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Department of Energy
Albuquerque Operations
Los Alamos Area Office
Los Alamos, New Mexico 87544

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AIR QUALITY BUREAU

Mr. Bruce Nicholson
Air Quality Bureau
Environmental Improvement Division
1190 St. Francis Drive
Harold Runnels Building
Santa Fe, New Mexico 87503

Dear Mr. Nicholson:

Enclosed is the air quality permit application for the Low Level Waste/Mixed Waste (LLW/MW) Incinerator that the Los Alamos National Laboratory (Laboratory) is proposing to construct. This facility is intended to alleviate the problem of long-term storage of untreated radioactive low level and mixed wastes at the Laboratory.

The permit application addresses all of the requirements of New Mexico Environmental Improvement Division's Air Quality Control Regulation 702 Permits and all other applicable state and federal air regulations. To ensure that none of the ambient air quality standards or toxic air pollutant guidelines are exceeded, a conservative analysis of the impacts of the incinerator is also included. Other supporting documentation required by Regulation 702 is part of the application.

If you have any questions or need additional technical information, please call Donna Lacombe at 667-5288.

Sincerely,

Harold E. Valencia
Area Manager

Enclosure

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AIR QUALITY PERMIT APPLICATION FOR THE PROPOSED LOW LEVEL WASTE/MIXED WASTE INCINERATOR TECHNICAL AREA 50 BUILDING 37

Los Alamos National Laboratory
Los Alamos, New Mexico

February 1989

LANL
TA-50/89

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1.0 INTRODUCTION

The Department of Energy (DOE) is proposing to construct an incinerator to process low-level radioactive waste/mixed waste (LLW/MW) at Los Alamos National Laboratory (LANL). Low level waste is defined as materials contaminated with alpha-emitting transuranium isotopes and/or fission products at concentrations of <100 nCi/g or 10^{-9} Ci/g of waste. Mixed waste is that which includes a Resource Conservation and Recovery Act (RCRA) waste and a radioactive component. This incinerator will complement the capabilities of Los Alamos to treat radioactive wastes. LANL currently operates the Transuranic Waste Controlled-Air Incinerator (TRU-CAI) which is used to process combustible TRU wastes (concentrations $\geq$ 100 nCi/g). The TRU-CAI has been granted interim status for the incineration of RCRA wastes by the New Mexico Environmental Improvement Division (NMEID), and is permitted by the U.S. Environmental Protection Agency (EPA), Region VI, for the thermal destruction of liquid PCBs. The existing TRU facility does not have adequate capacity for LLW/MW streams. The LLW/MW incinerator will provide this capability and alleviate the problem of long-term storage of these untreated wastes at LANL.

This document contains the application and supporting documentation for an air quality permit required under NMEID Air Quality Control Regulation (AQCR) 702: Permits. The LLW/MW incinerator shall not burn any RCRA wastes, including mixed wastes, until all necessary approvals have been obtained.

2.0 SUMMARY OF RESULTS

Due to the research nature of LANL, chemical usage and waste may change radically from year to year. Therefore, it was not possible to determine the exact composition of the LLW/MW that will require incineration in the future. To conservatively address emissions of each chemical contained in AQCR 702, emissions were calculated based on maximum possible throughput of each chemical. Four types of pollutants had to be addressed: toxic air pollutants (TAPs), criteria pollutants, new source performance standards (NSPS), and National Emissions Standards for Hazardous Air Pollutants (NESHAP).

For TAPs, Regulation 702 requires the identification of all regulated chemicals that exceed the pound per hour limits listed in the regulation. For each pollutant exceeding these limits, the regulation states that if "the division finds that the eight-hour average concentration of the toxic air pollutant in the ambient air does not exceed one-one hundredth of the OEL [occupational exposure limit], or for compounds without an OEL, the minimum detection levels as shown in Appendix A [of the regulation], the division shall grant the permit." Therefore, the ambient impact was calculated for each pollutant exceeding the hourly thresholds and compared to one-one hundredth of the OEL. The ambient impacts were calculated using the Environmental Protection Agency's Industrial Source Complex model and assuming that the input capacity of the incinerator was composed entirely of each TAP. The ambient impacts resulting from this very conservative analysis were lower than one-one hundredth of the applicable OEL for each TAP identified except ethylene dibromide, an organic liquid. To ensure that ethylene dibromide does not exceed one-

one hundredth of its OEL, LANL will limit the input of this chemical to the incinerator to levels which the modeling shows will result in impacts less than OEL x 100. The amount of ethylene dibromide in liquid wastes will be determined by the chemically characterizing all wastes of unknown composition.

A similar analysis was conducted for chemicals with ambient air quality standards. However, instead of considering wastes on a chemical specific basis, the total input to the system was analyzed. For instance, sulfur dioxide was assumed to form from incineration of all sulfur-containing compounds. Therefore, a limit for total sulfur input was calculated based on the modeling and destruction/removal efficiencies. LANL will enforce this limit by determining the sulfur content of wastes. The other ambient air quality standards were similarly addressed, except carbon monoxide, which will be continuously monitored to ensure that a performance standard of 1000 ppm is not exceeded. The final set of standards addressed were the NSPS and NESHAP. LANL has already received a NESHAP permit for this incinerator for its radioactive emissions. The source will not exceed the NESHAP limit of 10 grams of beryllium over a 24-hour period. The calculations supporting this finding are contained in Appendix C. The incinerator has too low a charging rate to be regulated by NSPS for incinerators.

3.0 PROJECT DESCRIPTION

The proposed new source will be a dual-chamber, controlled-air incinerator. The primary combustion chamber (PCC) will be a multiple-hearth chamber with provision for positive ash transport down the hearths. The second and third hearths will have separate temperature sensor systems and underfire air controls. This chamber, rated at 3 million BTU/hr, will be used for incineration of solid wastes. Auxiliary heat to the PCC, as required, is provided by a natural gas burner up to the 3 million BTU/hr design capacity of the chamber.

The secondary combustion chamber (SCC) will be a down-fired excess-air combustion chamber used for the incineration of liquid or gaseous wastes and to complete combustion of volatilized solids exiting the primary chamber. Liquid wastes will be introduced to the SCC through a dual-fuel vortex burner in the top of the chamber. Liquid waste charging rates will not exceed 3 million BTU/hr, with up to an additional 1 million BTU/hour of auxiliary heat, if required. The auxiliary heat is provided by co-firing the burner with natural gas. The design for introducing gaseous wastes has not been finalized. Requirements for auxiliary fuel input to the SCC will be dependent on heat content of the waste input, operating temperature requirements, and SCC oxygen (excess air) levels. Low heat-of-combustion liquids or gases may require blending with either No. 2 fuel oil or high heat-of-combustion wastes to achieve desired fuel characteristics (~8000 BTU/lb) and stable burner firing.

The SCC will be designed to provide not less than 2 seconds of residence time to achieve complete combustion of volatilized

solids from the PCC and injected liquid or gaseous wastes. The total thermal capacity of the incinerator is anticipated to be 7 million BTU/hr, including the 1 million BTU/hour auxiliary heat capacity. Based on waste feed limitations of 3 million BTU/hr to each of the primary and secondary combustion chambers and anticipated waste heat content, the following feed rates and heating values were used to establish maximum emission levels of the regulated compounds:

Primary Combustion Chamber	
Solid Feed Rate:	500 lbs/hr maximum
Solid Waste Heating Value:	6000 BTU/lb average
Secondary Combustion Chamber	
Liquid Feed Rate:	400 lbs/hr maximum
Liquid Waste Heating Value:	7500 BTU/lb average
Gaseous Feed Rate:	400 lbs/hr maximum
Gaseous Waste Heating Value:	7500 BTU/lb average

The off-gas from the SCC will be cleaned by a combination of wet scrubbing and filtration. Figures 3-1 and 3-2 are schematic diagrams of the system. The off-gas will pass through a quench column, venturi particulate scrubber, packed bed absorber column/demister, superheater (to reduce relative humidity prior to passage through the high efficiency air particulate filters), two high efficiency air particulate (HEPA) filters in series, then a third HEPA filter. LANL is also evaluating the effectiveness of adding a carbon bed adsorber before the final HEPA filter. Steam injection will be used to enhance the carbon monoxide/carbon dioxide water/gas conversion reaction. A process scrub and recycle solution system will include sump tanks, process heat exchangers, a scrub solution hydrocyclone and filters, and pumps. Ash removed from the process will be containerized to prevent fugitive air emissions. The technology of the planned incinerator is nearly identical to the TRU-CAI that has been in operation at LANL since 1979. A RCRA trial burn of the TRU-CAI was recently conducted. Due to the similarity in the technology,

the destruction/removal efficiencies for the planned LLW/MW incinerator are expected to be similar to those measured for the TRU-CAI. The design characteristics of the incinerator are:

Heat Input (BTU/hr)	7 million total
Fuel Type	
PCC	natural gas
SCC	natural gas or No. 2 fuel oil
SCC Temperature	2000 °F
SCC Oxygen Level	~ 5 %
Material Processed	liquid and solid LLW/MW
Standard Operating Schedule	24 hours/day 7 days/week 2 weeks/month 12 months/year
Off-Gas Treatment Equipment (in series)	water spray quench column high-energy venturi scrubber packed-bed absorber column and demister double HEPA filter activated carbon adsorber (optional) single HEPA filter
Stack Data	
Stack Height (ft)	66
Stack Diameter (ft i.d)	3
Gas Temp. (°F)	152*
Gas Velocity (ft/sec)	37*
Moisture (%)	31 (off-gas only)
Flow Volume (acfm)	15,500*

*Estimate based on co-discharge of room ventilation air through stack.

Unlike most commercial incinerators, the LLW/MW incinerator will have no bypass around the off-gas treatment system. Thus, when upset conditions occur in the incinerator, requiring shutdown or non-routine operations, no off-gases will be released to

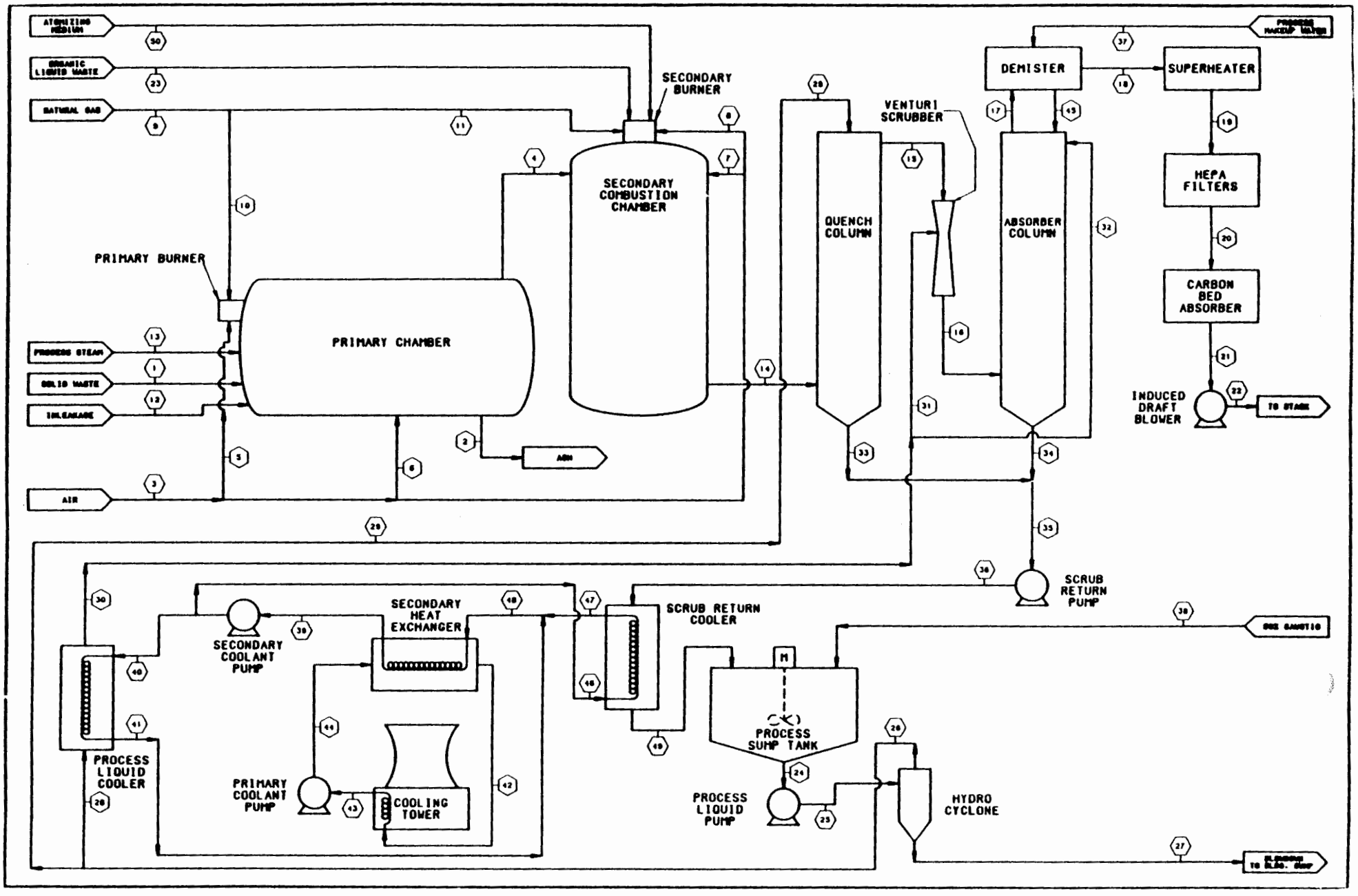
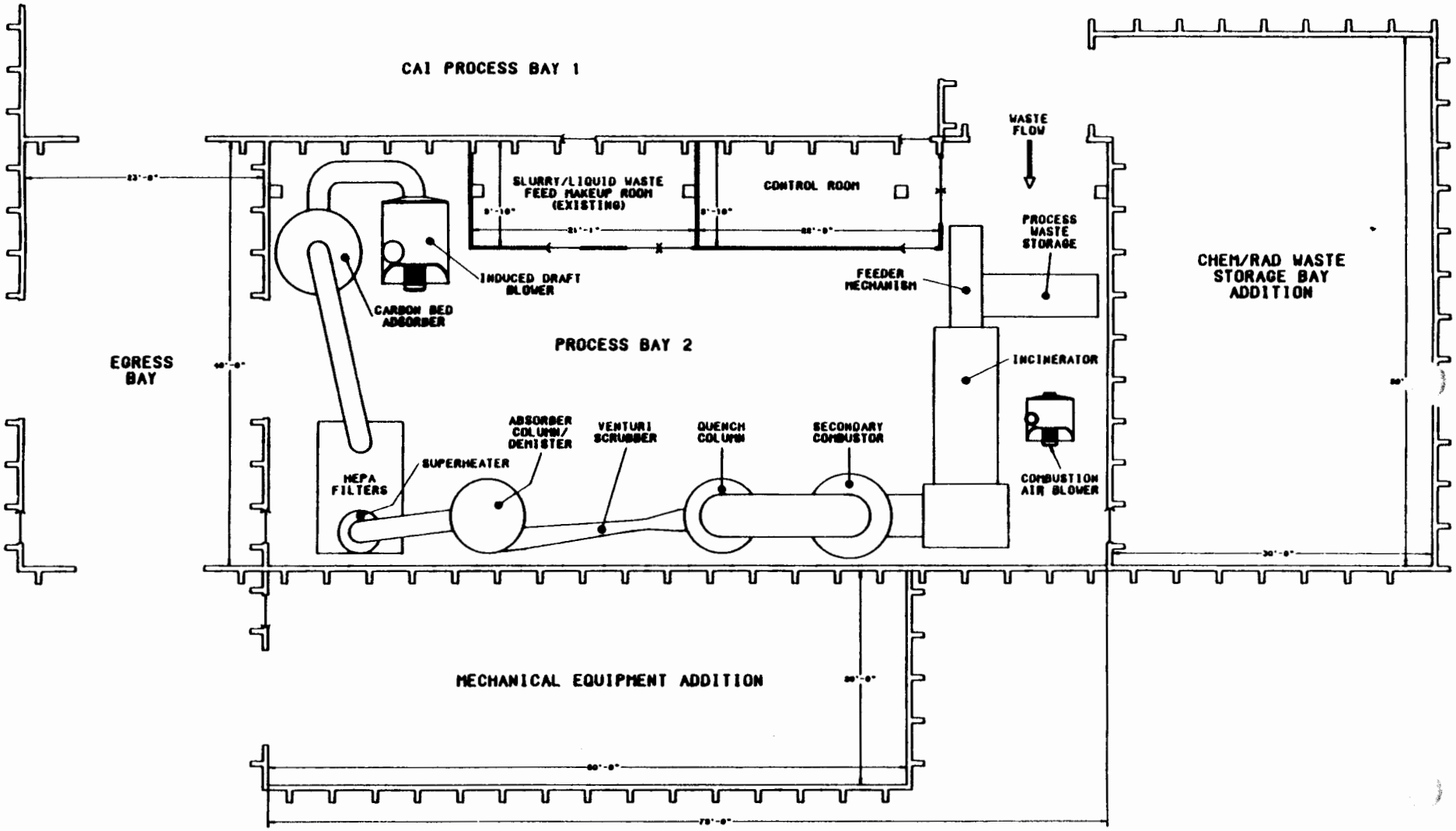


Figure 3-1. LLW/MW Incinerator and Off-Gas Treatement System Flow Diagram.



PROPOSED LOS ALAMOS LOW-LEVEL AND MIXED WASTE INCINERATOR
TA-50 BUILDING 37

Figure 3-2. Off-Gas Treatment System for the Proposed LLW/MN Incinerator.

the environment except through the off-gas treatment system. Single pieces of equipment may either fail or for a short time operate at less than optimal efficiency. Estimates of the efficiency of the off-gas treatment system are contained in Appendix E.

Continuous monitoring of the off-gas will be conducted for oxygen, carbon monoxide, and carbon dioxide. Oxygen levels in the secondary combustion chamber will be monitored in the SCC exit duct using a zirconium oxide analyzer. Carbon monoxide and carbon dioxide concentrations will be monitored downstream of the induced draft fan outlet just upstream of the exhaust stack using infrared analyzers. Strip chart recorders will continuously record these data.

The incinerator and off-gas control system will be monitored. Alarms indicating departures from optimum operating conditions will alert operators to problems so that rapid response can be undertaken. The systems with alarms, the procedures for routine startup and shutdown, and procedures for shutdown during malfunctions are described in Appendix F.

4.0 PROJECT SITE DESCRIPTION

4.1 TOPOGRAPHY

LANL is located in Los Alamos County, in north central New Mexico, approximately 25 miles northwest of Santa Fe. The laboratory is situated on Pajarito Plateau, consisting of a series of finger-like mesas separated by deep east-west canyons cut by intermittent streams. Mesa tops range in elevation from 7,800 feet in the western portions of the site to 6,200 feet to the east. The Jemez Mountains rise rapidly west of the site to peak in excess of 10,000 feet. The topography near the proposed facility is shown on the attached contour map (Figure 4-1).

4.2 LAND USE

Most development at the site is confined to mesa tops. The land surrounding LANL is largely undeveloped and consists primarily of the Santa Fe National Forest and Bandelier National Monument. The area is considered rural in nature for dispersion modeling purposes.

4.3 CLIMATE

Los Alamos has a semiarid, temperate mountain climate. Average annual precipitation is about 18 inches. Summers are generally sunny with moderately warm days and cool nights. Maximum temperatures are usually below 90 °F. Winter temperatures typically range from about 15 to 25 °F during the night and from 30 to 50 °F during the day.

Surface winds in Los Alamos often vary dramatically with time of day and with location because of the complex terrain. A

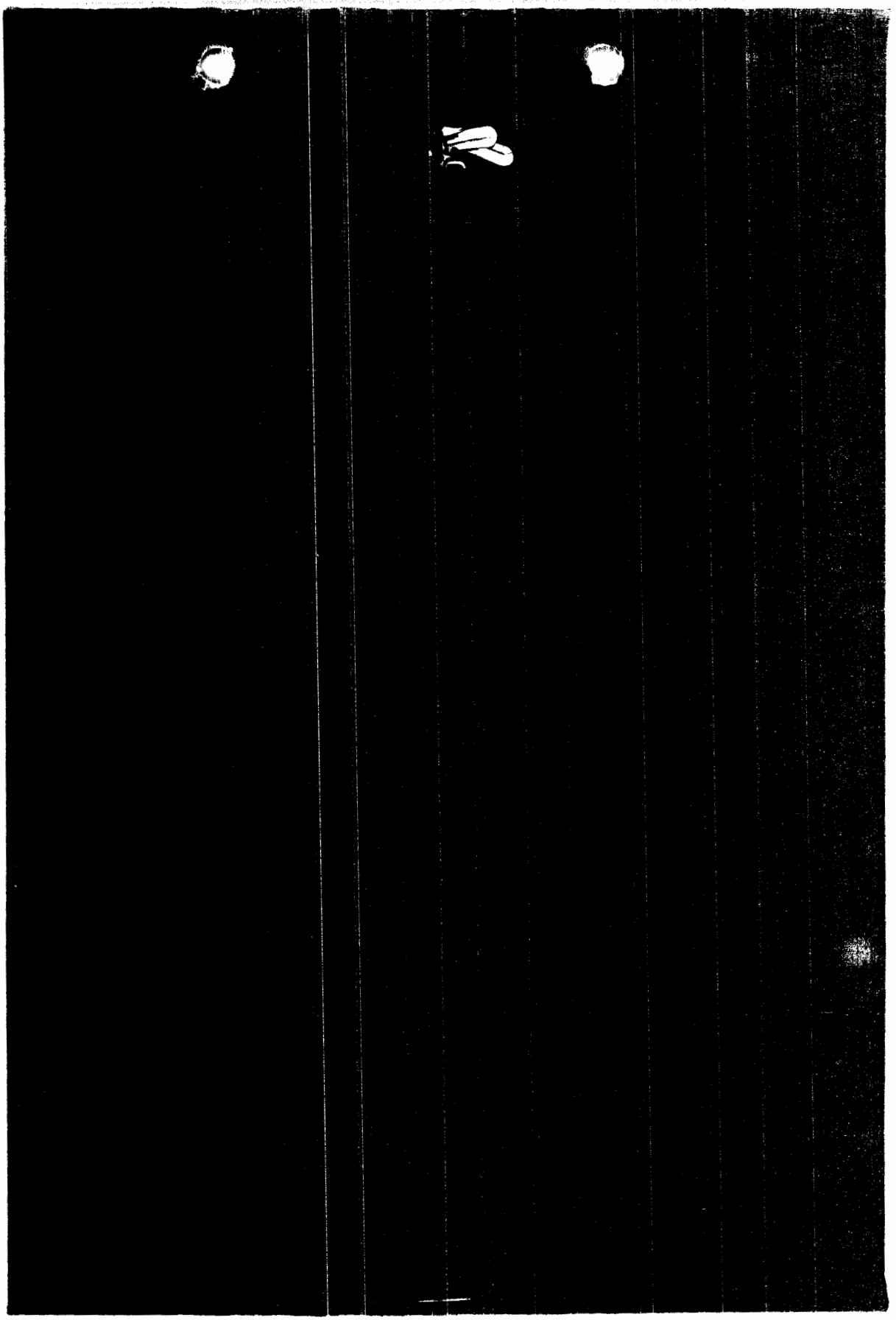


FIGURE 4-1. Topography of the Proposed LLW/MW Site

See A. G. [illegible]
File 772

diurnal upslope/drainage wind cycle often occurs, particularly in the western portions of the Laboratory near the Jemez Mountains. Light southeasterly to southerly upslope winds occur during the day with a light westerly to north westerly drainage flow during the night.

Atmospheric dispersion characteristics for this area are generally good; the open exposure and complex terrain result in enhanced atmospheric turbulence and mixing. Nighttime inversions do occur, limiting dispersion of pollutants. However, these are much stronger in the canyons than on the more developed mesas.

4.4 AIR QUALITY

The Los Alamos area is currently classified as "attainment" for all criteria pollutants, meaning that the air quality is in compliance with ambient air quality standards for all criteria pollutants. The applicable federal and state ambient air quality standards are included in Table 4-1.

TABLE 4-1. AMBIENT AIR QUALITY STANDARDS
(micrograms/m^3 except where otherwise noted)

	State	Federal Primary	Federal Secondary
Particulate matter			
Total Suspended Particulate			
24-hour average	150		
7-day average	110		
30-day average	90		
Annual Geometric mean	60		
PM-10			
24-hour average		150[a]	150[a]
Annual arithmetic mean		50	50
Asbestos			
30-day average	0.01		
Beryllium			
30-day average	0.01		
Heavy Metals (total combined)			
30-day average	10		
Sulfur Dioxide			
3-hour average			1300[a]
24-hour average	260 (0.1 ppm)	365[a]	
Annual average	52 (0.02 ppm)	80	
Carbon Monoxide			
1-hour average	15 mg/m^3 (13.1 ppm)	40 mg/m^3[a]	40 mg/m^3[a]
8-hour average	10 mg/m^3 (8.7 ppm)	10 mg/m^3[a]	10 mg/m^3[a]
Nitrogen Dioxide			
24-hour average	188 (0.10 ppm)		
Annual average	94 (0.05 ppm)	100	100
Lead			
Calendar quarter		1.5	1.5
Non-methane Hydrocarbons			
3-hour average	125 (0.19 ppm)		

[a]Not to be exceeded more than once per year.

5.0 AIR QUALITY ASSESSMENT

This section describes the air quality dispersion modeling analysis for the proposed incinerator and the calculated emission limits for all criteria and toxic air pollutants (TAPs) addressed in AQCR 702.

5.1 AIR QUALITY MODELING ANALYSIS

Ambient air concentrations of LLW/MW incinerator emissions were calculated using the Industrial Source Complex Model (EPA 1987), a Gaussian plume model. The stack height of the releases is 20 m (66 feet). Plume rise was calculated using the Briggs equations with an exit temperature of 152 °F and 11.25 m/sec exit velocity. Because the building stack is not 2.5 times the building height, building wake effects were considered in determining plume rise and in the dispersion coefficients according to the Huber and Snyder building downwash procedures.

The model was run in the short term mode to calculate the highest 1, 3, 8, and 24-hour air concentrations and in the long term mode to calculate annual emissions. The ambient impact for a calendar quarter averaging period was obtained by applying an EPA adjustment factor to the annual impact to account for the differences in expected meteorology between the two averaging periods. Similarly, 7-day and 30-day impacts were calculated by applying the EPA adjustment factors appropriate to these averaging periods to the 24-hour modeled impact. To determine the worst-case concentrations, ten individual days of meteorological conditions were assumed. The conditions analyzed were designed to

maximize concentrations and to represent realistic meteorology for Los Alamos. The conditions producing the highest 1, 3, and 8-hour concentrations at the worst-case receptor were average wind speed of 6 m/sec and neutral (D) stability class (Table 5-1). The highest 24-hour air concentrations were produced by 4 to 6 m/sec wind speeds and unstable (B and C) stability classes (Table 5-2).

The distance to the nearest public access receptor was 270 meters. The highest modeled impacts at a distance of 270 meters or greater, regardless of direction, was used. For time periods between 24 hour and annual, concentrations were calculated as a ratio of the 24 hour or the annual concentration, whichever was most applicable.

Based on this modeling, the unit impact for each one pound per hour of emissions is:

TABLE 5-3. AMBIENT IMPACTS RESULTING FROM UNIT EMISSIONS OF 1 LB/HR OF A POLLUTANT

Averaging Period	Ambient Concentration (ug/m^3)	(mg/m^3)
1-hour	4.3	0.0043
3-hour	4.3	0.0043
8-hour	4.3	0.0043
24-hour	2.3	0.0023
7-day	1.6	0.0016
30-day	0.20	0.00020
Calendar quarter	0.16	0.00016
Annual	0.12	0.00012

TABLE 5-1. METEOROLOGY FOR 1-HOUR, 3-HOUR, AND 8-HOUR MAXIMUM AIR CONCENTRATIONS

Hour	Wind Dir.	Wind Speed (m/s)	Mixing Height (m)	Stability
1	WNW	5.0	350	D
2	WNW	5.0	350	D
3	WNW	5.0	350	D
4	WNW	5.0	350	D
5	WNW	5.0	350	D
6	WNW	5.0	350	D
7	WNW	5.0	350	D
8	S	6.0	1400	D
9	S	6.0	1400	D
10	S	6.0	1400	D
11	S	6.0	1400	D
12	S	6.0	1400	D
13	S	6.0	1400	D
14	S	6.0	1400	D
15	S	6.0	1400	D
16	S	6.0	1400	D
17	S	6.0	1400	D
18	S	6.0	1400	D
19	WNW	5.0	350	D
20	WNW	5.0	350	D
21	WNW	5.0	350	D
22	WNW	5.0	350	D
23	WNW	5.0	350	D
24	WNW	5.0	350	

TABLE 5-2. METEOROLOGY FOR 24-HOUR MAXIMUM AIR CONCENTRATIONS

Hour	Wind Dir.	Wind Speed (m/s)	Mixing Height (m)	Stability
1	WNW	4.0	550	D
2	WNW	4.0	550	D
3	WNW	4.0	550	D
4	WNW	4.0	550	E
5	WNW	4.0	550	E
6	WNW	4.0	550	D
7	S	4.0	4000	C
8	S	4.0	4000	C
9	S	4.0	4000	B
10	S	4.0	4000	B
11	S	4.0	4000	B
12	S	4.0	4000	B
13	S	4.0	4000	B
14	S	4.0	4000	B
15	S	4.0	4000	B
16	S	4.0	4000	B
17	S	4.0	4000	B
18	S	6.0	4000	C
19	S	6.0	4000	C
20	S	6.0	4000	C
21	S	6.0	4000	D
22	WNW	4.0	550	D
23	WNW	4.0	550	D
24	WNW	4.0	550	D

5.2 EMISSIONS DATA

There are two sources of emissions from the proposed incinerator. The first is the auxiliary fuel that will be used during startup and shutdown and in combination with LLW/MW having low heating values. The hourly emissions calculated for the system when it is running at a maximum of 6 million BTU/hour on auxiliary fuel alone are contained in Appendix D. The amount of auxiliary fuel used by the incinerator on an annual basis will be dependent on the number of startup/shutdown cycles and how much of the waste that is incinerated requires auxiliary fuel.

The second source of emissions will be the LLW/MWs. Because activities at LANL change frequently, it is not possible to estimate the exact amounts and types of LLW/MW that will be produced in the future, especially with regard to the hundreds of toxic pollutants (TAPs) addressed in AQCR 702. Rather than attempt to make insupportable assumptions about the quantities of each of the TAPs that might be processed, maximum inputs of 400 pounds per hour of liquids, 500 pounds per hour of solids, and 400 pounds per hour of gases to the incinerator were assumed. This is conservative assumption. Calculations contained in Appendix B for toxic pollutants known to be produced as waste at LANL show that the amounts of liquids that can be input to the proposed incinerator will usually be less than 250 pounds per hour. Also, it is highly unlikely that the feed to the incinerator will consist of only one chemical. In reality, the liquids will be mixed to form a feed of approximately 8000 BTU/hour or will be burned with auxiliary fuel. Solids will consist mainly of non-toxic materials contaminated with trace amounts of radioactive compounds.

AQCR 702 requires that all TAPs be identified if their potential emissions might exceed the pounds per hour screening

levels listed in the regulation. The regulation allows a correction factor to be applied to the screening level to adjust for the release height of the TAPs. For a stack of the height planned for the proposed incinerator (66 feet), a correction factor of 19 is allowed. Therefore, all the pounds per hour screening limits were multiplied by 19. To compare the emissions of TAPs from the incinerator with the adjusted limits, the list of TAPs regulated had to be subdivided into categories which reflected the destruction efficiency of the incinerator: elemental solids, non-elemental solids, organic liquids, inorganic liquids, organic gases, and inorganic gases. AQCR 702 states that if the modeled 8-hour average ambient impacts are less than one-one hundredth of a TAP's occupational exposure limit (OEL), the permit will not be denied. The modeled 8-hour maximum impact was used to calculate ambient air quality impacts for each pollutant, assuming the entire feed consisted of a single chemical. The methods of identifying the pollutants exceeding the pounds per hour screening level in each category, their uncontrolled and controlled emissions, and the ambient impacts are described in Appendix A.

Pollutants with ambient air quality standards (particulate matter, asbestos, beryllium, heavy metals, sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and non-methane hydrocarbons) were treated in a slightly different manner. With ambient air standards it is not the input of an individual pollutant that is of concern but the total amount generated from all fuels and wastes input to the system. For instance, sulfur dioxide is formed from any sulfur input to the system. For the purposes of this analysis, it is assumed that all sulfur would be converted to sulfur dioxide in the excess air atmosphere of the secondary combustion chamber. As shown in Appendix C, the total sulfur that could be input to the system without exceeding the 0.10 ppm sulfur dioxide 24-hour standard would be 141 lbs/hour. Because the sulfur dioxide emissions from burning auxiliary fuel will

generally be less than 1 lb/hour (see Appendix D), up to 140 lbs/hour could be introduced in the LLW/MW feed without exceeding ambient standards. The detailed calculations for uncontrolled and controlled emissions for each criteria pollutant are contained in Appendix C. The maximum ambient impacts are also calculated and compared to the state and federal ambient air quality standards.

References

EPA 1987: "Industrial Source Complex (ISC) Dispersion Model User's Guide-Second Edition (Revised)," EPA 450/4-88-002a, December 1987.

SECTION 6
APPLICATION FOR PERMIT AND CERTIFICATE OF REGISTRATION

Return to:

EID-AIR QUALITY BUREAU
NEW SOURCE REVIEW UNIT
P. O. BOX 968
SANTA FE, NM 87504-0968
TELEPHONE: (505) 827-0070

APPLICATION FOR PERMIT
AND CERTIFICATE OF REGISTRATION
GENERAL FORM FOR
SOURCES LOCATED WITHIN THE STATE
OF NEW MEXICO

SECTION 1 - GENERAL DATA

1. Name of Company: Los Alamos National Laboratory 2. Date Submitted: _____

3. Company Address: Los Alamos, New Mexico 87545 Phone: (505) 667-5105

   Person to Contact: Harold E. Valencia Title: DOE\Los Alamos Office, Area Manager Phone: (505) 667-5105

4. Name, Address and location of new plant or modification: Technical Area 50, Building 37, Room 114

   _____ Is U.S.G.S. quadrangular mpa or equipvalent attached? Yes

5. Describe briefly the type and capacity of the plant and nature of modifications (if applicable) and products:

   6 million BTU/hr dual-chamber controlled air incinerator with wet off-gas treatment system, HEPA filtration, and ash immobilization system for volume reduction and thermal destruction of combustible components of low-level ratdioactive and mixed chemical wastes

6. Class of land at plantsite (private, State, Federal, Indian, etc.): Federal

7. Is this permanent? yes If not, how long is it expected to be occupied? NA Date of Anticipated Startup: July 1991

8. Normal operation schedule: 24 hours per day, 7 days per week, 2 weeks per month, 12 months per year.

9. Specify maximum operating periods: During maximum operating periods, the source could run 4 week/month

10. Specify percent annual production by quarters: Dec-Feb 25, Mar-May 25, Jun-Aug 25, Sept-Nov 25

SECTION 2 - FUEL USAGE

Unit No.	Type of Fuel Burning Equipment	Equipment Manufacturer	Rated Capacity Million BTU/Hr.	Fuel Type	FUEL DATA		Percent Sulfur	Percent Ash
					Amount Per Hour	Heating Value		
1	Dual Chamber Incin.	Joy Energy System	6	natural gas	2913 scf*	1030 BTU/ft^3		
		or McGill/Consumat	3	#2 fuel oil	22 gal*	2780 BTU/gal	0.22	
			3	LLW/MW Solid	variable	variable	variable	variable
			3	" Liquid	variable	variable	variable	
			3	" Gas	variable	variable	variable	

*Maximum hourly usage. Annual usage will depend on the types of LLW/MW incinerated. The 6 million BTU/hr for natural gas represents both the primary and secondary combustion chambers being fired on natural gas. The 3 million BTU/hour for fuel oil represents the fact that the SCC can also accomodate fuel oil. The maximum usages shown for auxillary fuel will only occur during startup and shutdown. When LLW/MW are being incinerated, less auxillary fuel should be required. The total capacity of the incinerator is 7 million BTU.

SECTION 3 - MATERIALS PROCESSED AND PRODUCED

A. RAW MATERIALS PROCESSED				
Unit No.	Type	Composition	Condition	Quantity (Specify Units)
1	Low Level and Mixed Wastes	Variable	Solid and liquid	*Approximately 2,000,000 lb/yr solid waste
				and 1,600,000 lb/yr liquid waste or gases
B. MATERIALS PRODUCED (DO NOT INCLUDE EMISSIONS AND PRODUCTS LISTED IN SECTIONS 4, 8 AND 9)				
	NA			

*These estimates were made using the normal operation schedule (~4000 hrs/yr) and assuming the maximum feed rates of 400 lbs/hr liquids or gases and 500 lbs/hr solids. The maximum amount of radioactivity in these wastes will be regulated by the NESHAP permit for this source.

SECTION 4 - UNIT EMISSION (PRIOR TO AIR POLLUTION CONTROL EQUIPMENT, OR TO ATMOSPHERE, IF UNCONTROLLED)

Unit No.	Process or Operation	Quantity of Gases Discharged to Air Pollution Control Equipment	ESTIMATES OF AIR POLLUTION						Basis of Estimate
			Pollutant No. 1		Pollutant No. 2		Pollutant No. 3		
			Type	Quantity	Type	Quantity	Type	Quantity	
1	auxillary fuel - gas	See Section 6	See Appendix D			lb/hr T/yr		lb/hr T/yr	AP-42
	auxillary fuel - oil	See Section 6	See Appendix D			lb/hr T/yr		lb/hr T/yr	AP-42
	LLW/MW	See Section 6	See Appendix A			lb/hr T/yr		lb/hr T/yr	Modeling Estimates
				lb/hr T/yr		lb/hr T/yr		lb/hr T/yr	

SECTION 5 - AIR POLLUTION CONTROL EQUIPMENT, EMISSIONS TO ATMOSPHERE

Unit No.	Air Pollution Control Equipment		EMISSIONS TO ATMOSPHERE						Pollution Control Equipment Collection Efficiency	
			Pollutant No. 1		Pollutant No. 2		Pollutant No. 3			
	Type	Manufacturer and Model No.	Type	Quantity	Type	Quantity	Type	Quantity	Percent by Weight	How Determined
1	Quench Column Venturi Scrubber	To Follow Contract Award	See Appendix E "			lb/hr T/yr		lb/hr T/yr	See Appendix E	Manufacturer's Estimate or
	Absorber Column Demister	" "	" "			lb/hr T/yr		lb/hr T/yr	" "	CAI Trial Burn
	HEPA Filters Carbon Absorber	" "	" "			lb/hr T/yr		lb/hr T/yr	" "	" "
				lb/hr T/yr		lb/hr T/yr		lb/hr T/yr	" "	" "
				lb/hr T/yr		lb/hr T/yr		lb/hr T/yr		

SECTION 5 - CONTINUED

Capital Costs (Optional):
Approximate expected capital investment of new or modified air pollution control equipment: $_____
Estimated yearly operation and maintenance costs for air pollution control equipment:$_____

SECTION 6 - STACK DATA - Include drawings or sketches (plan view and elecations) of any buildings or equipment in close proximity to stacks.

Unit No.	Stack Height, Feet	Inside Diameter Feet	EXIT GAS CONDITIONS		Moisture Percent by Volume	SAMPLING PORTS		
			Temperature °F	Velocity Ft/Sec		Number	Size	Location*
1	66	3	152	37 acfs	31	2	3.5 in.	12 pipe diameters upstream
								of duct entrance to stack
						1	3.5 in.	7 pipe diameters upstream
								of duct entrance to stack

*These port locations are what is currently on the existing TRU-CAI. Orientation on proposed LLW/MW could be different.

SECTION 7 - EMISSION MEASUREMENT EQUIPMENT

Unit No.	Pollutant	Type of Instrument	Manufacturer - Model No.	Range	Sensitivity	Accuracy
1	CO	NDIR	Following Contract Award	1-1000ppm	20 ppm	± 5%
	CO2	NDIR	Following Contract Award	0 - 20%	0.5 %	± 5%
	O2	Zirconium Oxide Cell	Following Contract Award	0 - 20%	0.5 %	± 5%

SECTION 8 - HAZARDOUS AIR POLLUTANTS, OTHER TOXIC CHEMICALS, AND ODORS

A. Describe any hazardous air pollutants and toxic chemicals used or emitted in plant processes.

Unit	Description of Chemicals	Quantity Emitted to Atmosphere	How, Where Emitted
1	see Appendix A	see Appendix A	NA

SECTION 9 - WASTE PRODUCT DISPOSAL (SOLID AND LIQUID WASTES, AND AUXILIARY INCINERATION EMISSIONS NOT COVERED IN SECTIONS 4 OR 50

A. Auxillary Incineration Operation:
Normal on-site combustion operating schedule:____ hours per day, ____ days per week, ____ weeks per year.

Seasonal or peak combustion operating periods (specify):_____

Unit No.	Waste Material		Method of Disposal	Incinerator Capacity lb. per llr.	Auxillary Fuels Used	Type and Efficiency of Air Cleaning Equipment	Estimate of Air Pollutants, if any	
	Type	Amount					Type	Quantity per Year
1	ash	~40 #/hr /yr	landfill*	NA	NA	NA	NA	/hr /yr
	scrub solution	26-88#/hr /yr	TA-50-1	NA	NA	NA	NA	/hr /yr
	HEPA filters	NA /hr ~1500 #yr	landfill	NA	NA	NA	NA	/hr /yr
		/hr /yr						/hr /yr

*Solid wastes will be potential mixed waste and will be stored outside prior to establishment of mixed waste landfill at LANL or other DOE site, or until WIPP accepts.

COMPANY NAME Los Alamos National Laboratory

SECTION 10; CERTIFICATION:

I, Harold E. Valencia, Area Manager, hereby certify that the information and data submitted in this application are completely true and as accurate as possible, to the the best of my personal knowledge and professional expertise and experience.

Signed this _____ day of _____, 19___, upon my oath or affirmation, before a notary of the State of New Mexico.

SIGNATURE **DATE** 5-1-89

Harold E. Valencia, Area Manager
PRINTED NAME

Subscribed and sworn to before me on this 1ST day of May, 1989.

NOTARY'S SIGNATURE **DATE** May 1, 1989

OFFICIAL SEAL
CARMEN G. LUCERO

NOTARY'S PRINTED NAME
NOTARY BOND FILED WITH SECRETARY OF STATE
My Commission Expires 5/20/89

APPENDIX A
CALCULATIONS FOR POTENTIAL AND ACTUAL EMISSIONS FOR TOXIC AIR POLLUTANTS

To determine which of the toxic air pollutants (TAPs) exceeded the pounds per hour screening limits contained in AQCR 702, potential (uncontrolled) emissions were calculated for each TAP. For those TAPs exceeding screening limits, the actual (controlled) emissions and the ambient impacts resulting from the controlled emissions were calculated. The ambient impacts were compared to the AQCR 702 occupational exposure limits (OEL) x 0.01 limits. To calculate these emissions, the very conservative assumption was made that the entire feed of 400 pounds per hour for liquids and gases, and 500 pounds per hour for solids would consist of a single TAP. The solid, liquid, and gaseous TAPs were further subdivided to more accurately reflect the incinerator destruction efficiency and off-gas treatment system removal efficiency for different types of compounds. The assumptions and calculations for each category are described below.

Elemental Solids: As a conservative estimate, it was assumed that the elemental solids, mainly metals, and their oxides would not be destroyed by the incinerator but would continue to exist in their elemental or oxide form. The pounds per hour screening levels (adjusted for the stack height of 66 feet) were compared to the uncontrolled emissions. Since no destruction was assumed, uncontrolled emissions would equal 500 pounds per hour. For those TAPs exceeding the adjusted screening limits, the controlled emissions were calculated. Manufacturers contacted estimated that the particulate removal efficiency of the off-gas treatment system would be 99.9999996 percent for

particulate matter, resulting in controlled emissions of:

$$500 \text{ lbs/hr} \times (1-0.999999996) = 0.000002 \text{ lbs/hr}.$$

When this assumption was combined with the modeled 8-hour impact per pound per hour of emissions, the TAP ambient concentrations were calculated as follows:

$$\frac{500 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{(1-0.999999996) \text{ lbs emitted}}{\text{lb input}}$$

$$= 9 \times 10^{-9} \text{ mg/m}^3$$

The resulting concentration was compared to the OELs as shown in Table A-1. Based on these calculations, none of the OEL x 0.01 ambient limits were exceeded for elemental solids and their oxides.

Non-Elemental Solids: It was assumed that the non-elemental solids would decompose at temperatures of 2000°F, no longer existing in their regulated state. To determine which chemicals exceeded the pounds per hour screening levels (adjusted for the stack height of 66 feet), the maximum input of 500 pounds per hour was used in the calculations. For the non-elemental solids, it was assumed that 90 percent would be combusted, 5 percent would remain in the ash, and 5 percent would be emitted as fine particulate matter, resulting in uncontrolled emissions of:

$$500 \text{ lbs/hr} \times (1-0.95) = 25 \text{ lbs/hr uncontrolled}.$$

The actual emissions and ambient impacts were calculated for those chemical exceeding the adjusted pounds per hour screening level. Manufacturers contacted estimated that the efficiency of the off-gas treatment system would be 99.9999996 percent for particulate matter, resulting in controlled emissions of:

$$25 \text{ lbs/hr} \times (1-0.999999996) = 1 \times 10^{-7} \text{ lbs/hr controlled}.$$

When this assumption was combined with the modeled 8-hour impact

Table A-1. Potential Emissions, Actual Emissions, and Ambient Impacts for Elemental Solids or Their Oxides

Chemical	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
ALUMINUM - METAL AND OXIDES	0.1	500	0.000002	0.0000000086
ALUMINUM - PYRO POWDERS	0.05	500	0.000002	0.0000000086
ANTIMONY & COMPOUNDS, AS Sb	0.005	500	0.000002	0.0000000086
BORON OXIDE	0.1	500	0.000002	0.0000000086
CADMIUM DUSTS & SALTS, AS Cd	0.0005	500	0.000002	0.0000000086
CADMIUM OXIDE - FUME AS Cd	0.0005	500	0.000002	0.0000000086
CALCIUM OXIDE	0.02	500	0.000002	0.0000000086
CHROMIUM (VI) WATER INSOLUBLE,	0.0005	500	0.000002	0.0000000086
CHROMIUM (VI) WATER SOLUBLE	0.0005	500	0.000002	0.0000000086
CHROMIUM METAL	0.005	500	0.000002	0.0000000086
COBALT - METAL DUST & FUME	0.001	500	0.000002	0.0000000086
COBALT AS Co	0.001	500	0.000002	0.0000000086
COPPER - DUSTS AND MISTS	0.01	500	0.000002	0.0000000086
COPPER - FUME	0.002	500	0.000002	0.0000000086
FERROVANADIUM DUST	0.01	500	0.000002	0.0000000086
FLUORIDES, AS F	0.025	500	0.000002	0.0000000086
HAFNIUM	0.005	500	0.000002	0.0000000086
INDIUM & COMPOUNDS AS In	0.001	500	0.000002	0.0000000086
IODINE	0.01	500	0.000002	0.0000000086
IRON OXIDE FUME (FE2O3) AS Fe	0.05	500	0.000002	0.0000000086
MAGNESIUM OXIDE FUME	0.1	500	0.000002	0.0000000086
MANGANESE - DUST & COMPOUNDS,	0.05	500	0.000002	0.0000000086
MANGANESE - FUME, AS Mn	0.01	500	0.000002	0.0000000086
MANGANESE TETROXIDE	0.01	500	0.000002	0.0000000086
MOLYBDENUM AS Mo - SOLUBLE	0.05	500	0.000002	0.0000000086
NICKEL - METAL	0.01	500	0.000002	0.0000000086
OSMIUM TETROXIDE AS Os	0.00002	500	0.000002	0.0000000086
PHOSPHOROUS (YELLOW)	0.001	500	0.000002	0.0000000086
PLATINUM - METAL	0.01	500	0.000002	0.0000000086
RHODIUM - METAL	0.01	500	0.000002	0.0000000086
SILVER - METAL	0.001	500	0.000002	0.0000000086
TANTALUM	0.05	500	0.000002	0.0000000086
TELLURIUM & COMPOUNDS AS Te	0.001	500	0.000002	0.0000000086
TIN - METAL	0.02	500	0.000002	0.0000000086
TIN - OXIDE & INORG. CMPDS	0.02	500	0.000002	0.0000000086
TUNGSTEN AS W, COMPOUNDS	0.05	500	0.000002	0.0000000086
URANIUM (NATURAL)	0.002	500	0.000002	0.0000000086
VANADIUM AS V2O5 RESPIRABLE	0.0005	500	0.000002	0.0000000086
YTTRIUM	0.01	500	0.000002	0.0000000086
ZINC OXIDE FUME	0.05	500	0.000002	0.0000000086

per pound per hour of emissions, the ambient concentration was calculated as follows:

$$\frac{500 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{(1-0.95) \text{ uncontrolled lbs}}{\text{lb input}}$$

$$\times \frac{1-0.999999996 \text{ lbs controlled}}{\text{lb uncontrolled}} = 4 \times 10^{-10} \text{ mg/m}^3$$

The resulting concentration was compared to the OELs as shown in Table A-2. Based on these calculations, none of the OEL x 0.01 ambient limits were exceeded for non-elemental solids.

Organic liquids: Organic liquids were shown in the TRU-CAI trial burn to have a destruction/removal efficiency of 99.99824 percent. The manufacturers estimated the efficiencies for the off-gas treatment system for hydrocarbons to be low, with most of the reduction resulting from the incinerator itself. To determine which chemicals exceeded the pounds per hour screening levels (adjusted for the stack height of 66 feet), the maximum input of 400 pounds per hour was used in the calculations. As a conservative estimate, the destruction efficiency of the incinerator was assumed to be only 99.99 percent, instead of the entire 99.99824 percent measured during the TRU-CAI trial burn. The controlled emissions were calculated using the entire destruction/removal efficiency. These assumptions result in emissions of:

400 lbs/hr x (1-0.9999) = 0.040 lbs/hr uncontrolled and

400 lbs/hr x (1-0.9999824) = 0.0070 lbs/hr controlled.

For each chemical exceeding the adjusted screening level, the modeling and entire destruction efficiency were used to calculate ambient impacts emissions as follows:

$$\frac{400 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{(1-0.9999824) \text{ lbs emitted}}{\text{lb input}}$$

$$= 3.0 \times 10^{-5} \ \mu\text{g/m}^3$$

The resulting concentration was compared to the OELs as shown in Table A-3. Based on these calculations, the only OEL x 0.01 ambient limit exceeded was for ethylene dibromide.

Table A-2. Potential Emissions, Actual Emissions, and Ambient Impacts for Non-Elemental Solids

Chemical	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
ACETYLSALICYLIC ACID	0.05	25	0.0000001	0.0000000004
ACRYLAMIDE	0.003	25	0.0000001	0.0000000004
ALDRIN	0.0025	25	0.0000001	0.0000000004
ALUMINUM - SOLUBLE SALTS	0.02	25	0.0000001	0.0000000004
ALUMINUM - WELDING FUMES	0.05	25	0.0000001	0.0000000004
AMINODIPHENYL (4-)	0.01	25	0.0000001	0.0000000004
AMINOPYRIDINE (2-)	0.02	25	0.0000001	0.0000000004
AMITROLE	0.002	25	0.0000001	0.0000000004
AMMONIUM CHLORIDE FUME	0.1	25	0.0000001	0.0000000004
AMMONIUM SULFAMATE	0.1	25	0.0000001	0.0000000004
ANTU	0.003	25	0.0000001	0.0000000004
ATRAZINE	0.05	25	0.0000001	0.0000000004
AZINPHOS-METHYL	0.002	25	0.0000001	0.0000000004
BARIUM, SOLUBLE COMPOUNDS	0.005	25	0.0000001	0.0000000004
BENOMYL	0.1	25	0.0000001	0.0000000004
BENZIDINE	0.00004	25	0.0000001	0.0000000004
BENZO(a)PYRENE	0.00001	25	0.0000001	0.0000000004
BENZOYL PEROXIDE	0.05	25	0.0000001	0.0000000004
BIPHENYL	0.015	25	0.0000001	0.0000000004
BISMUTH TELLURIDE	0.1	25	0.0000001	0.0000000004
BISMUTH TELLURIDE - Se DOPED	0.05	25	0.0000001	0.0000000004
BORATES, TETRA, ANHYDROUS	0.01	25	0.0000001	0.0000000004
BORATES, TETRA, DECAHYDRATES	0.05	25	0.0000001	0.0000000004
BORATES, TETRA, PENTAHYDRATE	0.01	25	0.0000001	0.0000000004
BROMACIL	0.1	25	0.0000001	0.0000000004
BUTYL CHROMATE (TERT-)	0.001	25	0.0000001	0.0000000004
CADMIUM OXIDE - PRODUCTION	0.0005	25	0.0000001	0.0000000004
CALCIUM CYANAMIDE	0.005	25	0.0000001	0.0000000004
CALCIUM HYDROXIDE	0.05	25	0.0000001	0.0000000004
CAMPHOR, SYNTHETIC	0.12	25	0.0000001	0.0000000004
CAPROLACTAM - DUST	0.01	25	0.0000001	0.0000000004
CAPTAFOL	0.001	25	0.0000001	0.0000000004
CAPTAN	0.05	25	0.0000001	0.0000000004
CARBARYL	0.05	25	0.0000001	0.0000000004
CARBOFURAN	0.001	25	0.0000001	0.0000000004
CARBON BLACK	0.035	25	0.0000001	0.0000000004
CARBON TETRABROMIDE	0.014	25	0.0000001	0.0000000004
CESIUM HYDROXIDE	0.02	25	0.0000001	0.0000000004
CHLORINATED CAMPHENE	0.005	25	0.0000001	0.0000000004

(continued)

Table A-2 (continued)

Chemical	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
CHLORINATED DIPHENYL OXIDE	0.005	25	0.0000001	0.0000000004
CHLOROACETOPHENONE (alpha)	0.003	25	0.0000001	0.0000000004
CHLOROBENZYLIDENE MALONITRILE	0.004	25	0.0000001	0.0000000004
CHLORPYRIFOS	0.002	25	0.0000001	0.0000000004
CHROMIUM (II) COMPOUNDS	0.005	25	0.0000001	0.0000000004
CHROMIUM (III) COMPOUNDS	0.005	25	0.0000001	0.0000000004
CHRYSENE	0.00001	25	0.0000001	0.0000000004
CLOPIDOL	0.1	25	0.0000001	0.0000000004
COBALT CARBONYL, AS Co	0.001	25	0.0000001	0.0000000004
COBALT HYDROCARBONYL AS Co	0.001	25	0.0000001	0.0000000004
COTTON DUST, RAW	0.002	25	0.0000001	0.0000000004
CRUFOMATE	0.05	25	0.0000001	0.0000000004
CYANAMIDE	0.02	25	0.0000001	0.0000000004
CYANIDES AS CN	0.05	25	0.0000001	0.0000000004
CYCLONITE	0.015	25	0.0000001	0.0000000004
CYHEXATIN	0.05	25	0.0000001	0.0000000004
D (2,4-)	0.1	25	0.0000001	0.0000000004
DDT	0.01	25	0.0000001	0.0000000004
DECABORANE	0.003	25	0.0000001	0.0000000004
DICHLOROBENZIDINE (3,3-)	0.00004	25	0.0000001	0.0000000004
DICHLOROPROPIONIC ACID (2,2-)	0.06	25	0.0000001	0.0000000004
DICYCLOPENTADIENYL IRON	0.1	25	0.0000001	0.0000000004
DIELDRIN	0.0025	25	0.0000001	0.0000000004
DINITOLMIDE	0.05	25	0.0000001	0.0000000004
DINITRO-O-CRESOL	0.002	25	0.0000001	0.0000000004
DINITROBENZENE (ALL ISOMERS)	0.01	25	0.0000001	0.0000000004
DINITROTOLUENE	0.015	25	0.0000001	0.0000000004
DIOXATHION	0.002	25	0.0000001	0.0000000004
DIPHENYLAMINE	0.1	25	0.0000001	0.0000000004
DIQUAT	0.005	25	0.0000001	0.0000000004
DISULFIRAM	0.02	25	0.0000001	0.0000000004
DISULFOTON	0.001	25	0.0000001	0.0000000004
DITERT,BUTYL-P-CRESOL (2,6-)	0.1	25	0.0000001	0.0000000004
DIURON	0.1	25	0.0000001	0.0000000004
ENDOSULFAN	0.001	25	0.0000001	0.0000000004
ENDRIN	0.001	25	0.0000001	0.0000000004
EPN	0.005	25	0.0000001	0.0000000004
FENAMIPHOS	0.001	25	0.0000001	0.0000000004
FERBAM	0.1	25	0.0000001	0.0000000004
FIBROUS GLASS DUST	0.1	25	0.0000001	0.0000000004
HEPTACHLOR	0.005	25	0.0000001	0.0000000004
HEXACHLORONAPHTHALENE	0.002	25	0.0000001	0.0000000004
HYDROGENATED TERPHENYLS	0.05	25	0.0000001	0.0000000004
HYDROQUINONE	0.02	25	0.0000001	0.0000000004
IODOFORM	0.1	25	0.0000001	0.0000000004
IRON SALTS, SOLUBLE AS Fe	0.01	25	0.0000001	0.0000000004
ISOPHORONE DIISOCYANATE	0.0009	25	0.0000001	0.0000000004
LEAD CHROMATE AS Cr	0.0005	25	0.0000001	0.0000000004
LINDANE	0.005	25	0.0000001	0.0000000004
LITHIUM HYDRIDE	0.00025	25	0.0000001	0.0000000004
MALEIC ANHYDRIDE	0.01	25	0.0000001	0.0000000004
MANGANESE CYCLOPENTADIENYL ...	0.001	25	0.0000001	0.0000000004
METHOMYL	0.025	25	0.0000001	0.0000000004

(continued)

Table A-2 (continued)

Chemical	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
METHOXYCHLOR	0.1	25	0.0000001	0.0000000004
METHOXYPHENOL (4-)	0.05	25	0.0000001	0.0000000004
METHYL PARATHION	0.002	25	0.0000001	0.0000000004
METHYLENE BIS(2-CHLOROANILINE)	0.0022	25	0.0000001	0.0000000004
METHYLENE BIS(4-CYCLOHEXY...	0.0011	25	0.0000001	0.0000000004
METHYLENE BISPHENYL ISOCYANATE	0.002	25	0.0000001	0.0000000004
METHYLENEDIANILINE (4,4-)	0.008	25	0.0000001	0.0000000004
METRIBUZIN	0.05	25	0.0000001	0.0000000004
MOLYBDENUM AS Mo, INSOLUBLE	0.1	25	0.0000001	0.0000000004
MONCROTOPHOS	0.0025	25	0.0000001	0.0000000004
NALED	0.03	25	0.0000001	0.0000000004
NAPHTHYLAMINE (B-)	0.00003	25	0.0000001	0.0000000004
NICKEL - SOLUBLE COMPOUNDS	0.001	25	0.0000001	0.0000000004
NITRAPYRIN	0.1	25	0.0000001	0.0000000004
NITROANILINE (P-)	0.03	25	0.0000001	0.0000000004
NITRODIPHENYL (4-)	0.19	25	0.0000001	0.0000000004
OCTACHLORONAPHTHALENE	0.001	25	0.0000001	0.0000000004
OXALIC ACID	0.01	25	0.0000001	0.0000000004
PARAQUAT RESPIRABLE SIZES	0.001	25	0.0000001	0.0000000004
PENTACHLORONAPHTHALENE	0.005	25	0.0000001	0.0000000004
PENTACHLOROPHENOL	0.005	25	0.0000001	0.0000000004
PHENOL	0.19	25	0.0000001	0.0000000004
PHENOTHIAZINE	0.05	25	0.0000001	0.0000000004
PHENYL GLYCIDYL ETHER (PGE)	0.06	25	0.0000001	0.0000000004
PHENYL-BETA-NAPHTHYLAMINE (N-)	0.05	25	0.0000001	0.0000000004
PHENYLENE DIAMINE (P-)	0.001	25	0.0000001	0.0000000004
PHOSPHOROUS PENTACHLORIDE	0.01	25	0.0000001	0.0000000004
PHOSPHOROUS PENTASULFIDE	0.01	25	0.0000001	0.0000000004
PHTHALADINITRILE (M-)	0.05	25	0.0000001	0.0000000004
PHTHALIC ANHYDRIDE	0.06	25	0.0000001	0.0000000004
PICLORAM	0.1	25	0.0000001	0.0000000004
PICRIC ACID	0.001	25	0.0000001	0.0000000004
PINDONE	0.001	25	0.0000001	0.0000000004
PIPERAZINE DIHYDROCHLORIDE	0.05	25	0.0000001	0.0000000004
PLATINUM - SOLUBLE SALTS, AS Pt	0.00002	25	0.0000001	0.0000000004
POTASSIUM HYDROXIDE	0.02	25	0.0000001	0.0000000004
PROPOXUR	0.005	25	0.0000001	0.0000000004
PYRETHRUM	0.05	25	0.0000001	0.0000000004
QUINONE	0.004	25	0.0000001	0.0000000004
RHODIUM - INSOLUBLE COMPOUNDS	0.01	25	0.0000001	0.0000000004
RHODIUM - SOLUBLE COMPOUNDS	0.0001	25	0.0000001	0.0000000004
RONNEL	0.1	25	0.0000001	0.0000000004
ROTENONE (COMMERCIAL)	0.05	25	0.0000001	0.0000000004
SELENIUM COMPOUNDS AS Se	0.002	25	0.0000001	0.0000000004
SESONE	0.1	25	0.0000001	0.0000000004
SILVER - SOLUBLE COMPOUNDS	0.0001	25	0.0000001	0.0000000004
SODIUM AZIDE	0.003	25	0.0000001	0.0000000004
SODIUM BISULFATE	0.05	25	0.0000001	0.0000000004
SODIUM FLUOROACETATE	0.0005	25	0.0000001	0.0000000004
SODIUM HYDROXIDE	0.02	25	0.0000001	0.0000000004
SODIUM METABISULFITE	0.05	25	0.0000001	0.0000000004
STRYCHNINE	0.0015	25	0.0000001	0.0000000004
SUBTILISINS	0.000001	25	0.0000001	0.0000000004
T (2,4,5-)	0.1	25	0.0000001	0.0000000004

(continued)

Table A-2 (continued)

Chemical	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
TEMEPHOS	0.1	25	0.0000001	0.0000000004
TERPHENYLS	0.05	25	0.0000001	0.0000000004
TETRACHLORONAPHTHALENE	0.02	25	0.0000001	0.0000000004
TETRAMETHYL SUCCINONITRILE	0.03	25	0.0000001	0.0000000004
TETRASODIUM PYROPHOSPHATE	0.05	25	0.0000001	0.0000000004
TETRYL	0.015	25	0.0000001	0.0000000004
THALLIUM SOLUBLE COMPOUNDS	0.001	25	0.0000001	0.0000000004
THIOBIS(6-TERT, BUTYL-M-CRESOL	0.1	25	0.0000001	0.0000000004
THIRAM	0.05	25	0.0000001	0.0000000004
TOLIDINE (O-)	0.11	25	0.0000001	0.0000000004
TOLUIDINE (P-)	0.09	25	0.0000001	0.0000000004
TRICHLOROACETIC ACID	0.07	25	0.0000001	0.0000000004
TRICHLORONAPHTHALENE	0.05	25	0.0000001	0.0000000004
TRIMELLITIC ANHYDRIDE	0.0004	25	0.0000001	0.0000000004
TRINITROTOLUENE (2,4,6-) (TNT)	0.005	25	0.0000001	0.0000000004
TRIPHENYL AMINE	0.05	25	0.0000001	0.0000000004
TRIPHENYL PHOSPHATE	0.03	25	0.0000001	0.0000000004
WARFARIN	0.001	25	0.0000001	0.0000000004
WOOD DUST - HARDWOODS	0.01	25	0.0000001	0.0000000004
WOOD DUST - SOFTWOODS	0.05	25	0.0000001	0.0000000004
ZINC CHLORIDE FUME	0.01	25	0.0000001	0.0000000004
ZIRCONIUM COMPOUNDS AS Zr	0.05	25	0.0000001	0.0000000004

Table A-3. Organic Liquids Emitted at Levels Greater Than the Adjusted Pounds Per Hour Threshold and Estimated Ambient Impacts

Chemical	7:2 OEL	OEL x 0.01 (mg/m^3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m^3)
BIS(CHLOROMETHYL)ETHER	.005	0.00005	0.04	0.0074	0.00003027
ETHYLENE DIBROMIDE	.380	0.00002	0.04	0.0074	0.00003027
HEXAMETHYL PHOSPHORAMIDE	—	0.0004	0.04	0.0074	0.00003027

Therefore, LANL will limit the input of ethylene dibromide to a level which ensures the OEL x 0.01 limit will not be exceeded. The limit will be:

$$\frac{0.00002 \text{ mg allowed}}{m_3} \times \frac{\text{lb/hr emissions}}{0.0043 \text{ mg/m}^3} \times \frac{\text{lb input}}{(1-0.9999824)\text{lb emitted}}$$

= 264 lbs/hr input allowed

To ensure that this limit is met, uncharacterized organic liquids will be chemically analyzed for ethylene dibromide.

Inorganic liquids: At temperatures of 2000 °F, it was assumed that the inorganic liquids would dissociate, no longer existing in their regulated state. To determine which chemicals exceeded the pounds per hour screening levels (adjusted for the stack height of 66 feet), the maximum input of 400 pounds per hour was assumed. The destruction efficiency of the incinerator was assumed to be 95 percent, resulting in uncontrolled emissions of:

400 lbs/hr x (1-0.95) = 20 lbs/hr.

Because most of the inorganic liquids exceeding the adjusted screening level were acids, the control efficiency of 99.585 percent measured during the CAI-TRU trial burn for HCl removal was used, resulting in controlled emissions of:

20 lbs/hr x (1-0.99585) = 0.083 lbs/hr

When these assumption were combined with the modeled 8-hour impact per pound per hour of emissions, the ambient impacts were calculated for those pollutants exceeding the pounds per hour screening limit as follows:

$$\frac{400 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{(1-0.95) \text{ uncontrolled lbs}}{\text{lb input}}$$

$$\times \frac{1-0.99585 \text{ lbs controlled}}{\text{lb uncontrolled}} = 0.00036 \text{ mg/m}^3$$

As shown in Table A-4, pentaborane is the only TAP exceeding the OEL x 0.01 ambient impact level. Because pentaborane becomes very unstable upon heating, the destruction efficiency of the incinerator should be much greater than the 95 percent assumed

for the purposes of addressing this entire category. The high heating value of pentaborane (29,100 BTU/lb) reflects this instability. The destruction efficiency of this compound should be much higher than for carbon tetrachloride (heating value of 436 BTU/lb) which was found in the TRU-CAI trial burn to be destroyed/removed with an efficiency of at least 99.99824 percent. It would probably be more appropriate to use the destruction efficiency of more than 99.999 percent for pentaborane. Using a destruction efficiency of 99.999 percent to provide a conservative estimate, the pentaborane emissions would be:

$$400 \text{ lbs/hr} \times (1-0.99999) = 0.0040 \text{ lbs/hr}.$$

Even assuming no additional removal in the off-gas treatment system, the ambient impacts would be:

$$\frac{0.004 \text{ lbs}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} = 1.7 \times 10^{-5} \text{ mg/m}^3$$

Using these assumptions, the OEL x 0.01 limit of 1×10^{-4} would not be exceeded.

Table A-4. Potential Emissions, Actual Emissions, and Ambient Impacts for Inorganic Liquids

Chemical	OEL x 0.01 (MG/M3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m3)
BORON TRIBROMIDE	0.1	20	0.083	0.0003569
BROMINE	0.007	20	0.083	0.0003569
BROMINE PENTAFLUORIDE	0.007	20	0.083	0.0003569
CHROMYL CHLORIDE	0.0015	20	0.083	0.0003569
HYDROGEN FLUORIDE AS F	0.025	20	0.083	0.0003569
HYDROGEN PEROXIDE	0.015	20	0.083	0.0003569
IRON PENTACARBONYL AS Fe	0.008	20	0.083	0.0003569
NICKEL CARBONYL	0.0035	20	0.083	0.0003569
NITRIC ACID	0.05	20	0.083	0.0003569
PENTABORANE	0.0001	20	0.083	0.0003569
PHOSPHORIC ACID	0.01	20	0.083	0.0003569
PHOSPHOROUS OXYCHLORIDE	0.006	20	0.083	0.0003569
PHOSPHOROUS TRICHLORIDE	0.015	20	0.083	0.0003569
SULFUR MONOCHLORIDE	0.06	20	0.083	0.0003569
SULFUR PENTAFLUORIDE	0.001	20	0.083	0.0003569
SULFUR TETRAFLUORIDE	0.004	20	0.083	0.0003569
SULFURIC ACID	0.01	20	0.083	0.0003569
THIONYL CHLORIDE	0.05	20	0.083	0.0003569

Organic gases: It was assumed that organic gases would have at least the destruction/removal efficiency of 99.99824 percent that was measured during the CAI-TRU trial burn for organic liquids. Therefore, the same assumptions were made for organic gases as were made for the organic liquids to compare the maximum potential pounds per hour emitted with the screening limits: a maximum input of 400 pounds per hour and an incinerator destruction efficiency of 99.99 percent. Using these assumptions, no organic gases exceeded the pounds per hour screening limit. Therefore, no ambient impacts were calculated.

Inorganic gases: At temperatures of 2000 °F, it was assumed that most of the compounds would dissociate, no longer existing in their regulated state. This assumption would not apply to hydrogen bromide or hydrogen chloride. To determine which chemicals exceeded the pounds per hour screening levels (adjusted for the stack height of 66 feet), the maximum input of 400 pounds per hour was assumed. The destruction efficiency of the incinerator was assumed to be 95 percent, except for hydrogen bromide and hydrogen chloride, resulting in uncontrolled emissions of:

400 lbs/hr x (1-0.95) = 20 lbs/hr.

For hydrogen chloride and hydrogen bromide, it was assumed that while they might dissociate in the incinerator, they would reform upon cooling. Therefore, the uncontrolled emissions of these two compounds was assumed to be 400 pounds per hour.

Because most of the inorganic gases that exceeded the adjusted pounds per hour screening level contain chlorine and fluorine groups amenable to scrubbing, the control efficiency of 99.585 percent measured during the CAI-TRU trial burn for HCl removal was used. When this assumption was combined with the modeled 8-hour impact per pound per hour of emissions, the impacts were calculated for all compounds except hydrogen bromide and hydrogen chloride as follows:

$$\frac{400 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{(1-0.95) \text{ uncontrolled lbs}}{\text{lb input}}$$

$$\times \frac{1-0.99585 \text{ lbs controlled}}{\text{lbs uncontrolled}} = 0.00036 \text{ mg/m}^3$$

For hydrogen chloride and hydrogen bromide the ambient impacts were calculated as:

$$\frac{400 \text{ lbs input}}{\text{hr}} \times \frac{0.0043 \text{ mg/m}^3}{\text{lb/hr}} \times \frac{1-0.99585 \text{ lbs controlled}}{\text{lbs uncontrolled}}$$

$$= 0.0071 \text{ mg/m}^3$$

The resulting concentration was compared to the OEL as shown in Table A-5. Based on these calculations, none of the OEL x 0.01 ambient limits were exceeded for inorganic gases.

Table A-5. Potential Emissions, Actual Emissions, and Ambient Impacts for Inorganic Gases

Chemical	OEL x 0.01 (MG/M3)	Maximum potential emissions (lbs/hr)	Actual emissions (lbs/hr)	Ambient impacts (mg/m3)
ARSINE	0.002	20	0.083	0.00036
BORON TRIFLUORIDE	0.03	20	0.083	0.00036
CHLORINE	0.03	20	0.083	0.00036
CHLORINE DIOXIDE	0.003	20	0.083	0.00036
CHLORINE TRIFLUORIDE	0.004	20	0.083	0.00036
DIBORANE	0.001	20	0.083	0.00036
FLUORINE	0.02	20	0.083	0.00036
GERMANIUM TETRAHYDRIDE	0.006	20	0.083	0.00036
HYDROGEN BROMIDE	0.1	400	1.7	0.0071
HYDROGEN CHLORIDE	0.07	400	1.7	0.0071
HYDROGEN SELENIDE AS Se	0.002	20	0.083	0.00036
OXYGEN DIFLUORIDE	0.001	20	0.083	0.00036
PERCHLORYL FLUORIDE	0.14	20	0.083	0.00036
PHOSPHINE	0.004	20	0.083	0.00036
SELENIUM HEXAFLUORIDE AS Se	0.002	20	0.083	0.00036
SILICON TETRAHYDRIDE	0.07	20	0.083	0.00036
TELLURIUM HEXAFLUORIDE AS Te	0.002	20	0.083	0.00036

APPENDIX B
TYPICAL INPUTS FOR WASTES CURRENTLY GENERATED AT LANL

For the purposes of this analysis, the following constraints have been established:

1) Total input per burner equals $\frac{3 \text{ million Btu}}{\text{hr}}$

2) The incinerator feed (waste plus supplemental fuel) must have a minimum fuel value of 8,000 Btu per pound.

3) The auxillary fuel is assumed to be natural gas.

The following relationships have been established.

1) $\frac{\text{Kilocalorie}}{\text{gram-mole}}$

Given, $\frac{\text{kilocalories}}{\text{gram-mole}} \times \frac{3.966 \text{ Btu}}{\text{kilocalorie}} \times \frac{453.6 \text{ gram}}{\text{lb}} =$

1,799 Btu/lb-mole

$1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}}$ is the conversion factor for

$\frac{\text{kilocalorie}}{\text{gram-mole}}$ to $\frac{\text{Btu}}{\text{lb-mole}}$

2) Natural gas, 21,533 Btu/lb (CHRIS Manual)

The heats of combustion given are from the Handbook of Chemistry and Physics.

A. Acetonitrile

Molecular Weight = 41 lb/lb-mole

$$302.4 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{544{,}018 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{544{,}018 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{41 \text{ lb}} = 13{,}269 \frac{\text{Btu}}{\text{lb}}$$

No supplemental fuel will be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{13{,}269 \text{ Btu}} = 226 \frac{\text{lb}}{\text{hr}} \text{ input possible}$$

B. Carbon Tetrachloride

Molecular Weight = 153.8 lb/lb-mole
State = liquid

$$37.3 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{67{,}103 \text{ Btu}}{\text{lb}}$$

$$67{,}103 \frac{\text{Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{153.8 \text{ lb}} = 436 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will be required:

Given that the fuel mixture must equal $\frac{8000 \text{ Btu}}{\text{lb}}$,

then: $436 \frac{\text{Btu}}{\text{lb } CCL_4} (x \text{ lb } CCl_4) + 21{,}533 \frac{\text{Btu}}{\text{lb natural gas}}$

$(y \text{ lb natural gas}) = \frac{8000 \text{ Btu}}{\text{lb total}}$

and x lb CCl_4 + y lb natural gas = 1 lb total,

then $436 (1 - y) + 21{,}533 (y) = 8{,}000$

$436 - 436y + 21{,}533y = 8{,}000$

$y = 0.36$
$x = 1 - 0.36 = 0.64$

Check: $(0.64 \text{ lb } CCl_4)(436 \frac{\text{Btu}}{\text{lb } CCl_4}) + (0.36 \text{ lb natural gas})$

$(21{,}533 \frac{\text{Btu}}{\text{lb natural gas}}) = \frac{8{,}030 \text{ Btu}}{1 \text{ lb total}}$

Therefore, for every 0.64 lb CCl_4 incinerated, 0.36 lb of natural gas must be burned as auxiliary fuel.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb total}}{8{,}000 \text{ Btu}} = 375 \frac{\text{lb total}}{\text{hr}}$$

$$375 \frac{\text{lb total}}{\text{hr}} \times \frac{0.64 \text{ lb } CCl_4}{1 \text{ lb total}} = 240 \frac{\text{lb}}{\text{hr}} \; CCl_4 \text{ input possible}$$

C. Chloroform

Molecular weight = 119.4 lb/lb-mole
State = liquid

$$89.2 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{160{,}471 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{160{,}471 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{119.4 \text{ lb}} = \frac{1{,}344 \text{ Btu}}{\text{lb}}$$

Therefore, supplemental fuel will be required.

Given, that the fuel mixture must equal 8,000 Btu/hr, then:

$$(1{,}344 \frac{\text{Btu}}{\text{lb } CHCl_3})(x \text{ lb } CHCl_3) + (21{,}533 \frac{\text{Btu}}{\text{lb natural gas}})$$

$$(y \text{ lb natural gas}) = 8{,}000 \frac{\text{Btu}}{\text{lb total}}$$

and x lb $CHCl_3$ + y lb natural gas = 1 lb total,

then $1{,}334\ (1 - y) + 21{,}533\ y = 8{,}000$

$$1{,}334 - 1{,}334\ y + 21{,}533\ y = 8{,}000$$

$y = 0.33$
$x = 1 - 0.33 = 0.67$

Check: $(0.67 \text{ lb } CHCl_3)(1{,}334 \frac{\text{Btu}}{\text{lb}} CHCl_3) + (0.33 \text{ lb nat'l gas})(21{,}422 \frac{\text{Btu}}{\text{lb}} \text{ nat'l gas}) = 8{,}000 \frac{\text{Btu}}{\text{lb}} \text{ total}$

Therefore, for every 0.67 lb of CCl_3 incinerated, 0.33 lb of natural gas would have to be burned as auxiliary fuel.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb total}}{8{,}000 \text{ Btu}} = 375 \frac{\text{lb total}}{\text{hr}}$$

$$375 \frac{\text{lb total}}{\text{hr}} \times \frac{0.67 \text{ lb } CHCl_3}{1 \text{ lb total}} = 251 \frac{\text{lb}}{\text{hr}} CHCl_3 \text{ input possible}$$

D. Ethyl Acetate

Molecular Weight = 88.1 lb/lb-mole
State = liquid

$$536.9 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = 965{,}883 \frac{\text{Btu}}{\text{lb-mole}}$$

$$\frac{965{,}883 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{88.1 \text{ lb}} = \frac{10{,}963 \text{ Btu}}{\text{lb}}$$

Supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{10{,}963 \text{ Btu}} = 274 \frac{\text{lb}}{\text{hr}}$$

E. Ethylene Glycol

Molecular Weight = 62.06 lb/lb-mole
State = liquid

$$281.9 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{507{,}138 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{507{,}138 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{62.06 \text{ lb}} = 8{,}172 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{8{,}172 \text{ Btu}} = 367 \frac{\text{lb}}{\text{hr}}$$

F. Hexane

Molecular Weight = 86.15 lb/lb-mole
State = liquid

$$995 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}790{,}005 \text{ Btu}}{\text{lb-mole}}$$

$$1{,}790{,}005 \frac{\text{Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{86.15 \text{ lb}} = 20{,}778 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{20{,}778 \text{ Btu}} = 144 \frac{\text{lb}}{\text{hr}} \quad \text{input possible}$$

G. Isopropyl Alcohol

Molecular Weight = 60.09 lb/lb-mole
State = liquid

$$474.8 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie}} = 854{,}165 \frac{\text{Btu}}{\text{lb-mole}}$$

$$854{,}165 \frac{\text{Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{60.09 \text{ lb}} = 14{,}215 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{14{,}215 \text{ Btu}} = 211 \frac{\text{lb}}{\text{hr}} \quad \text{input possible}$$

H. Methyl Ethyl Ketone

Molecular Weight = 72.10 lb/lb-mole
State = liquid

$$584.17 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}050{,}922 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{1{,}050{,}922 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{72.10 \text{ lb}} = 14{,}576 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{14{,}574 \text{ Btu}} = 206 \frac{\text{lb}}{\text{hr}} \text{ MEK input possible}$$

I. Methylene Chloride

Molecular Weight = 84.93 lb/lb-mole
State = liquid

$$106.8 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = 192{,}133 \frac{\text{Btu}}{\text{lb-mole}}$$

$$\frac{192{,}133 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{84.93 \text{ lb}} = 2{,}262 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel will be required.

Given, that the fuel mixture must equal 8,000 Btu/lb, then:

$$\frac{2{,}262 \text{ Btu}}{\text{lb MeCl}} (x \text{ lb MeCl}) + \frac{21{,}533 \text{ Btu}}{\text{lb nat'l gas}} (y \text{ lb nat'l gas}) =$$

$$8{,}000 \frac{\text{Btu}}{\text{lb total}}$$

and, x lb MeCl + y lb nat'l gas = 1 lb total,

then, $2{,}262 (1 - y) + 21{,}533 y = 8{,}000$

$2{,}262 - 2{,}262 y + 21{,}533 y = 8{,}000$

$y = 0.298$
$x = 1 - y = 0.702$

Check: $(0.702 \text{ lb MeCl})(2{,}262 \frac{\text{Btu}}{\text{lb}} \text{ MeCl}) + (0.298 \text{ lb nat'l gas})(21{,}533 \frac{\text{Btu}}{\text{lb}} \text{ nat'l gas}) = 8{,}000 \frac{\text{Btu}}{\text{lb total}}$

Therefore, for every 0.702 lb of MeCl incinerated, 0.298 lb of auxiliary fuel must be burned.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb total}}{8000 \text{ Btu}} \times \frac{0.702 \text{ lb MeCl}}{1 \text{ lb total}} = 263 \frac{\text{lb}}{\text{hr}} \text{ MeCl}$$

input possible.

J. n-Butyl Acetate

State = liquid

Given, 13,130 Btu/lb, supplemental fuel will not be required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{13{,}130 \text{ Btu}} = 228 \frac{\text{lb}}{\text{hr}}$$

K. Naphthalene

Molecular Weight = 128.16 lb/lb-mole
State = liquid

$$1{,}231.8 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{2{,}216{,}008 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{2{,}216{,}008 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{128.16 \text{ lb}} = 17{,}291 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel is not required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{17{,}291 \text{ Btu}} = 174 \frac{\text{lb}}{\text{hr}}$$

L. Phenol

Molecular Weight = 94.11 lb/lb-mole
State = solid

$$729.8 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}312{,}910 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{1{,}312{,}910 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{94.11 \text{ lb}} = 13{,}951 \text{ Btu/lb}$$

Supplemental fuel is not required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{13{,}951 \text{ Btu}} = 215 \frac{\text{lb}}{\text{hr}}$$

M. Pyridine

Molecular Weight = 79.10 lb/lb-mole
State = liquid

$$665 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}196{,}335 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{1{,}196{,}355 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{79.10 \text{ lb}} = 15{,}124 \frac{\text{Btu}}{\text{lb}}$$

Supplemental fuel is not required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{15{,}124 \text{ Btu}} = 198 \frac{\text{lb}}{\text{hr}}$$

N. Stoddard Solvent

Given, 18,200 Btu/lb, supplement fuel is not required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{18{,}200 \text{ Btu}} = 165 \frac{\text{lb}}{\text{hr}}$$

O. Styrene

Molecular Weight = 104.16 lb/lb-mole

$$1047.1 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}883{,}733 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{1{,}883{,}733 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{104.16 \text{ lb}} = 18{,}085 \frac{\text{Btu}}{\text{lb}}$$

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{18{,}085 \text{ Btu}} = 166 \frac{\text{lb}}{\text{hr}}$$

P. Toluene

Molecular Weight = 92.15 lb/lb-mole
State = liquid

$$934.2 \frac{\text{kilocalories}}{\text{gram-mole}} \times 1{,}799 \frac{\text{Btu-gram}}{\text{kilocalorie-lb}} = \frac{1{,}680{,}626 \text{ Btu}}{\text{lb-mole}}$$

$$\frac{1{,}680{,}626 \text{ Btu}}{\text{lb-mole}} \times \frac{\text{lb-mole}}{92.15 \text{ lb}} = 18{,}238 \frac{\text{Btu}}{\text{lb}}$$

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{18{,}238 \text{ Btu}} = 164 \frac{\text{lb}}{\text{hr}}$$

Q. VM and P Naphtha

Same as Stoddard Solvent.

Given: 18,200 Btu/lb, supplemental fuel is not required.

$$\frac{3 \text{ million Btu}}{\text{hr}} \times \frac{\text{lb}}{18{,}200 \text{ Btu}} = 165 \frac{\text{lb}}{\text{hr}}$$

APPENDIX C
POTENTIAL AND ACTUAL EMISSIONS FOR CRITERIA AND NESHAP POLLUTANTS

Particulate Matter

Particulate (PART) emissions will result from the incineration of solid LLW/MW and from combustion of the auxiliary fuel. Since fuel combustion contributes a maximum of only 0.028 (100% natural gas) to 0.058 (50% natural gas and 50% No. 2 fuel oil) lbs/hr of particulate (see Appendix D calculations), the contribution from auxiliary fuel combustion can be considered negligible.

Assuming that 90 percent of the solid feed is combusted, five percent remains in the ash, and five percent is emitted as particulate, the uncontrolled emissions would be:

$$\frac{500 \text{ lbs solids}}{\text{hr}} \times \frac{5 \text{ lb PART generated}}{100 \text{ solids}}$$

$$= 25 \text{ lbs PART emitted/hr uncontrolled.}$$

Assuming that the removal efficiency of the control equipment is 99.9999996 percent, the controlled emissions of particulate matter would be:

$$25 \text{ lbs PART/hr} \times (1-0.999999996) = 1 \times 10^{-7} \text{ lbs PART/hr.}$$

Assuming that none of the particulate matter is destroyed, such as would occur with metals, the maximum uncontrolled emissions would be 500 pounds uncontrolled and the controlled emissions would be:

$$500 \text{ lbs PART/hr} \times (1-0.999999996) = 2 \times 10^{-6} \text{ lbs PART/hr.}$$

There are particulate matter standards for 24-hour, 7-day, 30-day, and annual averaging periods. The standards are shown in Table 4-1 and the modeled impacts for each averaging period are shown in Table 5-3.

24-hour Impact: Using the most conservative estimate that none of the particulate matter is destroyed and given the modeling results that 1 lb/hr emissions result in a 24-hour average impact of 2.3 $\mu g/m^3$, the controlled emissions would result in an impact of:

$$\frac{2.3\ \mu g/m^3}{1\ lb/hr\ PART} \times 2 \times 10^{-6} lb\ PART/hr = 4.6 \times 10^{-6}\ \mu g\ PART/m^3$$

Annual Impact: Given the modeling results that 1 lb/hr emissions would cause an annual average impact of 0.12 $\mu g/m^3$, the estimated impacts would be:

$$\frac{0.12\ \mu g/m^3}{1\ lb/hr\ TSP} \times (2 \times 10^{-6})\ lb\ PART/hr = 2.4 \times 10^{-7}\ \mu g\ PART/m^3$$

Both the 24-hour and the annual impact are many orders of magnitude less than the 24-hour and annual standards for total suspended particulate and PM-10 shown in Table 4-1. There are also 7-day and 30-day average standards. The impacts and standards for these averaging periods lie between the 24-hour and the annual standard. Like the impacts for the two averaging periods calculated above, the impacts for the 7-day and 30-day averaging periods would be orders of magnitude less than the standards.

Beryllium

Beryllium (Be) is not a constituent of either natural gas or No. 2 fuel oil. Therefore, beryllium would have to be introduced in the feed. Beryllium would not be destroyed by the incinerator. Instead, it would exit in the off-gas in a fine particle form. Therefore, the collection efficiency of the off-gas treatment system should be 99.9999996 percent. Assuming that the maximum solid feed rate of 500 lbs/hr consists totally of beryllium, the uncontrolled emissions would be 500 lbs/hr. The controlled emissions would be:

$$500\ lbs/hr \times (1-0.999999996) = 2 \times 10^{-6}\ lbs\ Be/hr$$

In accordance with AQCR 201, beryllium levels cannot exceed 0.01 $\mu g/m^3$ based on a 30 day average. Using the 30-day impact estimate that 1 lb/hour emissions result in a 0.20 $\mu g/m^3$ impact, the impact of the controlled emissions would be:

$$\frac{0.20\ \mu g/m^3}{\text{lb/hr emitted}} \times (2 \times 10^{-6})\ \text{lbs Be emitted/hr}$$

$$= 4.0 \times 10^{-7}\ \mu g\ Be/m^3$$

This impact is much lower than the 30-day beryllium standard. Beryllium is also regulated under NESHAP; the emissions of beryllium must not exceed 10 grams over a 24-hour period. Making the same extremely conservative assumption that beryllium will be continuously input at 500 pounds per hour for 24 hours that was used to calculate the above impacts, the emissions would average 2×10^{-6} pounds of beryllium per hour over the 24-hour period, resulting in total emissions of:

$$2 \times 10^{-6}\ \text{lbs Be/hr} \times 24\ \text{hr} \times 454\ \text{g/lb} = 0.0218\ \text{g Be}$$

This maximum emission is significantly below the NESHAP limit of 10 grams over 24 hours.

Asbestos

It is not the intent of LANL to incinerate asbestos-containing materials. Therefore, there should be no asbestos emissions from the incinerator.

Heavy Metals

The total combined heavy metals (HM) emissions would result from heavy metals being introduced with the feed. Although these metals may be converted to their oxide form, they would not be destroyed in the incinerator. Instead, heavy metals would exit in the off-gas in a fine particle form. The collection efficiency of the off-gas treatment system should be 99.9999996 percent. Assuming that the maximum solid feed rate of 500 lbs/hr consists totally of heavy metals, the uncontrolled emissions would be 500 lbs/hr. The controlled emissions would be:

$$500 \text{ lbs/hr} \times (1-0.999999996) = 2 \times 10^{-6} \text{ lbs HM/hr}$$

In accordance with AQCR 201, total combined heavy metal levels cannot exceed 10 $\mu g/m^3$ based on a 30 day average. Using the 30-day average impact estimate that 1 lb/hour emissions result in a 0.20 $\mu g/m^3$ impact, the impact of the controlled emissions would be:

$$\frac{0.20\ \mu g/m^3}{\text{lb/hr emitted}} \times (2 \times 10^{-6}) \text{ lbs HM emitted/hr}$$

$$= 4.0 \times 10^{-7}\ \mu g\ HM/m^3$$

This impact is much lower than the heavy metal standard.

Sulfur Dioxide

Sulfur dioxide (SO_2) emissions result from the sulfur being introduced in the feed as well as the auxiliary fuel. It is assumed that all sulfur input is oxidized to SO_2. The collection efficiency of the off-gas treatment system is estimated to be 60 percent for SO_2 (manufacturer's estimate). Sulfur may be introduced in either the solid or liquid feed. Assuming a maximum liquid feed rate of 400 lbs/hr consisting totally of sulfur, the uncontrolled emissions would be:

$$\frac{400 \text{ lbs S}}{\text{hr}} \times \frac{64 \text{ lbs } SO_2}{32 \text{ lbs S}} = 800 \text{ lbs } SO_2\text{/hour}$$

The controlled emissions would be:

$$800 \text{ lbs } SO_2\text{/hr} \times (1-0.60) = 320 \text{ lbs } SO_2\text{/hr}$$

There are 3-hour, 24-hour, and annual standards for sulfur dioxide.

3-hour Impact: Federal standards require that sulfur dioxide not exceed 1,300 $\mu g/m^3$ over a three hour average. Using the modeled three hour impact estimate that 1 lb/hr emissions results in a 4.3 $\mu g/m^3$ impact, the impact from the controlled emissions would be:

$$\frac{320 \text{ lbs } SO_2 \text{ emitted}}{\text{hr}} \times \frac{4.3\ \mu g/m^3}{\text{lb/hr emitted}} = 1{,}376\ \mu g\ SO_2/m^3$$

This exceeds the ambient standard; therefore, the amount of sulfur input to the incinerator must be restricted to:

$$1{,}300\ \mu g/m^3 \times \frac{\text{lb } SO_2\text{/hr emitted}}{4.3\ \mu g/m^3} \times \frac{\text{lb input}}{0.4 \text{ lb emitted}} \times \frac{32 \text{ lbs S}}{64 \text{ lbs } SO_2}$$

= 378 lbs S/hr

This requires that the input of sulfur to the incinerator cannot exceed an average of 378 lb/hr or a total of 1,134 pounds in a three hour period to stay below the three hour average standard of 1,300 ug/m^3.

24-hour Impact: The most restrictive 24-hour SO_2 standard is 0.10 ppm (260 μ/m^3). Using the modeled worst-case 24 hour impact estimate that 1 lb/hour emissions results in a 2.3 $\mu g/m^3$ impact, the 24-hour impact from the controlled emissions would be:

$$\frac{320 \text{ lbs } SO_2 \text{ emitted}}{\text{hr}} \times \frac{2.3\ \mu g/m^3}{\text{lb/hr emitted}} = 736\ \mu g\ SO_2/m^3$$

This exceeds the State ambient standard. Therefore, the amount of sulfur input to the incinerator must be restricted to:

$$\frac{260 \text{ ug}}{m^3} \times \frac{\text{lb } SO_2\text{/hr emitted}}{2.3 \text{ ug/m}^3} \times \frac{\text{lb input}}{0.4 \text{ lb emitted}} \times \frac{32 \text{ lb S}}{64 \text{ lbs } SO_2}$$

= 141 lbs S/hr.

Annual Impact: Annual average sulfur dioxide concentrations cannot exceed 0.02 ppm (52 $\mu g/m^3$). Using the modeled average annual impact estimate that 1 lb/hr of continuous SO_2 emissions results in a 0.12 $\mu g/m^3$ annual impact, the impact from the controlled emissions would be:

$$\frac{320 \text{ lbs } SO_2 \text{ emitted}}{\text{hr}} \times \frac{0.12\ \mu g/m^3}{\text{lb/hr emitted}} = 38\ \mu g\ SO_2/m^3$$

The value falls within the ambient standard by 27 percent.

To adequately protect air quality, LANL proposes to limit the ambient impact of sulfur from incineration to 35 percent of the level allowable under each standard except for the annual standard. If the amount of sulfur allowable under the annual standard was input to the incinerator, the 24-hour standard could be violated. Therefore, the 24-hour hourly input rates were used for the annual rates. Using this limit, the total amount that could be input during each averaging period is:

	Average lbs/hr	x	Averaging Period (hrs)	=	Total (lbs)
3-hour	130		3		400
24-hour	50		24		1,200
Annual	50		8760		440,000

To ensure that the total input over the averaging period is not exceeded, LANL will characterize wastes to determine sulfur content.

Hydrogen Sulfide and Total Reduced Sulfur

Hydrogen sulfide and total reduced sulfur emissions from the incinerator are assumed to be negligible. Since sulfur compounds are exposed to an oxidizing atmosphere in the incinerator's secondary chamber, it is assumed that virtually all sulfur would be converted to sulfur dioxide.

Carbon Monoxide

Carbon monoxide emissions should be significant only when the reactor is being, or has just been, recharged with fuel. Carbon monoxide emissions will not exceed 1000 ppm as measured by a continuous monitor located in the off-gas stack ductwork. They will typically be maintained at levels less than 500 ppm. Based on the anticipated stack parameters and making a conservative assumption that the carbon monoxide hourly average is 1000 ppm, the average hourly carbon monoxide emissions would equal 66 pounds/hour. Emissions at this level were modeled to have an

ambient impact of 0.28 mg/m^3. This impact is considerably below the 1-hour standard of 40 mg/m^3 and 8-hour standard of 10 mg/m^3. Assuming that the CO levels averaged 500 ppm, the emissions would be only 33 lbs/hr and the impacts only 0.14 $\mu g/m^3$.

Nitrogen Dioxide

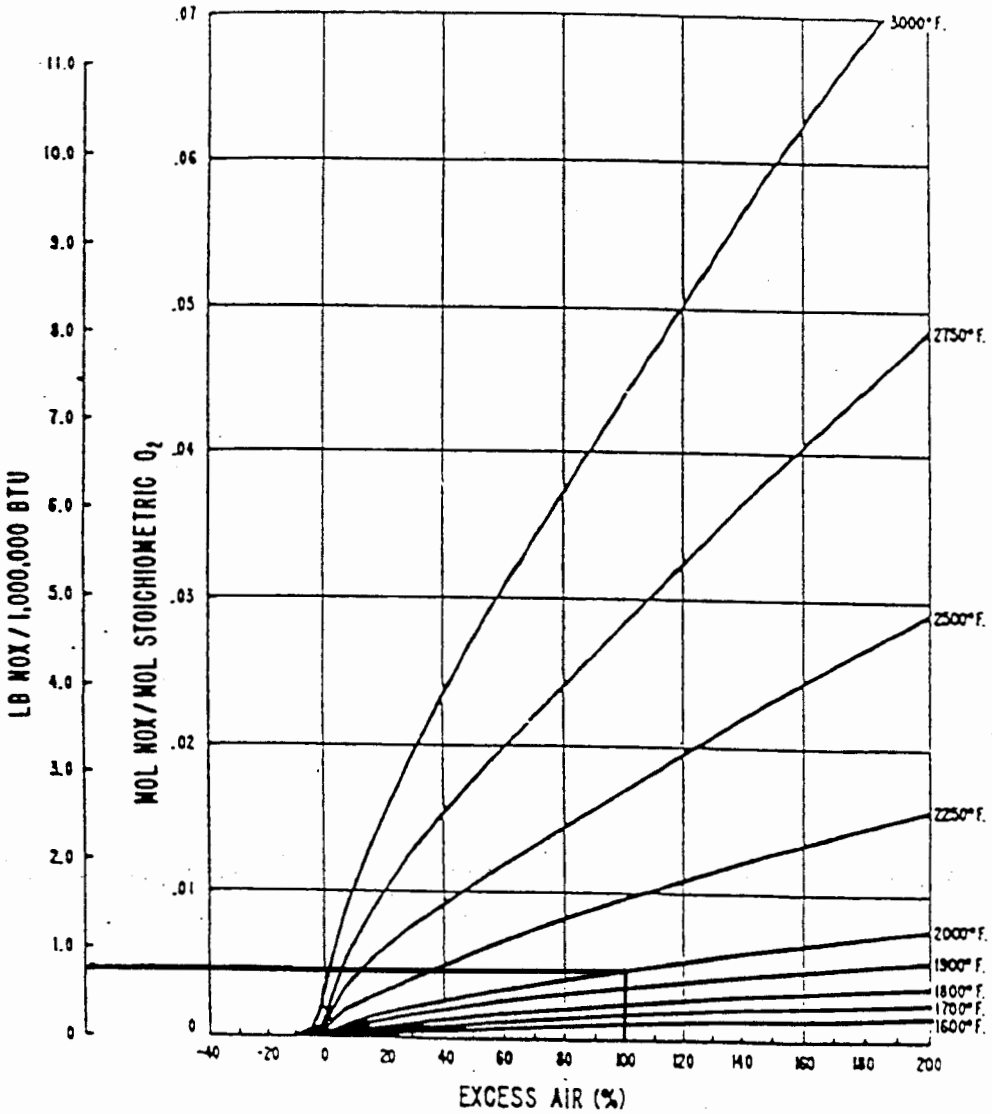
Nitrogen dioxide (NO_x) is formed by two mechanisms: oxidation of nitrogen in the auxiliary fuel and oxidation of nitrogen in the combustion air. In an incinerator, the fuel nitrogen will be relatively unimportant, both because the fuel nitrogen is expected to be low and because thermal nitrogen fixation increases with an increase in temperature, residence time in the combustion zone, and excess air, all of which an incinerator maximizes. Oxides of nitrogen emissions were estimated using Figure C-1. Using 2000 °F as the combustion temperature and excess air as 100 percent, the oxides of nitrogen emissions that would be emitted from a 6 million BTU incinerator would be approximately 0.8 pounds per million BTU, or 5.6 pounds for 7 million BTUs. This is somewhat conservative because the primary chamber will operate at only 1600 °F and lower excess air levels, resulting in lower oxides of nitrogen emissions. Assuming that the efficiency of the air pollution control equipment is zero for oxides of nitrogen, the controlled emissions would also equal 5.6 pounds. The 24-hour nitrogen dioxide ambient standard of 0.10 ppm (188 $\mu g/m^3$) would not be exceeded unless the amount of NO_x was over:

$$\frac{188\ \mu g\ NO_x}{m^3} \times \frac{1\ lb\ NO_x/hr\ emitted}{2.3\ \mu g/m^3} = 82\ \frac{lbs}{hr}\ \text{of}\ NO_x$$

The most restrictive annual nitrogen dioxide ambient standard of 0.05 ppm (94 $\mu g/m^3$) would not be exceeded unless the amount of NO_x was over:

$$\frac{9.4\ \mu g\ NO_x}{m^3} \times \frac{1\ lb\ NO_x/hr\ emitted}{0.12\ \mu g/m^3} = 780\ \frac{lbs}{hr}\ \text{of}\ NO_x$$

Since the incinerator should only emit about 5.6 lbs of NO_x per hour, there should be little danger of approaching the nitrogen



Brunner, Calvin R., Incineration Systems (Government Institutes, Inc., Rockville, Maryland, 1982). p. 120.

Figure C-1. Relation of NO_x in Flue Gas to Combustion Temperature

dioxide ambient air standard. Based on the uncertainty regarding the nitrogen content of the fuel, it is possible that total oxides of nitrogen emissions could exceed 5.6 pounds per hour. However, it is very unlikely that total emissions would exceed 11 lbs per hour. This level is well below the limits per hour calculated above.

Lead

The total lead emissions result from lead being introduced with the feed. Although lead may be converted to its oxide forms, it would not be destroyed in the incinerator. Instead, the lead would exit in the off-gas in a fine particulate form. The collection efficiency of the off-gas treatment system should be 99.9999996 percent. Assuming that a maximum solid feed rate of 500 lbs/hr consists totally of lead, the uncontrolled emissions would be 500 lb/hr. The controlled emissions would be:

$$500 \text{ lbs/hr} \times (1.-0.999999996) = 2 \times 10^{-6} \text{ lb Pb/hr}$$

Total lead levels cannot exceed the Federal standard of 1.5 $\mu g/m^3$ based on three month (calendar quarter) average. Using the quarterly impact estimate that 1 lb/hr emission results in a 0.16 $\mu g/m^3$ impact, the impact of the controlled emissions would be:

$$\frac{0.16\ \mu g/m^3}{\text{lb/hr emitted}} \times (2 \times 10^{-6}) \text{ lb Pb emitted/hr}$$

$$= 3.2 \times 10^{-7}\ \mu g\ Pb/m^3$$

This impact is significantly less than the calendar quarter impact of 1.5 $\mu g/m^3$.

Photochemical Oxidants

Photochemical oxidants will not be emitted from the incinerator. Non-methane hydrocarbon emissions for the incinerator will be so low that ozone formation will not be initiated.

Non-methane Hydrocarbons

Non-methane hydrocarbon (NMH) emissions result from the in-

complete combustion of organics. In accordance with AQCR 201, 3-hour average non-methane hydrocarbon levels cannot exceed 125 $\mu g/m^3$ (0.19 ppm). Assuming that combustion of organic compounds is 99.99 percent complete and the maximum feed to the incinerator is 900 lbs/hr (liquid + solid) consisting totally of organics, the uncontrolled emission would be:

$$900 \text{ lb/hr} \times (1-.9999) = .090 \text{ lbs NMH/hr.}$$

The collection efficiency of the off-gas treatment system is unknown. However, based on the trial burn of the TRU-CAI, the destruction/removal efficiency for organic hydrocarbons was measured as 99.99824 percent. Therefore the controlled emission would be:

$$900 \times (1-.9999824) = 0.016 \text{ lb NMH/hr.}$$

Using the worst-case 3 hour impact estimate that 1 lb/hour emissions result in a 2.3 $\mu g/m^3$ ambient level, the ambient impact would be:

$$\frac{0.016 \text{ lb NMH}}{\text{hr}} \times \frac{2.3\ \mu g/m^3}{\text{lb/hr emitted}} = 0.037\ \mu g/m^3$$

This level is orders of magnitude lower than the standard.

APPENDIX D
AIR POLLUTANT EMISSIONS FROM AUXILLARY FUEL COMBUSTION

Standard emission factors for criteria pollutants emitted from fuel combustion in hazardous waste incinerators are not available. To provide a ballpark figure, AP-42 estimates of emissions from boilers were used and an example of emissions from a refuse incinerator are given. In general, due to the greater combustion efficiency and excess air conditions in a hazardous waste incinerator, emissions will be lower for the pollutants addressed below, except for oxides of nitrogen. Levels of oxides of nitrogen increase with increasing temperature, residence time, and excess air. Therefore, hazardous waste incinerators (which are designed to maximize temperature, residence time, and excess air) result in higher emissions of oxides of nitrogen.

A. No. 2 fuel oil at 19,450 BTU/pounds (LANL) and 7.1 pounds/gallon (Perry's Handbook of Chemical Engineering)

$$3\ \frac{\text{million BTU}}{\text{hour}} \times \frac{\text{pound}}{19{,}450\ \text{BTU}} \times \frac{\text{gallons}}{7.1\ \text{pounds}} = 21.7\ \frac{\text{gallons}}{\text{hour}},$$

$$\approx 22\ \frac{\text{gallons}}{\text{hour}}$$

From AP-42, Table 1.3-1, use factors for commercial boilers with heat inputs of 0.5 to 10 $\frac{\text{million BTU}}{\text{hour}}$. Distillate oil factors are per thousand gallons so

$$22\ \frac{\text{gallons}}{\text{hour}} = 0.022\ \frac{\text{m gallons}}{\text{hour}}$$

1. Particulate

$$\frac{2\ \text{pounds}}{\text{m gallon}} \times 0.022\ \frac{\text{m gallon}}{\text{hour}} = 0.044\ \frac{\text{pounds}}{\text{hour}}$$

2. Sulfur Dioxide - Given 0.22 percent sulfur

$$\frac{142\ \text{pounds} \times 0.22}{\text{m gallon}} \times 0.022\ \frac{\text{m gallon}}{\text{hour}} = .687\ \frac{\text{pounds}}{\text{hour}}$$

3. Carbon Monoxide

$$\frac{5 \text{ pounds}}{\text{m gallon}} \times 0.022 \frac{\text{m gallon}}{\text{hour}} = 0.11 \frac{\text{pounds}}{\text{hour}}$$

4. Nitrogen Oxide

$$\frac{20 \text{ pounds}}{\text{m gallon}} \times 0.022 \frac{\text{m gallon}}{\text{hour}} = 0.44 \frac{\text{pounds}}{\text{hour}}$$

5. Organic compound (non-methane)

$$\frac{0.34 \text{ pounds}}{\text{m gallon}} \times 0.022 \frac{\text{m gallon}}{\text{hour}} = 0.0075 \frac{\text{pounds}}{\text{hour}}$$

B. Natural gas from AP-42, Table 1.4-1, use factors for commercial boilers under 10 $\frac{\text{million BTU}}{\text{hour}}$. Factors are per million scf.

$$3 \text{ million} \frac{\text{BTU}}{\text{hour}} \times \frac{\text{scf}}{1{,}050 \text{ BTU}} = 2{,}857 \frac{\text{scf}}{\text{hour}}$$

$$= 0.00286 \frac{\text{million scf}}{\text{hour}}$$

1. Particulate

$$\frac{5 \text{ pounds}}{\text{mmscf}} \times 0.00286 \frac{\text{mmscf}}{\text{hour}} = 0.014 \frac{\text{pounds}}{\text{hour}}$$

2. Sulfur Dioxide

$$\frac{0.6 \text{ pounds}}{\text{mmscf}} \times 0.00286 \frac{\text{mmscf}}{\text{hour}} = 0.0017 \frac{\text{pounds}}{\text{hour}}$$

3. Carbon Monoxide

$$\frac{20 \text{ pounds}}{\text{mmscf}} \times 0.00286 \frac{\text{mmscf}}{\text{hour}} = 0.0572 \frac{\text{pounds}}{\text{hour}}$$

4. Nitrogen Oxides

$$\frac{100 \text{ pounds}}{\text{mmscf}} \times 0.00286 \frac{\text{mmscf}}{\text{hour}} = 0.286 \frac{\text{pounds}}{\text{hour}}$$

5. Organic Compounds (non-methane)

$$\frac{5.3 \text{ pounds}}{\text{mmscf}} \times 0.00286 \frac{\text{mmscf}}{\text{hour}} = 0.0152 \frac{\text{pounds}}{\text{hour}}$$

C. From AP-42, Table 2.1-1, use emission factors for industrial/commercial waste in a multiple chamber incinerator. Emission factors are in pounds per ton of waste. Assume $\frac{3 \text{ million BTU}}{\text{hour}}$ input and that the waste has a fuel value of $\frac{8{,}000 \text{ BTU}}{\text{pound}}$.

$$3{,}000{,}000 \frac{\text{BTU}}{\text{hour}} \times \frac{\text{pound}}{8{,}000 \text{ BTU}} = 375 \frac{\text{pounds}}{\text{hour}} \times \frac{\text{ton}}{2{,}000 \text{ pounds}}$$

$$= 0.1875 \frac{\text{tons}}{\text{hour}}$$

1. Particulate

$$\frac{7 \text{ pounds}}{\text{ton}} \times 0.1875 \frac{\text{tons}}{\text{hour}} = 1.31 \frac{\text{pounds}}{\text{hour}}$$

2. Sulfur Dioxide

$$\frac{2.5 \text{ pounds}}{\text{ton}} \times 0.1875 \frac{\text{tons}}{\text{hour}} = 0.47 \frac{\text{pounds}}{\text{hour}}$$

3. Carbon Monoxide

$$\frac{10 \text{ pounds}}{\text{ton}} \times 0.1875 \frac{\text{tons}}{\text{hour}} = 1.88 \frac{\text{pounds}}{\text{hour}}$$

4. Nitrogen Oxides

$$\frac{3 \text{ pounds}}{\text{ton}} \times 0.1875 \frac{\text{tons}}{\text{hour}} = 0.56 \frac{\text{pounds}}{\text{hour}}$$

5. Organic

$$\frac{3 \text{ pounds}}{\text{ton}} \times 0.1875 \frac{\text{tons}}{\text{hour}} = 0.56 \frac{\text{pounds}}{\text{hour}}$$

APPENDIX E
AIR POLLUTION CONTROL EQUIPMENT

The pollution control equipment will consist of the following equipment in series:

- Quench Column
- High Energy Venturi Scrubber (or equivalent)
- Packed Column Absorber/Demister
- Off-gas Reheater
- High Efficiency Particulate Air (HEPA) Filters (two in series)
- Activated Carbon Bed Adsorber (optional)
- HEPA filters

The quench column, through evaporation of atomized, cooled recycle scrub solution injected into the column, will cool the off-gas from the incinerator exit temperature of 2000 °F to around 160 °F. The saturated gas phase will be routed to the venturi scrubber inlet, while excess scrub solution flowing to the base of the column will be returned to the process sump tank for recycling. The outlet temperature of the gas phase will be monitored and a system limit of 350 °F will be imposed to protect nearby equipment from radiant heat damage. Exceeding this limit will cause a waste feed shutoff and initiate an automatic controlled shutdown of the incinerator.

Particulate in the cooled exhaust gas exiting the quench column will be removed by the high energy variable-throat venturi scrubber located between the quench and absorber columns. The venturi assembly will consist of converging and diverging cones with a clamp valve throat to allow the pressure drop, normally

controlled at approximately 40 inches WC range, to be varied. Cooled recycle scrub solution will be injected through a nozzle located upstream of the venturi throat. The intent and use of the venturi scrubber is to prolong the service life of the downstream HEPA filters by reducing the particulate loading. Up to 99 percent (by weight) of the particulate should be removed by the venturi scrubber.

Acids in the saturated gas phase exiting the venturi will be removed by a counter-current contact with a cooled mixture of recycled scrub solution and fresh water in the packed column absorber. The flow rate of the absorber scrub solution will be monitored and a low flow limit of 10.0 GPM will be imposed to ensure proper acid gas scrubbing and cooling of the off-gas. Operating below the flow rate limit will cause a waste feed shutoff and initiate an automatic controlled shutdown of the incinerator.

By direct liquid-gas contact cooling of the saturated off-gas steam in the absorber, a significant portion of the water will be removed, resulting in a reduction of total off-gas volume. This reduction will ease the operating loads on the off-gas superheater, HEPA filters, and process induced draft fans. Off-gas leaving the absorber will flow through a demister, which will capture entrained water mist and further reduce water content.

Saturated scrubbed and cooled exhaust gas leaving the absorber/demister at around 130 °F will be reheated prior to entering the HEPA filters. By heating the exhaust gas above the dew point, condensation of moisture in the HEPA filters is avoided. This helps prevent blinding of the filters with condensate.

All HEPA filters are required to have a collection efficiency of 99.97 percent for a particle size of 0.3 microns and are tested in place and certified to meet this removal efficiency. The primary HEPA filtration system will consist of two parallel banks of multiple HEPA filters, installed upstream of the carbon bed. The two primary HEPA filter banks are operated independent-

ly of each other, with only one bank in on-line service at any time. The parallel bank serves as a backup unit to allow off-line maintenance without interrupting system operation. Flow through either bank when on-line will pass sequentially through two arrays of HEPA filters in series, for double filtration of the off-gas.

LANL is also evaluating the usefulness of adding a carbon bed adsorber downstream of the two HEPA filters. A final HEPA filter bank would be located downstream of the carbon bed adsorber, if one is installed. If a carbon bed adsorber is not found to be effective, the final HEPA filter will be located downstream of the two HEPA filters in series. The final filter will provide a final assurance that adequate backup systems exist for the removal of radioactive pollutants. In addition, in the event of a major process malfunction initiating a FAST or SCRAM SHUTDOWN, off-gas leaving the carbon bed HEPA filter bank, normally exhausted directly to the process exhaust stack, is automatically rerouted through the building ventilation exhaust HEPA filter plenum as an additional safeguard prior to discharge to the environment.

A scrub solution recycle/cooling system will be used to minimize liquid blowdown from the off-gas cleaning system. This system will consist of four main components:

1. a process liquid heat exchanger to cool the quench column, venturi scrubber, and absorber column scrub solution as it returns to the process sump tank;

2. a second plate type heat exchanger which provides a secondary coolant water loop to the process heat exchangers from the cooling towers;

3. a hydrocyclone to remove particulate from the scrub solution drawn from the sump tank; and

4. dual bag filters for filtration of process liquid blowdown.

The process scrub solution leaving the process sump tank will enter the hydrocyclone before being pumped to the quench and

absorber columns. Approximately 160 gpm of "filtered" scrub solution will go overhead to the process, while approximately 3-10 gpm of the particulate-laden slurry will become hydrocyclone blowdown. Prior to discharge to the building sump tank and ultimately to the industrial waste water treatment facility, the hydrocyclone blowdown will be filtered through a polypropylene felt bag filter.

For purposes of filing an air quality permit application under NMEID Regulation 702, the emission control efficiencies must be estimated for each control device and the entire system. This appendix contains the methodology and the estimated control efficiencies for major categories of emissions from the incinerator. In addition, the reduced control efficiencies that would result if an individual piece of air pollution control equipment failed are provided.

The pollutants evaluated are hydrocarbons (HC), particulate matter (PART), sulfur dioxide (SO_2), nitrogen oxides (NO_x), hydrogen chloride (HCl), and carbon monoxide (CO). For removal efficiency estimates, representatives of the four firms that will be invited to submit bids for the system, a carbon adsorber manufacturer, and an activated carbon producer were contacted. Names, locations, and telephone numbers of the sources contacted are:

1. David Giles, McGill Environmental, Inc., Tulsa, Oklahoma, 918/445-2431.

2. Colin Dogald, Monsanto Environmental, Inc., St. Louis, Missouri, 314/275-5730.

3. Tom Cannon, Vic Manufacturing Co., Minneapolis, Minnesota, 612/781-6601.

4. Mike Thomas, Ted Miller Associates, Denver, Colorado, 303/758-3912.

5. Duane Sander, Anderson 2000, Inc., Atlanta, Georgia, 800/241-5424.

6. Maury Luchen, ACT-Activated Carbon Technology, 800/821-7056.

The four vendors that will be invited to submit bids for the system all intend to build only the equipment that lies in their area of expertise and subcontract the rest. Consequently, the vendor's know-how is extensive for some of the system and limited for the rest. In some instances, vendors suggested that some of the emission controls design and operating parameters be other than as proposed in the air permit application. Vendors' estimates of removal efficiencies varied and the control efficiencies used were weighted averages based upon the vendor's apparent expertise for the particular control device. These estimates are supplied without having the final system design available for the vendors' review. Therefore, the estimates are based on a "good" control system. Actual efficiencies obtained for the LLW/MW incinerator may deviate from these estimates, depending on the final control system design.

Removal efficiencies can be concentration-dependent. For example, at HCl concentrations of five parts per million (ppm) and above, a caustic scrubber would remove at least 98 percent of the HCl. At lower concentrations, removal efficiency would be lower. Removal efficiency would also depend upon adsorption column heights and packing, as well as the pH of the scrub water. For the purposes of this analysis, the pH of the scrub solution was assumed to vary between 3 and 6, based on the pH values measured for the scrub solution during the TRU-CAI trial burn. Removal efficiencies were estimated as follows:

A. Hydrocarbons

Manufacturers estimated that the incinerator will destroy 99.99 percent or better of the hydrocarbons. Stack tests of the TRU-CAI demonstrated a destruction/removal efficiency of 99.99824 percent. It is unlikely that the control equipment contributed much to this efficiency and that the incinerator achieved more than 99.99 percent destruction. Since the manufacturers were uncertain about the effectiveness of the planned off-gas control

system, the destruction/removal efficiency measured for the TRU-CAI was used to calculate ambient impacts from incinerated materials. LANL is considering installing a carbon bed adsorber which may be effective for removing hydrocarbons. However, no credit was taken for this control because the capture efficiencies were not verified as part of the TRU-CAI trial burn.

B. Hydrogen Chloride (HCl)

Manufacturers estimated that the quench would remove about 30 percent of the HCl, the Venturi scrubber about 45 percent, and the absorber/demister combination (it is customary when determining control efficiencies to combine the scrubber and demister) would remove about 98 percent of the remaining material at a pH of 3. If the scrubber were to operate at pH 6 to 7, removal efficiency could be better than 99 percent. Scrubber efficiency could also exceed 99 percent with either a taller scrubber or a multistage scrubber. Scrubber efficiencies would be lower for HCl concentrations below 5 ppm. A source test of the TRU-CAI showed HCl removal efficiencies to be about 99.57 percent. Since the off-gas treatment system for the proposed LLW/MW incinerator is nearly identical to the TRU-CAI system, the 99.57 percent figure was considered better than the manufacture's estimates.

C. Sulfur Dioxide (SO_2)

At pH 3, manufacturers estimated that SO_2 removal efficiency would be about five percent for the quench, about 20 percent for the Venturi scrubber, and about 40 percent for the absorber at a scrub solution pH of 3, for an overall control of about 60 percent. At pH 6 to 7, removal efficiency was estimated to be about ten percent for the quench, about 40 percent for the Venturi scrubber, and about 95 percent for the absorber, for an overall control of about 97 percent.

D. Particulate Matter (PART)

Manufacturers estimated that the quench would remove about 5 percent of the particulate matter, the venturi scrubber about 95

percent, and each of the three HEPA filters a minimum of 99.97 percent. Credit was taken only for two of the HEPA filters to provide a conservative estimate of an overall removal efficiency of about 99.9999996 percent.

E. Nitrogen Oxides (NO_x)

Manufacturers estimated that system would remove little, if any, NO_x. The NO_x concentration out of the incinerator should be less than 100 ppm and it is difficult to remove NO_x from standard systems at these low concentrations. Some systems use an oxidizing agent such as potassium permanganate ($KMNO_4$) and achieve better removal through oxidation. The scrubber could possibly achieve 10 percent removal if operated at pH 7.

F. Carbon Monoxide (CO)

The manufacturers estimated that the system would not remove significant quantities of CO. Carbon monoxide emissions will be minimized by the combustion chamber design and carbon monoxide emissions will be continuously monitored in the off-gas.

G. Overall System Efficiencies:

Overall system efficiencies as well as efficiencies during control equipment failure are shown in the Tables E-1 through E-5.

TABLE E-1. PARTICULATE MATTER REMOVAL EFFICIENCIES

	Efficiency (percent)	Percent of Compound Remaining: All Systems Operational	Quench Column Failure	Venturi Scrubber Failure	Absorber Demister Failure	HEPA Filter Failure	Carbon Adsorber Failure
Quench Column	5	95.00	100.00	95.00	95.00	95.00	95.00
Venturi Scrubber	95	4.75	5.00	95.00	4.75	4.75	4.75
Absorber Column	0	4.75	5.00	95.00	4.75	4.75	4.75
HEPA Filters							
1	99.97	0.00	0.00	0.03	0.00	4.75	0.00
2	99.97	0.00	0.00	0.00	0.00	0.00	0.00
Carbon Bed Adsorber	0	0.00	0.00	0.00	0.00	0.00	0.00
Overall Efficiency		99.9999996	99.9999996	99.9999915	99.9999996	99.9985750	99.9999996

TABLE E-2. SULFUR DIOXIDE REMOVAL EFFICIENCIES

	Efficiency (percent)	Percent of Compound Remaining: All Systems Operational	Quench Column Failure	Venturi Scrubber Failure	Absorber Demister Failure	HEPA Filter Failure	Carbon Adsorber Failure
Quench Column	5	95.00	100.00	95.00	95.00	95.00	95.00
Venturi Scrubber	20	76.00	80.00	95.00	76.00	76.00	76.00
Absorber/Demister	40	45.60	48.00	57.00	76.00	45.60	45.60
HEPA Filters							
1	0	40.00	48.00	57.00	76.00	45.60	45.60
2	0	40.00	48.00	57.00	76.00	45.60	45.60
Carbon Bed Adsorber	0	40.00	48.00	57.00	76.00	45.60	45.60
Overall Efficiency		60.00	52.00	43.00	24.00	54.40	54.40

TABLE E-3. OXIDES OF NITROGEN REMOVAL EFFICIENCIES

	Efficiency (percent)	Percent of Compound Remaining: All Systems Operational	Quench Column Failure	Venturi Scrubber Failure	Absorber Demister Failure	HEPA Filter Failure	Carbon Adsorber Failure
Quench Column	0	100.00	100.00	100.00	100.00	100.00	100.00
Venturi Scrubber	0	100.00	100.00	100.00	100.00	100.00	100.00
Absorber Column	0	100.00	100.00	100.00	100.00	100.00	100.00
HEPA Filters							
1	0	100.00	100.00	100.00	100.00	100.00	100.00
2	0	100.00	100.00	100.00	100.00	100.00	100.00
Carbon Bed Adsorber	0	100.00	100.00	100.00	100.00	100.00	100.00
Overall Efficiency		0.00	0.00	0.00	0.00	0.00	0.00

TABLE E-4. HYDROGEN CHLORIDE REMOVAL EFFICIENCIES

	Efficiency (percent)	Percent of Compound Remaining: All Systems Operational	Quench Column Failure	Venturi Scrubber Failure	Absorber Demister Failure	HEPA Filter Failure	Carbon Adsorber Failure
Quench Column	30	70.00	100.00	70.00	70.00	70.00	70.00
Venturi Scrubber	45	38.50	55.00	70.00	38.50	38.50	38.50
Absorber/Demister	98	0.77	1.10	1.40	38.50	0.77	0.77
HEPA Filters							
1	0	0.77	1.10	1.40	38.50	0.77	0.77
2	0	0.77	1.10	1.40	38.50	0.77	0.77
Carbon Bed Adsorber	0	0.77	1.10	1.40	38.50	0.77	0.77
Overall Efficiency		99.23	98.90	98.60	61.50	99.23	99.23

TABLE E-5. HYDROCARBON REMOVAL EFFICIENCIES

	Efficiency (percent)	Percent of Compound Remaining					
		All Systems Operational	Quench Column Failure	Venturi Scrubber Failure	Absorber Column Failure	HEPA Filter Failure	Carbon Adsorber Failure
Quench Column	0	100.00	100.00	100.00	100.00	100.00	100.00
Venturi Scrubber	0	100.00	100.00	100.00	100.00	100.00	100.00
Absorber/Demister	0	100.00	100.00	100.00	100.00	100.00	100.00
HEPA Filters							
1	0	100.00	100.00	100.00	100.00	100.00	100.00
2	0	100.00	100.00	100.00	100.00	100.00	100.00
Carbon Bed Adsorber	0	100.00	100.00	100.00	100.00	100.00	100.00
Overall Efficiency		0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX F
PRELIMINARY OPERATIONAL PLAN FOR STARTUP, SHUTDOWN, AND MALFUNCTION OF AIR POLLUTION CONTROL EQUIPMENT

Procedures to mitigate emissions during normal startup and shutdown of the LLW/MW incinerator and in the event of a malfunction of air pollution control equipment (APCE) will closely parallel those of the existing TRU controlled air incinerator. These procedures and safeguards, summarized below, will be detailed in the facility Operations Manual, Final Safety Analysis Report (FSAR), formal Run Plans, and in the pertinent Operating Instructions (OIs) and Standard Operating Procedures (SOPs) for the processes and equipment involved.

NORMAL STARTUP

During startup procedures, waste feed to the incinerator will be disabled until system interlocks and alarms are satisfied, and until such time as nominal operating conditions, as specified in the Run Plan and appropriate operating permits, are achieved. When control panels are energized, the system interlocks place a pre-ignition block on the burners and establish a controlled shutdown condition on the process. As process components are sequentially activated individual alarm conditions are cleared and interlocks are satisfied until all pre-ignition blocks are removed and the burners can then be fired, allowing incinerator heatup. The following alarms should be indicated:

LOWER CHAMBER TEMPERATURE--LOW
UPPER CHAMBER TEMPERATURE--LOW
UPPER BURNER COMBUSTION AIR PRESSURE--LOW
LOWER BURNER COMBUSTION AIR PRESSURE--LOW
SECONDARY AIR PRESSURE--LOW
LOWER FUEL GAS PRESSURE--HIGH/LOW
UPPER FUEL GAS PRESSURE--HIGH/LOW

UPPER QUENCH SPRAY FLOW--LOW
LOWER QUENCH SPRAY FLOW--LOW
ABSORBER LIQUID FLOW--LOW
AUXILIARY WATER PRESSURE--LOW
AUXILIARY WATER LEVEL--LOW
PROCESS LIQUID RETURN PUMP PRESSURE--LOW
VENTURI LIQUID FLOW--LOW
CAUSTIC PUMP PRESSURE--LOW
PLANT WATER PRESSURE--LOW
PLANT AIR PRESSURE--LOW
PROCESS STEAM PRESSURE--LOW

AUXILIARY GENERATOR--OFF
PROCESS OFFGAS SUPERHEAT--LOW
COOLING TOWER SUMP PUMP PRESSURE--LOW
INDUCED DRAFT BLOWER FLOW--LOW
SECONDARY HX PUMP PRESSURE--LOW

HYDROCYCLONE DISCHARGE PRESSURE--LOW
HYDROCYCLONE DISCHARGE PRESSURE--LOW-LOW
PRIMARY HEPA FILTER BANK PRESSURE DROP--LOW
CARBON BED HEPA FILTER BANK PRESSURE DROP--LOW

WASTE OIL PRESSURE--LOW
ATOMIZING STEAM PRESSURE--LOW

Corrective action is taken on any other alarms that are indicated on the annunciator panels.

The following conditions activate the PRE-IGNITION INTERLOCK, which will prevent burner ignition until resolved:

PROCESS LIQUID RETURN PUMP PRESSURE LOW
INSTRUMENT AIR PRESSURE LOW
PROCESS LIQUID SUPPLY (HYDROCYLONE DISCHARGE) PRESSURE LOW
AUXILIARY GENERATOR OFF
COOLING TOWER PUMP PRESSURE LOW
SECONDARY HEAT EXCHANGER PUMP PRESSURE LOW
HEPA FILTER BANK PRESSURE DROP LOW
LOWER CHAMBER PRESSURE LOW or HIGH
LOWER BURNER FUEL GAS PRESSURE LOW or HIGH
UPPER BURNER FUEL GAS PRESSURE LOW or HIGH

Process subsystems are sequentially activated to clear the alarm conditions above, prior to ignition of the burners. These include activating appropriate equipment to place the following utilities/systems online:

PLANT WATER PRESSURE
PLANT AIR PRESSURE & BACKUP COMPRESSED N2 SUPPLY
PROCESS STEAM PRESSURE
AUXILIARY GENERATOR
COOLING TOWER SUMP PUMP PRESSURE
SECONDARY HX PUMP PRESSURE
PROCESS OFFGAS SUPERHEAT
HYDROCYCLONE DISCHARGE PRESSURE
BLOWDOWN FILTRATION SYSTEM
PROCESS LIQUID SUPPLY PUMP
AUXILIARY WATER LEVEL & WATER PRESSURE
LOWER QUENCH SPRAY FLOW
UPPER QUENCH SPRAY FLOW
VENTURI LIQUID FLOW
ABSORBER LIQUID FLOW
PROCESS LIQUID RETURN PUMP
INDUCED DRAFT BLOWER FLOW
HEPA FILTER BANK PRESSURE DROP verified
CAUSTIC PUMP PRESSURE
UPPER and LOWER BURNER FUEL GAS PRESSURE
ATOMIZING MEDIA (STEAM/AIR) PRESSURE

At this point, only the following alarms should be indicated:

LOWER CHAMBER TEMPERATURE--LOW
UPPER CHAMBER TEMPERATURE--LOW
COMBUSTION AIR PRESSURE--LOW
SECONDARY AIR PRESSURE--LOW
WASTE OIL PRESSURE--LOW

A final check is made to ensure that the air pollution control equipment and all incinerator subsystems are operating properly and within limits prior to attempting burner startup on natural gas. The lower and upper burners will be fired in sequence and be placed on automatic control for temperature ramp-up (~100-150°F/hr). No wastes may be fed until such time as the lower and upper chambers have reached operating temperatures and all alarm conditions have been satisfied.

WASTE FEED INTERRUPT/DISABLE INTERLOCKS

Waste feed to the incinerator will be disabled/interrupted whenever any of the following conditions are present or occur and until such time as the malfunctions are resolved, alarms are

cleared, and the incinerator has been returned to an operational mode:

ABSORBER SOLUTION FLOW LOW
VENTURI PRESSURE DROP LOW
OFFGAS CO LEVEL HIGH
FINAL OFFGAS FLOW LOW or HIGH
PROCESS SUMP pH LOW
QUENCH TOWER SUMP TEMPERATURE HIGH/HIGH
HEPA FILTER BANK SYSTEM PRESSURE DROP LOW
CARBON BED HEPA FILTER SYSTEM PRESSURE DROP LOW
LOWER CHAMBER TEMPERATURE LOW
UPPER CHAMBER TEMPERATURE LOW
LOWER CHAMBER TEMPERATURE HIGH/HIGH
UPPER CHAMBER TEMPERATURE HIGH/HIGH
UPPER CHAMBER O2 MEASUREMENT LOW
NO FLAME IN LOWER BURNER
NO FLAME IN UPPER BURNER
PRE-IGNITION INTERLOCK IS PRESENT
CONTROLLED SHUTDOWN IS INITIATED
FAST SHUTDOWN IS INITIATED
SCRAM SHUTDOWN IS INITIATED
ATOMIZING MEDIA (STEAM/AIR) PRESSURE LOW

NORMAL SHUTDOWN

Normal shutdown procedures are essentially a reversal of startup procedures. Waste feed is discontinued and chamber temperatures are gradually reduced (~100-150°F/hr) to a setpoint of 500°F via the automatic temperature controller. When a burner has been in the low fire position for one hour (0% output on the lower burner temperature controller, 0% on the upper burner temperature controller), the burners are shut off. At this point the following utilities/systems are sequentially shut down:

UPPER BURNER COMBUSTION AIR & SECONDARY AIR BLOWERS
PILOT GAS SUPPLY
BURNER GAS SUPPLY
ATOMIZING AIR & STEAM SUPPLY
MAIN PROCESS NATURAL GAS SUPPLY
SCRUB SOLUTION CAUSTIC SUPPLY

Following shutdown of the burners, the offgas cleanup system continues operation until the quench sump gas temperature can be

maintained below 250°F. The following systems are then sequentially shut down:

PROCESS LIQUID SUPPLY PUMP
ABSORBER LIQUID FLOW
VENTURI LIQUID FLOW
INDUCED DRAFT BLOWERS
UPPER QUENCH SPRAY FLOW
LOWER QUENCH SPRAY FLOW
PROCESS LIQUID RETURN PUMP
PROCESS SUMP TANK LEVEL is pumped down
PLANT WATER SUPPLY
COOLING TOWER FANS & SUMP PUMP
SECONDARY HEAT EXCHANGE PUMP
OFFGAS SUPERHEATER
HEPA PLENUM & DUCT HEATERS
CONTROL PANELS
AUXILIARY GENERATOR
AUXILIARY INSTRUMENT AIR (N2) SUPPLY
STEAM GENERATOR

CONTROLLED SHUTDOWN

A controlled shutdown occurs when a lesser-grade fault is detected which has potential adverse impacts on system safety or performance. Any event which initiates a controlled shutdown automatically interrupts solid or liquid waste feed. Under controlled shutdown, upper and lower chamber temperatures are reduced by lowering controller setpoint or by placing the controller in automatic ramp-down mode. Should the fault be corrected during the cooldown, operating temperatures in the upper and lower chambers are reestablished by adjusting the respective controllers in manual mode or by placing them in automatic ramp-up mode. Wastes may not be reintroduced until all alarms are cleared and operating conditions are satisfied.

The following events will initiate a controlled shutdown:

PROCESS LIQUID RETURN PUMP PRESSURE LOW
PROCESS LIQUID SUPPLY (HYDROCYCLONE DISCHARGE) PRESSURE LOW
INSTRUMENT AIR PRESSURE LOW
QUENCH TOWER SUMP TEMPERATURE HIGH/HIGH
LOWER BURNER FUEL GAS PRESSURE LOW or HIGH
UPPER BURNER FUEL GAS PRESSURE LOW or HIGH

UPPER BURNER COMBUSTION AIR BLOWER PRESSURE LOW
LOWER BURNER COMBUSTION AIR BLOWER PRESSURE LOW
SECONDARY AIR BLOWER PRESSURE LOW
UPPER BURNER FLAME OUT
LOWER BURNER FLAME OUT
LOWER CHAMBER PRESSURE HIGH

FAST SHUTDOWN

When a fault is detected that is serious enough to require a fast shutdown, waste feed is interrupted and the burners are shut off. However, to minimize the generation of volatile combustibles from solid waste introduced into the lower chamber, the control logic will allow an oxidizing atmosphere (burners on) to exist in the incinerator for two minutes following a fast shutdown initiating event. A snuffing medium (steam) will thereafter be injected to suppress combustion during the cool down period (until 1000°F).

The following automatic events will occur during cooldown:

1. The natural gas supply to the burners is shut off.

2. The upper & lower burner combustion air blowers and secondary air blower are shut off.

3. The induced-draft blowers are shut off. The bypass to the building HEPA plenum will automatically open and maintain a negative pressure in the system.
NOTE: THIS IS NOT A BYPASS OF THE OFFGAS TREATMENT SYSTEM--THERE IS NO OFFGAS BYPASS STACK OR DUMP FOR THE PROCESS--ALL OFFGAS WILL PASS THROUGH THE COMPLETE OFFGAS TREATMENT SYSTEM AT ALL TIMES.
Offgas exiting the carbon bed HEPA filter bank is merely rerouted through the building HEPA plenum (rather than directly out to the stack) as an additional safeguard.

4. The venturi throat is opened.

5. Snuffing steam injection is initiated.

Heat will be liberated primarily by convection and radiation from the incinerator shell, but also by sensible heating of the snuffing medium. This latter heat is dissipated by the quench column. The following events initiate a fast shutdown:

LOWER CHAMBER TEMPERATURE HIGH/HIGH
UPPER CHAMBER TEMPERATURE HIGH/HIGH

PRIMARY HEPA FILTER BANK PRESSURE DROP LOW
PROCESS EXHAUST BLOWER FAILURE (both #1 & #2)
and
PROCESS LIQUID SUPPLY (HYDROCYCLONE DISCHARGE) PRESSURE LOW

SCRAM SHUTDOWN

A SCRAM shutdown is identical to the fast shutdown except that the two minute time delay for combustible solids burnout is bypassed. The snuffing steam is injected immediately. Three events can trigger an SCRAM shutdown:

1. LOSS OF ELECTRICAL POWER (city and auxiliary generator combined)

2. BREACH OF PROCESS PRIMARY HEPA FILTER BANK

3. MANUAL OPERATOR ACTUATION OF THE SCRAM PUSHBUTTON

APCE MALFUNCTION

MAJOR OFFGAS SYSTEM COMPONENTS:

Quench Column
Venturi-type Particulate Scrubber
Packed-column absorber/demister
Offgas Superheater (HEPA protection)
Double in-line parallel HEPA filter banks
Carbon-bed adsorber
Final HEPA Filter

<u>BACKUP SYSTEMS</u>

1) <u>Electrical</u>
--City power used for normal operations

a) Auxiliary Generator
--On line during operations for immediate plant power backup

b) Uninterruptible Power Supply (UPS)
--For Controls & Instrumentation

2) <u>Scrub Solution Flow</u>
--City water used for normal makeup flow and demister flush to absorber; recycled solution via sump tank provides capacitance in the event of makeup water loss

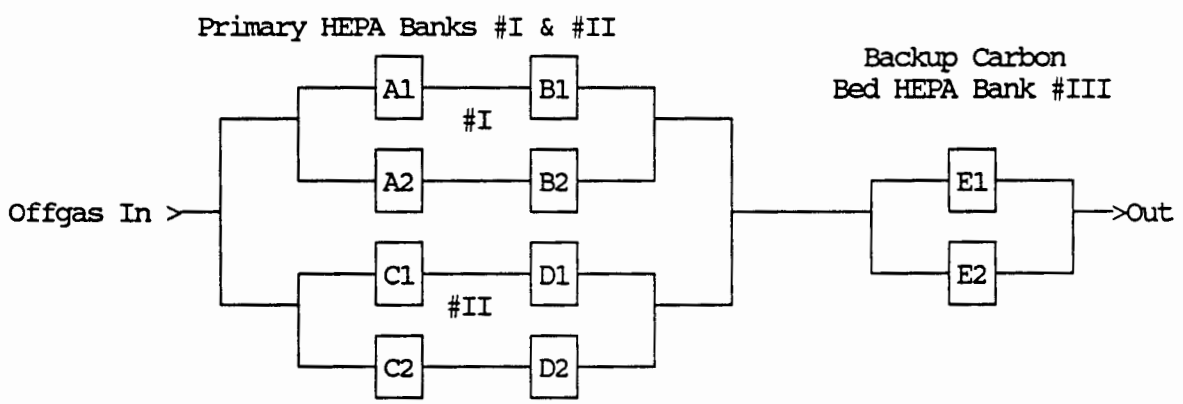
a) Gravity drain for quench & absorber column sumps
--in event of process liquid return pump failure (scrub solution return to process sump tank)

b) Pressurized Emergency Water Supply Tank (~ 1 hour Capacity)
--provides cooling liquid to quench spray nozzles in event of process liquid supply pump failure (Hydrocyclone discharge pressure low) or total loss of electrical power

c) City Water Emergency Supply to Quench, Venturi, & Absorber
--provides liquid to quench, venturi, & absorber in event of pump failure, electrical outage, exhaustion of auxiliary emergency water supply; can be used to recharge emergency water supply, if necessary (i.e., backup supply pump replacement delayed, etc.)

3) <u>HEPA Filters</u>--All individual HEPA filters are tested and certified, as installed, for 99.97% removal efficiency of 0.3 micron (or greater) particulate; a minimum of 2 certified HEPA filters, in series, is required for transuranic operation.

<u>LAYOUT:</u>



a) HEPA banks I & II are operated independently of each other; only one primary bank is online at any time, the other serves as a completely redundant backup to allow changeout of filters without interrupting operation.

Normally, only the upstream filters (A1 & A2 or C1 & C2) would require changeout due to excess loading.

b) HEPA bank III (downstream of carbon bed) is always online to act as a final trap and to maintain assurance of dual, in-series 99.97% removal efficiency in the event of an upstream HEPA filter changeout in which certification testing could not be immediately performed following changeout due to incinerator operation.

c) In the event of a FAST or SCRAM SHUTDOWN, offgas leaving the carbon bed HEPA filter bank is automatically rerouted through the building HEPA filter plenum as an additional safeguard before exiting the stack.