration concentration of the remaining liquid. It is anticipated that the radioactive substances will be present as particulates and not as soluble substances. The filtrate is held for monitoring; if below the levels of permitted radioactivity and total dissolved solids, it could be discharged to the POTW. If not, it would be sent to the metal solution tank where it would be treated with the other aqueous radioactive wastes. (Drawing 53299-2).

The other major liquid radioactive waste treatment process is for aqueous solutions containing soluble chemicals especially heavy metals. LLNL has established procedures for the oxidation, reduction, precipitation, pH adjustment and so on for these wastes and these procedures should be continued in the DWTF equipment. The destruction of the cyanide ion through a procedure such as the use of sodium hypochlorite (rather than chlorine) at alkaline pH should be possible in the same equipment. These treatment steps, while removing large

quantities of heavy metals, are not likely to be capable of operating with a high degree of assurance of meeting recently established effluent guidelines for electroplating and metal finishing operations. Also, the chemical adjustments for pH control and metals precipitation add significant quantities of dissolved salts to the treated wastewaters. A discussion of the significance of these chemical treatments on the concentration of total dissolved solids is given in Appendix G-D.

Since LLNL's present discharges to the Livermore POTW are borderline with respect to meeting sewer ordnance limits on total dissolved solids (TDS), an additional treatment step based on the use of reverse osmosis for removing about 85 percent of the TDS as a concentrated brine is proposed. The reverse osmosis permeate, low in TDS, might be reused or sent to the POTW following monitoring. Drawing 53299-3, which depicts the flowsheet, includes estimates of equipment size; however, material balances are not shown because of the batch-type operations in the chemical adjustment and precipitation steps. This flowsheet encompasses storage volumes that should permit maximum flexibility in dealing with streams of varying compositions. In developing the estimate of tank sizes we were guided by our premise that all radioactive liquids would be transported to the DWTF and that batch operations during a 40-hour work week would be the preferred mode of operation. Because of the widely varying pH's of the streams and the paucity of information on the TDS concentrations of the incoming streams, we prepared estimates (Appendix G-D) of the TDS concentrations based on acid/base neutralization. These estimates indicated the concentrations are likely to be in the range of 3,000-5,000 parts per million (ppm). The proposed reverse osmosis (R.O.) unit should be capable of producing a permeate equal to 85 percent of the feed to the R.O. unit and this permeate should have a TDS concentration in the vicinity of 400 ppm. When joined with the other wastewaters discharged to the Livermore POTW, the TDS concentration should be below the limits of 325 ppm even if a relatively rapid discharge rate from the DWTF occurs. The R.O. concentrate is estimated to be 33,000 ppm, i.e., approximately equal to seawater in TDS concentration. Off-site disposal of these wastes should follow the same methods as now used for ion-exchange regenerants for Levels I and II

treatment. If a Level III treatment is adopted, these brine will be further concentrated to the point where the salts contained therein can be solidified as discussed more extensively in a following section.

The continuous operation of a reverse-osmosis unit is generally most desirable as it minimizes the impact of frequent start-ups and shutdowns; consequently, we have assumed that the reverse-osmosis pump might operate continuously although the capacity of the system might permit processing the required volume of wastewaters in one shift per day. It is for this reason that cooling in the recycle loop is shown in order to prevent high temperatures from resulting should the flow of permeate be stopped while the pump remains running.

Precipitated solids from chemical treatment are to be removed in a continuous flow clarifier/flocculator. Since these units can be shut-in with no significant difficulty they can, therefore, provide additional in-process surge capacity. The slurry of solids removed from the clarifier/flocculator is to be filtered in a filter press. Filter pressing (Drawing 53299-5) was selected because high pressure filtration is usually capable of providing a filter cake with lower residual moisture than the present rotary vacuum filters.

It is believed that the future disposal of filter cakes, especially into near surface landfills, must have a moisture content sufficiently low to prevent the expression of liquid by the mass of cover material emplaced at the landfill. However, the rotary vacuum filters presently found satisfactory for DWTF operations could be used if there is no reason to require a lower moisture-content filter cake.

9.2.3 Non-Radioactive Liquid Waste Treatment

The process flow diagram for treating non-radioactive liquid wastes, primarily Class 6a wastes, is shown in Drawing 53299-4. The tankage and other equipment sizes were based on handling the major nonrad streams with enough storage volume and flexibility for treating other streams coming into the facility. The tank storage area includes six vertical

tanks, a 7,000 gallon dedicated storage tank for receiving 1,100 gal/d of waste from the circuit board facilities (L04TA, L04TB) and five 3,000 gallon tanks which include a dedicated tank for receiving ion exchange regeneration wastes (L01TA, L01TB) to be treated in the RO unit, three nondedicated tanks for wastes to be treated by chemical precipitation, and one nondedicated tank for receiving wastes to be treated in the RO unit only. The system, as configured, must treat the circuit board wastes by chemical precipitation at least once per week (5,500 gallons/batch). Other liquid waste streams would be campaigned through the system in batches. The equipment downstream of the storage tanks is sized to be able to process 5,500 gallon batches of waste.

As with the rad waste liquids, solids precipitated in the chemical treatment tanks will be concentrated in a continuous flow clarifier/flocculator before being pumped to a filter press (Drawing 53299-5). After passing through the clarifier, the clear liquids can be pumped to the chemical adjustment tank for pH neutralization or back to a chemical precipitation tank for further treatment. Liquids not requiring chemical treatment are pumped directly to the chemical adjustment tank for pH adjustment. In this fashion, the chemical adjustment tank can be operated on a semi-continuous basis.

The purpose and operation of the nonrad reverse osmosis unit is similar to that of the rad unit. Sufficient surge tankage and cooling is provided to enable the system to operate continuously by recycling liquid.

9.2.4 Incineration

Incineration of organic hazardous waste in a well-designed and operated incinerator was selected as the most feasible technology for destroying these materials and thereby ensuring that there is no long-term potential for their migration into the biosphere such as is likely to occur from the best of near surface landfill disposal sites. Despite a proven high degree of destruction, the licensing of hazardous wastes incinerators under present RCRA regulations and under the intense

scrutiny of environmental activists is a long and arduous task. Nevertheless, we believe that the destruction and volume reduction achievable by high temperature incineration will be recognized increasingly as a technology which reduces the environmental risks from hazardous wastes. Consequently, we believe that the presently installed controlled air incinerator should be continued to be used but that its control system be upgraded to meet RCRA regulations in the interim period from now to construction of the DWTF. The details of such a modification are presented in Report DCN 243-018-03 of September 11, 1984 by the Radian Corporation.

For a second level of treatment, we recommend that a small rotary-kiln incinerator be installed to increase the capabilities for thermal destruction of hazardous waste. The versatility of the rotary-kiln incinerator for handling solids as well as liquids is well established and it is the incinerator type most often selected where a wide diversity of waste types are to be destroyed. The preliminary design of a rotary-kiln incinerator system depicted in Drawing 53299-6 is based on the premise that solids such as drums and other bulky objects would be shredded before incineration in order to improve the capabilities of this small size incinerator for handling these materials. The residence time of the gases in the high temperature zones (rotary kiln and afterburner) and the temperature levels (typically up to 2100°F) should permit achieving 99.999 percent destruction of the most refractory organic compounds such as polychlorinated biphenyls.

The off-gas cleaning systems for an incinerator destroying hazardous wastes containing e.g., chlorides, requires that it be capable of removing both particulates and noxious gases in order to meet air emission regulations. The system shown on Drawing 53299-7 is the one most frequently used. It includes quenching of the hot gases, caustic scrubbing in a venturi scrubber and a packed absorber for the removal of particulates and acid gases such as hydrogen chloride, sulfur dioxide and so on. This system should be capable of meeting regulations on discharges at LLNL, however, we expect that its performance might not be adequate should reactive metals such as sodium, potassium, and

phosphorus be burned or if materials containing large quantities of nitrogen compounds are present. The reason for this expected marginal performance is that these materials generate either smokes (submicron diameter particulates) or difficult to absorb gases (nitrogen oxides). The scrubber liquids, which will have a high concentration of dissolved solids and will contain particulates, will be sent to the liquid waste treatment system in the DWTF.

The ash and other residuals, such as metals, may be disposed of in a variety of ways. The shredded metal might be sold to scrap recyclers. The ash, depending upon its metals content, could either be sent to commercial landfills or solidified for disposal in hazardous waste landfills.

Shown on Drawing 53299-7 is an independent burn pan for the oxidation of depleted uranium metal. Although the uranium could be oxidized in the rotary kiln incinerator, installation of the simplified burn box arrangement patterned after an Oak Ridge design could be accomplished separately should a rotary kiln incinerator not be installed.

For a third level of treatment, the incineration of radioactively contaminated wastes (and the on-site treatment of reactive materials (other than high explosives) should be considered. Increasingly throughout the nuclear industry at sites such as the Idaho National Engineering Laboratory, Los Alamos, and Savannah River radioactive waste incinerators are installed to reduce the volume of wastes and make it possible to put the residuals, essentially inorganic substances, into leach resistance forms. The radwaste incinerator (Drawing 53299-9) design is based on the use of a controlled air unit similar to the present Environmental Control Products, Inc. unit that has been operated at LLNL since 1977. This type of incinerator has been installed at other sites and has a proven record of operation.

The wet off-gas cleaning system has been based on the premise that the incinerator should be capable of destroying organic chlorides (e.g., PVC plastics, etc.) and that it could be used for the treatment of reactive

materials such as the alkali metals, and so on. Therefore, we have shown on Drawing 53299-9 a pressure vessel into which reactive materials such as sodium, NaK, etc. might be reacted with, e.g., ethyl alcohol, water, etc., followed by subsequent incineration, if necessary. Since the thermal destruction of treated liquids containing substances such as sodium, are likely to generate smokes, we have indicated the usual quench tower with a relatively low pressure drop venturi scrubber followed by an absorber and a high-efficiency scrubber such as the Hydrosonic®.

The Hydrosonic Scrubber® is envisioned to operate at approximately 65°F in order to remove the maximum amount of water vapor from the off-gases prior to reheating for purge through HEPA filters and activated carbon adsorber (for the removal of iodine or similar radioactive species). This system should provide a high degree of flexibility for thermally destroying a variety of materials including those contaminated with tritium. For example, by operating the system with a minimum amount of scrubbing liquid, batches of tritum contaminated materials could be incinerated and the liquids containing the major portion of the tritium could be solidified (Drawing 53299-6) for disposal at approved low-level radwaste site. Likewise, the dry ash would be incorporated into a solid form for similar disposal.

9.2.5 Solvent Recovery

Drawing 53299-8 indicates a solvent recovery step that might be considered at Level II. The small volumes of solvents handled at LLNL can be reclaimed in a package reclamation system which is widely available. This is simply a batch distillation. The installation of solvent recovery might be economical if the recovered solvents are useable in the operations at LLNL. This would mean that the segregation of similar solvents would need to be practiced. If recovered solvents are not likely to result in economies, it is likely that they will be candidates for incineration in the rotary-kiln incinerator recommended for a Level II treatment.

9.2.6 Evaporative Concentration

The further reduction in the volume of wastes leaving the LLNL site can be achieved by a Level III treatment system for the further concentration of various streams such as the brines from reverse osmosis and scrubber blow down from incineration. Following Level II treatment, the liquid streams leaving the DWTF are principally water solutions of inorganic salts. Removal of the still large volumes of water can be achieved, by e.g., vapor compression evaporation followed by further concentration in a crystallizing evaporator (Drawing 53299-10). The condensate can be either reused or sent to the POTW. The highly concentrated slurry of crystals can be solidified (Drawing 53299-6) for disposal into approved geological sites. The indicated size of the vapor compression evaporation and crystallizing equipment will require further evaluations since it is highly dependent upon a number of variables such as the degree of neutralization required for acid and alkaline streams, the acidic components such as chlorine sulfur, etc. in the wastes that are incinerated and the concentration levels achievable in the reverse osmosis units. The vapor compression evaporation unit should be available as a package from equipment vendors. Again, users of this report are cautioned that there will need to be considerably more information developed on flowrates and concentrations in order to provide an adequate basis for sizing the equipment.

9.2.7 Radwaste Laundry

As a further way of reducing LLNL dependency upon outside sources for the management of hazardous wastes, the laboratory might install its own laundry for radioactivly contaminated clothing. This laundry, presumed to be installed as a Level III treatment step, would utilize the radwaste liquid treatment facilities for treatment of its wastewaters. Because of the high concentrations of detergents and chelants in laundry wastewaters their indiscriminate introduction into the liquid radwaste facilities could not be tolerated; consequently, the treatment of laundry wastewaters at that facility should be carefully assessed.

Nevertheless, the radioactivity removed from clothing would ultimately be incorporated into solids at the solidification facility for disposal at an approved low-level radioactive waste site.

9.3 DWTF Analytical and Control Laboratory

The effective operation of the DWTF requires that the treatment procedures selected be capable of achieving the desired treatment without the creation of conditions hazardous to personnel or the emission of gases or liquids into the ambient environment. Furthermore, increasingly stringent regulations can be expected to require more detailed information on the types and compositions of Toxic and Hazardous Wastes destined for disposal into geological zones where their migration into the biosphere can be shown to be minimal over several millennia. Therefore, it is recommended that a well equipped laboratory be provided at the DWTF or assurances obtained that rapid analytical and testing services are obtainable. In either case, a twenty-four hour turnaround on most samples should be achieved. In Appendix G-G we present our perception of test required and the types of analytical equipment that should be available to such a laboratory. Not included are radioactivity measuring instrumentation which we have assumed is already available. However, provisions should be made for the preparation of samples for counting disintegrations and for decontamination of the preparation area. While we have indicated in the tables information on manufacturers or vendors capable of supplying the various equipment, we do not endorse these vendors as sole sources of the equipment.

10. OPERATING CONCEPTS FOR THE DWTF

The conceptual designs for DWTF equipment discussed in Section 9 and shown in Drawings 53299-1 thru 53299-11 were based not only upon the estimates of quantities of hazardous and toxic waste materials to be handled but also on operating concepts we envisioned. Because the DWTF must deal with such a variety of streams of different compositions and quantities, material balances usually included on drawings of this type were not developed, therefore, we describe in the following paragraphs our concepts of the operation of the equipment shown on the drawings and the expected limitation, estimates of the likely emissions and effluents and overall material balances.

10.1 Conceptual Process Operations

10.1.1 Drawing 53299-1 - Decontamination Methods

The operations shown for radioactive decontamination should utilize the presently established techniques with appropriate changes in equipment size and design to improve present operations. The handling of off-gases is based on the condensation of water vapor followed by reheat in order to avoid the occurrence of a visible steam plume at the stack. HEPA filters are included where there is the likelihood of airborne radioactivity. Treatment of all liquids generated during decontamination is to be carried out in other process areas of the DWTF as appropriate. The only non-radioactive decontamination is presumed to be drum cleaning. Here the cooled off-gases are sent to the vessel vent system in order to ensure removal of volatile organics or odors should these be generated. No bake-out ovens are to be used in the DWTF for the volatilization of tritium, mercury or other volatile materials. The operation of the equipment shown should permit meeting any likely regulations on discharges to the atmosphere.

10.1.2 Drawing 53299-2 - Liquid Radioactive Waste Treatment - Sheet No. 1

The flow scheme shown in this drawing is for the treatment of oily wastewaters containing radioactive substances. The objective is the removal and concentration of the oils in order to permit either further treatment of the water in the system shown in Drawing 53299-3 or, if within permitted discharge limits, discharge to the POTW. Acid breaking at temperatures in the vicinity of 160°F followed by allowing the oil to rise for decontamination should permit the lowest concentration of oils in the water sent to the ultrafiltration unit. Adjustment of pH maybe required before ultrafiltration. The concentrated oils may be sent to radwaste incineration or solidified for off-site disposal. In the latter case, the volume of solidified wastes should be much less than would result if the entire stream was solidified.

10.1.3 Drawing 53299-3 - Radioactive Liquid Waste Treatment

Drawing 53299-3 shows the flow scheme for treating aqueous radioactive wastes. The system is designed to treat 5700 liter (1500 gallon) batches of waste by chemical precipitation and reverse osmosis. The facility has two 6800 liter (1800 gallon) receiving tanks for storing incoming waste. Waste is pumped from these tanks to one of three 6800 liter (1800 gallon) chemical adjustment/chemical precipitation tanks. In these tanks reagents are added for pH adjustment oxidation, and precipitation reactions. Total mixing and reaction time may be several hours. One batch of waste, and with tight scheduling two batches of waste, can be treated in one eight hour shift. After chemical precipitation, the solids are first concentrated in a flocculator/clarifier and are then filtered (Drawing 53299-5) to collect the radioactive solids in a low-moisture filter cake which is suitable for shipment offsite.

Clear liquids from the flocculator and filter system are returned to another chemical adjustment/precipitation tank for monitoring, additional chemical treatment if necessary to remove residual

radioactivity or metals, or pH adjustment if the liquids nearly meet threshold levels of heavy metals and are ready to be transferred to the reverse osmosis system.

Liquids transferred to the pre-osmosis filtration surge tank have a pH of 5.0 for proper operation of the reverse osmosis modules. These liquids are filtered to remove any particulate matter carried over from the clarification and filtration operations. The reverse-osmosis unit will operate continuously. When a batch of waste is to be concentrated and discharged, the high pressure reverse osmosis pump will pump waste from the reverse osmosis feed tank; the brine stream exiting the modules will be collected for radioactive waste solidification and the reverse osmosis permeate will be collected for monitoring and then release to the POTW. During off-shift operation, or when waste is to be held up in the system, concentrated brine will be recycled back to the reverse osmosis feed tank; no permeate stream leaves the system. A cooling heat exchanger in he recycle loop prevents high temperatures which result from operating the pumps in a closed loop.

There is sufficient tankage and capacity in the radioactive liquid waste treatment facility to allow simultaneous processing of different batches of waste in the chemical precipitation areas and through the reverse osmosis unit.

10.1.4 Drawing 53299-4 - Non-Radioactive Liquid Treatment

The non-radioactive liquid waste treatment is designed to be able to process 21,000 liter (5,500 gallon) batches of waste. This system capacity is based on handling the largest projected waste stream volume which is the circuit board wastes (L04TA, L04TF), 4,200 liter/day (1,100 gal/day) in weekly (5 day) batches. The circuit board wastes will be treated by chemical precipitation once per week. Other waste streams will be accumulated in the receiving tanks and will be campaigned through the system in batches. The tank storage area includes six vertical tanks. Two are dedicated tanks, a 26,000 liter (7,000 gallon) tank for receiving the large volume of circuit board waste and an 11,000

liter (3,000 gallon) tank for receiving ion exchange wastes (L01TA, L01TF), 6400 L/day (1700 gal/day), which will be concentrated in the reverse osmosis unit. Four nondedicated 11,000 liter (3,000 gallon) storage tanks will receive the other lab-wide generated waste streams which have lower projected volumes.

Waste from the liquid storage tanks can be pumped to either one of three 26,000 liter (7,000 gallon) chemical precipitation tanks or to the chemical adjustment tank. The system is envisioned to be able to perform chemical precipitation reactions on at least one batch of waste per day. Appropriate reagents are added to the chemical precipitation tank for pH adjustment, oxidation, and precipitation reactions. Total mixing and reaction time may be several hours. After precipitation, the tank contents are pumped through the flocculator-clarifier. Thickened sludge is pumped to a slurry holding tank prior to filtration (Drawing 53299-5). Clarified liquids from the flocculator are pumped to the chemical adjustment tank or back to another chemical precipitation tank for monitoring and/or additional treatment such as chromate reduction, sulfide precipitation, or quinoline chelation.

The chemical adjustment tank receives clear liquids from the flocculator, filtrate from the filter press, and liquid wastes not requiring chemical treatment. The pH of the tank contents are adjusted to 5.0 for proper operation of the reverse osmosis unit and are then transferred to the pre-osmosis filtration surge tank. In this fashion, the chemical adjustment tank can be operated on a semi-continuous basis. There is sufficient holding tank capacity to simultaneously run different batches of waste through the chemical precipitation operations, clarification and filtration operations, and chemical adjustment and reverse osmosis operations. For example, a fresh batch of waste may be treated in a chemical precipitation tank at the same time as waste, which had been precipitated the previous day, is being filtered in the filter press and while a third batch of waste is pumped through the chemical adjustment tank and reverse osmosis unit.

Liquids in the pre-osmosis surge tank are filtered to remove any particulate matter carried over from the clarification and filtration operations. The reverse-osmosis unit will operate continuously. When a batch of waste is to be concentrated and discharged, the high pressure reverse osmosis pump will pump waste from the reverse osmosis feed tank. The brine stream exiting the modules will be collected for further treatment or disposal and the reverse osmosis permeate will be sewered or collected for reuse. During off-shift operation, or when waste is to be held up in the system, concentrated brine will be recycled back to the reverse osmosis feed tank; no permeate stream leaves the system. A cooling heat exchanger in the recycle loop prevents high temperatures which result from operating the pumps in a closed loop.

The capacity and layout of the liquid waste treatment facility provide flexibility for treating and monitoring batches of wastes brought to the DWTF.

10.1.5 Drawing 53299-5 - Radioactive/Non-Radioactive Waste Filtration

The solids precipitated or otherwise removed from wastewater streams are to be further concentrated through filtration in a high-pressure plate and frame filter press. Filter aid precoating of the filter cloth as well as the addition of filter aid to facilitate filtration rates is envisioned. The principal reason for the selection of filter presses is their expected capability for producing filter cakes with lower moisture content in order to prevent expression of additional liquid at the final disposal site should these be covered with overburdens as in a landfill. Although separate filters are shown for the radioactive and non-radioactive solids, it is possible that a single filter press could be used since it is likely that cleanup between cycles of filtering radioactive and non-radioactive wastes could be achieved without unacceptable levels of cross-contamination. If the present rotary filters are judged capable of producing filter cakes of the quality likely required for future disposal, these could, of course, be used instead of the filter presses. However, considerably larger electrical

demands would occur and the emission of larger volumes of air to the atmosphere would result.

10.1.6 Drawing 53299-6 - Compaction and Solidification

Compaction of both radioactive (TRU and LSA) wastes as well as non-radioactive is envisioned. Only radioactively contaminated drums are presumed to be compacted for shipment to approved radioactive waste disposal sites. Because there should be no liquid wastes contained in the materials to be compacted, we have presumed that one set of compaction equipment could be used for both non-radioactive and radioactive (TRU and LSA) wastes. However, provisions for removing any unexpected liquids expressed during compaction and sending them to liquid waste treatment are shown.

Solidification - Radioactive liquids are anticipated to be the principal ones for solidification since non-radioactive liquids are expected to be either destroyed by incineration or treated for the removal of hazardous substances as solids in the forms of filter cakes (Drawing 53299-5). Two Storage Bins for solidifying agents, presumed to be Envirostone® or Cement, with individual conveyors for feeding those to a mixer are shown. The type and design of the mixer will need to be established and it is suggested that this be done through discussion with suppliers of the solidifying agents or of mixers.

10.1.7 Drawing 53299-7 - Rotary Kiln Incinerator and Uranium Burn Pan

The thermal destruction of non-radioactive liquids and solid wastes in a rotary kiln incinerators is based on the flexibility of this system to destroy a wide variety of waste types and forms. The size of the rotary kiln incinerator is about the minimum size that can be satisfactory operated. Shredding of large material prior to incineration has been provided. Loose materials such as paper might require compaction before incineration to reduce the quantities of particulates going to the off-gas system and certain plastic materials that melt might need to be incorporated with other solids. The design shown provides ample

residence time at temperatures in excess of 2000°F to permit the destruction of organic chlorides including PCB's. The off-gas handling system should be capable of controlling the emissions of acid gases such as hydrogen chloride and sulfur dioxide to emission limitations likely to be required by permitting agencies such as the U.S. EPA in the State of California. As mentioned previously,the system may not be able to control emissions such as nitrogen oxides from wastes containing high quantities of nitrogenous compounds or from materials that generate smoke such as alkali metals. A preheater is provided in order to eliminate the appearance of a plume from the stack. While it is expected that this incinerator can be qualified for a license as a hazardous waste incinerator, the current state of licensing procedures makes it difficult to guarantee that the system shown will meet licencing requirements at the time of permitting.

Oxidation of scrap uranium metal in a burn box is based on a design developed at Oak Ridge. The batch system is based on manual loading of the scrap into the container box. Ignition is readily achieved by tossing a burning taper into the uranium scrap. Cooling of the metal walls of the can by water sprays and the limited access of oxygen prevents the generation of excessive temperatures and smokes. The induction of an air draft across the top of the burn pan and passage through a HEPA filter controls the emission of particulates from the burning process. Also, uranium metal could be burned in the rotary kiln incinerator if a burn box is not installed. However, since other DOE sites already have facilities for uranium, an economic analysis might indicate the shipment to another site would be preferable to an installation at LLNL.

10.1.8 Drawing 53299-8 - Solvent Recovery

Based on the small volume of wastes solvents from LLNL, we have proposed a package solvent reclaiming system with the still bottoms going to incineration or disposal, as required. However, we expect that this solvent recovery system will not be economic unless the recovered

solvents will be reused at LLNL; consequently, they might be best disposed of by incineration where they will provide auxiliary energy.

10.1.9 Drawing 53299-9 - Radioactive Incineration and Reactive Materials Treatment

Controlled air incineration in a unit of a size similar to the present incinerator has been selected for the incineration of low level radioactive wastes. The off-gas treatment system incorporates caustic scrubbing for the control of acid gases (see comments on non-radioactive incineration - Drawing 53299-7); however, the system includes additional off-gas treatment equipment such as a Hydrosonic® Scrubber for the removal of an finely divided particulates such as might result from the burning of alkali metals and the addition of an activated carbon adsorber for additional removal of certain gaseous substances such as iodine. This incinerator should be capable of destroying organic chlorides including PCB's and alkali metals while meeting likely emission limits for hazardous incinerators. Furthermore, the radioactivity contained in the off-gases when incinerating LSA or TRU wastes should be below the levels for uncontrolled areas listed in attachment XI-I of DOE 5480.1 Chg 2 dated 4/29/81 which is part of SAN MD No. 5480.1A, CH XI of March 21, 1982, unless materials with high contents of C-14, iodine isotopes, K-32, tritium or radioactive gases are fed to the incinerator. Chilled water cooling of the off-gases will permit the removal of appreciable portion of tritiated water that will result from the destruction of tritium contained materials. However, incineration of tritium containing materials should be carried out only when it is possible to operate the incinerator for incineration of wastes known to contain tritium. The degree of tritium removal will be dependent both on the concentrations of the tritium in the wastes and the length of time the system is operated. The tritium containing water from the scrubber system is assumed to be sent to solidification. If further reduction in tritium is required, a more sophisticated system based on molecular sieve dehumidification of the air stream following cooling would be required. Although the off-gas treatment system incorporates the best available technology in our opinion, airborne emissions that

meet the aforementioned limits might still exceed the radioactivity levels required in the vicinity of a facility doing sensitive counting of background radioactivity. Consequently, the location of the radioactive waste incinerator with respect to any such facility must be given careful consideration.

A pressure vessel for the purpose of treating reactive materials such as alkali metals has been included on this flowsheet. The water cooled vessel is envisioned to carry out reactions between reactive materials and appropriate substances that will result in a more easily disposable material. For example, the reaction of alkali metals with ethyl alcohol to produce ethylates that can be incinerated. The handling and disposal of reactive materials requires careful consideration in order to be carried out safety and it is not likely that all of the reactive materials can be dealt with by similar procedures, e.g., the reaction with other substances at controlled rates. It is our understanding that there are not very large quantities of these materials; however, we expect that some such as ethers that have been stored for a long time will require very careful and very special handling since they may well be sensitive to shock and cause explosions. Consequently, we suggest that the handling and disposal of these reactive materials be carried out by people trained in dealing with reactive materials.

10.1.10 Drawing 53299-10 - Advanced Wastewater Treatment Evaporative Concentrations

The purpose of this equipment is to remove dissolved solids from high concentration streams in order to reduce the volume of the final, solidified product which should have the highest integrity for disposal into near surface landfills. The processes chosen are vapor compression evaporation, a widely used and energy-efficient operation, followed by further concentration into a slurry of crystalline solids by a crystallizing evaporator. Installation of this equipment should be based on a thorough assessment of economics, and the risk expected in disposal of the waste streams in other forms.

10.1.11 Drawing 53299-11 - Support Facilities for DWTF

As the title indicates, this drawing summarizes the services and support facilities for the DWTF. It's major purpose is the serve as a reminder that provisions must be made for either obtaining these services from already available services or provide for their installation.

10.2 Emissions to Environment

The processes shown on the various drawings should be capable of being operated to meet all known regulations applicable at this time. Estimation of air borne emissions and wastewater effluents will be somewhat dependent upon the hazardous and toxic wastes to be treated. We expect, however, that the following emission levels will be achievable.

Water

City of Livermore Ordnance No. 1134, 40 CFR 413-Electroplating Point Source Category and 40 CFR 433 - Metal Finishing Point Source Category should be attainable through careful operation and monitoring of treated batches of wastewater before discharge.

Air Emissions

Air emissions from vessel vents and decontamination systems will depend upon the volatility of organic substances processes; however, hte systems should meet California Regulations.

Air emissions from the incinerators are estimated to be:

Non-Radioactive Wastes

Particulates - approximately 50 mg/cu meter

Hydrogen chloride - 0.2 kg/hr and volatile

Hydrocarbons <10 mg/cu meter

Radioactive Wastes

Particulates - approximately 10 mg/cu meter

Hydrogen chloride - 0.08 kg/hr

Volatile hydrocarbons <10 mg/cu meter

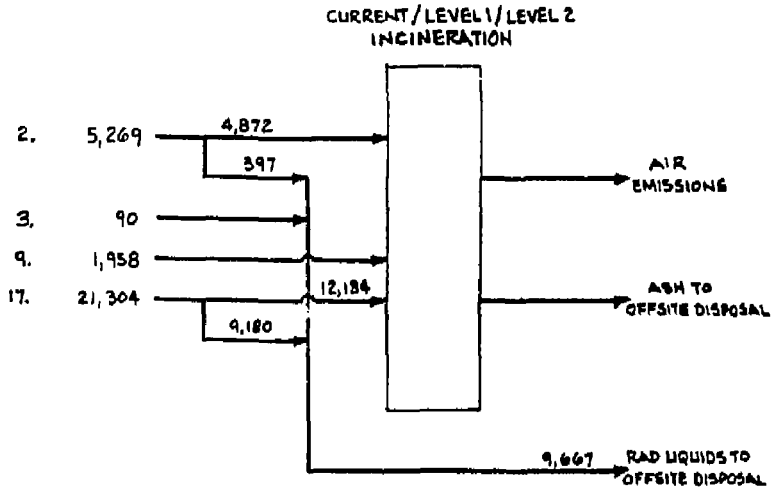
The total estimated emissions from the DWTF should be less than the amounts which would trigger the need to establish that there would be no significant degradation of the air quality at LLNL. (Reference - California Permit Handbook of May 1980 - Office of Planning and Research, Sacramento, CA 95814).

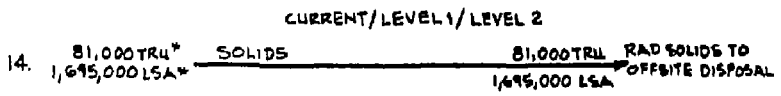
Solid Wastes

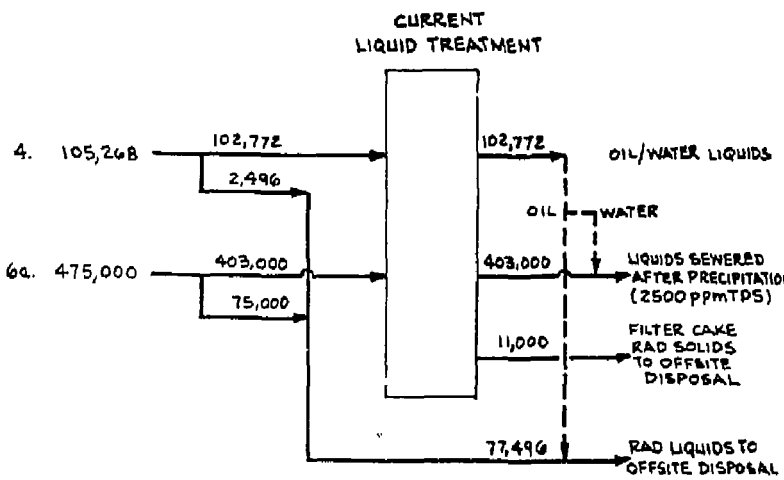
Solid wastes leaving the DWTF should be capable of being manifested and packaged in accordance with any foreseeable regulations.

10.3 Materials Balance Considerations

As mentioned elsewhere, the preparation of material balances for treatment processes handling such a wide variety of waste quantities and compositions will not be meaningful on an hourly or daily basis. However, to provide an appreciation of the quantities of materials entering and leaving the different levels of treatment we have prepared Figures G-9 and G-10. One of the most significant items in these material balances is the quantity of scrubber liquids that must be disposed of. These streams containing high concentrations of inorganic dissolved solids (principally salt) originate from the scrubbing of incineration off-gases when incinerating solvents and solids containing organic chlorides. Since the chlorine concentration of the wastes are unknown, we assumed 100% trichloroethylene wherever the data in UCID 202090 indicated high concentrations of TCH. Likewise, we assumed that the solid wastes incinerated contained an average of 5% chlorine.



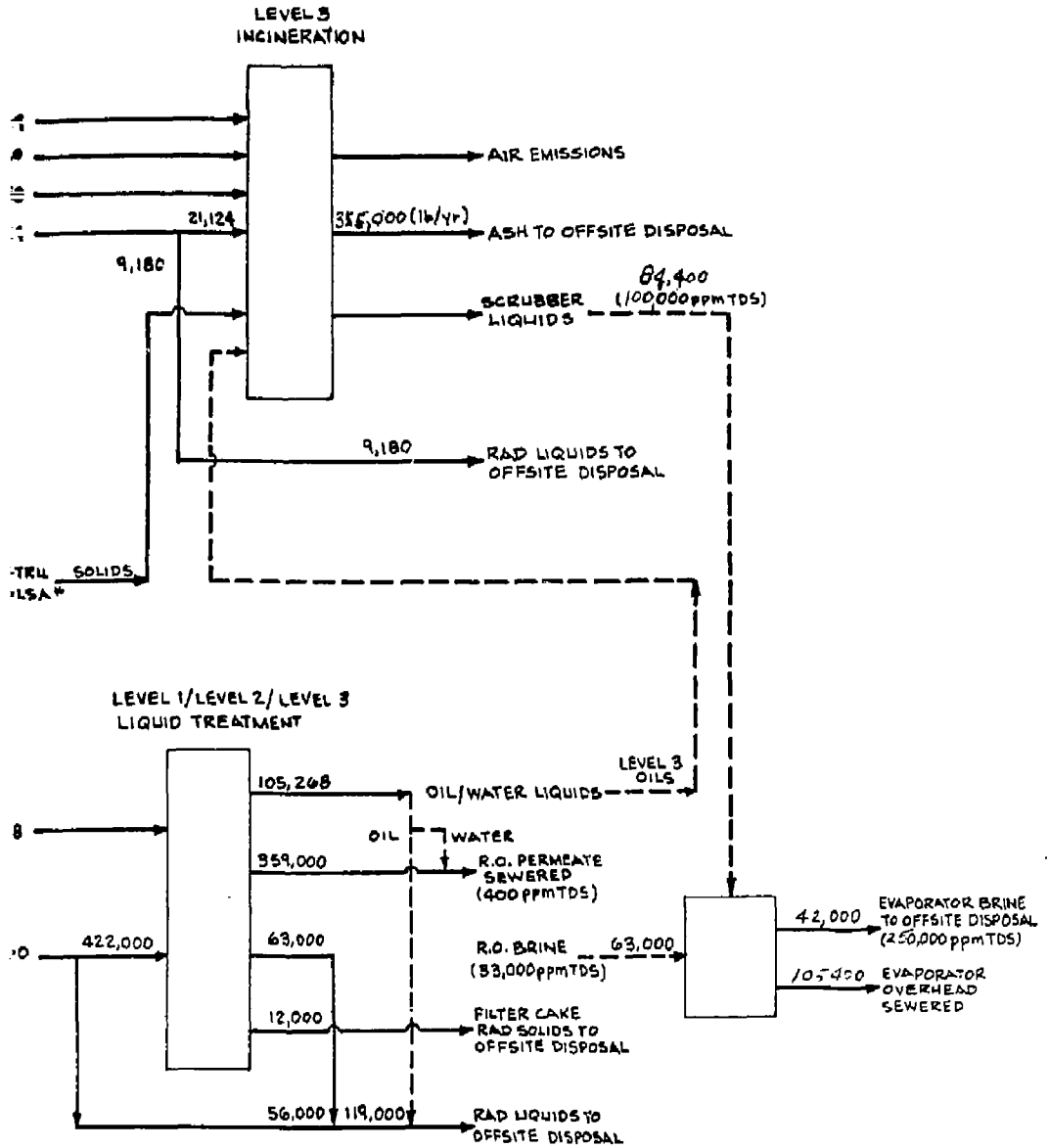




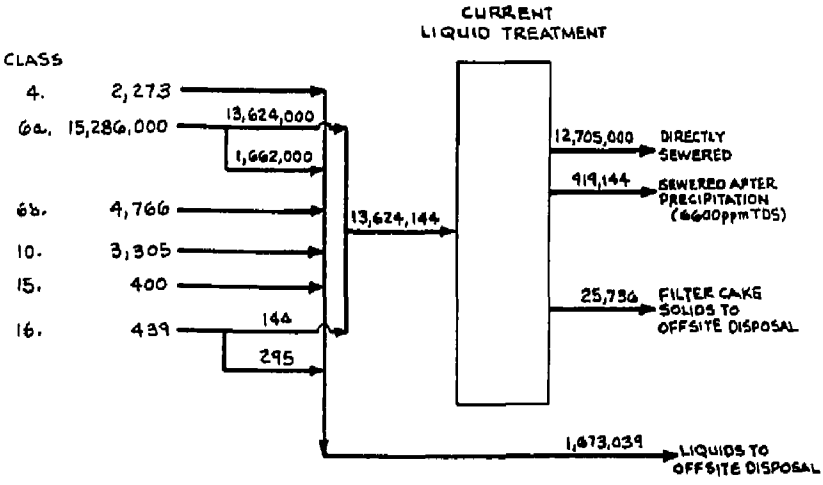
* 125% OF 1984 SOLID WASTE GENERATION RATES
ESTIMATED BY C. OZAKI, 1-15-85: TRU SOLIDS = 2284 cu.ft./yr.
LSA SOLIDS = 47,892 cu.ft./yr.; ρ = 25 lb./cu.ft.; 80% COMBUSTIBLES

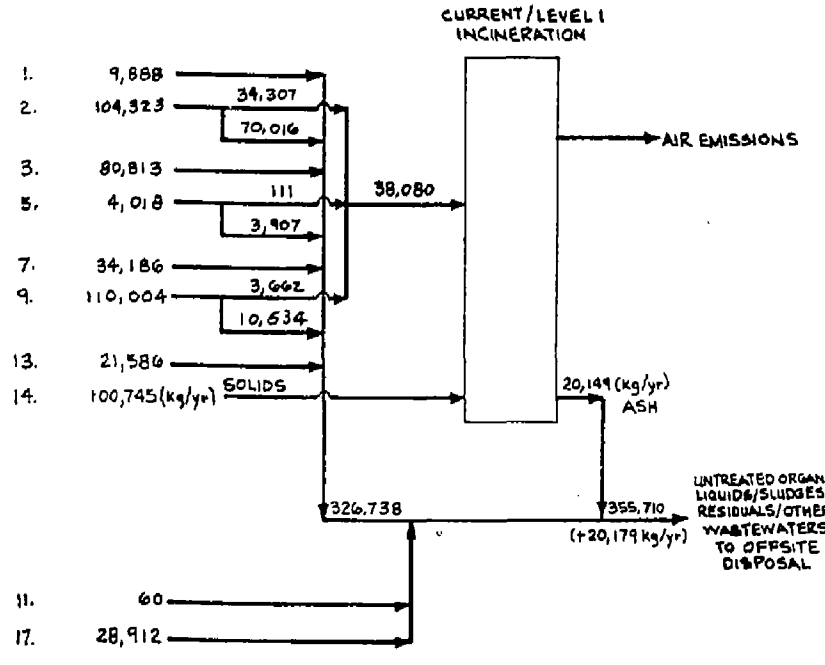
Note: ALL FLOWS IN L/yr UNLESS OTHERWISE NOTED

FIGURE G-9. WASTE FLOWS FOR RADIOACTIVE



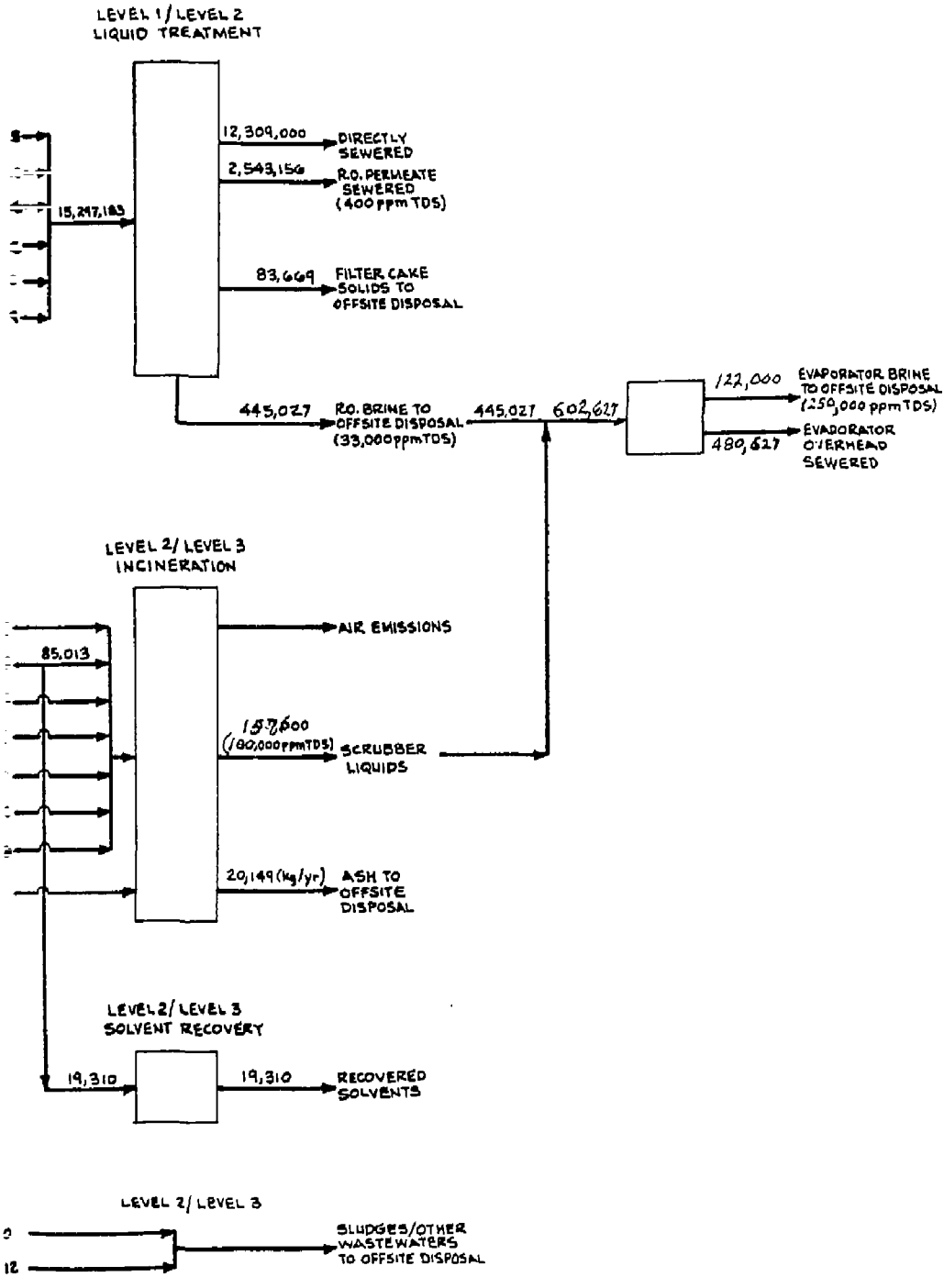
OACTIVE WASTE TREATMENT SCENARIOS





Note: ALL FLOW IN L/yr UNLESS OTHERWISE NOTED.

FIGURE G-10. WASTE FLOWS FOR NONRADIOACTIVE WA



TIVE WASTE TREATMENT SCENARIOS

APPENDIX G-A - ESTIMATE OF LIQUID WASTE GENERATION RATES

Information available from logbook records on the batches of waste brought to the TWCG include: the source of the waste material by building number, a description of the waste, the waste composition if available, radioactivity characteristics, and the treatment method. In UCID-20209 such information was the basis for aggregating batches of similar wastes and labeling them with a stream identification number. The waste streams so identified, were further grouped into 22 general facilities/operations classes. In Table G-A-1 we have assigned the radioactive waste streams and in Table G-A-2 the nonradioactive waste streams identified in UCID-20209 to the classes of hazardous wastes we established in Table G-A-1. These tables also give estimated current and projected rates of generation of each waste stream.

The largest quantities of both radioactive and nonradioactive waste are generated in Class 6a. These streams are aqueous solutions contaminated with heavy radioactive metals such as uranium, plutonium, osmium, and rhenium or nonradioactive heavy metals such as chromium, copper, nickel, zinc, silver, and lead. These wastes are generated lab-wide, however major sources of these wastes are:

- Nonrad ion exchange regeneration wastes (L01TA, L01TB, L03TD) from buildings; 325, 291, and 321 which are disposed of offsite.

- Both rad and nonrad plating shop wastes from building 322 (L03TA, L03TB, L03TC, L03TE, L03TH, L03TJ, L03TM, L03TRE, L03TRE). These wastewaters also contain chemical species such as sulfamate, hypophosphite, cyanide, chloride, sulfuric acid and phosphoric acid. The largest stream, L03TA ~ 5.2 million liters per year, is a rinse water stream which is currently sewered. The treatment method for the other nonrad streams is listed as B612 storage and offsite disposal is assumed. The larger of the radioactive plating wastes, stream L03TRC is treated while the other, L03TRE, is solidified.

- Nonrad spent etchant and rinse waste streams (L04TA, L04TF) from building 141, Electrical Engineering - Printed Circuit Board facility which are treated onsite.

- Nonrad spent photochemical solutions (L06TB, L06TD, L06TBD) containing silver, currently sent offsite or sewered.

- Radioactive waste waters coming from Nuclear Chemistry, building 151; stream L10TRC is treated onsite and stream L10TRF is solidified and shipped offsite.

- Decontamination at building 419 generates a large radioactive waste stream L01TRTA which is either treated onsite or solidified.

- Radioactive waste waters (L12TRAI) from the Laser Facility, building 298, are treated onsite. Radioactively contaminated nitric acid/water solutions (L13TRB) from the Laser Isotope Facilities, building 175, are either solidified or treated on site.

- Rad and nonrad laboratory streams (L17TRBA, L17TA) from the Chemistry and Material Sciences Facilities, buildings 222, 231 and 241, currently treated onsite.

- Site 300 also generates large quantities of metals-contaminated wastewaters. Stream S11TB is a photo rinse water stream treated onsite.

Large quantities of radioactive Class 4 oil and water wastes (L02TRE), are generated in the machine shop (Bldg. 321). These wastes are mixtures of oil, coolant, water, and chlorinated/nonchlorinated solvents. Some batches are solidified and others are treated onsite.

Nonrad solvents are generated throughout the site. Most of these streams are mixed organic solvents. For that reason and because of the small amounts generated they probably are not candidates for recovery unless segregation at the generating source is established. Because they are single solvent streams, lacquer from the paint shop, trichloroethylene from the plating shop, and methylene chloride from the plastic shop are the principal solvent wastes suitable for recovery. Nonhalogenated solvents such as ethanol, acetone, toluene, and methylethylketone are currently incinerated. The halogenated solvents which include freons and chlorinated organics are stored in B612 and assumed to be disposed of offsite.

Major sources of Class 5 waste are the Biomedical Facilities (Bldg. 361) which generate carcinogenic organic/water wastes (L02PDA) that are incinerated, the Magnet Fusion Energy Facilities which generate a rinse water with foam emulsifiers waste (L18TB) that is sewered, and water freon mixtures (S11TAT) from the Advanced Test Accelerator (Bldg. 865).

Salvage operations generate a large quantity of Class 3 oil wastes (L07TA) which are sold to an offsite processor and Class 13 polychlorinated biophenyl (PCB) contaminated coolant, oils, and solvents (L07TXY, L07TXZ, L07THA) which are stored in B612 before being shipped offsite.

Tritium contaminated streams were placed in Class 17 of Table G-A-1. These include large tritium contaminated streams (L11TRA, L11TRB) from the Physics Facilities buildings 292 and 212 which are now incinerated.

TABLE G-A-1

Waste Class	1	2		3		4		5	ESTIMATED QUANTITIES OF WA 6a	6b
Stream ID No. (3)										
	current rate, L/yr	current rate, L/yr	projected rate, L/yr	current rate, L/yr	projected rate, L/yr	current rate, L/yr	projected rate, L/yr	current rate, L/yr	projected rate, L/yr	
L01TRA		120	210							
L01TRC									212	319
L01TRTA									25,895	64,611
L02TRF						157,896	182,772			
L02TRA									864	1,837
L02TRB		4,868	4,872			2,600	2,496			
L02TRI										
L03TRC									21,600	38,880
L03TRE									684	1,231
L08TRAB										
L08TRCA										
L09TRA									1,664	2,995
L09TRG										
L10TRA									4,488	5,358
L10TRC									97,200	136,860
L10TRF									6,323	7,588
L10TRAA				119	19					
L10TRAB				119	19					
L10TRBC									20	20
L10TRAD									40	40
L11TRA										
L11TRB										
L12TRAI									8,278	18,466
L12TRAH										
L13TRG									1,156	55,780
L13TRG									5,160	129,462
L16TRA									265	576
L16TRB									57	67
L16TRG				139	52					
L16TRH										
L16TRC										
L17TRA		156	187							
L17TRBA									2,880	15,360
L17TRCA									28	28
L17TRCC									60	60
L93TRGB										
L97TRBM										
L99TRA										
TOTAL		4,336	5,269	77	98	59,176	185,268		246,830	476,017

(1) Rates are in kg/yr.
(2) Rates are in m^3/yr
(3) Stream ID numbers are from
UCID-20229-A Preliminary
Analysis of Toxic and Radioactive
Hazardous Waste Streams
Generated at LLNL-Sept. 23, 1984

TABLE G-A-1

QUANTITIES OF WASTES CONTAINING RADIOACTIVITY BY CLASS

6a		6b	7	8	9		10	11	12	13	14		15	16	17	
L/yr	projected rate, L/yr				current rate, L/yr	projected rate, L/yr					current rate, L/yr	projected rate, L/yr			current rate, L/yr	projected rate, L/yr
212	319															
895	64,611															
864	1,837															
21,600	38,888															
684	1,231															
					11,316	1,579										
					316	379										
1,664	2,595															
											428	770				
4,488	5,358															
77,200	136,860															
3,363	7,588															
28	28															
48	48															
															7,488	7,488
															3,738	4,258
8,278	18,466															
															5,188	9,168
51,156	55,788															
115,168	125,488															
288	576															
57	67															
											48	68			395	474
12,888	15,368															
28	28															
68	68										(2)	(2)				
											57 (1)	191 (1)				
											33 (2)	39 (2)				
											1497	597				
4,638	476,817				1,632	1,958									16,825	21,384

TABLE G-A-2

ESTIMATED QUANTITIES OF NONRADIOACTIVE WASTES BY CLASS

Waste Class	1		2		3		4		5		6a		6b		7	
Stream ID No. (2)																
	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr
L01TA											925,554	1,110,653				
L01TB											136,136	163,363				
L01TBA																
L01TBB			7,416	11,349												
L01TZZ									624	624						
L02TW											68	68				
L03TWA							11,263	2,273								
L03TD											277,400	332,880				
L03TA											5,238,816	9,429,869				
L03TB											1,664	2,995				
L03TC											2,496	4,492				
L03TE											68	152				
L03TH											152	274				
L03TI			1,664	2,995												
L03TJ											832	778				
L03TL																
L03TM											2,496	4,493				
L03TO													12,648	4,766		
L04TA											249,848	348,667				
L04TF											384,123	468,948				
L04TJ											3,408	6,576				
L04TB											1,565	2,818				
L04TH			2,348	4,227												
L05TAA	13,296	3,933														
L05TBB															6,672	12,010
L05TBC	13,296	3,955														
L05TBD															2,472	2,966
L05TBE															824	824
L05TBF			2,472	2,966												
L06TA																
L06TB											113,920	25,856				
L06TC											0	272				
L06TD											23,514	32,919				
L06TBD											4,992	5,990				
L06TI											76	99				
L06TDA											412	4,2				
L07TA					157,448	88,416										
L07TAA					60	120										
L07TAY																
L07TAZ																
L07TAB																
L08TBA															248	248
L08TBB																
L08TAG			1,166	1,421												
L08TDA																
L09TA			2,660	4,788												
L10TB			4,637	5,636												
L10TAE			68	68												

7	8	9	10	11	12	13	14	15	16	17
CURRENT Ayr rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr
								1288	312						
			1,664	2,995											
6,672	12,010														
2,472	2,966														
824	824														
										246	255				
						4,168	2,808								
						254	127								
						318,760	19,358								
248	248														
														1,648	1,648
		3,852	2,662												

TABLE G-A-2 (cont'd)

ESTIMATED QUANTITIES OF NONRADIOACTIVE WASTES BY CLASS

Waste Class	1		2		3		4		5		6a		6b		7	
Stream ID No. (2)	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr	CURRENT rate, L/yr	PROJECTED rate, L/yr
L11TA																
L11TK			618	734												
L11TH			416	416												
L11TDA																
L11TDB									11,824	3,283						
S11TA																
S11TB											382,496	362,995				
S11TAT																
L12TAA																
L12TAF					206	206										
L12TAG			1,040	1,230												
L12TAI																
L12TAM			19	19												
L12TAL			416	749												
L12TFA															2,496	9,465
L12TGA																
L12TGD			1,748	3,146												
L13TA			2,476	24,760												
L13TDB			4,944	24,720												
L14TA																
L14TE			412	483												
L15TE			498	896												
L15TC															60	60
L17TA											60,560	103,822				
L17TI									92	111						
L17TD			1,472	1,766												
L17TE			1,900	2,280												
L17TDA															512	614
L18TA			4,160	7,488												
L18TB																
L18TC					29	69										
L18TD											204	245				
L18TGC											304	365				
L18TAB			186	194												
L18TCA											160	288				
L18TGR															6,656	7,987
L18TEK																
L97NBO																
L97TGN																
L98KG.																
TOTAL	26,592	9,888	142,728	184,323	157,737	66,813	11,263	2,273	12,540	4,018	17,632,537	12,486,657	12,648	4,766	119,932	34,166

(1) Rates are in Kg/yr.

(2) Stream ID Numbers are from UCID-20289-"A Preliminary Analysis of Toxic and Radioactive Hazardous Waste Stream Generated at LLNL"-Sept. 23, 1984

7	8	9		10		11		12	13	14		15		16		17	
CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr	CURRENT rate,L/yr	PROJECTED rate,L/yr
												188	88				
														60	144		
																[illegible]	67,664
		119,568	23,962														
						160	60										
		3,788	3,788														
2,496	9,465																
				160	310												
		210	21,000														
60	60																
512	614																
		132,000	57,600														
6,656	7,987								13	13							
										522 [1]	627 [1]						
										56 [1]	116 [1]						
										150,000	160,000						
119,932	34,166	159,810	110,000	11,824	3,385	160	60	115,163	21,566	150,624 [1]	180,745 [1]	376	440	326	439	24,366	26,512

APPENDIX G-B - ESTIMATE OF SOLID WASTE GENERATION

Tables G-B-1 and G-B-2 list the rad and nonrad solid waste sources mentioned in the UCID-20209 document and those listed in the Radian report. The volumes in these tables are tabulated in the units reported, i.e., bulk densities were not estimated to convert waste generation rates reported in weight units to equivalent volume units.

UCID-20209 gives little detail on the solid wastes generated throughout the site. The nonrad solid wastes are primarily classified wastes such as classified documents to be incinerated. Both nonrad and rad animal carcasses (L97NBO, L97TBN, L97TRBM) are incinerated. Only gross estimates were made of generation rates of radioactive LSA solids from the LIS facilities (building 175, L93TRGB) and then overall lab-wide production of LSA solids. No description was given of the nature of these solids.

The Radian report lists the solid wastes, the waste quantity and the generation sources by building for the Livermore and site 300 areas. The quantities of both rad and nonrad solid wastes differs significantly from those reported in UCID-20209. For example, the quantity of LIS solid waste from building 175 is lower in the UCID document, 2013 cf/yr, than in the Radian report 3960 cf/yr. Despite the larger voluem of LIS solids, Radian reports a much lower total lab-wide production of solid rad waste, nearly 6,000 cf/yr (plus 29,160 cf/yr of contaminated shot debris and additional rad waste totalling 256 lb/yr) versus 19,564 cf/yr (plus 313 lb/yr additional SRW) reported in the UCID document.* Contaminated shot debris will not be disposed of by the TWC. All rad solids are all packaged and shipped to NTS. In addition to solid wastes

* Both sets of numbers are much lower than the figures provided by C. Ozaki for solid waste production at the site; he estimates that 52,800 cf/yr of radioactive solid wastes are generated lab-wide and 10,140 cf/yr of nonradioactive solid wastes are also generated throughout the site.

generated onsite, Radian reports that 36,000 cf/yr of liquids are solidified at building 513 and sent as solids (solidified volume of about 79,000 cf/yr) to NTS. No comparable figure was reported in UCID-20209. Most of the nonrad solids reported by Radian are HE contaminated wastes generated at site 300 and currently burned or buried at that site. Radian did not estimate the quantity of classified wastes to be incinerated.

In any case neither UCID-20209 nor the Radian appendix provides sufficient information on the nature of the solid wastes generated to develop a good basis for evaluating alternative treatment options which might include size reduction, incineration or decontamination.

TABLE G-B-1

SOLID WASTE STREAMS (1)

Generation Source Stream Class I,d, No.	Material Description	Rad cf/yr	Rad lb/yr	Non-rad lb/yr
LIS Solid LSA Wastes L93TRGB		2,013		
Biomed Animal Carcasses L97NBO	Control Animals			1151
L97TRBH			.53	
L97TBN	Mice		260	
Classified Non-Toxic Solid Wastes to be Incinerated L98NXX				110,230
LSA Solid Waste Generated Lab Wide L99TRA		17,551		
Total		19,564	313	111,381

(1) Source: UCID - 20209. "A Preliminary Analysis of Toxic and Radioactive Hazardous Waste Streams Generated by LLNL" - September 23, 1984.

TABLE G-B-2

SOLID WASTE STREAMS[1]

Generation Source Building		Material Description	Drums gal/yr Rad	Drums gal/yr Non-Rad	Other Rad cf/yr	Other Rad lb/yr	Other Nonrad cf/yr	Other Nonrad lb/yr
253	Hazards Control	Planchets			4			
		Air Filters			1			
		Solid Rad Waste (SRW)			36			
		Tritium Target			6			
		Hepa Filters			3			
419	Decontamination	SRW			40			
328	Fire Test Cel	Sediment					25	
297	Classified Waste Disposal	Paper					NR	
321	Materials Fab. Shop	SRW				16		
418	Paint Shop	Waste Sandblasting Abrasives		165				
131	Engineering	Solid toxic waste					NR	
232	Chem. High Press Lab	D-3B Metals	11,400					
241	Refractory Materials	SRW	660					
331	Gaseous Chemistry	SRW	660					
332	Metallurgical Chemistry	TRU SRW	17,160					
113	Theoretical Comp.	Filters (3/week) Cr and Solid Toxic Waste					NR	
361	Biomedical, Main Lab	SRW	660				120	
364	Main small animal	Animal carcasses					10	
366	Health effect lab	Solid carcinogenic waste					420	
592	Cow barn (Ashing Ovens)	RAD waste	660					
194	Elec. Pos. Accel.	SRW	660					
212	Accelerators	SRW	660					
292	RTNS II	Spent Tritium Targets			64			
		Tritium Cartridges (15/yr)			NR			
		SRW	1,320					
161	L.L.S. Dev. Lab.	SRW	1,320					
175	MARS Exp.	SRW	3,960					
298	Fusion Target Des.	SRW	660					
151	Nuclear Chem.	SRW	3,960					
		Scintillation vials			NR			
251	Heavy Elements	SRW	1,320					
		TRU Waste	330					
341	Physics Research	SRW	220					
345	Detonator Research	HE waste					3744[2]	
261	Special Projects	SRW	660					
806,807,817	L.E. Machining	Clarifier sludge and machine turnings[3] HF reactives[4] and contaminated trash						900[2] 3240[7]

TABLE G-B-2 (Continued)

SOLID WASTE STREAMS

Generation Source Building		Material Description	Drums gal/yr Rad	Drums gal/yr Nonrad	Other Rad cf/yr	Other Rad lb/yr	Other Nonrad CF/yr	Other Nonrad lb/yr
801	Flash X-ray	Contaminated shot debris (CSD)			9720[4]			
850	Hydrodynamic Testing	CSD			9720[4]			
		SRW				120[4]		
851	Hydrodynamic Testing	CSD			9720[4]			
		SRW				120[4]		
		HF contaminated trash						360[2]
827, 828	HE Machining	Clarifier sludge[3] machine turnings						600[2]
		HE reactives and contaminated trash						1200[2]
226	HE Chem.	HE organic waste						5[2]
227	HE Chem.	HE organic waste						NR[2]
827, 828	HE Machining	Clarifier sludge[3]						
261	Special Projects	SRW						
Subtotal			43,310	165	29314	256	4319	6305
Subtotal(CF/YR)			5,804	22	29314		4319	
513	Liquid Waste Storage	Contaminated Oil Solvents and Corrosives Solified/ shipped to NTS			36,000			

(1) Source: May 1984 report by Radian Corporation, Appendix C
(2) Currently burned at site 300
(3) Assumed 1 burn per month at site 300
(4) Currently buried in an approved landfill, site 300

APPENDIX G-C - COMPARISON OF UCID-20209 AND RADIAN DATA

We performed a cursory comparison of the liquid waste generation rates and sources data in UCID-20209 versus those reported by Radian. The major discrepancies between the two sources of information (major stream quantities differing by a factor greater than 2) are listed in Table G-C-1.

A major area of disagreement between the two sources is the quantity of retention/waste holding tank liquids being generated at buildings throughout the site and requiring treatment or being sewered. Also, UCID-20209 shows wastes from only buildings 801, 823, and 865. The Radian document reports wastes from other 800's buildings including large volumes 954,000 L/Yr (21,000 gallons/month), of high explosives contaminated water; currently treated by clarification and surface impoundment.

We have assumed that LLNL's new DWTF will not treat high explosives wastes. Where stream generation rates of the UCID-20209 document differ from those in the Radian report, or where a value is reported in only one document, we have used the larger value. The nonradioactive liquid waste treatment facility is designed for handling 2,879,000 L/Yr (3,800 gal/day) of retention/waste holding tank liquids, in addition to the streams identified in UCID-20209.

TABLE G-C-1

COMPARISON OF WASTE GENERATION SOURCES
UCID-20209 vs. RADIAN

Site Generation Area	UCID-20209 Stream ID	UCID-20209 Generation L/YR	Radian Generation L/YR	Stream Description
Plating		03	Bldg. 322	
	L03TD	277,000 (Bldg. 321)	30,000	Liquids sent off site
	L03TRC	22,000	NR	Radioactively contaminated solution
Salvage		07	Bldgs. 616-619	
	L07TA	59,000	NR	Oils and greases
Nuclear Chemistry		10	Bldg. 151	
	L10TRC	95,000	5,000	Building waste holding tanks, liquid rad waste
	L10TD	5,000	<300	Solvents
Laser Isotype Facilities		13	Bldgs. 161, 177, 175	
	L13TRB	11,000	NR	Spent acid cleaning solutions
	L13TRC	43,000	NR	Waste stream from LIS, Bldg. 175, requiring treatment
		NR	82,000	From Bldg. 175, sewered
Laser Facilities		12	Bldgs. 162, 166-168, 171-174, 298, 391	
	L12TRAI	10,000	NR	Rinse water

TABLE G-C-1 (Continued)

Site Generation Area	UCID-20209 Stream ID	UCID-20209 Generation L/YR	Radian Generation L/YR	Stream Description
General Plant		01	Bldg. 418	
	L01TPB	7,000	1,000	Paint solvent waste
Chemistry & Material Sciences		17	Bldgs. 221-228, 231-234, 241, 331-333	
	L17TA	59,000 (treated in D.O.)	91,000	Bldg. 222, retention tank sewered; ~4,000 L/Yr treated
		NR	136,000	Bldg. 227, retention tank sewered
	L17TRBA	282 (rad plating lab waste)	91,000	Bldg. 231, retention tank sewered; approximately 500 gal/month treated
		NR	68,000	Bldg. 241 sewered
		NR	55,000	Bldg. 332, sewered
Site 300		S11	Bldgs. 800s	
	S11TAT	439	91,000	Bldg. 865, coolant and cutting fluid
			16,000	Bldg. 872, paint rinse water disposed by contractor
			5,000	Bldg. 873, acidic rinse disposed by contractor
			659,000	Bldgs. 806,807,817, HE contaminated wastewater
			182,000	Bldg. 823, rinse water
			68,000	Bldg. 801, photolab rinse water
			68,000	Bldg. 851, photolab rinse water
			295,000	Bldgs. 825,826,828, HE contaminated wash water

APPENDIX G-D - THE TDS PROBLEM

Streams entering and leaving the liquid treatment facilities will contain dissolved solids arising from the following sources:

(1) Dissolved heavy metal cations such as nickel, copper, and silver and radioactive metals such as uranium, plutonium and rhenium. These metals are largely removed by the precipitation reactions.

(2) Dissolved anions associated with the presence of the heavy metal cations, these anions, e.g. nitrate, chloride, and sulfate remain in solution after the heavy metals are precipitated.

(3) Counterions of acids and bases present in the solution as received, e.g., sodium and potassium associated with basic solutions or nitrate, sulfate, and chloride associated with acidic streams. At high and low pH, these basic and acidic counterions can add substantial amounts of TDS. They are not removed in the precipitation reactions.

(4) The ions of neutral salts present in the solution as received, e.g., $CaCl_2$, Na_2SO_4, and KCl. These salts will also contribute to the TDS of the treated stream. TDS from this source must often be measured rather than estimated by calculation.

(5) Counterions of acids, bases, and salts added in pH adjustment and chemical precipitation procedures.

Table G-D-1 is a summary of the calculated TDS arising from an oxidation-hydroxide precipitation treatment of a waste stream containing 50 ppm copper and starting at various pH levels. It is evident that acidic solutions starting with a pH near 2 will have TDS concentrations greater than the POTW discharge limit of 325 ppm. Even neutral solutions with high heavy metals concentrations will be too high in TDS, e.g., at 300 ppm copper, sulfate counterion concentration is 460 ppm. Basic solutions with a pH near 12 will also have excess TDS upon neutralization.

Tables G-D-2 and G-D-3 are summaries of the calculated TDS values of some of the major liquid steams generated at Livermore.

TABLE G-D-1

TOTAL DISSOLVED SOLIDS CALCULATIONS

	pH	Original Metal Cu(ppm)	Copper Counterion SO_4 (ppm)	Original Acid Counterion SO_4/NO_3 (ppm)	Caustic Added to Neutralize Original Acid Na(ppm)	Caustic Added to Raise pH Na(ppm)	Caustic Added to Precipitate Cu Na(ppm)	Sulfuric Acid Added to Neutralize SO_4 (ppm)
of starting solution	1	50	76	4800/6200	2300			
	1.7	50	76	960/1240	460			
	2	50	76	480/620	230			
	3	50	76	48/62	23			
	4	50	76	5/6	2			
of precipitation	9				0.2	36	0.5	
	10				2	36	5	
	11				23	36	50	
	12				230	36	480	

	Original Solution At pH = 1,50 ppm Cu, NO_3 Counterion	After Neutralization with NaOH to pH=1	After Precipitation at pH=11	After Neutralization with H_2SO_4
Summary of Total TDS (ppm)	6326*	8626	8635	8683

*Assumed no TDS arising from neutral salts.

TABLE G-D-2

TDS OF NONRADIOACTIVE LIQUIDS

Stream ID #	Description	Treatment	Rate L/YR	Total Heavy Metals (ppm)	Before Treatment pH	Before Treatment TDS (ppm)	After Treatment pH	After Treatment TDS (ppm)
L03TD	Plating Waste	No	333,000	315	0.67	NR	7	19,027
L03TD	Plating Waste	Sewer	9,430,000	4	3	75	7	170
	Retention Tank Liquids	Sewer	2,879,000	NR	NR			
L01TA	Ion Exchange Waste	No	1,111,000	10	13.1	2,300	7	7,100
L01TB	Ion Exhange Waste	No	163,000	30	12.4	1,500	7	2,000
S11TB	Site 300-Photochem	Sewer	363,000		7	2,500		
L06TB	Photochem Chromate	No	25,000	NR	3	NR		
L06TD	After Ag Recovery	Sewer	33,000	NR	5	NR		
L06TBD	Photochem Bleach, CrO_4	No	6,000	NR	1.5	NR		
L04TA	Circuit Board Waste	Yes	349,000	1,130	1		7	11,150
L04TF	Circuit Board Waste	Yes	461,000	1,680	2		7	4,730
L17TA	*Chem. Mat. Sciences*	*Yes*	*109,000*	*20*	5		7	*170*

TABLE G-D-3

TDS OF RADIOACTIVE LIQUIDS

Stream ID #	Description	Treatment	Rate L/YR	Total Heavy Metals (ppm)	Before Treatment pH (ppm)	Before Treatment TDS (ppm)	After Treatment pH (ppm)	After Treatment TDS (ppm)
L01TRA	Decon. Nitric Acid (NA)	Yes	65,000	43	1	6300	7	8700
L03TRC	Plating Sulfuric Acid (SA)	Yes	39,000	320	1.7	1800	7	2500
L10TRC	Bldg 151	Yes	136,000	50*	1.7	1300	7	1900
L12TRA1	Target Rinse	Yes	18,000	6	4	20	7	100
L13TRB	LIS Acids: NA, HF	No	56,000		<1			
L13TRC	LIS Liquids	Yes	129,000	50*	<1-8.4	75	7	150
L17TRBA	Plating Rinse	Yes	15,000	15	6.2	25	7	100
12 Misc. Streams			38,000	50*	1*	6300	7	8700

*Assumed values.

APPENDIX G-E - DATA REQUIRED FOR FINAL PROCESS DESIGNS

Before preparing specifications for equipment purchase, it will be necessary to ensure that the operating rates and performance characteristics envisioned in this conceptual design report can be achieved. Furthermore, more information on the performance of treatment systems at other DOE sites should be obtained than was possible during the preparation of this report. While we have based our estimates of equipment size and performance on capacity and performance capabilities believed demonstrable, it must be recognized that the diversity of wastes to be processed at LLNL may significantly affect the performance capabilities of these new technologies. In particular, evaluation of the likely performance capabilities of the following technologies should be determined prior to preparation of specifications for equipment purchase.

-- Ultrafiltration. This technology has been widely used for the removal of water from organics/water streams (especially oils); however, tests at either equipment supplier's laboratories or pilot unit testing at LLNL should be carried out to determine the performance capability utilizing typical waste streams.

-- Reverse Osmosis. As with ultrafiltration, reverse osmosis pilot units should be tested for their capabilities to achieve the desired concentration limits on dissolved salts and heavy metals. In addition, the pH level of the permeate that may be returned for reuse or sent to the POTW must be established in order to determine if further chemical adjustment will be required.

-- Pressure Filtration. The selection of pressure filtration for the removal of solids produced in precipitation processes was based on its capabilities for producing cakes with lower moisture content than vacuum filtration, reduction in the volume of air emitted to the atmosphere, and the probably greater ease of decontaminating the filtration equipment; however, because some of the precipitation processes may produce solids that are subject to undue compaction under high pressures

with the concomitant reduction in filtration rates, it will be necessary that actual tests with pilot units be carried out. The evaluation and testing of pressure belt filters should also be considered since these units are finding increasing usage in the dewatering of sludges. We highly recommend testing at LLNL since the shipment of slurries to other locations will usually alter their characteristics so that little confidence can be placed in the test results.

-- Evaporative Concentration and Crystallization. Pilot testing of equipment for these technologies is not likely to be required. However, equipment suppliers must be furnished compositions of streams to be concentrated in order to provide bids on their equipment.

-- Solidification. Continuous mixing of aqueous streams with one or more solidifying agent, e.g., Envirostone®, cement, soil, etc., should be performed to establish the rates and product characteristics.

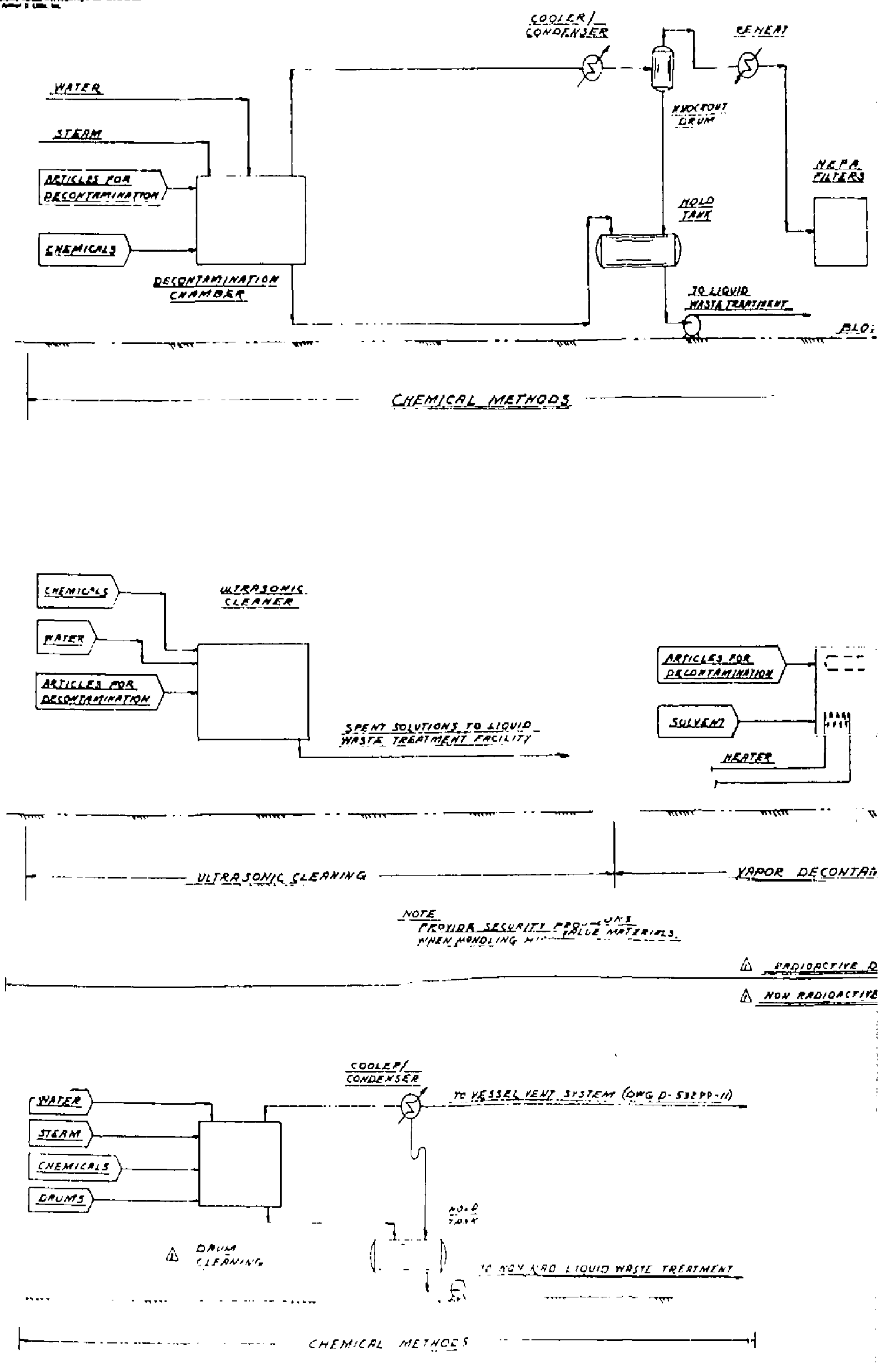
-- Flocculation/Clarification. Pilot plant testing of a Flocculator/Clarifier should be carried out if laboratory sedimentation tests are not acceptable as a design bases by equipment suppliers.

-- Reactive Materials Treatment. There is not likely to be a single method for inactivating reactive materials, consequently, the disposal procedures for these materials must be investigated individually taking into consideration the unique handling that might be required for reasons of safety.

APPENDIX G-F-1

LIST OF DRAWINGS

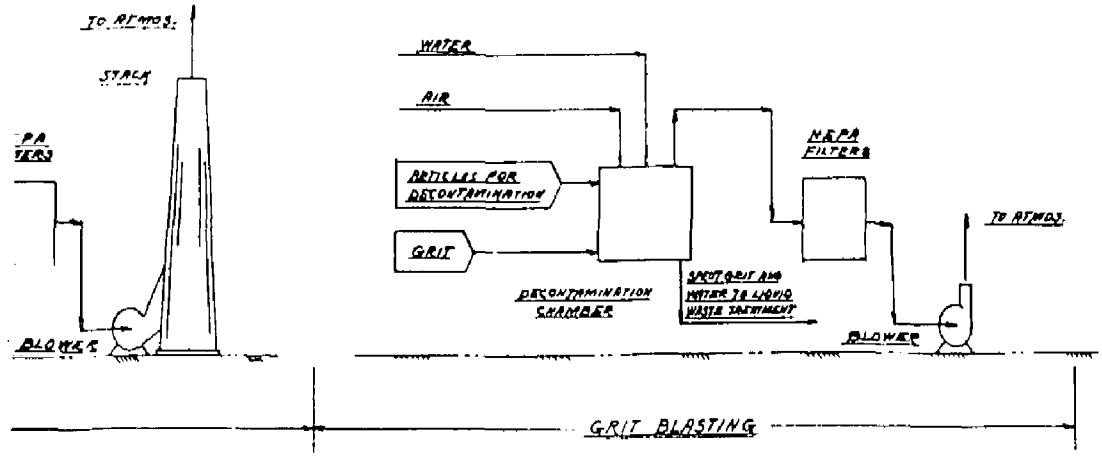
Drawing No. 53299-1	Schematic Flowsheet - Decontamination Methods (Chemical Methods, Grit Blasting, Ultrasonic Cleaning, Vapor Decontamination, Electropolishing)
Drawing No. 53299-2	Schematic Flowsheet - Liquid Radioactive Waste Treatment - Sheet No. 1
Drawing No. 53299-3	Schematic Flowsheet - Liquid Radioactive Waste Treatment - Sheet No. 2
Drawing No. 53299-4	Schematic Flowsheet - Non-Radioactive Liquid Treatment
Drawing No. 53299-5	Schematic Flowsheet - Radioactive/Non-Radioactive Wastes Filtration
Drawing No. 53299-6	Schematic Flowsheet - Compaction and Solidification
Drawing No. 53299-7	Schematic Flowsheet - Rotary Kiln Incinerator and Uranium Burn Pan
Drawing No. 53299-8	Schematic Flowsheet - Solvent Recovery
Drawing No. 53299-9	Schematic Flowsheet - Radioactive Incineration and Reactive Materials Treatment
Drawing No. 53299-10	Schematic Flowsheet - Advanced Wastewater Treatment - Evaporative Concentrations
Drawing No. 53299-11	Schematic Flowsheet - Support Facilities for DWTF

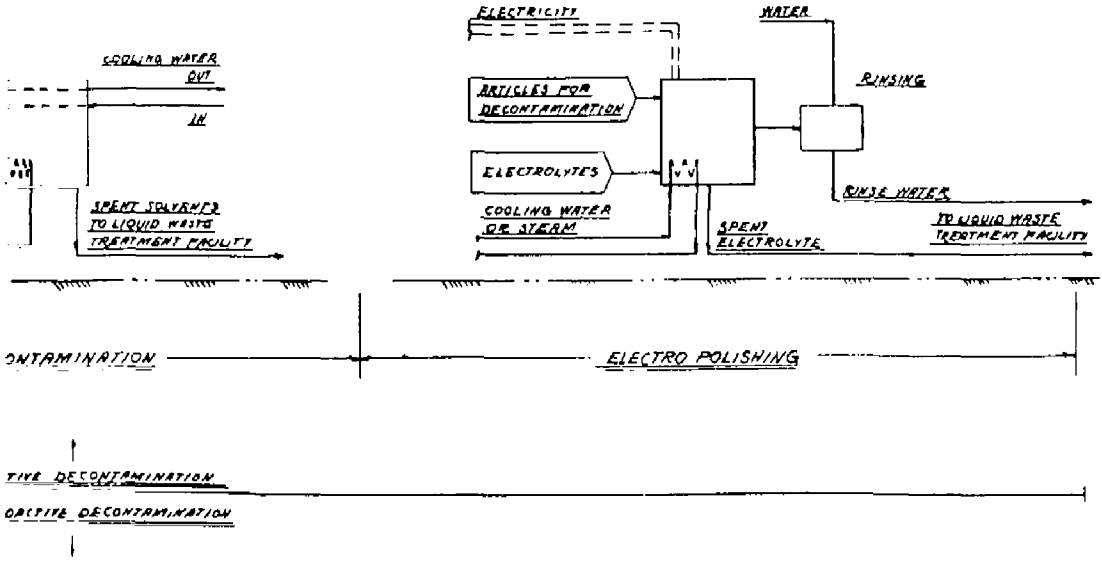


COOLER/ CONDENSER
REHEAT
WATER
STEAM
KNOCKOUT DRUM
HEPA FILTERS
ARTICLES FOR DECONTAMINATION
HOLD TANK
CHEMICALS
DECONTAMINATION CHAMBER
TO LIQUID WASTE TREATMENT
CHEMICAL METHODS
CHEMICALS
ULTRASONIC CLEANER
WATER
ARTICLES FOR DECONTAMINATION
SPENT SOLUTIONS TO LIQUID WASTE TREATMENT FACILITY
ARTICLES FOR DECONTAMINATION
SOLVENT
HEATER
ULTRASONIC CLEANING
VAPOR DECONTA
NOTE
NON RADIOACTIVE
COOLER/ CONDENSER
WATER
STEAM
CHEMICALS
DRUMS
TO VESSEL VENT SYSTEM (DWG D-53299-11)
HOLD TANK
DRUM CLEANING
CHEMICAL METHODS

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
P.I.T.	A	ADDED RAD. (NON-RAD DECONTAMINATION BASIS) DRAW CLEANED WAS IN RAD. AREA	11/4/85	





ITEM NO	QTY REQ	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED	ISSUE DATE:	
DIMENSIONS ARE IN INCHES TOLERANCES	DRAWN 10/29/85	F.M.
	CHECKED	
DECIMAL .XX ± .090 .XXX ± .005	APPROVED	
FRACTIONAL ± 1/64		
ANGULAR ± 2°		
FINISHED SURFACES BREAK SHARP CORNERS	RMS	
DO NOT SCALE THIS DRAWING		
MATERIAL		
NEXT ASSY	USED ON	
APPLICATION		

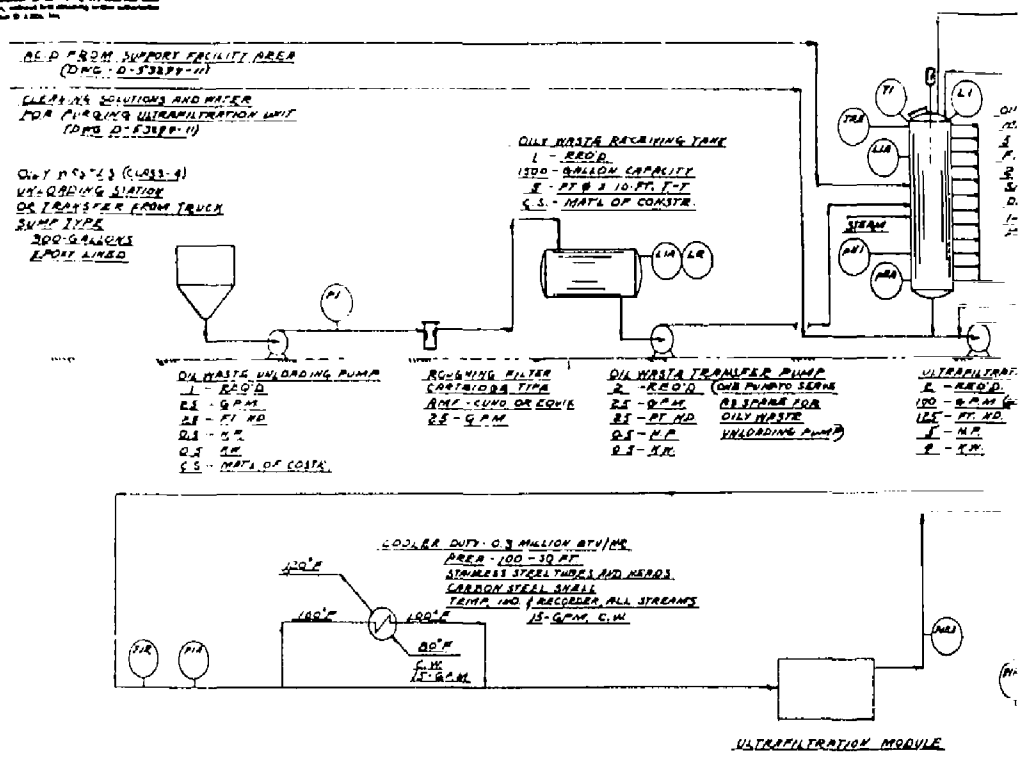
Arthur D Little Inc.
CAMBRIDGE, MASSACHUSETTS 02140

SCHEMATIC FLOWSHEET
DECONTAMINATION METHODS
(CHEMICAL METHODS, GRIT BLASTING, ULTRASONIC CLEANING, VAPOR DECONTAMINATION, ELECTRO POLISHING)

SIZE	CODE IDENT NO	DRAWING NO.	REVISION
D	75629	63290-1	1

CAGE 53299

SCALE SHEET



FLOWSHEET NOTES

ALL RADIOACTIVE WASTE OPERATIONS ARE TO BE CARRIED OUT IN A CONTROLLED ACCESS AREA SEPARATED FROM NON-RADIOA
EQUIPMENT MAY BE INSTALLED EITHER IN OR OUT OF BUILDINGS.
ALL EQUIPMENT INSTALLED OUTSIDE OR ENCLOSED BUILDINGS SHOULD BE PROVIDED WITH ROOFS TO PREVENT RAIN WATE
RECEIVING TANKS MAY BE INSTALLED IN COMMON AREA ; HOWEVER NO MORE THAN FOUR TANKS SHOULD BE GROUPED TOG
UNLOADING STATIONS TO BE PROVIDED WITH SLOPING AREAS DRAINING TO COLLECTION SUMPS.
ALL DIKED AREAS SHOULD HAVE IMPERVIOUS BOTTOMS AND SIDES. PROVISIONS SHOULD BE MADE FOR REMOVAL OF LIQU
ALL PROCESS TANKS (OTHER THAN RECEIVING TANKS) SHOULD BE INSTALLED WITH THEIR SERVICE PUMPS IN CURBED
ALL CURBED AREAS SHOULD BE PROVIDED FOR GRAVITY DRAINAGE TO TANK LOCATED IN SUMP. DOUBLE PIPING FO
PROVIDE STAIRS AND WORK PLATFORMS AROUND TREATMENT TANKS.
ENTIRE AREA SHOULD BE CURBED TO PREVENT LIQUIDS FROM EITHER ENTERING OR LEAVING.
PROVIDE APPROPRIATE CONTROL AREA.
PROVIDE HAND AND FOOT COUNTERS AT ALL ENTRANCES AND EXITS.

PROVIDE STORAGE CABINETS FOR SHOE COVERS AND COATS AT ALL ENTRANCES AND EXITS. ALSO RECEPTACLES

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED

TO VESSEL VENT SYSTEM (DWG D-53299-1)

OILY WASTE TREATMENT TANK (VERTICAL)
HORIZONTAL AT TOP
5-FT DIA X 12-FT T-T
FRP - MATL OF CONSTR
2-HP MIXER 15-RM
SIDE DRAIN LINES AT 4-FT INTERVALS W/VALVES
DIRECT STEAM INJECTION AT 600 LBS/HR 30-PSIG
INSULATE FOR PERSONNEL PROTECTION
MAX. TEMP - 160°F

CONCENTRATED OIL RECEIVER TANK
3.5 FT DIA X 7 FT T-T
500-GALLON CAPACITY
FRP - MATL OF CONSTR

TO SOLIDIFICATION & DISPOSAL OFF SITE (LEVEL I EQUIPMENT) (INCINERATION LEVEL III TREATMENT)
(LEVEL I DWG D-53299-6)
(LEVEL III DWG D-53299-9)

CONCENTRATED OIL TRANSFER PUMP
1 - REQ'D
10 - GPM
50 - FT. HD.
0.5 - H.P.
0.5 - KW

TO VENDOR IF REQUIRED

TO METAL SOLUTION CHEMICAL ADJUSTMENT TANK IF REQUIRED (DWG D-53299-1)

ULTRAFILTRATE RECEIPT TANK
5-FT Ø X 12-FT T-T
FRP - MATL OF CONSTR

TO POTW UPON APPROVAL FOR DISCHARGE

ULTRAFILTRATE TRANSFER PUMP
1 - REQ'D
25 - GPM
50 - FT. HD.
0.5 - H.P.
0.5 - KW
FRP - OR PLASTIC CONSTR

-N-RADIOACTIVE WASTE OPERATIONS.

RAIN WATER FROM ENTERING RADIOACTIVE AREAS.
CURBED TOGETHER, DIKES FOR 125% OF LARGEST TANK SHOULD BE PROVIDED.

OIL OR LIQUIDS FROM DIKED AREAS.
CURBED AREAS
PIPING FOR UNDERGROUND DRAIN LINES.

-RACLES FOR CONTAINMENT OF USED SHOE COVERS AND COATS.

ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL
XX ± .010
XXX ± .005
FRACTIONAL ± 1/64
ANGULAR ± 1°
FINISHED SURFACES BREAK SHARP CORNERS RMS
DO NOT SCALE THIS DRAWING

ISSUE DATE
DRAWN 11/28/84 KM
CHECKED
APPROVED

Arthur D. Little, Inc.
CAMBRIDGE, MASSACHUSETTS 02140

SCHEMATIC FLOW SHEET
LIQUID RADIOACTIVE WASTE TREATMENT
SHEET NO. 1

NEXT ASSY	USED ON

APPLICATION

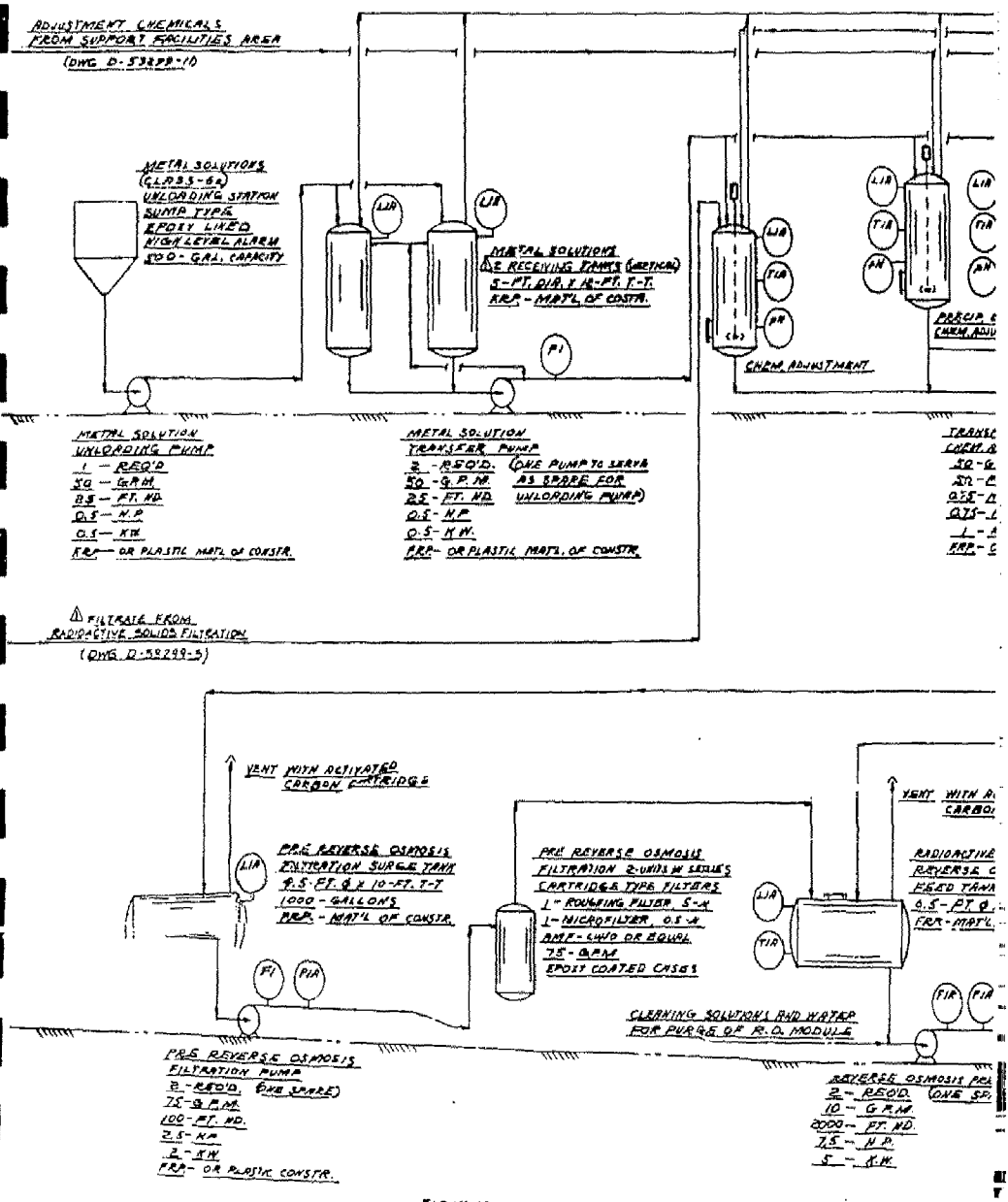
MATERIAL

SIZE	CODE IDENT NO	DRAWING NO	REVISION
D	75629	53299-2	

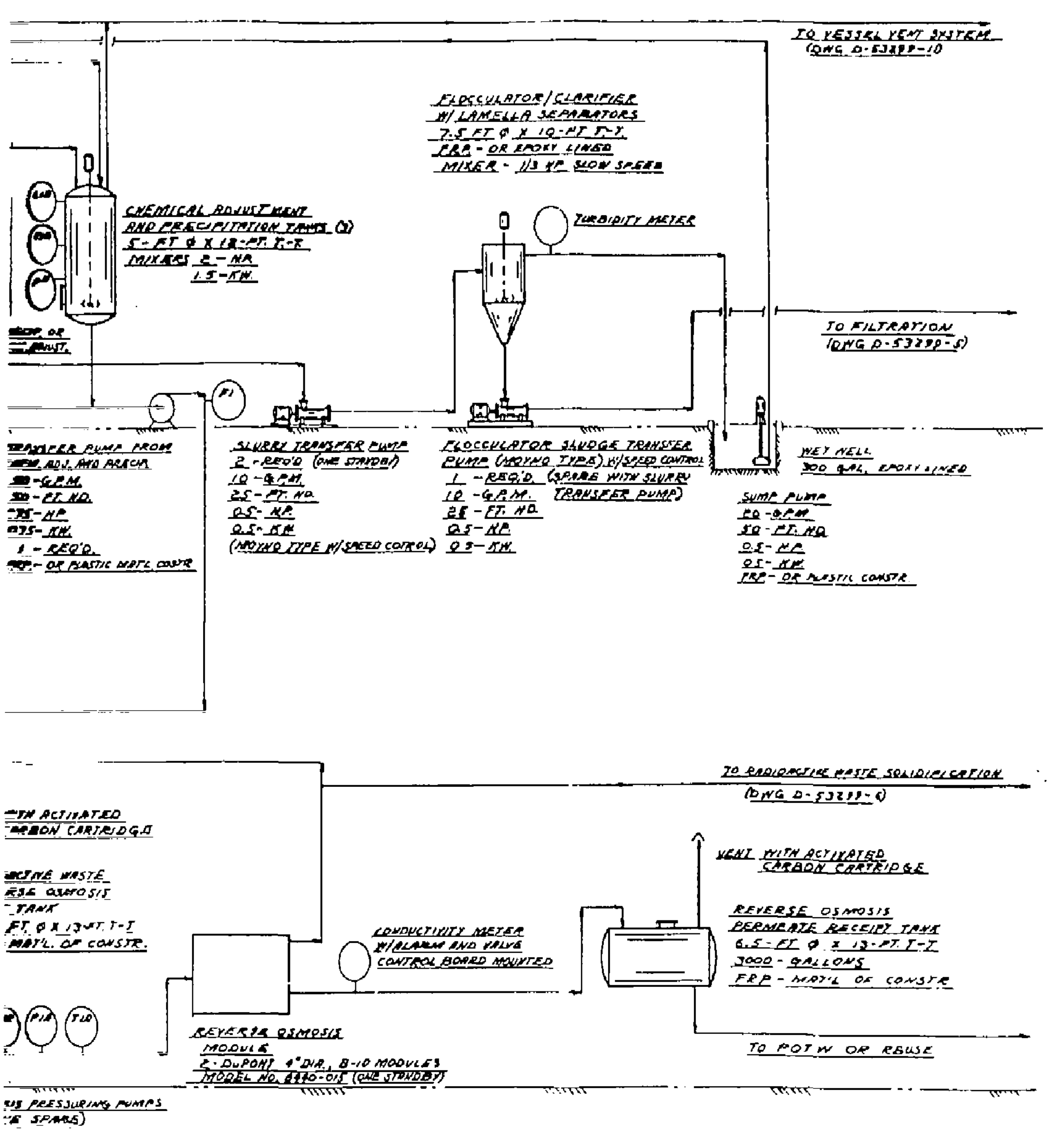
LAST 53299

SCALE

SHEET


ADJUSTMENT CHEMICALS FROM SUPPORT FACILITIES AREA
(DWG D-59299-10
METAL SOLUTIONS (CLASS-6A) UNLOADING STATION SUMP TYPE EPOXY LINED HIGH LEVEL ALARM 500-GAL. CAPACITY
METAL SOLUTION ⚠2 RECEIVING TANKS (VERTICAL) 5'-FT. DIA. X 12'-FT. T-T. FRP - MAT'L OF CONSTR.
CHEM. ADJUSTMENT
METAL SOLUTION UNLOADING PUMP
1 — REQ'D
30 — G.P.M.
85 — FT. HD.
0.5 — H.P.
0.5 — KW
FRP — OR PLASTIC MAT'L OF CONSTR.
METAL SOLUTION TRANSFER PUMP
2 - REQ'D. (ONE PUMP TO SERVE AS SPARE FOR UNLOADING PUMP)
30 - G.P.M.
25 - FT. HD.
0.5 - H.P.
0.5 - K.W.
FRP - OR PLASTIC MAT'L OF CONSTR.
⚠ FILTRATE FROM RADIOACTIVE SOLIDS FILTRATION
(DWG D-59299-3)
VENT WITH ACTIVATED CARBON CARTRIDGE
PRE REVERSE OSMOSIS FILTRATION SURGE TANK
9.5'-FT. Ø X 10-FT. T-T
1000 - GALLONS
FRP. - MAT'L OF CONSTR.
PRE REVERSE OSMOSIS FILTRATION 2-UNITS IN SERIES CARTRIDGE TYPE FILTERS
1" ROUGHING FILTER 5-M
1-MICROFILTER 0.5-M
AMF-CUNO OR EQUAL
75 - G.P.M.
EPOXY COATED CASES
CLEANING SOLUTION'S AND WATER FOR PURGE OF R.O. MODULE
PRE REVERSE OSMOSIS FILTRATION PUMP
2 - REQ'D. (ONE SPARE)
75 - G.P.M.
100 - FT. HD.
2.5 - H.P.
2 - KW
FRP - OR PLASTIC CONSTR.
REVERSE OSMOSIS PRE
2 - REQ'D. (ONE SP
10 - G.P.M.
2000 - FT. HD.
7.5 - H.P.
5 - K.W.
FLOWSHEET NOTES
SEE DWG D-59290-2 (SHEET NO 1)

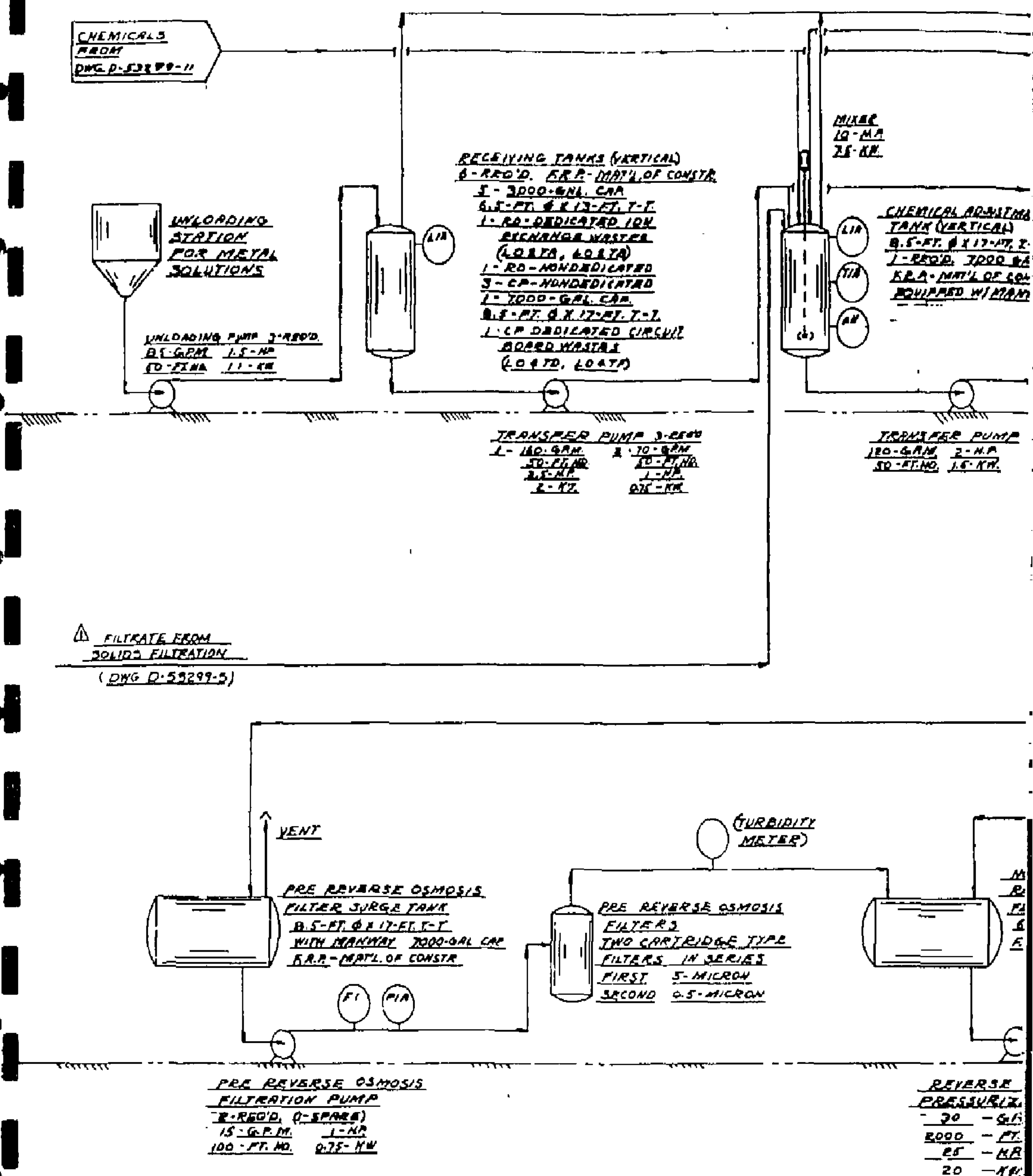
ZONE	LTR	DESCRIPTION	DATE	APPROVED
C 8 D 6	1	CHANGED FILTRATE TO CHEMICAL ADJUSTMENT TANK ADDED & RECANNING TANKS	1/1585	



ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

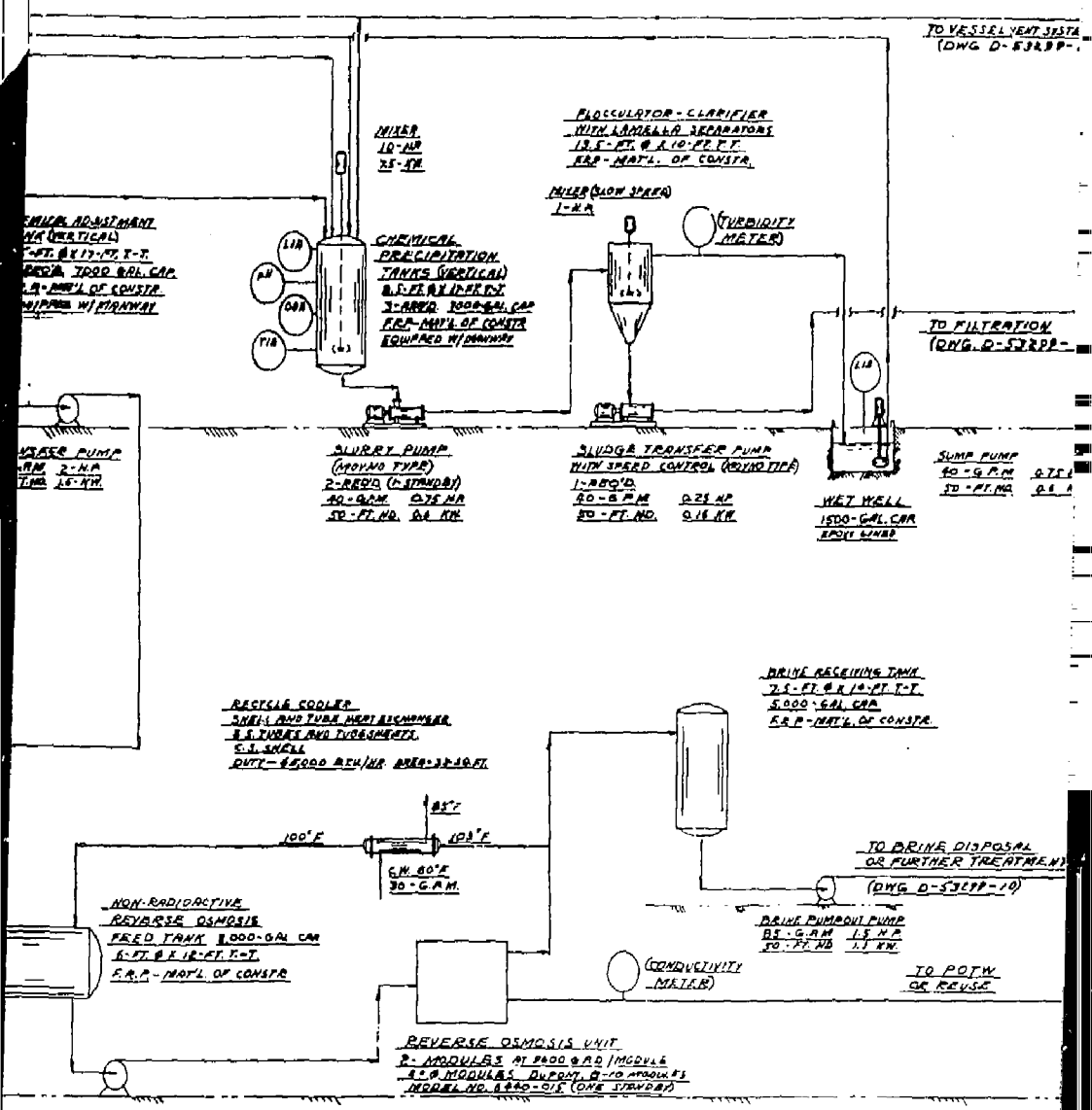
LIST OF PARTS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMAL .XX ± .010 .XXX ± .005 FRACTIONAL ±1/64 ANGULAR ±1° FINISHED SURFACES BREAK SHARP CORNERS RMS DO NOT SCALE THIS DRAWING MATERIAL	ISSUE DATE DRAWN 11/28/84 FJM CHECKED APPROVED	Arthur D. Little, Inc. CAMBRIDGE, MASSACHUSETTS 02140	SCHEMATIC FLOWSHEET LIQUID RADIOACTIVE WASTE TREATMENT SHEET NO. 2
NEXT ASSY / USED ON — APPLICATION	CASE 53299	SIZE D CODE IDENT NO 75629	DRAWING NO. 53299-3 REVISION 1 SCALE SHEET



NOTES
SEE DWG. D-53299-2 (SHEET-NO.1)
EXCEPT HAND AND FOOT COUNTERS
EXCEPT STORAGE FOR CONTAMINATED CLOTHING
PROVIDE MANUAL WORK STATION FOR HANDLING CLASSIFYING AND COMPOSITING WASTES FROM SMALL CONTAINERS TO INCLUDE 4-SS COVERED TABLES WITH 55-GALLON COLLECTING DRUMS.

ZONE	LTR	DESCRIPTION
C	B	CHANGED FILTRATE TO CHEMICAL ADJUSTMENT TANK



REVERSE OSMOSIS PRESSURIZING PUMPS (2)
- 30 - G.P.M.
- 8000 - FT. OF HD.
- 85 - H.P.
- 20 - K.W.

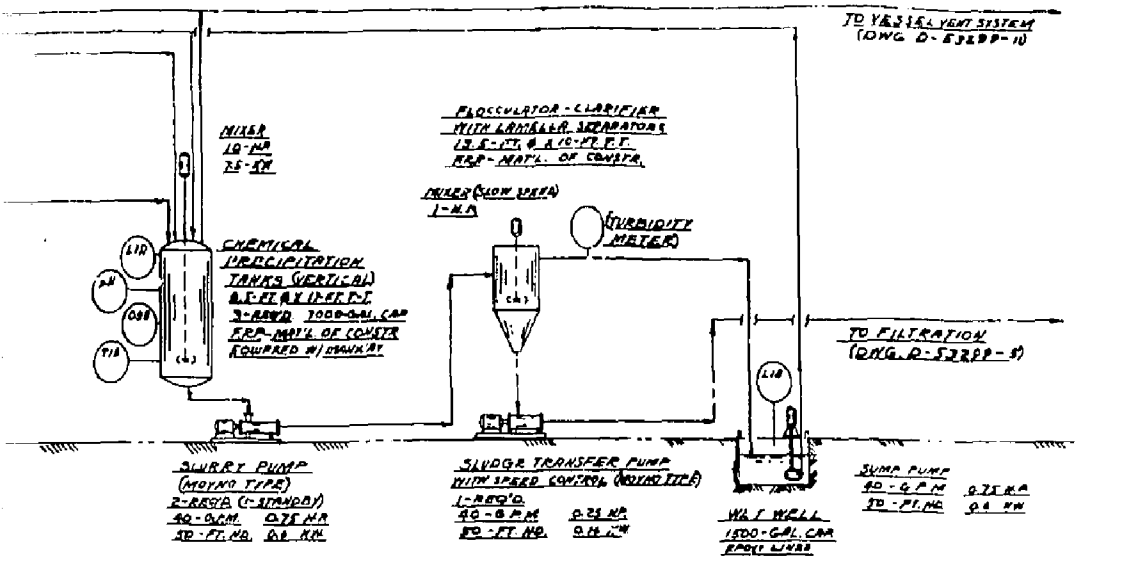
CENTRIFUGAL TYPE WITH ALL WETTED PARTS 316-S.S.

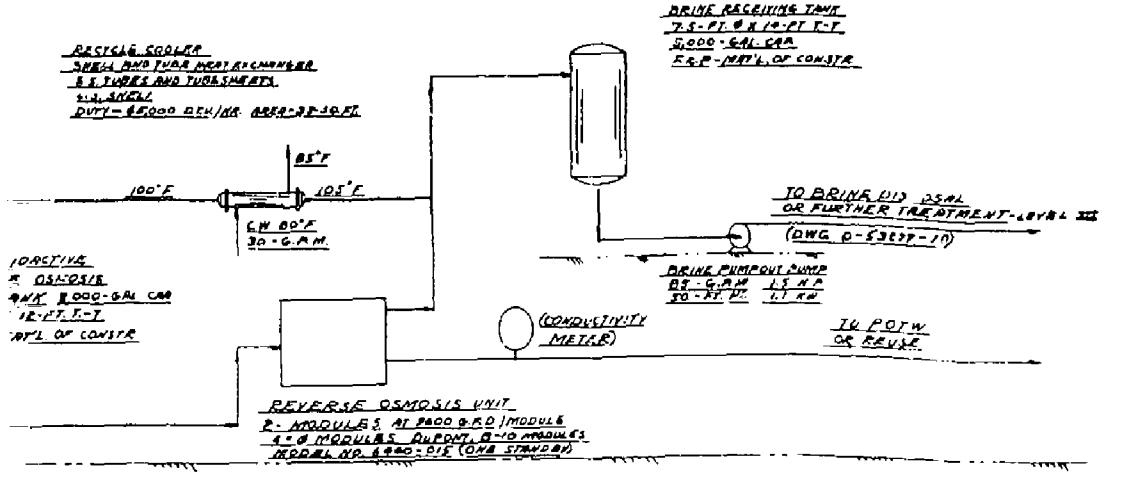
ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED	ISSUE DATE		Arthur D. Little CAMBRIDGE, MASSACHUSETTS
DIMENSIONS ARE IN INCHES TOLERANCES	DRAWN 11/26/84 FJM		
DECIMAL XX ± .010 XXX ± .005 / FRACTIONAL ±1/64 / ANGULAR ±	CHECKED		SCHEMATIC FLOWS
FINISHED SURFACES BREAK SHARP CORNERS RMS	APPROVED		NON-RADIOACTIVE LIQUID
DO NOT SCALE THIS DRAWING			
MATERIAL		SIZE D	CODE IDENT NO 75629
NEXT ASSY USED ON APPLICATION	CAGE 53299	SCALE —	DRAWING NO 53299-4

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
C-8	A	CHANGED FILTRATE TO CHEMICAL ADJUSTMENT TANK	1/6/83	





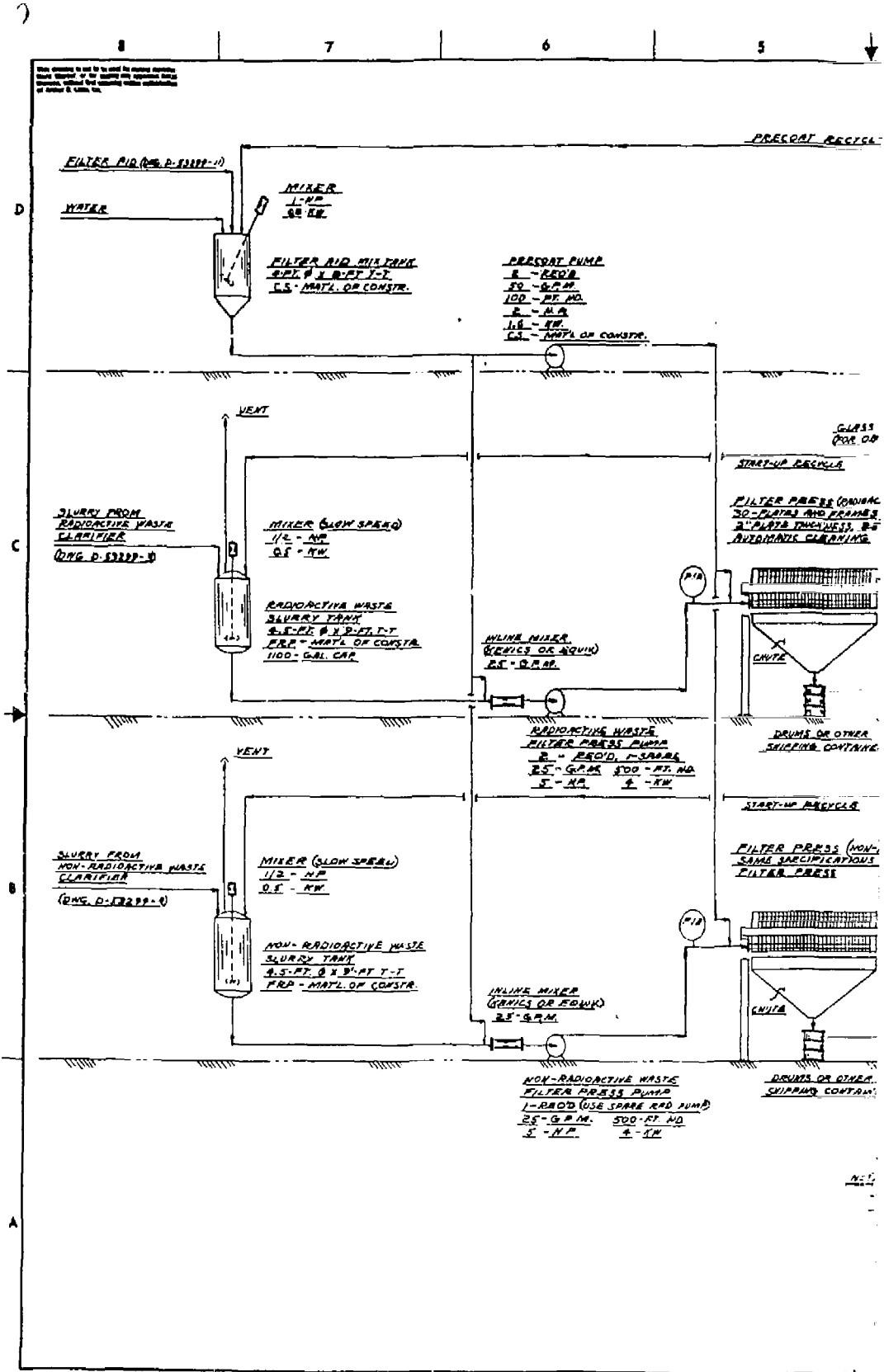
SIS
UMPS (2)

WITH
4-SS

ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED	ISSUE DATE	Arthur D. Little, Inc.
DIMENSIONS ARE IN INCHES TOLERANCES	DRAWN 11/26/84 FM	
DECIMAL XX = ± .010 XXX = ± .005 / FRACTIONAL 1/16 / ANGULAR 1°	CHECKED	SCHEMATIC FLOWSHEET NON-RADIOACTIVE LIQUID TREATMENT
FINISHED SURFACES BREAK SHARP CORNERS 125 RMS	APPROVED	
DO NOT SCALE THIS DRAWING		SIZE D / CODE IDENT NO 75629 / DRAWING NO 53299-4 / REVISION A
MATERIAL / NEXT ASSY / USED ON	CAGE 53299	


8
7
6
5
4
D
C
B
A
PRECOAT RECYCL
FILTER AID (DWG. D-53299-11)
WATER
MIXER
1-HP
60 RPM
FILTER AID MIX TANK
6'-0" ϕ X 8'-0" T-T
C.S. - MATL. OF CONSTR.
PRECOAT PUMP
2 - REQ'D
50 - G.P.M.
100 - FT. HD.
2 - H.P.
1.6 - KW.
C.S. - MATL OF CONSTR.
VENT
GLASS FOR OB
START-UP RECYCLE
SLURRY FROM RADIOACTIVE WASTE CLARIFIER (DWG. D-53299-9)
MIXER (SLOW SPEED)
1/2 - HP
0.5 - KW
FILTER PRESS (RADIOAC
30-PLATES AND FRAMES
2" PLATE THICKNESS, 8-5
AUTOMATIC CLEANING
RADIOACTIVE WASTE SLURRY TANK
4.5-FT. ϕ X 9'-0" T-T
FRP - MATL OF CONSTR.
1100 - GAL. CAP.
INLINE MIXER (GRACO OR EQUIV)
25 - G.P.M.
P1A
CHUTE
DRUMS OR OTHER SHIPPING CONTAINE
RADIOACTIVE WASTE FILTER PRESS PUMP
2 - REQ'D, 1-SPARE
25 - G.P.M. 500 - FT. HD
5 - HP 4 - KW
VENT
START-UP RECYCLE
SLURRY FROM NON-RADIOACTIVE WASTE CLARIFIER (DWG. D-53299-8)
MIXER (SLOW SPEED)
1/2 - HP
0.5 - KW
FILTER PRESS (NON-
SAME SPECIFICATIONS
FILTER PRESS
NON-RADIOACTIVE WASTE SLURRY TANK
4.5-FT. ϕ X 9'-0" T-T
FRP - MATL OF CONSTR.
P1B
CHUTE
INLINE MIXER (GRACO OR EQUIV)
25 - G.P.M.
DRUMS OR OTHER SHIPPING CONTAIN
NON-RADIOACTIVE WASTE FILTER PRESS PUMP
1-REQ'D (USE SPARE RAD PUMP)
25 - G.P.M. 500 - FT. HD
5 - H.P. 4 - KW

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

AT RECYCLE

GLASS SECTION (FOR OBSERVATION)

RECYCLE

...ESS (RADIOACTIVE WASTE) ...AND FRAME $, 849 SQ FT ...KNESS, 8-50 - A.P.M. CLEANING

FI

TURBIDITY METER

CAKE REMOVAL

...S OR OTHER ...NG CONTAINERS

TO ROUGHING FILTER SURGE TANK RADIOACTIVE WASTES (DWG. D-53299-3)

RADIOACTIVE WASTE FILTRATE RECEIVER SUMP TYPE - 300 GALLONS WITH HI-LO LEVEL PUMP CONTROL

PUMP: 50 - G.P.M. 50 - FT. HD. 0.75 - H.P. 0.75 - K.W.

GLASS SECTION FOR OBSERVATION

RECYCLE

...RESS (NON-RADIOACTIVE WASTE) ...CIFICATIONS AS RADIOACTIVE ...RESS

FI

TURBIDITY METER

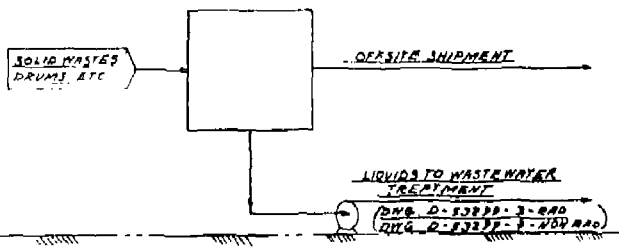
CAKE REMOVAL

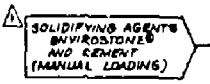
...S OR OTHER ...NG CONTAINERS

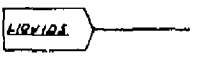
TO ROUGHING FILTER SURGE TANK NON-RADIOACTIVE WASTES (DWG D-53299-4)

NON-RADIOACTIVE FILTRATE RECEIVER SUMP TYPE - 300 GALLONS WITH HI-LO LEVEL PUMP CONTROL

PUMP: 50 - G.P.M. 50 - FT. HD. 0.75 - H.P. 0.75 - K.W.



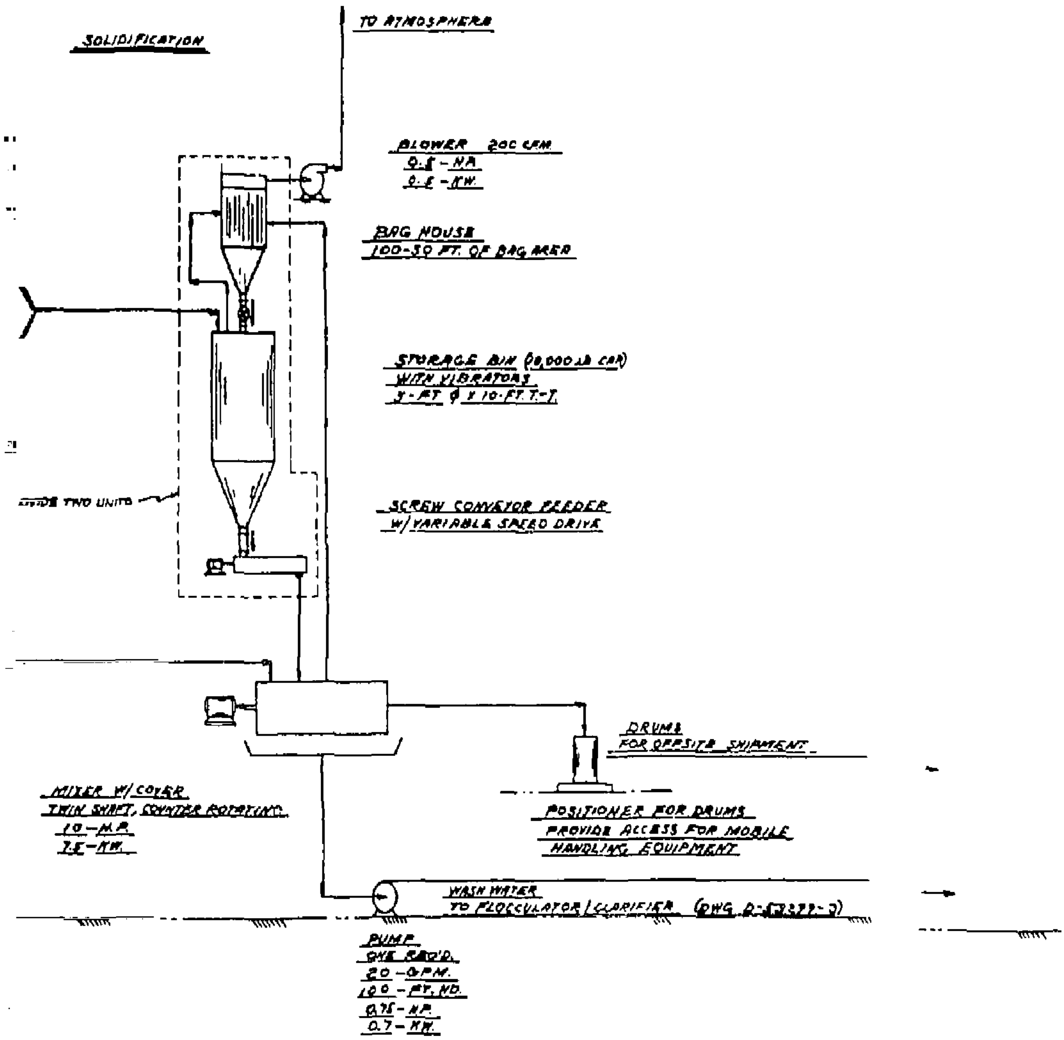




NOTE
PROVIDE AN ESTIMATED 500-SQ.FT.AREA
FOR INSTALLATION OF TRU ASSAYING EQUIPMENT

8 7 6 5

ZONE	LTR	DESCRIPTION	DATE	APPROVED
D-5 C-4	1	CHANGED SOLIDIFYING AREA ADDED TWO UNITS	1/7/85	



ITEM NO	QTY REQ	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL .XX = ± .010 .XXX = ± .005
FRACTIONAL ± 1/64
ANGULAR ± 1°
FINISHED SURFACES
BREAK SHARP CORNERS
DO NOT SCALE THIS DRAWING
MATERIAL

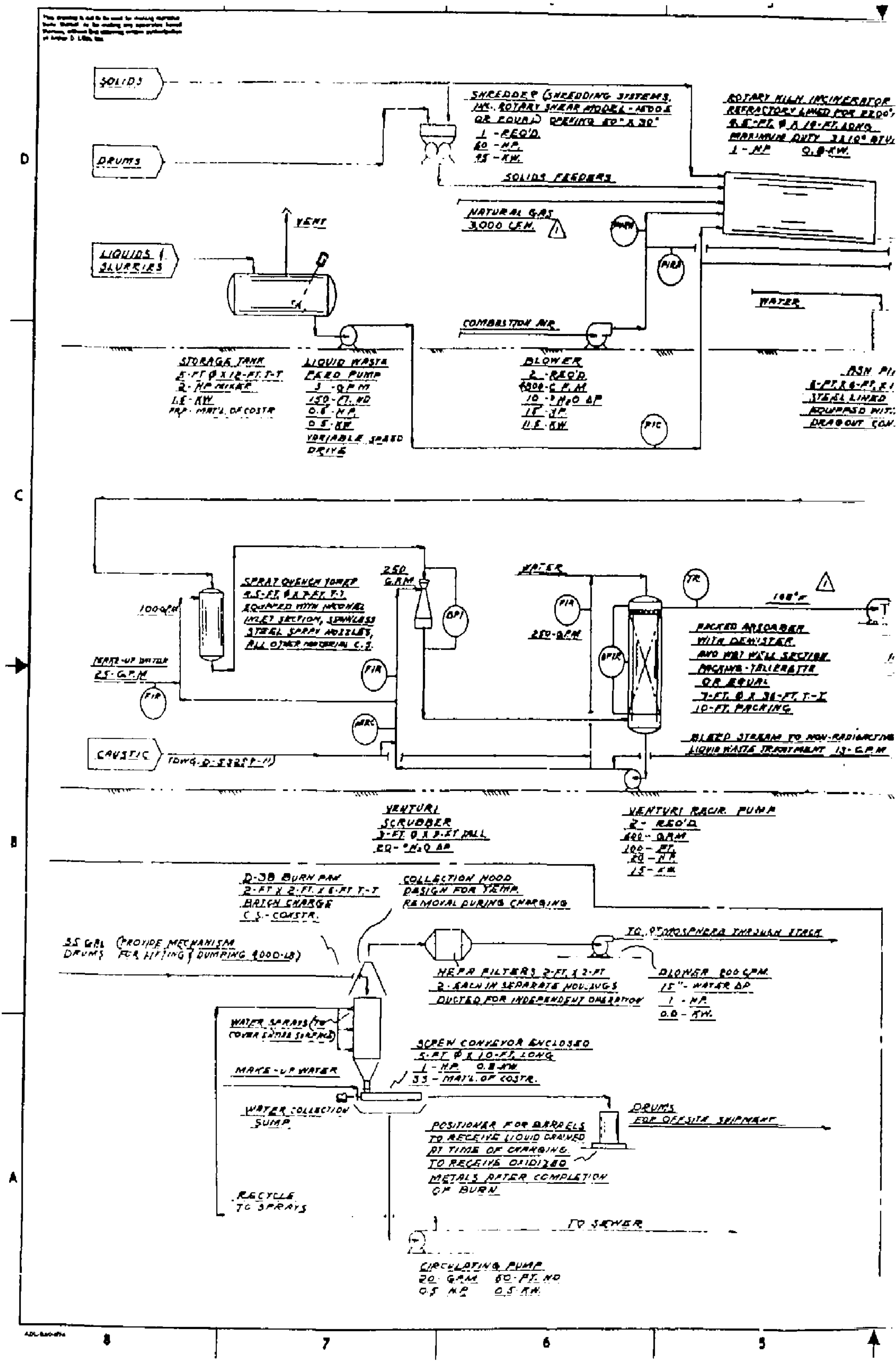
NEXT ASSY | USED ON

ISSUE DATE
DRAWN 11/9/84 F.M.
CHECKED
APPROVED

Arthur D. Little, Inc.

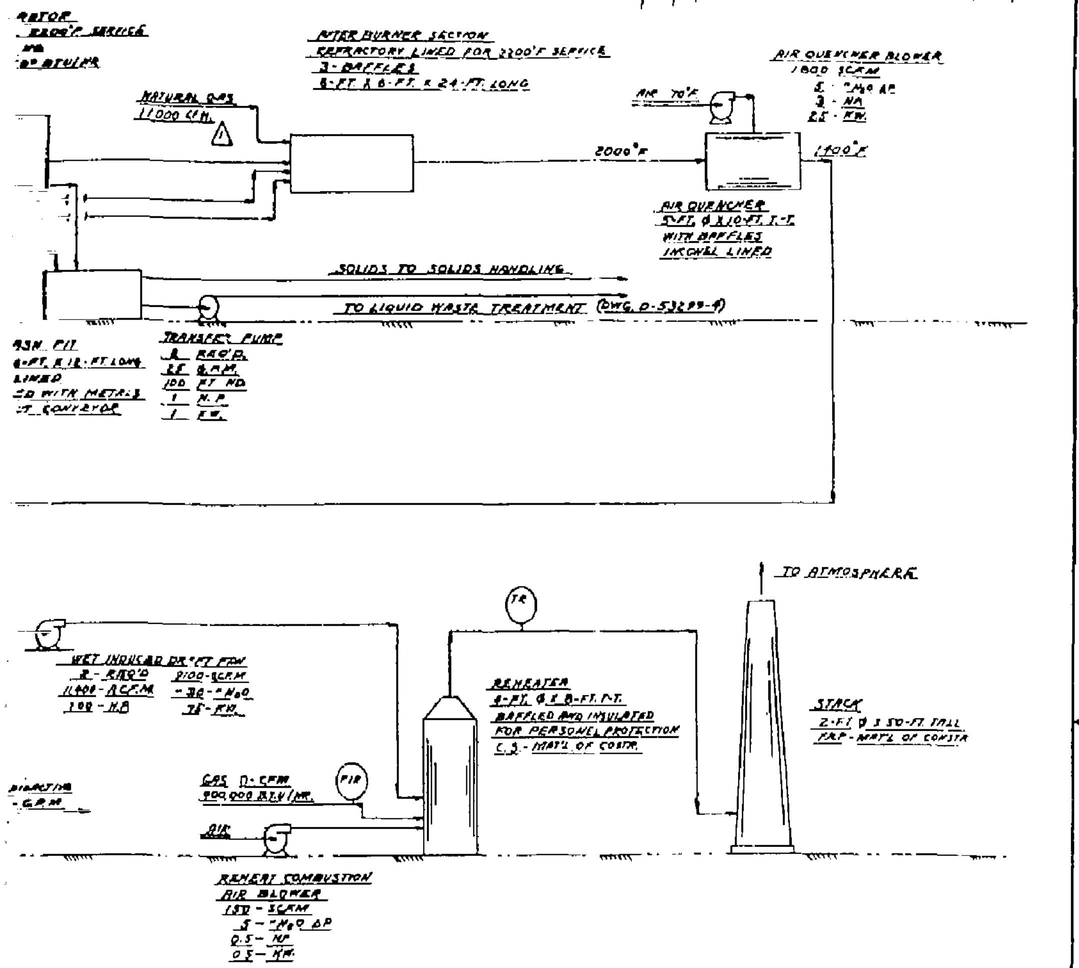
SCHEMATIC FLOWSHEET
COMPACTION AND SOLIDIFICATION

SIZE D | CODE IDENT NO 7562 | DRAWING NO



SOLIDS
DRUMS
SHREDDER (SHREDDING SYSTEMS, INC. ROTARY SHEAR MODEL - 4000 E OR EQUAL) OPENING 60" X 30"
1 - REQ'D.
60 - HP.
45 - KW.
SOLIDS FEEDERS
ROTARY KILN INCINERATOR
REFRACTORY LINED FOR 2200°
MAXIMUM DUTY
1 - HP
NATURAL GAS
3,000 CFH.
VENT
LIQUIDS & SLURRIES
PIRA
WATER
COMBUSTION AIR
STORAGE TANK
5-FT Ø X 12-FT. T-T
2 - HP MIXER
1.5 - KW
FRP - MAT'L. OF COSTR.
LIQUID WASTE FEED PUMP
3 - GPM
150 - FT. HD
0.5 - HP.
0.5 - KW
VARIABLE SPEED DRIVE
BLOWER
2 - REQ'D.
10 - " H₂O ΔP
15 - HP.
11.5 - KW.
PIC
ASH PIT
STEEL LINED
EQUIPPED WITH DRAGOUT CON.
250 GPM
WATER
TR
100 GPM
SPRAY QUENCH TOWER
EQUIPPED WITH INCONEL INLET SECTION, STAINLESS STEEL SPRAY NOZZLES, ALL OTHER MATERIAL C.S.
DPI
FIR
250 - GPM
DPIR
PACKED ABSORBER
WITH DEMISTER
AND WET WELL SECTION
PACKING - TELLERETTE
OR EQUAL
10-FT. PACKING
MAKE-UP WATER
25 - GPM
FIR
ARC
CAUSTIC
BLEED STREAM TO NON-RADIOACTIVE LIQUID WASTE TREATMENT 13 - GPM
VENTURI SCRUBBER
VENTURI RECIR. PUMP
2 - REQ'D
100 - FT.
20 - HP.
15 - KW
D-38 BURN PAN
BATCH CHARGE
C.S. - CONSTR.
COLLECTION HOOD
DESIGN FOR TEMP. REMOVAL DURING CHARGING
55 GAL DRUMS (PROVIDE MECHANISM FOR LIFTING & DUMPING 1000-LB)
TO ATMOSPHERE THROUGH STACK
HEPA FILTERS 2-FT. X 2-FT
2 - EACH IN SEPARATE HOUSINGS
DUCTED FOR INDEPENDENT OPERATION
BLOWER 800 CFM
15" - WATER ΔP
1 - HP.
WATER SPRAYS (TO COVER ENTIRE SURFACE)
MAKE - UP WATER
SCREW CONVEYOR ENCLOSED
1 - HP.
SS - MAT'L. OF COSTR.
WATER COLLECTION SUMP
DRUMS FOR OFFSITE SHIPMENT
POSITIONER FOR BARRELS TO RECEIVE LIQUID DRAINED AT TIME OF CHARGING. TO RECEIVE OXIDIZED METALS AFTER COMPLETION OF BURN
RECYCLE TO SPRAYS
TO SEWER
CIRCULATING PUMP
20 - GPM 60 - FT. HD
0.5 HP 0.5 KW
D
C
B
A
8
7
6
5

ZONE	LTR	DESCRIPTION	DATE	APPROVED
D-E,4 C-3	1	CFH WAS CFM 1600°F WAS 1600°F	10/?/84	



NOTE:

INCINERATOR CONTROL SYSTEM SHOULD INCLUDE AUTOMATIC CUT OFF OF FEED UNDER FOLLOWING CONDITIONS:

- LOW OR HIGH TEMPERATURES IN THE KILN OR AFTERBURNER.
- HIGH CARBON MONOXIDE CONTENT IN THE STACK GASES.
- HIGH COMBUSTION GAS VELOCITY OR HIGH OXYGEN CONTENT IN THE STACK GASES.

MONITORING AND CONTROL INSTRUMENTS TO INCLUDE

- CONTINUOUS OPACITY MONITORING OF OFF-GASES.
- CONTINUOUS MONITORING OF OFF-GASES FOR CARBON MONOXIDE AND OXYGEN.
- CONTINUOUS MONITORING AND RECORDING OF TEMP. AT EXIT OF ROTARY KILN AND AFTERBURNER.
- CONTINUOUS MEASUREMENTS OF STACK GAS VELOCITY.

ITEM NO.	QTY REQ	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL .XX ± .010 .XXX ± .005
FRACTIONAL ± 1/64
ANGULAR ± 1°
FINISHED SURFACES
BREAK SHARP CORNERS
DO NOT SCALE THIS DRAWING
MATERIAL

DRAWN 10/?/84
CHECKED
APPROVED

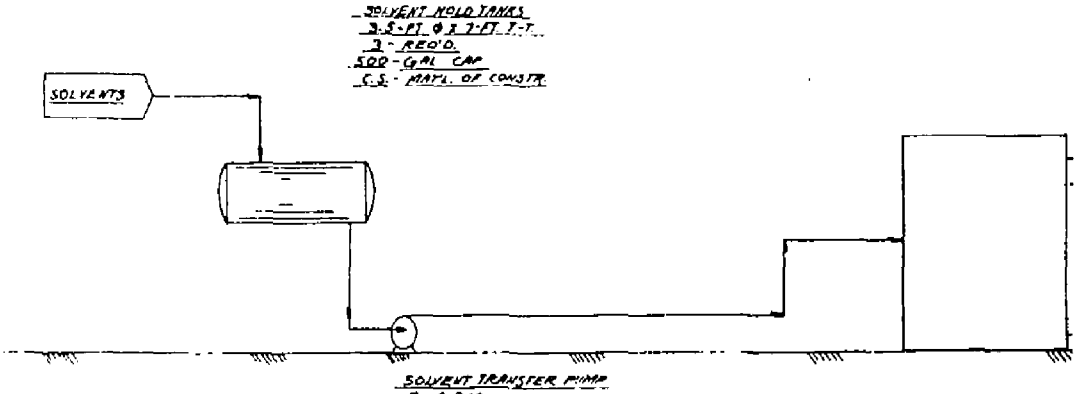
Arthur D Little Inc
CAMBRIDGE, MASSACHUSETTS

SCHEMATIC FLOWSHEET
ROTARY KILN INCINERATOR
AND URANIUM ...

SIZE D | CODE IDENT NO 75629 | DRAWING NO 53299-? | REVISION 1

CASE 53299

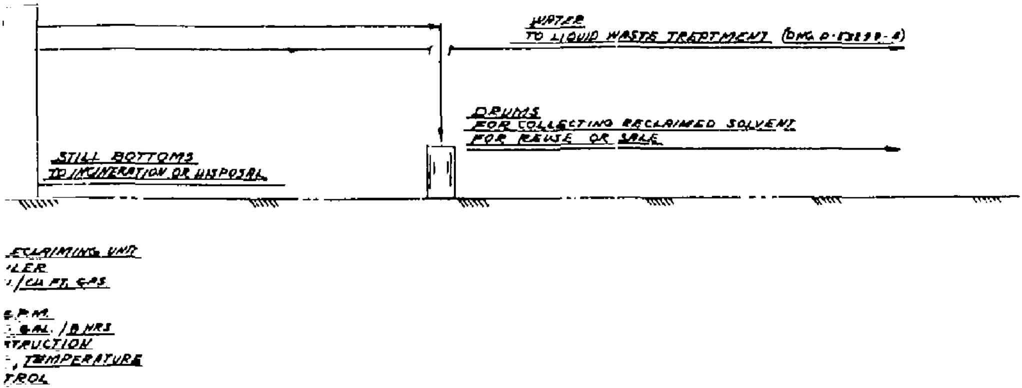
NEXT ASSY | USED ON
APPLICATION



SOLVENT HOLD TANKS
3.5-FT Ø x 7-FT T-T
3 - REQ'D.
500 - GAL CAP
C.S. - MATL. OF CONSTR

SOLVENT TRANSFER PUMP
5 - G.P.M.
20 - FT HD
0.25 - H.P.
0.25 - KW.

PACKAGE SOLVENT RECL
WITH GAS FIRED BOILER
175 CFM - 1000 BTU/CU
ELECTRICITY - 2 KW.
COOLING WATER - 5 G.P.M
CAPACITY OF UNIT - 450 GA
STAINLESS STEEL CONSTRU
WATER SEPARATOR, TH
AND VISCOSITY CONTRO



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL .XX ± .010 .XXX ± .005
FRACTIONAL ± 1/64
ANGULAR ± 1°
FINISHED SURFACES RMS
BREAK SHARP CORNERS
DO NOT SCALE THIS DRAWING
MATERIAL

ISSUE DATE
DRAWN 11/1/80 FM
CHECKED
APPROVED
CASE 53299

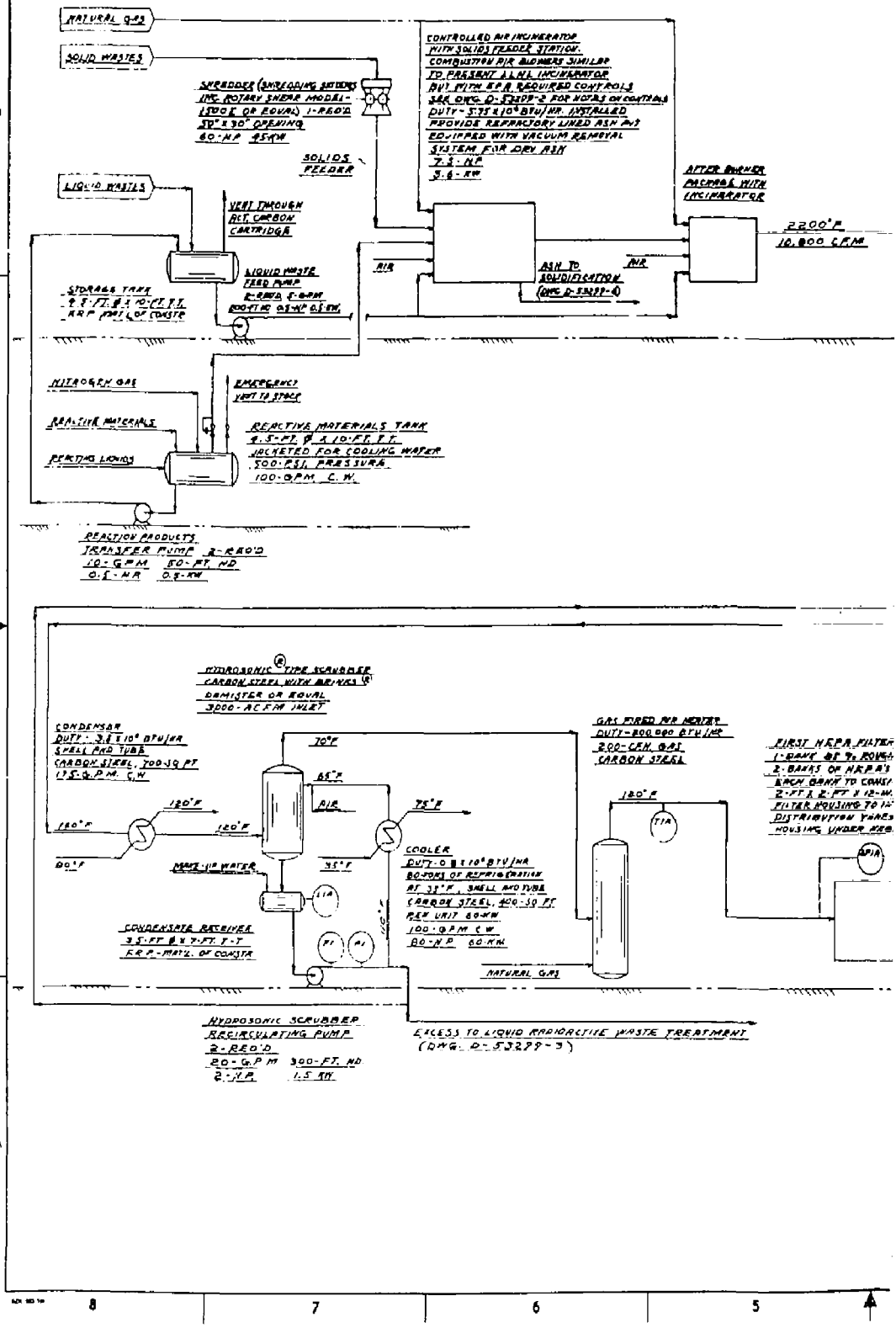
Arthur D. Little, Inc.
CAMBRIDGE, MASSACHUSETTS 02140

SCHEMATIC FLOWSHEET
SOLVENT RECOVERY

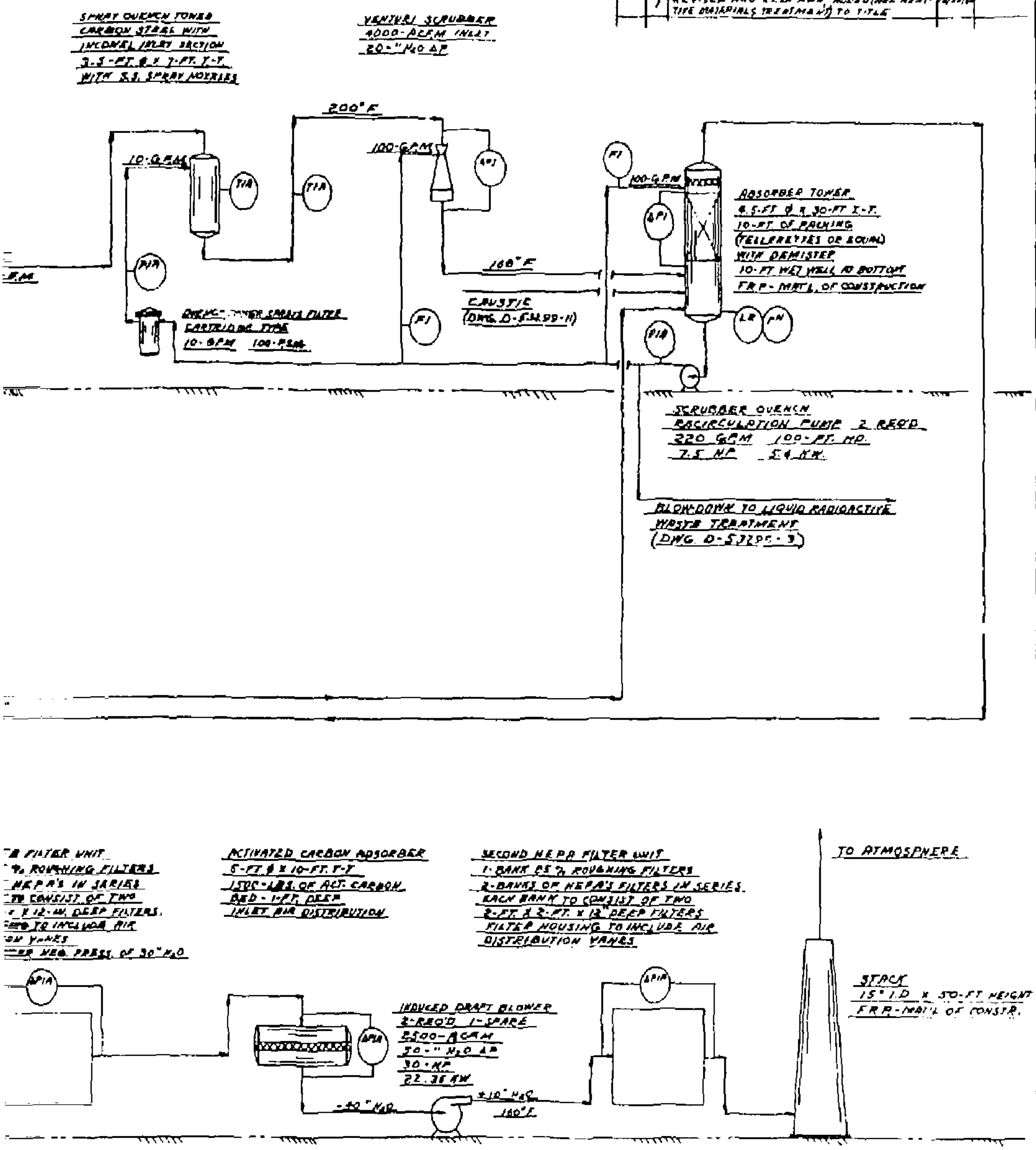
SIZE	CODE IDENT NO	DRAWING NO	REV
D	75629	53299-8	

SCALE SHEET

NEXT ASSY | USED ON
APPLICATION


NATURAL GAS
SOLID WASTES
SHREDDER (SHREDDING SYSTEMS INC. ROTARY SHEAR MODEL-1500E OR EQUAL) 1-REQ'D 30" X 30" OPENING 60-HP 45KW
SOLIDS FEEDER
CONTROLLED AIR INCINERATOR WITH SOLIDS FEEDER STATION. COMBUSTION AIR BLOWERS SIMILAR TO PRESENT ANL INCINERATOR BUT WITH RCRA REQUIRED CONTROLS SEE DWG. D-53299-2 FOR NOTES ON CAPACITY DUTY- 5.75 X 10⁶ BTU/HR INSTALLED PROVIDE REFRACTORY LINED ASH PIT EQUIPPED WITH VACUUM REMOVAL SYSTEM FOR DRY ASH 7.5 - HP 5.6 - KW
AFTER BURNER PACKAGE WITH INCINERATOR
2200°F 10,800 C.F.M.
LIQUID WASTES
VENT THROUGH ACT. CARBON CARTRIDGE
LIQUID WASTE FEED PUMP 2-REQ'D 5 G.P.M. 200 FT. HD 0.5 HP 0.5 KW
STORAGE TANK - 8.5 FT. Ø X 10 FT. T.T. - RCRA PART L OF CONSTR.
AIR
ASH TO SOLIDIFICATION (DWG. D-53299-4)
AIR
NITROGEN GAS
EMERGENCY VENT TO STACK
REACTIVE MATERIALS
PURGING LIQUIDS
REACTIVE MATERIALS TANK 4.5-FT. Ø X 10-FT. T.T. JACKETED FOR COOLING WATER 500-PSI PRESSURE 100-GPM C.W.
REACTION PRODUCTS TRANSFER PUMP 2-REQ'D 10-G.P.M. 50-FT. HD 0.5-HP 0.5-KW
HYDROSONIC® TYPE SCRUBBER CARBON STEEL WITH MARVEX® DEMISTER OR EQUAL 3000-ACFM INLET
CONDENSER DUTY- 3.8 X 10⁶ BTU/HR SHELL AND TUBE CARBON STEEL, 700-SQ FT 175 G.P.M. C.W.
120°F
180°F
120°F
80°F
MAKE-UP WATER
70°F
65°F
AIR
95°F
75°F
COOLER DUTY- 0.8 X 10⁶ BTU/HR 80-TONS OF REFRIGERATION AT 35°F, SHELL AND TUBE CARBON STEEL, 400-SQ FT PER UNIT 60-KW 100-GPM C.W. 80-H.P. 60-KW
CONDENSATE RECEIVER 3.5-FT Ø X 7-FT. T-T FRP-MATL. OF CONSTR.
LIA
FI
AI
GAS FIRED AIR HEATER DUTY-800,000 BTU/HR 200-CFM GAS CARBON STEEL
180°F
TIA
NATURAL GAS
FIRST HEPA FILTER 1-BANK OF 9 POWER 2-BANKS OF HEPA'S EACH BANK TO CONSIST 2-FT X 2-FT X 12-IN. FILTER HOUSING TO IN DISTRIBUTION TUBES HOUSING UNDER NEG.
DPIA
HYDROSONIC SCRUBBER RECIRCULATING PUMP 2-REQ'D 20-G.P.M. 300-FT. HD 2-H.P. 1.5 KW
EXCESS TO LIQUID RADIOACTIVE WASTE TREATMENT (DWG. D-53299-3)
D
C
B
A
8
7
6
5

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	1	REVISED AND REDRAWN. ADDED (AND REACTIVE MATERIALS TREATMENT) TO TITLE		



ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL .XX ± .010, .XXX ± .005 — FRACTIONAL ± 1/64 — ANGULAR ± 1°
FINISHED SURFACES — BREAK SHARP CORNERS
DO NOT SCALE THIS DRAWING
MATERIAL

NEXT ASSY	USED ON
APPLICATION	

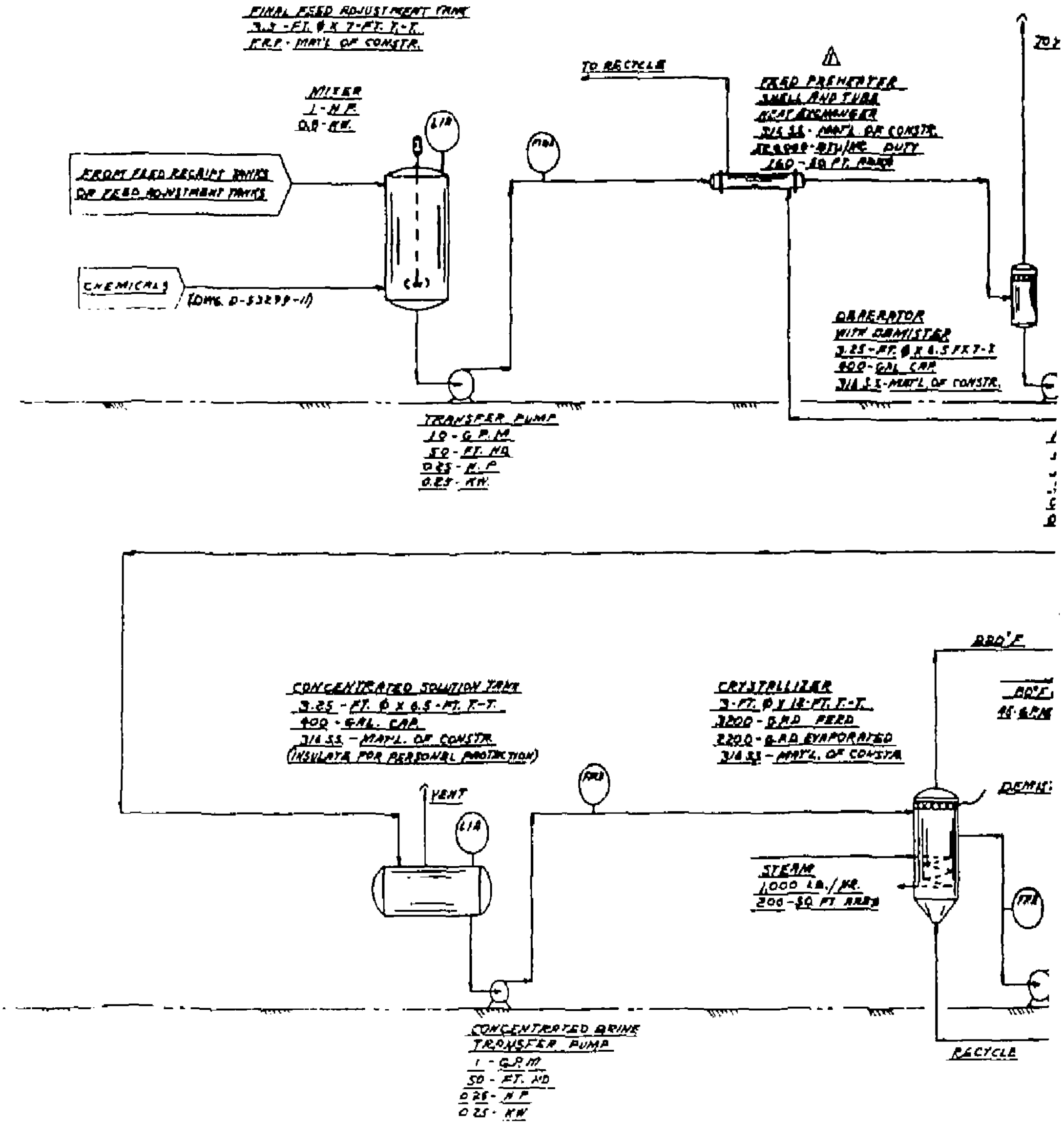
ISSUE DATE
DRAWN 12/6/89 F.M.
CHECKED
APPROVED

Arthur D. Little, Inc.
CAMBRIDGE, MASSACHUSETTS

SCHEMATIC FLOWSHEET
RADIOACTIVE INCINERATION
AND REACTIVE MATERIALS TREATMENT

SIZE	CODE IDENT NO	DRAWING NO	REVISION
D	75629	53299-9	1

CASE 53299
SCALE — SHEET



FINAL FEED ADJUSTMENT TANK
F.R.P. - MAT'L OF CONSTR.
MIXER
1 - H.P.
FROM FEED RECEIPT TANKS
OR FEED ADJUSTMENT TANKS
CHEMICALS
TO RECYCLE
FEED PREHEATER
SHELL AND TUBE
HEAT EXCHANGER
DEAERATOR
WITH DEMISTER
TRANSFER PUMP
10 - G.P.M.
50 - FT. HD.
CONCENTRATED SOLUTION TANK
400 - GAL. CAP.
316 SS - MAT'L. OF CONSTR.
(INSULATE FOR PERSONAL PROTECTION)
VENT
CRYSTALLIZER
316 SS - MAT'L. OF CONSTR.
STEAM
1,000 LB./HR.
CONCENTRATED BRINE
TRANSFER PUMP
1 - G.P.M.
50 - FT. HD.
0.25 - H.P.
0.25 - KW
RECYCLE

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
D-5	1	PREHEATER WAS MISSPELLED REHEATER	11/86	

BRINE CONCENTRATOR
FEED = 12,500 G.P.D.
EVAPORATED = 7,500 G.P.D.

TO VENT

VAPOR COMPRESSION EVAPORATOR
9'-0" Ø X 12'-0" T-T
REQ - SS ST. HORZ TRANSFER
1 - BANK OF TUBES
S.S. - MATL. OF CONSTR.

COMPRESSOR
1 - REQ'D.
P (in) = 15 P.S.I.A
P (out) = 45 P.S.I.A
60 - HP
45 - KW

DEMISTER

STEAM FOR START-UP
1200 - LB./HR.
(1-HR DURATION)

STEAM CHEST

CONDENSATE RECEIVER TANK
3.85'-Ø X 6.6'-H. T-T
600 - GAL. CAP.
C.S. - MATL. OF CONSTR.

HOT BRINE TRANSFER PUMP
2 - REQ'D.
10 - G.P.M.
50 - FT. HD.
0.25 - H.P.
0.25 KW.

CONDENSATE TRANSFER PUMP
(FLOODED SUCTION)
10 - G.P.M.
50 - FT. HD.
0.25 - H.P.

VENT TO ATMOS.

120°F

80°F

100°F

80°F C.W.
15 G.P.M.

CONDENSER
900,000 - BTU/HR.
100 - SQ. FT. AREA

CONDENSATE RECEIVER TANK
100 - GAL. C.S. MATL. OF CONSTR.

TO RECYCLE OR DISCHARGE

CONDENSATE TRANSFER PUMP
0.5 - G.P.M.
50 - FT. HD.
0.25 - H.P.

DEMISTER

100°F

TO SOLIDIFICATION
(DWG. D-53299-6)

COOLER
100,000 - BTU/HR
20 - SQ. FT.

80°F
C.W.
10 G.P.M.

RECYCLE PUMP
15 - G.P.M.
20 - FT. HD.
0.25 - H.P.
0.25 - KW.

LIST OF PARTS

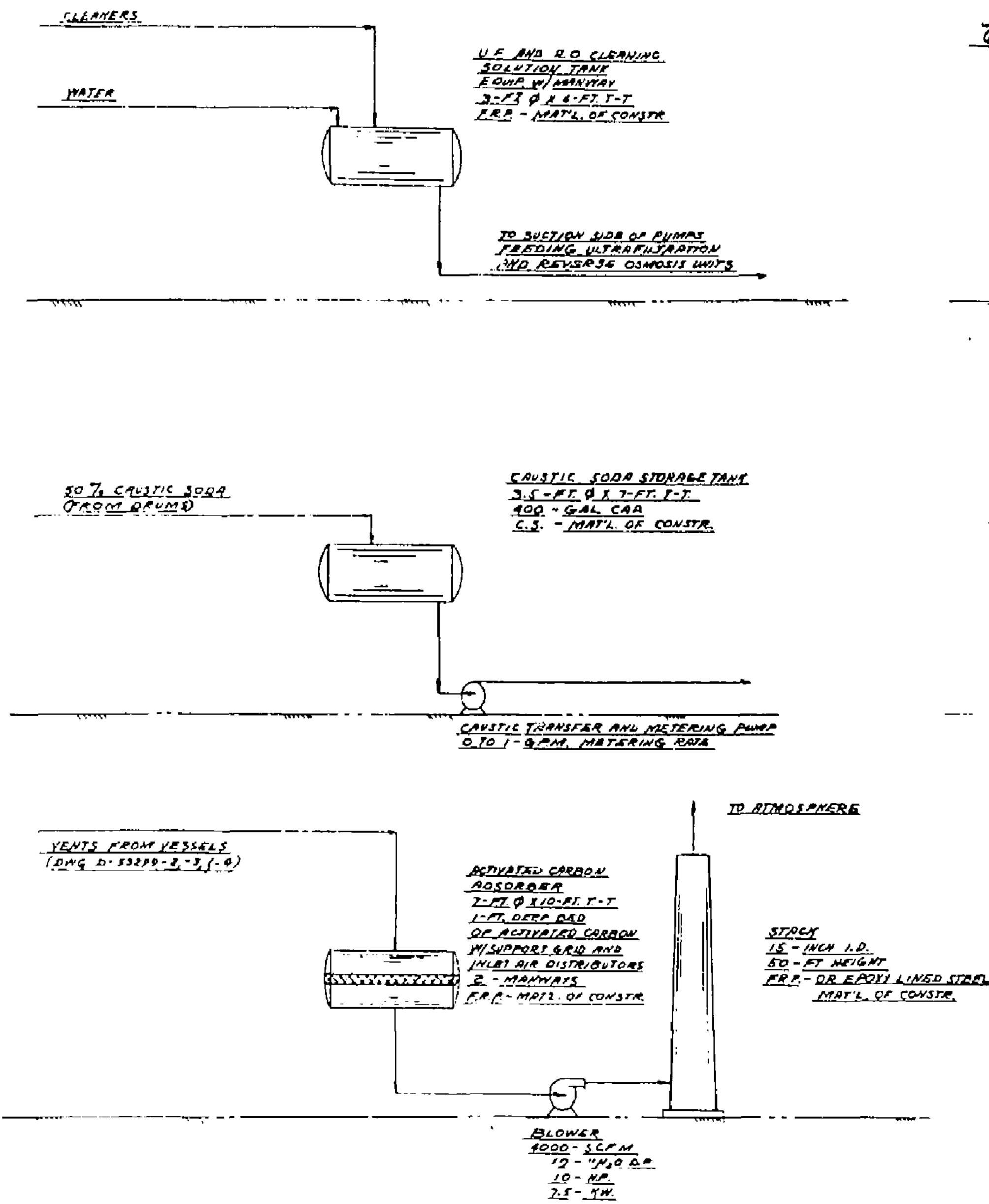
ITEM NO.	QTY REQ	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL

UNLESS OTHERWISE SPECIFIED	ISSUE DATE:
DIMENSIONS ARE IN INCHES TOLERANCES	DRAWN 11/3/86 FLM
DECIMAL .XX ± .010 .XXX ± .005 / FRACTIONAL ± 1/64 / ANGULAR ± 1°	CHECKED
FINISHED SURFACES BREAK SHARP CORNERS / RMS	APPROVED
DO NOT SCALE THIS DRAWING	MATERIAL
NEXT ASSY / USED ON / APPLICATION	CAGE 53299

Arthur D. Little, Inc.
CAMBRIDGE, MASSACHUSETTS 02140

SCHEMATIC FLOWSHEET
ADVANCED WASTEWATER TREATMENT
EVAPORATIVE CONCENTRATION

SIZE	CODE IDENT NO	DRAWING NO	REVISION
D	75629	53299-10	1
SCALE		SHEET	



PROVIDE FOR UTILITIES AS FOLLOWS	LEVEL - I	LEVEL - II	LEVEL - III
COOLING WATER G.P.M. - 80°F. INLET	50	60	⚠ 500
NATURAL GAS (1000-BTU/CF) - CFD	130,000	⚠ 295,000	⚠ 295,000
WATER - G.P.M.	50	75	75
CONNECTED ELECTRIC LOAD - KW	120	360	⚠ 700
STEAM 30 PSIG - LBS/HR	1,000	1,000	2,000
⚠ COMPRESSED AIR 100 PSIG (SCFM)	—	—	150

DOES NOT INCLUDE LIGHTING, BUILDING HEATING OR UTILITIES FOR DWG'S D-53299-1 AND COMPLETION OF DWG. D-53299-4

ZONE	LTR	DESCRIPTION	DATE	APPROVED
A-E, G, H, B	1	ADDED NAT GAS CITY TO LEVEL-II, AND LEVEL-III LEVEL-III C.W. WAS 300, LEVEL-III ELEC. 1000 AMPS ADDED COMPRESSED AIR TO TABLE	12/5/89	

93% SULFURIC ACID (FROM DRUMS)

ACID STORAGE TANK
3.5-FT. Ø X 7-FT. T-T
900-GAL. CAP.
C.S. - MAT'L. OF CONSTR.

ACID TRANSFER AND METERING PUMP
0 TO 1 - G.P.M. METERING RATE

FLOCCULANTS (FROM DRUMS)

WATER

WATER
D.S.-NR.

FLOCCULANT STORAGE TANK
3-FT. Ø X 6-FT. T-T
F.R.P. - MAT'L. OF CONSTR.

FLOCCULANT TRANSFER AND METERING PUMP
0 TO 1 - G.P.M. METERING RATE

NOTE

- PROVIDE STORAGE SPACE FOR
  1 - HYDROGEN PEROXIDE (30%) ——— 1 TO 2 DRUMS
  2 - SODIUM SULFITE ——— SEVERAL 100-LB. BAGS
  3 - CHELATOR - 8 - HYDROXY QUINOLINE ——— 100-LBS.
  4 - SODIUM SULFIDE ——— 100-LBS.
  5 - FILTER AID 40-(50-LB BAGS) AND SOLID ADSORBENTS (OIL DRI) 40-(50 LB BAGS)
- PROVIDE LABORATORY EQUIPPED FOR RCRA ANALYSES. (SEE APPENDIX G-G)
- PROVIDE STORAGE/AREA FOR 600 DRUMS OF HAZARDOUS WASTE
- PROVIDE PARKING FOR 3-TANKERS, 3-FORK LIFTS AND OTHER MOBIL EQUIPMENT
- ALL STORAGE SURFACES RECEIVING RAINWATER ARE TO BE DRAINED TO STORM WATER RETENTION BASINS FOR MONITORING PRIOR TO DISCHARGE

ITEM NO	QTY REQ	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMAL .XX ± .010 .XXX ± .005
FRACTIONAL ± 1/64
ANGULAR ± 1°
FINISHED SURFACES BREAK SHARP CORNERS
RMS
DO NOT SCALE THIS DRAWING

ISSUE DATE
DRAWN 12/5/89 F.M.
CHECKED
APPROVED

Arthur D. Little, Inc.
CAMBRIDGE, MASSACHUSETTS 02140

SCHEMATIC FLOWSHEET
SUPPORT FACILITIES FOR D.W.T.F.

MATERIAL		SIZE	CODE IDENT NO	DRAWING NO	REVISION
		D	75629	53299 11	1
NEXT ASSY	USED ON	CAGE		SCALE	SHEET
APPLICATION		53299			

APPENDIX G-G - DWTF ANALYTICAL AND CONTROL EQUIPMENT

The tests are organized by RCRA characteristics (Table G-G-1), general parameters (Table G-G-2), specific parameters (Table G-G-3) and miscellaneous laboratory equipment are given on Table G-G-4. RCRA characteristics are tests given in CFR, Volume 45, No. 98, May 19, 1980. If a waste exhibits any of the characteristics, then it is defined as a hazardous waste. The general parameters describe the overall composition of the sample. The specific parameters are tests that are focused on specific chemicals which may be of concern when disposing of wastes. Those chemicals may include solvents and polychlorinated biphenyls. References for the tests are included on the tables and also given below.

EPA-600/4-79020
"Methods for Chemical analysis of Water and Wastes," U.S. EPA, Cinn, OH, March 1979 and Additions. EPA-600/4-84-017, March 1984, EPA-600/4-82-055, December 1982.

SW846, 2nd Edition
"Test Methods for Evaluating Solid Waste Physical/Chemical Methods," U.S. EPA, Wash., D.C., July 1982.

EPA-600/8-84-002
"Sampling and Analysis Methods for Hazardous Waste Combustion," U.S. EPA, Research Triangle Park, N.C., December 1983.

ASTM
American Society for Testing and Materials, Philadelphia, Pennsylvania, "Annual Book of ASTM Standards."

TABLE G-G-1

RCRA CHARACTERISTIC EQUIPMENT

TEST (Reference)	EQUIPMENT	MANUFACTURER OR VENDOR (Phone no. or address)
Ignitability (flashpoint) (EPA-SW846, 2nd ed, Methods 1010 and 1020)	Pensky-Martens Closed flash tester Set a flash closed tester (for paints)	SGA (201-748-6600)
Corrosivity-towards steel (EPA-SW846, 2nd ed. Method 1110)	SAE Type 1020 Steel Kettle or flask reflux condenser thermowell temperature regulator	
pH (aqueous)	heating device pH meter	Beckman or Fisher (Medford, MA)
EP Toxicity (EPA-SW846, 2nd ed. Method 1410)	Extractor	Associated Designs & Manufacturing Co. (Alexandria VA) Kraft Apparatus, Inc. (Mineola, NY) Millipore(Bedford, MA) Rexnord (Milwaukee, WN)
	pH meter or pH controller	Chemtrix, Inc. (Hillsboro, Oregon) for pH controller
	Filter holder (vacuum or pressure)	Nalgene Nuclepore Millipore Microfiltration Systems
Pesticides* (EPA-SW846, 2nd ed. Method 8150)	Gas Chromatograph with electron capture detector with autosampler microprocessor/recorder	Hewlett Packard Varian
Metals** (EPA SW846, 2nd ed.)	Atomic Absorption Spectrophotometer with autosampler	Instrumentation Laboratory, Perkin Elmer, Varian

*Also listed under specific parameters section

**Inductively coupled plasma equipment should be considered if a wider range of anlayses is required.

TABLE G-G-2

GENERAL PARAMETERS

TEST (Reference)	EQUIPMENT	MANUFACTURER OR VENDOR (Phone no. or address)
Total Cyanides (Ref. EPA SW846, 2nd ed. Method 8010)	Autoanalyzer with sampler Manifold with UV digestor Proportioning pump Heating bath with distillation coil, Distillation head	Technicon
Total Phenols (Ref. EPA-600/4-79020 Method 420.2)	Autoanalyzer with sampler equipped with continuous mixer Manifold Proportioning Pump Heating bath with distillation coil Distillation head Colorimeter	Technicon (Model I or II)
Total Organic Carbon (TOC) (Ref. EPA 600/4-79020, Methods 415.2, 415.1)	TOC Analyzer	OI Corporation (713-693-1711) Dohrman (408-249-6000) Beckman Sybron (617-469-3300)
Total Organic Halogens (TOX) (Ref. EPA SW846, 2nd ed. Method 9020)	TOX Analyzer	Dohrman (408-246-6000)
Chemical Oxygen Demand (Ref. EPA 600/4-79020, Method 410)	Titrimetric procedure	
Sulfides (Ref. EPA 600/4-79020, Method 376)	Titrimetric procedure	
Chloride (Ref. EPA 600/4-79020, Method 325)	Titrimetric procedure	
Turbidity (Ref. EPA 600/4-79020, Method 180.1)	Turbidimeter	Fisher

TABLE G-G-2 (Cont'd)

GENERAL PARAMETERS

TEST	EQUIPMENT	MANUFACTURER OR VENDOR
Conductance (Ref. EPA 600/4-79020 (Method 120.1)	Conductivity meter	Fisher, Beckman
Flocculation	6 Stirrers	Fisher
Residue (Ref. EPA 600/4-79020)		Fisher
-Filterable (Method 160.1)	Filter Holder	
-Non-filterable (Method 160.2)	Drying Oven (180°C±2°C)	Fisher
-Total (Method 160.3)		
-Volatile (Method 160.4)		
-Settleable Matter (Method 160.5)	Ihmhoff Cone	
Moisture, Solids, Ash Content (Ref. EPA 600/8-84-002, Methods A001-A002)	Thermogravimetric	Dupont Co. (302-772-5500) Mettler Instrument Corp. (609-448 3000)
		Perkin Elmer Corp.
	OR	
	Drying Oven (130°C±2°C) Muffle Furnace	Fisher
Elemental Composition (Ref. ASTM)		Fisher
C,H		
(ASTM-D-3178-73)	Adsorbers, flowmeter, combustion unit/tube/boat	
N		
(ASTM D-3179-73)	Digestion unit, distillation unit, condenser, Kjedahl digestion flask and connecting bulb	
O		
(ASTM D-3176-74)	No equipment	
P		
(ASTM D-2795)	Absorption spectrophotometer	Fisher

TABLE G-G-2 (Cont'd)

GENERAL PARAMETERS

TEST	EQUIPMENT	MANUFACTURER OR VENDOR
S		
(ASTM D-3177-7 D-129-64)	Oxygen bomb calorimeter or tube furnace	Fisher
Cl		
(ASTM D-2361-66 D-3286-77)	Oxygen bomb/capsule/firing wire and circuit, or muffle furnace, potentiometric titration assembly	Fisher
Heating Value of the Waste (Ref. ASTM D-2015-77 D-3286-77)	Combustion bomb Calorimeter/jacket Thermometers	Fisher
Kinematic Viscocity (Ref. ASTM-D-445-79)	Calibrated glass capillary ciscometer	

TABLE G-G-3

SPECIFIC PARAMETERS

Organics - Solvents and other species (e.g. pesticides, PCBs) (Ref. EPA SW846, 2nd ed.)	Gas chromatograph with electron capture detector and flame ionization detector with autosampler microprocessor/recorder for packed and capillary column	Hewlett Packard (800-227-9770) Varian (Palo Alto,CA)
Metals (Ref. EPA SW846, 2nd ed.)	Atomic Absorption Spectrophotometer with autosampler	Instrumentation Laboratory Perkin Elmer (Norwalk, CN) Varian (Palo Alto,CA)

TABLE G-G-4

MISCELLANEOUS

ITEM	EQUIPMENT	MANUFACTURER OR VENDOR (Phone no. or address)
Supply of Reagent Grade Water	Barnstead or MilliQ	Fisher (Medford,MA)
General Laboratory Equipment	Analytical balance (Mettler) Balance Chromatographic columns Dishwasher Eyewash centrifuge Hoods Refrigerator/freezer (or Cold Room) Solvent Cabinets Steam generator Water Bath	
Glassware	Bottles Beakers Buret Crucibles Erlenmeyer flacks Evaporating dishes Kuderna Danish apparatus Pipettes Reflux apparatus (flask & condenser) Separatory funnels Soxhlet apparatus Spatulas Syringes Vials Volumetric flasks	
Other	Clamps Filters (course, medium, fine) Header for reflux apparatus Rings Standards and reagents Stands	