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UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

AIR POLLUTION EMISSION ASSESSMENT NO. 42-21-0475-91
TRIAL BURN FOR DEACTIVATION FURNACE
BUILDING 97
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
19 FEBRUARY - 6 MARCH 1991

Under the command jurisdiction of the U.S. Army Health Services Command, AEHA's mission is to support the worldwide preventive medicine programs of the Army and other Department of Defense and Federal agencies.

The Agency is unique with the variety of scientific disciplines working together in one military unit to protect the health and well being of soldiers and civilians and enhance the environment.

This is accomplished through support in environmental quality, occupational and environmental health, toxicology, industrial hygiene, radiation and entomological sciences, pest management, and laboratory services. Various types of field services are provided upon request.

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ME-AP (40) 30 May 1991

MEMORANDUM FOR Commander, U.S. Army Materiel Command, ATTN: AMCSG, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

SUBJECT: Air Pollution Emission Assessment No. 42-21-0475-91, Trial Burn for Deactivation Furnace, Building 97, Lake City Army Ammunition Plant, Independence, Missouri, 19 February - 6 March 1991

Copies of report with Executive Summary are enclosed.

FOR THE COMMANDER:

Encl

DAVID L. DAUGHDRILL
Acting Division Chief
Air Pollution Engineering Division

CF:
HQDA(SGPS-PSP) (wo/encl)
HQDA(ENVR-E) (w/encl)
DA, USAEHSC, ATTN: CEHSC-FU-S (w/encl)
Cdr, AMCCOM, ATTN: AMSMC-SG (w/encl)
Cdr, HSC, ATTN: HSCL-P (w/encl)
Cdr, LCAAP (w/encl)
Cdr, MEDDAC, Ft Leavenworth, ATTN: PVNTMED Svc (2 cy) (w/encl)
Cdr, FAMC, ATTN: PVNTMED Svc (w/encl)
Cdr, USATHAMA, ATTN: CETHA-TS-S (w/encl)
Cdr, USATHAMA, ATTN: CETHA-RM(TIC) (2 cy) (w/encl)
Cdr, USAEHA-W (w/encl)

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

EXECUTIVE SUMMARY
AIR POLLUTION EMISSION ASSESSMENT NO. 42-21-0475-91
TRIAL BURN FOR DEACTIVATION FURNACE
BUILDING 97
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
19 FEBRUARY - 6 MARCH 1991

1. PURPOSE. To determine if the deactivation furnace (DF) located at Building 97, as tested, met the performance standards for hazardous waste incinerators (HWI's) and to provide operational data required for a RCRA Part B Permit for the furnace.

2. CONCLUSIONS. The DF located at Building 97, as tested, met all of the performance standards for HWI's. The corrected carbon monoxide 1-hour rolling average for all tests conducted was below the Tier I limit of 100 ppm. The additional data required to establish permit conditions for this incinerator was obtained. The chromium emissions exceeded the Tier II metals emission limit for two of the six 20mm M96 runs.

3. RECOMMENDATION. Provide a copy of this report to the Missouri Department of Natural Resources.

Air Pollution Emission Assessment No. 42-21-0475-91, 19 Feb-6 Mar 91

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Appendix

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

HSHB-ME-AP

AIR POLLUTION EMISSION ASSESSMENT NO. 42-21-0475-91
TRIAL BURN FOR DEACTIVATION FURNACE
BUILDING 97
LAKE CITY ARMY AMMUNITION PLANT
INDEPENDENCE, MISSOURI
19 FEBRUARY - 6 MARCH 1991

1. REFERENCES. See Appendix A for a listing of references.

2. AUTHORITY.

a. AEHA Form 250-R, AMC, 26 May 1988.

b. Memorandum, USAEHA, HSHB-ME, 14 Dec 1990, subject: USAEHA Schedule of Field Services, FY 91.

3. PURPOSE. The purpose of this assessment was to determine if the deactivation furnace (DF), located at Building 97, met the performance standards for hazardous waste incinerators (HWI) and to establish operating limits for the RCRA Part B Permit.

4. GENERAL.

a. System Description.

(1) Facility Description. The DF system consists of a waste feed weighing system (WFWS), a dual conveyor feed system, discharge conveyor, a rotary kiln, and afterburner, high and low temperature gas coolers, cyclone, baghouse, draft fan and exhaust stack. The entire furnace system is completely enclosed in a carbon steel shroud. The shroud is approximately 8 inches away from the kiln exterior. The shroud confines the fugitive emissions from the furnace by holding it under a negative pressure. This is created by the burner blower which routes emissions back into the furnace. A number of sensors (temperature, gas flow, pressure differential, combustion gases, etc.) are used to monitor operating conditions at various points in the system. Signals from these sensors are monitored by a data acquisition system (DAS) which constantly compares the operating conditions to preset operating standards.

Use of trademark names does not imply endorsement by the U.S. Army but is intended only to assist in identification of a specific product.

(2) Waste Feed Weighing System. The WFWS consists of two conveyors, a conveyor scale, a vibrator feeder hopper, and a discharge chute. The waste feed is fed on to the conveyor scale where it is weighed to within 0.1 lb. If the waste weight is equal to or less than the preprogrammed weight specified for the type of waste, it is fed onto the feed conveyor, the discharge sweep gate retracts, and the waste is allowed to pass to the primary waste feed conveyor. If the waste exceeds the allowable weight or if the primary waste feed conveyor is not operating, a discharge gate remains across the conveyor and directs the waste into a catch bin.

(3) Feed Conveyors. The primary waste feed conveyor transports the munitions from the WFWS to the short conveyor. The short conveyor transports the munitions into the feed chute at the low temperature inlet of the incinerator. The conveyor is covered by a shroud to prevent loading of munitions before and after the WFWS. Both conveyors have the flights spaced 18 inches apart. The short conveyor is implemented for safety precautions. When an emergency situation arises, the primary waste feed conveyor shuts down while the short conveyor continues to operate. This allows munitions near the high temperature end of the kiln to continue moving through the furnace and deters possible explosions outside the furnace.

(4) Discharge Conveyor. Metal components of end-item munitions are discharged from the furnace onto the discharge conveyor. The discharge conveyor transports the waste through a hole in the reinforced concrete barricade wall to a collection point outside the wall.

(5) Rotary Kiln. The rotary kiln was designed to destroy, by incineration, small ammunition or explosive end items and bulk explosive or propelling materials. The rotary kiln walls are designed to contain any abnormal detonations. Also, the furnace is barricaded by a concrete enclosure designed to contain the effects of a high-order detonation. Internal spiral flights propel the waste through as the kiln rotates and also separates the munitions. This discourages sympathetic propagation of detonations and defeats any fragments generated by detonations. The kiln is equipped with a variable speed drive which allows it to burn at different speeds, ranging from 0.5 to 4.5 rpm.

(6) Afterburner. The afterburner is designed to raise the temperature of the exhaust gases exiting from the kiln. This elevated temperature and the added residence time enhances the complete combustion of the explosive. The afterburner is capable of heating 4,000 scfm of air at 400-900 °F up to 1200-1600 °F with a minimum residence time of 1 second. The afterburner is mounted above the furnace retort and fits directly into the 24-inch duct exiting from the rotary kiln.

(7) Gas Coolers. The gas coolers are cross current heat exchangers with ambient air as the cooling medium and are designated the high temperature heat exchanger (HTHE) and the low temperature heat exchanger (LTHE). The hot exhaust gases enter the inlet plenum of the cooler and pass alternately

downward and upward through the first and second sections and then exit through the outlet plenum. Ambient air is forced through the cooling chambers by a blower. The heavier particles fall out of the gas stream in the coolers due to pressure drops in the Air Pollution Control System (APCS). Particles are cleaned from the plates by using a sonic horn. The particles are discharged from the cooler via a double tipping valve into a sealed 55-gallon container. The cleaning of the heat transfer surface area and the discharging of the residue are automatic, continuous processes.

(8) Cyclone. Large particles from the gas stream are removed by the cyclone. The cyclone has a clock-wise rotation, with inlet and outlet ducts at 90° separation. The pressure drop across the cyclone is designed at 2 to 5 inches water gage (wg). The separated particles fall into a collection hopper. Discharge from the collection hopper is through an airtight, manually operated slide gate valve.

(9) Baghouse. The baghouse is a fabric-filtration collector, used for final particulate cleansing of the gas stream. The baghouse contains 100 bags. The bags are Nomex® felt and are silicone treated, heat set, and flame proofed. The dust laden gas stream enters the baghouse near the bottom of the hopper where it is dispersed evenly along the rows of bags. Dust particles are deposited on the filter bags as the gases pass through them. The baghouse uses the pulse-jet cleaning method. The particles settle into the hopper below and are exhausted through a double tipping gate valve into a sealed 55-gallon drum while maintaining an air seal on the baghouse assembly.

(10) Draft Fan. The gas stream is pulled through the APCS by an induced draft fan. The fan is capable of pulling 6700 actual cubic feet per minute (acfm) at a draft (negative pressure) of 30 inches wg at the fan inlet. The total system pressure drop is approximately 25 inches wg.

(11) Exhaust Stack. The A36 carbon steel, circular exhaust stack is 30 feet high and has an inside diameter (ID) of 19 3/8 inches.

(12) Data Acquisition System. The system controller has the capability to control furnace operations in a programmed sequence, make decisions based on sensor input, and provide a totally automated furnace operation. The control configuration includes the following items:

(a) AT 2 MB Ram computer with 80 MB hard disk.

(b) Standard AT keyboard, industrially hardened and designed to mount in the front panel of an enclosure.

®Nomex is a registered trademark of E.I. DuPont de Nemours & Co., Inc., Wilmington, Delaware.

(c) High resolution color graphics monitor.

(d) PID loop analog controller. The controller is capable of automatically calculating the optimum tuning parameters and entering the parameters into memory. It provides digital input allowing remote setting of setpoints and selecting Auto/Manual operation.

(e) Line printer. The line printer is capable of a minimum of 180 characters per second draft mode and 60 characters per second letter quality mode.

(f) Strip chart recorder. The strip chart recorder is capable of recording a minimum of 14 channels simultaneously.

(g) Programmable logic controller. The programmable logic controller is capable of supporting isolated 120 VAC outputs, 24 VDC inputs, thermocouple inputs, 4-20 mA inputs, 0-10 VDC inputs, 4-20 mA outputs, and 0-10 VDC outputs. A full compliment of programming instructions including counters, timers, relays, sequencers (drum controller), file functions, bit functions, and math functions. The programmable logic controller is capable of transmitting and receiving bidirectionally via an RS 232/422 serial link. This data communication takes place between the programmable logic controller and the AT computer.

b. Emission Standards. Stack sampling was conducted during the trial burn to demonstrate that the subject incinerator met the performance standards under RCRA regulations for HWI's found in reference 5. Additional monitoring was conducted to evaluate the performance of the incinerator with respect to proposed carbon monoxide (CO) regulations and also to comply with the requirements of the approved Trial Burn Test Plan (reference 11) as amended by references 12, 13, and 14.

(1) Existing RCRA Emission Standards. Emission standards and monitoring requirements are specified in Title 40, Code of Federal Regulations (CFR), Parts 264.343 and 264.345. These are discussed below:

(a) Destruction and Removal Efficiency (DRE). A DRE of 99.99 percent must be achieved for each designated principal organic hazardous constituent (POHC). The POHC's for this unit are 2,4-dinitrotoluene (2,4-DNT), diphenylamine (DPA), and nitroglycerin (NG).

(b) Particulate Emissions. Particulate emissions may not exceed 180 milligrams per dry standard cubic meter [0.08 grains per dry standard cubic foot (gr/dscf)] when corrected for the amount of oxygen (O_2) in the stack gas per formula in reference 5.

(c) Hydrogen Chloride (HCl) Emissions. The HCl emissions may not exceed 1.8 kilograms per hour [4 pounds per hour (lbs/hr)] or 1 percent of the HCl that is present in the exhaust gases prior to the air pollution control

device, whichever is larger. As per reference 14, HCl testing was not performed since the there is no chlorine in any of the listed feed items to be treated in the DF.

(2) Proposed RCRA CO Emission Requirements. Rules have been proposed (reference 12) to use continuous monitoring of CO as a means of indicating the formation of products of incomplete combustion (PIC's). The rules are being used as guidance for permitting HWI's and utilize a two-tiered approach. The tier requirements are as follows:

(a) Tier 1. The CO concentration in the exhaust gas, when corrected to 7 percent O_2, must remain below 100 parts per million (ppm), based on a 60-minute rolling average.

(b) Tier 2. If CO concentrations exceed the 100 ppm 60-minute rolling average, then total hydrocarbon emissions (THC's) must be continuously monitored during the trial burn.

As per the Trial Burn Test Plan (TBTP) (references 14, 15, 16, and 17) the CO and THC's were continuously monitored during all test runs.

(3) Proposed RCRA Metals Emission Requirements. The EPA has established emission limits for four carcinogenic metals (arsenic, beryllium, cadmium, and chromium) and for six noncarcinogenic metals (antimony, barium, lead, mercury, silver, and thallium) based on suggested guidelines (reference 11). Control of metals is to be based on a three-tiered structure. The tiers are as follows:

(a) Tier I. If it can be demonstrated that the quantities of metals being fed would not exceed the Tier 1 limits, as presented in reference 11, then no testing will be required. For the parameters existing at the LCAAP DF (10-meter effective stack height, noncomplex terrain, and rural area), the Tier I limits per reference 18 are: antimony (Sb) - 0.1 pounds per hour (lb/hr); barium (Ba) - 17.0 lb/hr; lead (Pb) - 0.031 lb/hr; chromium (Cr) - 0.00029 lb/hr; beryllium (Be) - 0.0014 lb/hr; cadmium (Cd) - 0.0019 lb/hr; mercury (Hg) - 0.01 lb/hr; silver (Ag) - 1.0 lb/hr; and thallium (Tl) - 0.1 lb/hr. Only Sb, Ba, and Pb are known constituents of Lake City Army Ammunition Plant (LCAAP) trial burn waste feed items.

(b) Tier II. If Tier I requirements cannot be met, then emission testing must be performed using a metals sampling train (per reference 10) being developed by the EPA. Actual emission rates are compared to emission limits set by the EPA (reference 11). The Tier II limits corresponding to the Tier I limits of reference 18 are: Sb - 0.1 lb/hr; Ba - 17.0 lb/hr; Pb - 0.031 lb/hr; Cr - 0.00029 lb/hr; Be - 0.0014 lb/hr; Cd - 0.0019 lb/hr; Hg - 0.01 lb/hr; Ag - 1.0 lb/hr; and Tl - 0.1 lb/hr.

(c) Tier III. Should emissions exceed the limits set by the EPA, then site specific dispersion modeling and emission characterization is used

to demonstrate that the emissions from the facility will not adversely impact upon existing ambient air quality.

Metals emission testing was conducted as per the TBTP. (The words " metals" or "metal emissions" when used in this document will refer to the above 10 listed metals). As the metals feed rate cannot be determined for the 20mm M96, Tier II limits will be used instead of Tier I.

c. Trial Burn Requirements.

(1) Sampling and Analysis Requirements. Sampling and analysis was required for the APCS exhaust gases, the APCS residues, the auxiliary fuel, and some of the waste feed items. Table 1 summarizes the sampling and analysis requirements.

TABLE 1. SAMPLING/ANALYSIS SUMMARY

Feed Item	Sample Matrix	Analysis
20mm M96 and FA-956 Primer	Exhaust Gas	Particulate; Metals; CO and THC (continuous monitor); CO, O_2, carbon dioxide (CO_2) by Orsat; moisture
	Fuel Oil	Metals, HHV*
	APCS Residues	Total Metals, TCLP†
Hi Skor 700X and IMR 5010	Exhaust Gas	Particulate; POHC; CO and THC; CO, O_2, and CO_2; moisture
	Fuel Oil	POHC, HHV
	APCS Residues	POHC

* Higher Heating Value
† Toxicity Characteristic Leaching Procedure

(2) Additional Operational Parameter Monitoring Requirements. Other parameters that were monitored and stored in the DAS include combustion gas temperature at the retort inlet (feed end), combustion gas temperature at the retort outlet (burner end), afterburner temperature, HTHE exit temperature, LTHE exit temperature, baghouse exit temperature, baghouse pressure drop and

rotary kiln draft, auxiliary fuel usage, exhaust gas velocity, and waste feed (both individual charge weight and accumulated weight). Although not stored in the DAS, the kiln rotational speed was manually recorded.

(3) Waste Characterization. The characterization of all feed items is found in Appendix B.

(a) 20mm M96 Cartridge. This feed item, produced in 1945, does not have a complete characterization. The propellant/explosive/pyrotechnic (PEP) feed rate for this item was calculated using the estimated cartridge weight.

(b) FA-956 Primer. The FA-956 primer was improperly characterized in the TBTP (references 14, 15, 16, and 17). The actual PEP weight is 0.365 gr per primer while the total weight of each primer is 2.84 gr. The actual PEP and metals feeds are discussed in the metals emission section of this report.

d. Sampling Location.

(1) Exhaust Gases.

(a) The sampling ports were located on the 19 3/8-inch ID exhaust stack at an elevation that was 4.90 duct diameters (dd) from the nearest upstream disturbance (fan inlet duct) and 4.83 dd from the nearest downstream disturbance (CO/O_2 monitor probe). The number of traverse points used was 24 as determined by EPA Reference Method (RM) 1 of reference 3. The velocity traverse points within the stack are shown in Appendix C. A cyclonic flow check was done per RM 1, and the flow was found to be acceptable. Velocity traverse and cyclonic flow data are found in Appendix D.

(b) The extraction tube for the THC continuous monitor was placed into the exhaust stack at the same sample ports described in above paragraph.

(c) The CO/O_2 monitoring system is permanently affixed to the stack 93 1/2 inches above the sample ports.

(d) The permanent pitot/venturi device is located on the exhaust stack just upstream of the CO/O_2 monitoring system.

(2) Process streams. In addition to the exhaust gases, process stream samples were also taken.

e. Sampling Procedures and Equipment. A description of sampling apparatus and procedures is presented in Appendix C.

f. Sample Recovery and Analysis. The procedures for recovery and analysis of all samples are discussed in Appendix E. Quality assurance/ quality control (QA/QC) procedures are also discussed in Appendix E.

g. Calibration Procedures. A summary of calibration procedures and calibration data for the sampling trains and the calibration procedure for the Orsat analyzer is contained in Appendix F.

h. Continuous Emission Monitoring. A description of the continuous emission analyzer system and the calibration procedures for that system are contained in Appendix G.

i. Nomenclature and Equations. The nomenclature and equations used for this assessment are found in Appendix H.

j. Assessment Personnel. Personnel who participated in this assessment are listed in Appendix I.

5. FINDINGS AND DISCUSSION.

a. Data Summary. Detailed summaries of all sampling runs are found in Appendix J. All sampling field data sheets will be forwarded to the appropriate regulatory agencies.

b. Process Operation Data Summary. A summary of the average process operation data for all valid test runs for all feed items are found in Table 2. Tables 3 through 6 summarize the process data by run for each feed item. A data summary, compiled from the data acquisition system output, for each run is found in Appendix K. A printout of all data accumulated by the DAS will be provided to the appropriate regulatory agencies by LCAAP. The kiln rotation data, which is not recorded by the DAS, is recorded manually and will also be provided.

c. Emissions Performance. A summary of the average emission performance data for all valid test runs for all feed items are found in Table 7. Tables 8 through 11 summarize the data by run for each feed item. Detailed POHC data is found in Appendix L and detailed particulate data is found in Appendix M.

d. Metals Emissions. A summary of the average metal emissions data for all valid test runs for the 20mm M96 cartridge and the FA-956 primer are found in Table 12. Tables 13 and 14 summarize the data by run for each feed item. Detailed metals data is found in Appendix N.

e. Nonstandard Events.

(1) Run 1. Run 1 (22 February 1991) was considered invalid because of fugitive emissions from the discharge end of the retort. There were two detonations on the discharge conveyor. The feed item for this run was the 20mm M96 cartridge. Although not included in emission performance data (paragraph 5c), detailed particulate data for this run is found in Appendix M. Likewise, detailed metals emission data is found in Appendix N.

TABLE 2. SUMMARY OF TRIAL BURN AVERAGE WASTE FEED AND OPERATING PARAMETERS*

Parameter	20 mm M96 Cartridge	FA-956 Primer	Hi-Skor 700X Propellant	IMR 5010 Propellant
FEED DATA				
Avg Waste Feed Rate (lb/hr)	543.68	123.80	40.47	181.94
PEP Feed Rate (lb/hr)	86.80 (est)	15.91	40.47	181.94
Avg Auxiliary Fuel Rate (gal/hr)	39.81	36.52	42.35	39.38
OPERATIONAL DATA				
Kiln Rotation (rpm)	1.03	1.67	2.8	2.8
Avg Kiln Inlet Temp (°F)	403	304	351	609
Avg Kiln Outlet Temp (°F)	939	744	696	707
Avg Afterburner Outlet Temp (°F)	1400	1350	1449	1400
Avg HTHE Outlet Temp (°F)	804	801	822	804
Avg LTHE Outlet Temp (°F)	294	295	295	294
Avg Baghouse Outlet Temp (°F)	264	264	264	263
Avg Stack Gas Volumetric Flow Rate (acfm)†				
RM 4‡	5124	5127	5201	5192
In-stack pitot/venturi	4185	4339	4365	4170

* Averages of valid runs.
† Indicator of stack gas velocity.
‡ Average of both sampling trains.

TABLE 3. SUMMARY WASTE FEED AND OPERATING PARAMETERS - 20mm M96 PROJECTILE FEED

Parameter	Run 6	Run 9	Run 10	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	579.20	568.02	483.81	543.68
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24	86.80
Auxiliary Fuel Rate (gal/hr)	41.54	33.90	44.00	39.81
OPERATIONAL DATA				
Kiln Rotation (rpm)	1.0	1.1	1.0	1.03
Avg Kiln Inlet Temp (°F)	400	418	390	403
Avg Kiln Outlet Temp (°F)	917	846	1053	939
Avg Afterburner Outlet Temp (°F)	1399	1400	1400	1400
Avg HTHE Outlet Temp (°F)	805	803	805	804
Avg LTHE Outlet Temp (°F)	294	294	293	294
Avg Baghouse Outlet Temp (°F)	264	264	264	264
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5158	5216	4998	5124
In-stack pitot/venturi	4356	4056	4144	4185

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 4. SUMMARY WASTE FEED AND OPERATING PARAMETERS - FA-965 PRIMER FEED

Parameter	Run 8	Run 14	Run 15	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	90.75	133.88	146.78	123.80
PEP Feed Rate (lb/hr)	11.66	17.21	18.86	15.91
Auxiliary Fuel Rate (gal/hr)	33.90	37.83	37.83	36.52
OPERATIONAL DATA				
Kiln Rotation (rpm)	1.7	1.6	1.7	1.67
Avg Kiln Inlet Temp (°F)	307	301	303	304
Avg Kiln Outlet Temp (°F)	694	853	684	744
Avg Afterburner Outlet Temp (°F)	1350	1350	1350	1350
Avg HTHE Outlet Temp (°F)	801	802	800	801
Avg LTHE Outlet Temp (°F)	294	295	296	295
Avg Baghouse Outlet Temp (°F)	263	264	265	264
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5103	5145	5133	5127
In-stack pitot/venturi	4261	4389	4369	4339

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 5. SUMMARY WASTE FEED AND OPERATING PARAMETERS - HI-SKOR 700X PROPELLANT FEED

Parameter	Run 3	Run 4	Run 7	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	43.42	40.18	37.82	40.47
Auxiliary Fuel Rate (gal/hr)	43.03	44.13	39.88	42.35
OPERATIONAL DATA				
Kiln Rotation (rpm)	2.8	2.8	2.8	2.8
Avg Kiln Inlet Temp (°F)	349	321	383	351
Avg Kiln Outlet Temp (°F)	712	652	724	696
Avg Afterburner Outlet Temp (°F)	1448	1449	1450	1449
Avg HTHE Outlet Temp (°F)	832	828	806	822
Avg LTHE Outlet Temp (°F)	295	295	294	295
Avg Baghouse Outlet Temp (°F)	267	264	262	264
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5262	5140	5200	5201
In-stack pitot/venturi	4326	4462	4302	4365

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 6. SUMMARY WASTE FEED AND OPERATING PARAMETERS - IMR 5010 PROPELLANT FEED

Parameter	Run 11	Run 12	Run 16	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	151.33	199.94	194.55	181.94
Auxiliary Fuel Rate (gal/hr)	40.79	39.53	37.83	39.38
OPERATIONAL DATA				
Kiln Rotation (rpm)	2.8	2.8	2.8	2.8
Avg Kiln Inlet Temp (°F)	654	559	615	609
Avg Kiln Outlet Temp (°F)	732	667	722	707
Avg Afterburner Outlet Temp (°F)	1400	1400	1401	1400
Avg HTHE Outlet Temp (°F)	803	804	804	804
Avg LTHE Outlet Temp (°F)	293	294	295	294
Avg Baghouse Outlet Temp (°F)	265	256	267	263
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5305	5175	5095	5192
In-stack pitot/venturi	4127	4278	4105	4170

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 7. SUMMARY OF TRIAL BURN AVERAGE EMISSIONS*

Parameter	20 mm M96 Cartridge	FA-956 Primer	Hi-Skor 700X Propellant	IMR 5010 Propellant
FEED DATA				
Waste Feed Rate (lb/hr)	543.68	123.80	40.47	181.94
PEP Feed Rate (lb/hr)	86.80 (est)	15.91	40.47	181.94
Auxiliary Fuel Rate (gal/hr)	39.81	36.52	42.35	39.38
EMISSION DATA				
NG DRE (%)	-	-	99.9980	-
DNT DRE (%)	-	-	-	99.9985
DPA DRE (%)	-	-	-	99.9937
Avg Corrected Particulate Conc. (gr/dscf)	0.0160	0.0186	0.0206	0.285
Max Corrected CO Hourly Rolling Avg (ppm)	24.27	16.30	20.99	62.26
Max THC Conc. (ppm)	7.8	6.2	12.1	8.2
Avg Corrected CO-CEM (ppm)	20.42	11.07	5.32	23.42
Avg O_2-CEM (%)	15.84	16.83	16.35	16.45
Avg Stack Gas Volumetric Flow Rate (acfm)†				
RM 4‡	5124	5127	5201	5192
In-stack pitot/venturi	4185	4339	4365	4170

* Averages of valid runs.
† Indicator of stack gas velocity.
‡ Average of both sampling trains.

TABLE 8. SUMMARY OF TRIAL BURN EMISSIONS - 20mm M96 PROJECTILE FEED

Parameter	Run 6	Run 9	Run 10	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	579.20	568.02	483.81	543.68
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24	86.80
Auxiliary Fuel Rate (gal/hr)	41.54	33.90	44.00	39.81
EMISSION DATA				
Corrected Particulate Conc. (gr/dscf)	0.0151	0.0177	0.0153	0.0160
Max Corrected CO Hourly Rolling Avg (ppm)	22.64	24.47	20.98	-
Max THC Conc. (ppm)	6.0	5.9	7.8	-
Avg Corrected CO-CEM (ppm)	21.67	20.61	18.97	20.42
Avg O_2-CEM (%)	16.29	15.99	15.25	15.84
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5158	5216	4998	5124
In-stack pitot/venturi	4356	4056	4144	4185

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 9. SUMMARY OF TRIAL BURN EMISSIONS - FA-965 PRIMER FEED

Parameter	Run 8	Run 14	Run 15	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	90.75	133.88	146.78	123.80
PEP Feed Rate (lb/hr)	11.66	17.21	18.86	15.91
Auxiliary Fuel Rate (gal/hr)	33.90	37.83	37.83	36.52
EMISSION DATA				
Corrected Particulate Conc. (gr/dscf)	0.0171	0.0211	0.0177	0.0186
Max Corrected CO Hourly Rolling Avg (ppm)	16.30	12.19	10.67	-
Max THC Conc. (ppm)	5.9	6.2	5.2	-
Avg Corrected CO-CEM (ppm)	10.94	11.92	10.36	11.07
Avg O_2-CEM (%)	16.50	16.78	17.22	16.83
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5103	5145	5133	5127
In-stack pitot/venturi	4261	4389	4369	4339

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 10. SUMMARY OF TRIAL BURN EMISSIONS - HI-SKOR 700X PROPELLANT FEED

Parameter	Run 3	Run 4	Run 7	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	43.42	40.18	37.82	40.47
Auxiliary Fuel Rate (gal/hr)	43.03	44.13	39.88	42.35
EMISSION DATA				
NG DRE (%)	99.9987	99.9979	99.9975	99.9980
Corrected Particulate Conc. (gr/dscf)	0.0074	0.0250	0.0293	0.0206
Max Corrected CO Hourly Rolling Avg (ppm)	1.95	9.08	20.99	-
Max THC Conc. (ppm)	12.1	5.2	3.1	-
Avg Corrected CO-CEM (ppm)	0.75	4.65	10.57	5.32
Avg O_2-CEM (%)	16.13	16.49	16.42	16.35
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5262	5140	5200	5201
In-stack pitot/venturi	4326	4462	4302	4365

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 11. SUMMARY OF TRIAL BURN EMISSIONS - IMR 5010 PROPELLANT FEED

Parameter	Run 11	Run 12	Run 16	Avg
FEED DATA				
Waste Feed Rate (lb/hr)	151.33	199.94	194.55	181.94
Auxiliary Fuel Rate (gal/hr)	40.79	39.53	37.83	39.38
EMISSION DATA				
DNT DRE (%)	99.9982	99.9986	99.9986	99.9985
DPA DRE (%)	99.9924	99.9943	99.9944	99.9937
Corrected Particulate Conc. (gr/dscf)	0.0403	0.0203	0.0249	0.0285
Max Corrected CO Hourly Rolling Avg (ppm)	39.99	17.26	62.26	-
Max THC Conc. (ppm)	8.2	3.3	8.1	-
Avg Corrected CO-CEM (ppm)	24.63	15.28	30.36	23.42
Avg O_2-CEM (%)	15.94	16.70	16.71	16.45
Avg Stack Gas Volumetric Flow Rate (acfm)*				
RM 4†	5305	5175	5095	5192
In-stack pitot/venturi	4127	4278	4105	4170

* Indicator of stack gas velocity.
† Average of both sampling trains.

TABLE 12. SUMMARY OF TRIAL BURN AVERAGE METALS EMISSIONS*

Parameter	20 mm M96 Cartridge	FA-956 Primer
FEED DATA		
Waste Feed Rate (lb/hr)	543.68	123.80
PEP Feed Rate (lb/hr)	86.80 (est)	15.91
Auxiliary Fuel Rate (gal/hr)	39.81	36.52
METALS EMISSION DATA		
Avg Max Ag Emission Rate (lb/hr)	7.02×10^{-5}	5.65×10^{-5}
Avg Max As Emission Rate (lb/hr)	2.82×10^{-5}	2.77×10^{-5}
Avg Max Ba Emission Rate (lb/hr)	1.64×10^{-3}	1.03×10^{-3}
Avg Max Be Emission Rate (lb/hr)	5.58×10^{-6}	5.59×10^{-6}
Avg Max Cd Emission Rate (lb/hr)	1.24×10^{-4}	1.23×10^{-4}
Avg Max Cr Emission Rate (lb/hr)	2.45×10^{-4}	6.39×10^{-4}
Avg Max Hg Emission Rate (lb/hr)	3.64×10^{-5}	4.68×10^{-5}
Avg Max Pb Emission Rate (lb/hr)	6.92×10^{-3}	6.13×10^{-3}
Avg Max Sb Emission Rate (lb/hr)	7.04×10^{-4}	7.44×10^{-4}
Avg Max Tl Emission Rate (lb/hr)	5.58×10^{-6}	5.59×10^{-6}

BLE 13. SUMMARY OF TRIAL BURN METAL EMISSIONS - 20mm M96 PROJECTILE FEED

rameter	Run 6	Run 9	Run 10	Avg
ED DATA				
ste Feed Rate (lb/hr)	579.20	568.02	483.81	559.80
t PEP Feed Rate (lb/hr)	92.47	90.68	77.24	86.80
xiliary Fuel ate (gal/hr)	41.54	33.90	44.00	39.81
TALS EMISSION DATA				
ximum Ag Emission Rate (lb/hr)	5.73×10^{-5}	9.75×10^{-5}	5.57×10^{-5}*	7.02×10^{-5}
ximum As Emission Rate (lb/hr)	2.87×10^{-5}	2.81×10^{-5}	2.78×10^{-5}*	2.82×10^{-5}
ximum Ba Emission Rate (lb/hr)	1.31×10^{-3}	8.89×10^{-4}	2.73×10^{-3}	1.64×10^{-3}
ximum Be Emission Rate (lb/hr)	5.56×10^{-6}*	5.62×10^{-6}*	5.57×10^{-6}*	5.58×10^{-6}
ximum Cd Emission Rate (lb/hr)	1.25×10^{-4}	1.57×10^{-4}	9.13×10^{-5}	1.24×10^{-4}
ximum Cr Emission Rate (lb/hr)	4.17×10^{-5}*	8.87×10^{-5}	6.04×10^{-4}	2.45×10^{-4}
ximum Pb Emission Rate (lb/hr)	6.07×10^{-3}	1.07×10^{-2}	3.99×10^{-3}	6.92×10^{-3}
ximum Hg Emission Rate (lb/hr)	4.04×10^{-5}	3.53×10^{-5}	3.34×10^{-5}	3.64×10^{-5}
ximum Sb Emission Rate (lb/hr)	7.40×10^{-4}	6.82×10^{-4}	6.91×10^{-4}	7.04×10^{-4}
ximum Tl Emission Rate (lb/hr)	5.56×10^{-6}*	5.62×10^{-6}*	5.57×10^{-6}	5.58×10^{-6}

All samples below analytical MDL.

ABLE 14. SUMMARY OF TRIAL BURN METAL EMISSIONS - FA-965 PRIMER FEED

arameter	Run 8	Run 14	Run 15	Avg
EED DATA				
aste Feed Rate (lb/hr)	90.75	133.88	146.78	123.80
EP Feed Rate (lb/hr)	11.66	17.21	18.86	15.91
uxiliary Fuel Rate (gal/hr)	3.90	37.83	37.83	36.52
ETALS EMISSION DATA				
aximum Ag Emission Rate (lb/hr)	6.05×10^{-5}	4.89×10^{-5}	6.02×10^{-5}	5.65x1
aximum As Emission Rate (lb/hr)	2.76×10^{-5}	2.75×10^{-5}*	2.79×10^{-5}	2.77x1
aximum Ba Emission Rate (lb/hr)	7.60×10^{-4}	1.01×10^{-3}	1.33×10^{-3}	1.03x1
aximum Be Emission Rate (lb/hr)	5.51×10^{-6}*	5.58×10^{-6}*	5.67×10^{-6}*	5.59x1
aximum Cd Emission Rate (lb/hr)	1.06×10^{-4}	1.04×10^{-4}	1.60×10^{-4}	1.23x1
aximum Cr Emission Rate (lb/hr)	4.00×10^{-5}	5.75×10^{-5}	9.43×10^{-5}	6.39x1
aximum Pb Emission Rate (lb/hr)	6.87×10^{-3}	6.86×10^{-3}	4.65×10^{-3}	6.13x1
aximum Hg Emission Rate (lb/hr)	3.05×10^{-5}	7.37×10^{-5}	3.61×10^{-5}	4.68x1
aximum Sb Emission Rate (lb/hr)	6.90×10^{-4}	8.77×10^{-4}	6.65×10^{-4}	7.44x1
aximum Tl Emission Rate (lb/hr)	5.51×10^{-6}*	5.58×10^{-6}*	5.67×10^{-6}*	5.59x1

All samples below analytical MDL.

(2) Run 2. Run 2 (22 February 1991) was also considered invalid because of fugitive emissions from the discharge end of the retort. There were multiple detonations on the discharge conveyor. This run was terminated at the 57.5-minute mark of the run. The feed item for this run was the 20mm M96 cartridge. As per Run 1, the detailed particulate and metals data are found in Appendices M and N, respectively.

(3) POHC Sampling Time. Run 3 was to pull 105 dscf of gas sample through the meter box in a period of 2 hours. Immediately upon starting the run, the orifice differential pressure jumped to 20 in. Hg (maximum on the vacuum gage), making it impossible to maintain the correct sampling flow rate. After the run was completed and after further research, EPA agreed to reduce the sampling requirements to a 2-hour run at a minimum sampling rate of 35 dscf/hr. Previous calculations showed that there was ample sample collected to prove the minimum DRE of 99.99 percent. All remaining POHC runs were 2 hours in duration.

(4) Run 5. Run 5 (25 February 1991) was considered invalid because of fugitive emissions from the shroud short feed conveyor (at feed end of retort). There were several puffs of smoke from the shroud during the run. The feed item for this run was the 20mm M96 cartridge. Additionally, the multiple metals (MeM5) train did not pass the posttest leak check required by RM 5. Also, the gas bag for RM 3 analysis was lost. Gas bag values for Run 6 (the same feed item) were used to determine the isokinetic sampling rate and the corrected particulate concentration. As per Run 1, the detailed particulate data is found in Appendix M.

(5) Unnumbered Run of 1 March 1991. A POHC run was started at 1101 hours on 1 March 1991. A problem with the WFWS caused a cessation of sampling 39 minutes into the run. The scale was weighing each individual charge, but the DAS was not totalizing them. It was agreed by EPA to manually count the number of charges and establish the minimum POHC feed rate in that manner. Sampling resumed at 1226 but was stopped again at 1236 due to a loss of heat in the sample box. On-stack troubleshooting isolated the problem, and as the sample box was being changed, worsening weather conditions precluded continued testing.

(6) Run 13. Run 13 (2 March 1991) was considered invalid because of a failed posttest leak check of the MeM5. Also, the RM 3 gas bag was lost. The average O_2 reading from the continuous monitor for this run was used to calculate the isokinetic sampling rate and the corrected particulate concentration. As per Run 1, the detailed particulate data is found in Appendix M.

(7) Analog card failure. As indicated in paragraph (4) above, a DAS problem developed on 1 March. After the run was aborted, the system was evaluated. The problem was isolated to an analog card in the weighing circuitry. The individual weight (for feed or no-feed) was operating

properly, but the signal from the analog card that totalized the weights was not evident. A call was placed to the vendor for a replacement card, but it was found that this was not a stock item and had to be ordered. The replacement was promised no later than Monday, 4 March. After some discussion, it was agreed by all parties (EPA, Olin, and USAEHA) that the feed rate could be ascertained by assuring a minimum charge weight in each cardboard box and by manually counting the feed boxes. This would provide the minimum waste feed rate to the incinerator. This in turn provides the minimum DRE for POHC's. It was also agreed to continue the test schedule using this method until the analog card was replaced. Runs 12 through 16 were completed using this method as the card had not yet arrived.

f. Performance Results.

(1) Particulate Emission Standard. Particulate testing was conducted concurrently with all POHC and metals testing. Tables 15, 16, 17, and 18 summarize the particulate concentrations for the valid runs for each of the four feed items. Table 19 summarizes the particulate emissions for the runs that are considered invalid. Particulate concentrations were found using the samples generated by the M5 train. Sampling and analysis methods are described in Appendices C and E, respectively. Detailed particulate data is found in Appendix M.

(2) DRE Performance Standard. The DRE performance standard was conducted for the POHC's of NG; 2,4-DNT; and DPA. The feed item for the POHC of NG was Hi-Skor 700X propellant. The feed item for DNT and DPA was IMR 5010 bulk propellant that was spiked with DPA.

(a) Input Rate. The POHC input rate was calculated by using the propellant feed rate and the POHC concentration in the propellant. For the trial burn, the feed rate was determined from the data collected by the DAS. Individual charges were prepared using a tared cardboard box and a minimum weight of propellant. The charges are weighed by the WFWS, and the data is fed into the DAS which records the individual charge and the total weight feed. The total feed rate is the net propellant divided by the total time of propellant feed. The concentration of POHC in the propellant was determined by the analysis of five propellant grab samples/run. The concentration used for input calculations was the mean of the five samples/run. The analysis is discussed in Appendix E. Detailed input data is found in Appendix L.

TABLE 15. EMISSION PERFORMANCE SUMMARY - HI-SKOR 700X PROPELLANT FEED

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
Propellant Feed Rate (lb/hr)	43.42	40.18	37.82
Min NG Input Rate (lb/hr)	17.5677	16.1925	14.5229
Max NG Emission Rate (lb/hr)	2.263×10^{-4}	3.428×10^{-4}	3.618×10^{-4}
Min NG DRE (%)	99.9987	99.9979	99.9975
Min DRE Standard (%)	99.99	99.99	99.99
Corrected Particulate Concentration (gr/dscf)	0.007	0.025	0.029
Min Particulate Standard (gr/dscf)	0.080	0.080	0.080

TABLE 16. EMISSION PERFORMANCE SUMMARY - IMR 5010 PROPELLANT

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
Propellant Feed Rate (lb/hr)	151.33	199.94	194.55
Min DNT Input Rate (lb/hr)	10.124	12.730	12.543
Min DPA Input Rate (lb/hr)	2.388	3.113	3.064
Max DNT Emission Rate (lb/hr)	1.825×10^{-4}	1.777×10^{-4}	1.728×10^{-4}
Max DPA Emission Rate (lb/hr)	1.825×10^{-4}	1.777×10^{-4}	1.728×10^{-4}
Min DNT DRE (%)	99.9982	99.9986	99.9986
Min DPA DRE (%)	99.9924	99.9943	99.9944
Min DRE Standard (%)	99.99	99.99	99.99
Corrected Particulate Concentration (gr/dscf)	0.040	0.020	0.025
Min Particulate Standard (gr/dscf)	0.080	0.080	0.080

TABLE 17. EMISSION PERFORMANCE SUMMARY - 20mm M96 CARTRIDGE

Run Number	6	9	10
Date	26 Feb 91	27 Feb 91	28 Feb 91
Waste Feed Rate (lb/hr)	579.20	568.02	483.81
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24
Corrected Particulate Concentration (gr/dscf)	0.015	0.018	0.015
Min Particulate Standard (gr/dscf)	0.080	0.080	0.080

TABLE 18. EMISSION PERFORMANCE SUMMARY - FA-956 PRIMER

Run Number	8	14	15
Date	27 Feb 91	4 Mar 91	4 Mar 91
Waste Feed Rate (lb/hr)	90.75	133.88	146.78
PEP Feed Rate (lb/hr)	11.66	17.21	18.86
Corrected Particulate Concentration (gr/dscf)	0.017	0.021	0.018
Min Particulate Standard (gr/dscf)	0.080	0.080	0.080

TABLE 19. EMISSION PERFORMANCE SUMMARY - POTENTIALLY INVALID RUNS

	Waste Feed Rate (lb/hr)	Corrected Particulate Concentration (gr/dscf)	Particulate Standard (gr/dscf)
Run 1 20mm	495.33	0.013	0.080
Run 2 20mm	410.48	0.021	0.080
Run 5 20mm	558.23	0.014	0.080
Run 13 Primer	142.94	0.015	0.080

(b) Emission Rate. The POHC stack emission rate was found using the train samples generated by the USAEHA sampling train for energetic materials (STEM). All train samples had POHC levels that were below the analytical detection limit. The maximum weight of the POHC collected by the sampling was calculated by setting the concentration equal to the method detection limit. The maximum POHC emission rates are summarized in Tables 15 and 16. Sampling and analysis methods are described in Appendices C and E, respectively. Detailed data is found in Appendix L.

(c) DRE for NG. The DRE's for NG were calculated for Runs 3, 4, and 7. The summaries of the NG input rate, NG emission rate, NG DRE, and particulate emissions for each individual run are found in Table 15. The DRE for NG exceeded the 99.99 percent minimum for all runs. Detailed NG data is found in Appendix L.

(d) DRE for DNT. The DRE's for DNT were calculated for DNT Runs 11, 12, and 16. The summaries of the POHC input rate, POHC emission rate, POHC DRE, and particulate emissions for each individual run are found in Table 16. The DRE for DNT exceeded the 99.99 percent minimum for all runs. Detailed data is found in Appendix L.

(e) DRE for DPA. The DRE's for DPA were calculated for Runs 11, 12, and 16. The summaries of the POHC input rate, POHC emission rate, POHC DRE, and particulate emissions for each individual run are found in Table 16. The DRE for DPA exceeded the 99.99 percent minimum for all runs. Detailed data is found in Appendix L.

(3) CO and THC Emissions. The CO and THC emissions were continuously monitored as per the trial burn test plan to determine CO limits per the proposed rules for HWI's. The maximum hourly rolling average of CO (corrected to 7 percent O_2) attained during the trial burn was 62.26 ppm which is below the Tier I limit of 100 ppm. The maximum THC value attained was 18.4 ppm. The maximum hourly rolling average of corrected CO values and the maximum THC values obtained during all runs are summarized in Table 20. A summary of the THC emissions data is found in Appendix O. Detailed CO and THC data will be provided to the appropriate regulatory agencies.

(4) Metals Emissions.

(a) Metals Feed Rate. Metal feed rates were calculated for those metals listed in reference 11 and known to be in the waste feed (per Appendix B). The Sb, Pb, and Ba feed rates for the FA-956 primer were calculated using the concentration per item as per the military specification (Appendix B) and the quantity fed as recorded by the DAS. The only characterization available for the 20mm M96 feed was the PEP component of the round. This shows only Sb and Pb as components of the PEP. The feed rates for these two metals are minimum values, as the total metal feed cannot be fully characterized. The presence and amount of the additional eight target metals present in other components of the cartridge cannot be quantified.

TABLE 20. CO AND THC EMISSION DATA SUMMARY

	Feed	Maximum THC Concentration (ppm)	Maximum Corrected CO Rolling Average (ppm)
Run 1*	20mm M96	11.4	39.41
Run 2*	20mm M96	18.4	1.49
Run 3	Hi-Skor 700X	12.1	1.95
Run 4	Hi-Skor 700X	5.2	9.08
Run 5*⁻	20mm M96	6.2	38.29
Run 6	20mm M96	6.0	22.64
Run 7	Hi-Skor 700X	3.1	20.99
Run 8	FA-956 Primer	5.9	16.30
Run 9	20mm M96	5.9	24.47
Run 10	20mm M96	7.8	20.98
Run 11	IMR-5010	8.2	39.99
Run 12	IMR-5010	3.3	17.26
Run 13⁻	FA-956 Primer	2.7	7.61
Run 14	FA-956 Primer	6.2	
Run 15	FA-956 Primer	5.2	10.67
Run 16	IMR 5010	8.1	62.26

* Fugitive emissions
⁻ MeM5 train failed posttest leak check

(b) Metals Emission Rates. The stack metal emission rates were found using the analysis of samples generated by the MeM5 train. The metals emission rates for the FA-956 primer, as tested, did not exceed the Tier II limits (corresponding to the Tier I levels as specified in reference 18). The Cr emission rate for runs 1 and 10 for the 20mm M96 cartridge, as tested, exceeded the Tier II limit. Detailed sampling and analysis methods are described in Appendices C and E, respectively. Detailed metals emission data is found in Appendix N.

(c) Metals Removal Efficiency. The system metals removal efficiency (RE) was calculated for Sb and Pb for the 20mm M96 feed and Sb, Pb, and Ba for the FA-956 primer feed. The RE calculation is comparable to the DRE calculation in that the metal feed (input) and the stack emissions (output) are used. The RE's for the 20mm M96 are minimum values as the metal input values used in the RE calculation are minimum values [see paragraph 5f(4)(a)]. Table 21 summarizes the metals RE's for all valid 20mm M96 runs and Table 22 for the valid FA-956 primer runs. Since the metals emission data for Runs 5 and 13 were invalidated because of a failed posttest leak check, the RE could not be calculated.

g. Process Operating Conditions.

(1) Incinerator Operating Conditions. The incinerator operating conditions are summarized in Tables 23 through 26. Only data from valid runs for each particular feed item are shown.

TABLE 21. METALS RE SUMMARY - 20mm M96 CARTRIDGE FEED

Parameter	Run 6	Run 9	Run 10	Avg
Waste Feed Rate (lb/hr)	579.20	568.02	483.81	543.68
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24	86.80
Min Sb Feed Rate (lb/hr)	0.0265	0.0260	0.0221	0.0249
Min Pb Feed Rate (lb/hr)	0.0474	0.0465	0.0396	0.0445
Max Sb Emission Rate (lb/hr)	7.40×10^{-4}	6.82×10^{-4}	6.91×10^{-4}	7.04×10^{-4}
Max Pb Emission Rate (lb/hr)	6.07×10^{-3}	1.07×10^{-2}	3.99×10^{-3}	6.92×10^{-3}
Min System Sb RE (%)	97.21	97.38	96.88	97.16
Min System Pb RE (%)	87.19	77.00	89.92	84.70

TABLE 22. METALS RE SUMMARY - FA-956 PRIMER FEED

Parameter	Run 8	Run 14	Run 15	Avg
Waste Feed Rate (lb/hr)	90.75	133.88	146.78	123.80
PEP Feed Rate (lb/hr)	11.66	17.21	18.86	15.16
Sb Feed Rate (lb/hr)	1.2291	1.8131	1.9880	1.5977
Ba Feed Rate (lb/hr)	1.9245	2.8390	3.1127	2.5017
Pb Feed Rate (lb/hr)	1.9199	2.8322	3.1053	2.4957
Max Sb Emission Rate (lb/hr)	6.90×10^{-4}	8.77×10^{-4}	6.65×10^{-4}	7.44×10^{-4}
Max Ba Emission Rate (lb/hr)	7.60×10^{-4}	1.01×10^{-3}	1.33×10^{-4}	6.34×10^{-4}
Max Pb Emission Rate (lb/hr)	6.87×10^{-3}	6.86×10^{-3}	4.53×10^{-3}	6.09×10^{-3}
System Sb RE (%)	99.94	99.95	99.97	99.95
System Ba RE (%)	99.96	99.96	99.99	99.97
System Pb RE (%)	99.64	99.76	99.85	99.74

TABLE 23. INCINERATOR OPERATING DATA - 20mm M96 CARTRIDGE FEED

Run Number Date	6 26 Feb 91	9 27 Feb 91	10 28 Feb 91
FEED DATA			
Waste Feed Rate (lb/hr)	579.20	568.02	483.81
Heat of Combustion (Btu/lb)*	750-1000	750-1000	750-1000
Auxiliary Fuel Rate (gal/hr)	41.54	33.90	44.00
Heating Value (Btu/lb)	137,000	137,000	137,000
OPERATIONAL DATA			
Kiln Rotation (rpm)	1.0	1.1	1.0
Kiln Inlet Temp (°F)			
Max	415	464	429
Min	386	399	355
Avg	400	418	390
Kiln Outlet Temp (°F)			
Max	1090	1016	1076
Min	776	760	1009
Avg	917	846	1053
Afterburner Outlet Temp (°F)			
Max	1430	1429	1429
Min	1370	1374	1375
Avg	1399	1400	1400

* Round not produced at LCAAP. Estimated value.

TABLE 24. INCINERATOR OPERATING DATA - FA-956 PRIMER FEED

Run Number Date	8 27 Feb 91	14 4 Mar 91	15 4 Mar 91
FEED DATA			
Waste Feed Rate (lb/hr)	90.75	116.37	146.78
Heat of Combustion (Btu/lb)	1084	1084	1084
Auxiliary Fuel Rate (gal/hr)	33.90	37.83	37.83
Heating Value (Btu/lb)	137,000	137,000	137,000
OPERATIONAL DATA			
Kiln Rotation (rpm)	1.7	1.6	1.7
Kiln Inlet Temp (°F)			
Max	404	311	309
Min	373	296	298
Avg	307	301	303
Kiln Outlet Temp (°F)			
Max	877	943	707
Min	725	770	671
Avg	694	853	684
Afterburner Outlet Temp (°F)			
Max	1477	1368	1372
Min	1372	1330	1330
Avg	1350	1350	1350

TABLE 25. INCINERATOR OPERATING DATA - HI-SKOR 700X PROPELLANT FEED

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
FEED DATA			
Propellant Feed Rate (lb/hr)	43.42	40.18	37.82
Heat of Combustion (Btu/lb)	6498-6994	6498-6994	6498-6994
Auxiliary Fuel Rate (gal/hr)	43.03	44.13	39.88
Heating Value (Btu/lb)	137,000	137,000	137,000
OPERATIONAL DATA			
Kiln Rotation (rpm)	2.8	2.8	2.8
Kiln Inlet Temp (°F)			
Max	386	351	395
Min	307	283	362
Avg	349	321	382
Kiln Outlet Temp (°F)			
Max	729	667	730
Min	667	627	714
Avg	712	652	724
Afterburner Outlet Temp (°F)			
Max	1475	1468	1475
Min	1177	1428	1427
Avg	1448	1449	1450

TABLE 26. INCINERATOR OPERATING DATA - IMR 5010 PROPELLANT FEED

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
FEED DATA			
Propellant Feed Rate (lb/hr)	151.33	199.94	194.55
Heat of Combustion (Btu/lb)	4156-4653	4156-4653	4156-4653
Auxiliary Fuel Rate (gal/hr)	40.79	39.53	37.83
Heating Value (Btu/lb)	137,000	137,000	137,000
OPERATIONAL DATA			
Kiln Rotation (rpm)	2.8	2.8	2.8
Kiln Inlet Temp (°F)			
Max	730	638	685
Min	526	432	373
Avg	654	559	615
Kiln Outlet Temp (°F)			
Max	747	679	736
Min	702	635	679
Avg	732	667	722
Afterburner Outlet Temp (°F)			
Max	1427	1424	1452
Min	1363	1368	1377
Avg	1400	1400	1401

(2) APCS Operating Conditions.' The APCS operating conditions are summarized in Tables 27 through 30. Only data from the valid runs for the particular feed item are shown.

TABLE 27. APCS OPERATING DATA - 20mm M96 CARTRIDGE FEED

Run Number Date	6 26 Feb 91	9 27 Feb 91	10 28 Feb 91
HTHE Outlet			
Temp (°F)			
Max	816	815	815
Min	795	795	796
Avg	805	846	801
LTHE Outlet			
Temp (°F)			
Max	307	306	306
Min	282	283	280
Avg	294	294	293
Baghouse Outlet			
Temp (°F)			
Max	268	267	269
Min	261	260	260
Avg	264	264	264

TABLE 28. APCS OPERATING DATA - FA-956 PRIMER FEED

Run Number Date	8 27 Feb 91	14 4 Mar 91	15 4 Mar 91
HTHE Outlet			
Temp (°F)			
Max	831	811	811
Min	795	791	788
Avg	801	853	800
LTHE Outlet			
Temp (°F)			
Max	309	308	308
Min	282	284	285
Avg	294	295	295
Baghouse Outlet			
Temp (°F)			
Max	269	268	269
Min	262	260	261
Avg	263	264	265

TABLE 29. APCS OPERATING DATA - HI-SKOR 700X PROPELLANT FEED

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
HTHE Outlet			
Temp (°F)			
Max	838	837	820
Min	789	816	796
Avg	832	828	806
LTHE Outlet			
Temp (°F)			
Max	308	309	307
Min	281	282	282
Avg	295	295	294
Baghouse Outlet			
Temp (°F)			
Max	274	269	270
Min	262	259	256
Avg	267	264	262

TABLE 30. APCS OPERATING DATA - IMR 5010 PROPELLANT FEED

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
HTHE Outlet			
Temp (°F)			
Max	815	817	814
Min	794	795	794
Avg	803	804	804
LTHE Outlet			
Temp (°F)			
Max	307	306	308
Min	280	282	282
Avg	293	294	295
Baghouse Outlet			
Temp (°F)			
Max	270	262	272
Min	261	252	262
Avg	265	256	267

h. Sampling and Analysis Results.

(1) Methods Summary. A summary of the sampling and analysis performed for this trial burn is found in Table 1.

(2) Stack Gas Data. The stack gas data is summarized in Tables 31 through 34. The data are only from the valid runs for the particular feed item.

(3) APCS Residues. The only measurable ash generated by the APCS was at the HTHE and the baghouse. The samples for POHC runs were analyzed for the POHC, while the ash samples from the metals runs were analyzed for total metals and for TCLP (metals). Detailed sample recovery and analysis of the residues are discussed in detail in Appendix E. Appendix P contains the APCS residue data.

(a) APCS Ash - Total POHC. The APCS ash from all POHC runs was analyzed for POHC to for use in a material balance. This is necessary to determine the fate of the POHC's as required by reference 6. Tables 35, 36, and 37 summarize the POHC in the system ash. Detailed analytical data is found in Appendix L.

(b) APCS Ash - TCLP. The TCLP (metals) was conducted to determine if the ash generated at the HTHE and baghouse is a hazardous waste by virtue of the toxicity characteristic. The total amount of ash generated at the HTHE did not allow for TCLP analysis runs 2, 10, 14, and 15. The HTHE ash and the baghouse ash for all samples for both feed items was found to exceed the maximum value for Pb. For the 20mm M96 feed, one sample from the HTHE and one sample from the baghouse exceeded the Cd limit and one baghouse ash sample exceeded the Hg limit. Additionally, one HTHE ash sample exceeded the limit for Cd. Table 38 summarizes the TCLP data for the metals known to be present in the feed for the 20mm M96 and Table 39 the FA-956 primer feed. Detailed TCLP data is found in Appendix P.

(c) APCS Ash - Total Metals. The APCS ash at the HTHE and the baghouse was analyzed for total metals. Tables 40 and 41 summarize the ash total metals data for the 20mm M96 and FA-956 primer for those metals known to be in the feed. Detailed total metal residue data for all target metals are found in Appendix P.

(d) Auxiliary Fuel. The fuel oil was analyzed for POHC's and for metals content. There were no detectable amounts of any of the POHC's in the auxiliary fuel. Table 42 summarizes the metals analysis of the fuel oil.

i. POHC Material Balance. A material balance for POHC's is required by reference 6 to demonstrate the ultimate fate of the POHC's. Tables 43, 44, and 45 provides the material balances for NG, DNT, and DPA respectively.

TABLE 31. STACK GAS DATA - 20mm M96 CARTRIDGE FEED

Run Number Date	6 26 Feb 91	9 27 Feb 91	10 28 Feb 91
CEM DATA			
Corrected CO (ppm)			
Max	76.89	118.03	56.6
Min	0.00	2.57	0.00
Avg	21.67	20.61	18.97
O_2 (%, dry)			
Max	16.80	16.50	15.60
Min	15.50	15.30	14.90
Avg	16.29	15.99	15.25
Max Corrected CO Hourly Rolling Avg (ppm)	22.64	24.47	20.98
Max THC (ppm)	6.0	5.9	7.8
ORSAT DATA			
CO_2 Concentration (%, dry)	4.20	4.00	4.20
O_2 Concentration (%, dry)	16.00	16.00	15.53
N_2 Concentration (%, dry)	79.80	80.00	80.27
CO Concentration (%, dry)	<0.05	<0.05	<0.05
OTHER PARAMETERS			
Moisture (%)			
M5 Train	3.9	3.9	4.6
MeM5 Train	4.0	4.0	4.5
Avg Stack Gas Volumetric Flow Rate (acfm)			
RM 4			
M5 Train	5140	5152	4940
MeM5 Train	5176	5280	5056
In-stack pitot/venturi	4356	4056	4144
STACK GAS EMISSIONS			
Corrected Particulate Concentration (gr/dscf)	0.017	0.018	0.015
Max Ag Emission Rate (lb/hr)	5.73×10^{-5}	9.75×10^{-5}	5.57×10^{-5}
Max As Emission Rate (lb/hr)	2.87×10^{-5}	2.81×10^{-5}	2.78×10^{-5}
Max Ba Emission Rate (lb/hr)	1.31×10^{-3}	8.89×10^{-4}	2.73×10^{-3}
Max Be Emission Rate (lb/hr)	5.56×10^{-6}	5.62×10^{-6}	5.57×10^{-6}
Max Cd Emission Rate (lb/hr)	1.25×10^{-4}	1.57×10^{-4}	9.13×10^{-5}
Max Cr Emission Rate (lb/hr)	4.17×10^{-5}	8.87×10^{-5}	6.04×10^{-4}
Max Hg Emission Rate (lb/hr)	4.04×10^{-5}	3.53×10^{-5}	3.34×10^{-4}
Max Pb Emission Rate (lb/hr)	6.07×10^{-3}	1.07×10^{-2}	3.99×10^{-3}
Max Sb Emission Rate (lb/hr)	7.40×10^{-4}	6.82×10^{-4}	6.91×10^{-4}
Max Tl Emission Rate (lb/hr)	5.56×10^{-6}	5.62×10^{-6}	5.57×10^{-6}

TABLE 32. STACK GAS DATA - FA-956 PRIMER FEED

Run Number	8	14	15
Date	27 Feb 91	4 Mar 91	4 Mar 91
CEM DATA			
Corrected CO (ppm)			
Max	25.86	25.61	20.44
Min	3.02	6.47	3.66
Avg	10.94	11.92	10.36
O_2 (%, dry)			
Max	16.70	17.20	17.50
Min	16.30	16.30	17.00
Avg	16.50	16.78	17.22
Max Corrected CO Hourly Rolling Avg (ppm)	16.30	12.19	10.67
Max THC (ppm)	5.9	6.2	5.2
ORSAT DATA			
CO_2 Concentration (%, dry)	3.40	3.60	3.40
O_2 Concentration (%, dry)	16.53	16.20	16.20
N_2 Concentration (%, dry)	80.07	80.20	80.40
CO Concentration (%, dry)	<0.05	<0.05	<0.05
OTHER PARAMETERS			
Moisture (%)			
M5 Train	3.4	3.6	3.6
MeM5 Train	3.5	3.8	3.7
Avg Stack Gas Volumetric Flow Rate (acfm)			
RM 4			
M5 Train	5091	5163	5138
MeM5 Train	5115	5127	5128
In-stack pitot/venturi	4056	4388	4369
STACK GAS EMISSIONS			
Corrected Particulate Concentration (gr/dscf)	0.017	0.021	0.018
Max Ag Emission Rate (lb/hr)	6.05×10^{-5}	4.89×10^{-5}	6.02×10^{-5}
Max As Emission Rate (lb/hr)	2.76×10^{-5}	2.75×10^{-5}	2.79×10^{-5}
Max Ba Emission Rate (lb/hr)	7.60×10^{-4}	1.01×10^{-3}	1.33×10^{-3}
Max Be Emission Rate (lb/hr)	5.51×10^{-6}	5.58×10^{-6}	5.67×10^{-6}
Max Cd Emission Rate (lb/hr)	1.06×10^{-4}	1.04×10^{-4}	1.60×10^{-4}
Max Cr Emission Rate (lb/hr)	4.00×10^{-5}	5.75×10^{-5}	9.43×10^{-5}
Max Hg Emission Rate (lb/hr)	3.05×10^{-5}	7.37×10^{-5}	3.61×10^{-5}
Max Pb Emission Rate (lb/hr)	6.87×10^{-3}	6.86×10^{-3}	4.65×10^{-3}
Max Sb Emission Rate (lb/hr)	6.90×10^{-4}	8.77×10^{-4}	6.65×10^{-4}
Max Tl Emission Rate (lb/hr)	5.51×10^{-6}	5.58×10^{-6}	5.67×10^{-6}

TABLE 33. STACK GAS DATA - HI-SKOR 700X PROPELLANT FEED

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
CEM DATA			
Corrected CO (ppm)			
Max	71.74	29.09	62.88
Min	0.00	0.00	0.00
Avg	0.75	4.65	10.57
O_2 (%, dry)			
Max	17.80	16.70	16.70
Min	15.80	16.20	16.20
Avg	16.13	16.49	16.42
Max Corrected CO Hourly Rolling Avg (ppm)	1.95	9.08	20.99
Max THC (ppm)	12.1	5.2	3.1
ORSAT DATA			
CO_2 Concentration (%, dry)	3.86	4.00	3.60
O_2 Concentration (%, dry)	15.96	16.00	16.20
N_2 Concentration (%, dry)	80.18	80.00	80.20
CO Concentration (%, dry)	<0.05	<0.05	<0.05
OTHER PARAMETERS			
Moisture (%)			
M5 Train	4.0	3.8	3.9
STEM Train	4.0	3.7	3.8
Avg Stack Gas Volumetric Flow Rate (acfm)			
RM 4			
M5 Train	5168	5092	5139
STEM Train	5355	5187	5260
In-stack pitot/venturi	4326	4462	4306
STACK GAS EMISSIONS			
Corrected Particulate Concentration (gr/dscf)	0.007	0.025	0.029
Max NG Concentration (µg/dscf)	0.422	0.640	0.667

TABLE 34. STACK GAS DATA - IMR 5010 PROPELLANT FEED

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
CEM DATA			
Corrected CO (ppm)			
Max	164.53	57.03	89.36
Min	0.00	0.00	0.00
Avg	24.63	15.28	30.36
O_2 (%, dry)			
Max	16.40	17.00	17.00
Min	15.60	16.40	16.40
Avg	15.94	16.70	16.71
Max Corrected CO Hourly Rolling Avg (ppm)	39.66	17.26	62.26
Max THC (ppm)	8.2	3.3	8.1
ORSAT DATA			
CO_2 Concentration (%, dry)	4.00	4.06	4.00
O_2 Concentration (%, dry)	16.00	15.93	16.20
N_2 Concentration (%, dry)	80.00	80.01	79.80
CO Concentration (%, dry)	<0.05	<0.05	<0.05
OTHER PARAMETERS			
Moisture (%)			
M5 Train	4.3	4.0	4.3
STEM Train	4.2	3.9	4.0
Avg Stack Gas Volumetric Flow Rate (acfm)			
RM 4			
M5 Train	5316	5203	5082
STEM Train	5294	5147	5107
In-stack pitot/venturi	4127	4278	4105
STACK GAS EMISSIONS			
Corrected Particulate Concentration (gr/dscf)	0.040	0.020	0.025
Max DNT Concentration (µg/dscf)	0.341	0.334	0.338
Max DPA Concentration (µg/dscf)	0.341	0.334	0.338

TABLE 35. NG RESIDUE SUMMARY - HI-SKOR 700X RUNS

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
Max HTHE NG Collected (lb)	2.20×10^{-9}	2.38×10^{-9}	2.20×10^{-9}
Max Baghouse NG Collected (lb)	1.56×10^{-8}	1.92×10^{-8}	5.50×10^{-8}
Total APCS NG (lb)	1.78×10^{-8}	2.15×10^{-8}	5.72×10^{-8}

TABLE 36. DNT RESIDUE SUMMARY - IMR-5010 RUNS

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
Total HTHE DNT Collected (lb)	6.92×10^{-9}	1.10×10^{-9}	2.05×10^{-8}
Total Baghouse DNT Collected (lb)	1.85×10^{-7}	7.01×10^{-9}	4.96×10^{-8}
Total APCS DNT (lb)	1.92×10^{-7}	8.11×10^{-9}	7.01×10^{-8}

TABLE 37. DPA RESIDUE SUMMARY - IMR-5010 RUNS

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
Total HTHE DPA Collected (lb)	1.38×10^{-8}	2.20×10^{-9}	9.55×10^{-9}
Total Baghouse DPA Collected (lb)	3.70×10^{-7}	1.40×10^{-8}	9.92×10^{-8}
Total APCS DPA (lb)	3.84×10^{-7}	1.62×10^{-8}	1.09×10^{-7}

TABLE 38. TCLP DATA - 20mm M96 CARTRIDGE FEED

Run Number	1	2	6	9	10
Regulatory Pb Level (mg/L)	5.0	5.0	5.0	5.0	5.0
HTHE Ash Pb Level (mg/L)	83.3	*	76.1	55.6	*
Baghouse Ash Pb Level (mg/L)	44.1	21.8	18.8	1.59	54.3

* Insufficient quantity of ash for TCLP analysis.

TABLE 39. TCLP DATA - FA-956 PRIMER FEED

Run Number	8	14	15
Regulatory Ba Level (mg/L)	100.0	100.0	100.0
HTHE Ash Ba Level (mg/L)	<10.0	*	*
Baghouse Ash Ba Level (mg/L)	<10.0	<10.0	<10.0
Regulatory Pb Level (mg/L)	5.0	5.0	5.0
HTHE Ash Pb Level (mg/L)	65.8	*	*
Baghouse Ash Pb Level (mg/L)	12.8	16.6	15.8

* Insufficient quantity of ash for TCLP analysis.

TABLE 40. ASH TOTAL METALS DATA SUMMARY - 20mm M96 CARTRIDGE FEED

Run Number	6	9	10
Sb DATA			
Total Sb HTHE Ash (lb)	0.0018	0.0028	0.0008
Total Sb Baghouse Ash (lb)	0.0798	0.0878	0.0378
Total Sb APCS Ash (lb)	0.0816	0.0906	0.0386
Pb DATA			
Total Pb HTHE Ash (lb)	0.0291	0.0311	0.0087
Total Pb Baghouse Ash (lb)	0.0111	0.7415	0.3600
Total Pb APCS Ash (lb)	0.0402	0.7726	0.3687

TABLE 41. ASH TOTAL METALS DATA SUMMARY - FA-956 PRIMER FEED

Run Number	8	14	15
Sb DATA			
Total Sb HTHE Ash (lb)	0.0013	0.0005	0.0004
Total Sb Baghouse Ash (lb)	0.0556	0.0126	0.0139
Total Sb APCS Ash (lb)	0.0569	0.0131	0.0143
Ba DATA			
Total Ba HTHE Ash (lb)	-	-	-
Total Ba Baghouse Ash (lb)	0.0002	0.0001	0.0002
Total Ba APCS Ash (lb)	0.0002	0.0001	0.0002
Pb DATA			
Total Pb HTHE Ash (lb)	0.0255	0.0060	0.0042
Total Pb Baghouse Ash (lb)	0.4635	0.3235	0.5404
Total Pb APCS Ash (lb)	0.4890	0.3295	0.5446

TABLE 42. METALS ANALYSIS OF AUXILIARY FUEL

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
Concentration (mg/L)	<1.0	<0.5	5.1	0.2	<1.0	2.2	0.05	43.9	<10.0	<0.10

TABLE 43. NG MATERIAL BALANCE - HI-SKOR 700X PROPELLANT FEED

	NG In (lb/test)	Max NG Out Stack (lb/test)	Max NG APCS Ash (lb/test)	Max NG Destroyed (lb/test)
Run 3	54.4599	7.015×10^{-4}	1.78×10^{-8}	54.4592
Run 4	35.6235	7.542×10^{-4}	2.15×10^{-8}	35.6227
Run 7	30.7401	7.440×10^{-4}	5.72×10^{-8}	30.7394

TABLE 44. DNT MATERIAL BALANCE - IMR-5010 PROPELLANT FEED

	DNT In (lb)	Max DNT Out Stack (lb)	Max DNT APCS Ash (lb)	Max DNT Destroyed (lb)
Run 11	21.0915	3.802×10^{-4}	1.92×10^{-7}	21.0911
Run 12	26.7334	3.717×10^{-4}	8.11×10^{-9}	26.7330
Run 16	26.3395	3.629×10^{-4}	7.01×10^{-8}	26.3391

TABLE 45. DPA MATERIAL BALANCE - IMR-5010 PROPELLANT FEED

	DPA In (lb)	Max DPA Out Stack (lb)	Max DPA APCS Ash (lb)	Max DPA Destroyed (lb)
Run 11	4.9750	3.802×10^{-4}	3.84×10^{-7}	4.9746
Run 12	6.5375	3.717×10^{-4}	1.62×10^{-8}	6.5371
Run 16	6.4346	3.629×10^{-4}	1.09×10^{-7}	6.4342

j. Sampling/Analysis Quality Control.

(1) QA Objectives. Quality assurance objectives and methods for this trial burn are given in the Table in Appendix E.

(2) Sampling Procedures. Quality assurance for emission sampling consisted primarily of performing necessary calibrations per reference 7 and operating stack sampling equipment as per reference 3. Appendix F contains a summary of calibration data.

(3) POHC QA Results. Precision and accuracy data for POHC analysis is based upon the field surrogate spiking of sampling train components, the spiking of component solutions and the insertion of blind QA/QC samples at the central laboratory. Tables 46, 47, and 48 summarize the results of these QA/QC procedures. The results indicate that the objectives for precision and accuracy were achieved. Additionally, all runs were considered analytically valid since the resin section analysis showed no POHC/surrogate detected in the last resin section for all runs.

TABLE 46. PRECISION DATA FOR FIRST EXTRACTIONS OF SURROGATE-SPIKED RESIN SECTION AND IMPINGER CONDENSATE

Surrogate	Matrix	Percent Relative Standard Deviation (RSD)
EGDN	Resin	7.03
EGDN	Impinger Condensate	4.12
3,4-DNT	Resin	5.10
3,4-DNT	Impinger Condensate	11.37

TABLE 47. FIELD/SAMPLE TRAIN SPIKING PRECISION AND ACCURACY DATA

POHC/ Surrogate	Matrix	Recovery Accuracy (%)	Standard Deviation (%)	RSD (%)
EGDN	Resin	97.25	5.909	6.08
EGDN	Impinger H_2O	99.15	2.791	2.81
EGDN	Filter/Toluene	100.00	-	-
3,4-DNT	Resin	103.00	2.380	4.62
3,4-DNT	Impinger H_2O	98.50	4.349	8.83
3,4-DNT	Filter/Toluene	96.00	-	-
NG	Resin	110.00	-	-
NG	Impinger H_2O	98.00	-	-
NG	Filter/Toluene	110.00	-	-
2,4-DNT	Resin	100.00	-	-
2,4-DNT	Impinger H_2O	100.00	-	-
2,4-DNT	Filter/Toluene	90.00	-	-
DPA	Resin	108.00	-	-
DPA	Impinger H_2O	104.00	-	-
DPA	Filter/Toluene	94.00	-	-

TABLE 48. PRECISION AND ACCURACY DATA OF BLIND QA SAMPLES

Surrogate/POHC	Matrix	Precision: Relative Standard Deviation (%)	Accuracy: Percent Recovery	Accuracy: Standard Deviation (%)
EGDN	Solvent	7.71	116.00	8.94
EGDN	Resin	27.00	93.44	25.23
3,4-DNT	Solvent	0.58	99.69	0.58
3,4-DNT	Resin	2.51	100.61	2.53
NG	Solvent	15.47	126.00	19.49
NG	Resin	14.23	94.12	13.39
2,4-DNT	Solvent	7.80	97.22	7.59
2,4-DNT	Resin	4.41	99.75	4.40
DPA	Solvent	6.96	95.00	6.61
DPA	Resin	2.44	97.49	2.37

(4) Data Completeness. The data completeness of 100 percent was greater than the 95 percent objective. Of the 344 field samples submitted, all were analyzed.

6. CONCLUSIONS.

a. Performance Standard. The DF located at Building 97, as tested, met the performance standards for HWI's (reference 5).

(1) Particulate Emissions. The corrected particulate concentrations for all test runs were below the 0.080 gr/dscf corrected particulate concentration standard for HWI's.

(2) DRE. The DRE's for the POHC's of NG, 2,4-DNT and DPA for all runs exceeded the required minimum DRE standard of 99.99 percent.

b. CO Requirements. The corrected CO 1-hour rolling average for all runs was below the Tier 1 limit of 100 ppm.

c. Operating Requirements. The additional data required to establish permit operating conditions for this incinerator was obtained.

d. Metals Data.

(1) Metals Emissions.

(a) 20mm M96 Feed. The Cr emission rate for Runs 1 and 10 for the 20mm M96 cartridge, as tested, exceeded the Tier II emission limit.

(b) FA-956 Primer Feed. The metals emission rates for the FA-956 primer, as tested, did not exceed the Tier II limits.

(2) APCS Ash TCLP Data. The HTHE and baghouse ash generated during the 20mm M96 and FA-956 runs was found to be a hazardous waste per the toxicity characteristic.

7. RECOMMENDATION. Provide a copy of this report to the Missouri Department of Natural Resources.

8. TECHNICAL ASSISTANCE. Requests for services should be directed through appropriate command channels of the requesting activity to the Commander, U.S. Army Environmental Hygiene Agency, ATTN: HSHB-ME-AS, Aberdeen Proving Ground, MD 21010-5422, with an information copy furnished the Commander, U.S. Army Health Services Command, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000.

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APPENDIX A

REFERENCES

1. AR 40-5, 15 October 1990, Preventive Medicine.

2. AR 200-1, 23 April 1990, Environmental Protection and Enhancement.

3. Title 40, CFR, 1990 rev, Part 60, Standards of Performance for New Stationary Sources.

4. Title 40, CFR, 1990 rev, Part 261, Identification and Listing of Hazardous Waste.

5. Title 40, CFR, 1990 rev, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Treatment Facilities.

6. Title 40, CFR, 1990 rev, Part 270, EPA Administered Permit Programs: The Hazardous Waste Permit Program.

7. EPA 600/4-77-027b, March 1983, Quality Assurance Handbook for Air Pollution Measurement Systems, Vol III, Stationary Source Specific Methods.

8. EPA APTD-0576, March 1982, Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment.

9. EPA Manual SW-846, November 1986, Test Methods for Evaluating Solid Waste, Third Edition, Vol IA: Laboratory Manual Physical/Chemical Methods.

10. EPA Manual, November 1989, Proposed Methods For Stack Emissions Measurement of CO, O_2, THC, HCl, and Metals at Hazardous Waste Incinerators, Volume VI of the Hazardous Waste Incineration Guidance Series.

11. EPA Guidance Document (Draft), March 1988, subject: Guidance on Metals and Hydrogen Chloride Controls for Hazardous Waste Incinerators, Vol. IV of the Hazardous Waste Guidance Series.

12. EPA Guidance Document (Draft), March 1989, subject: Guidance on Carbon Monoxide Controls for Hazardous Waste Incinerators.

13. Standard Methods for Water and Wastewater Analysis, 16th Edition.

14. Memorandum, USAEHA, HSHB-ME-AS, 31 May 1989, subject: Trial Burn Test Plan (TBTP) for Deactivation Furnace.

15. Memorandum, USAEHA, HSHB-ME-AS, 20 July 1989, subject: Trial Burn Test Plan (TBTP) for Deactivation Furnace Revision A.

Air Pollution Emission Assessment No. 42-21-0475-91, 19 Feb-4 Mar 91

16. Memorandum, USAEHA, HSHB-ME-AS, 3 August 1989, subject: Trial Burn Test Plan (TBTP) for Deactivation Furnace Revision B.

17. Memorandum, USAEHA, HSHB-ME-AS, 4 February 1991, subject: Trial Burn Test Plan (TBTP) for Deactivation Furnace Revision C.

18. Certified Letter, State of Missouri Department of Natural Resources, 18 August 1989, subject: The LCAAP Draft RCRA Incinerator Permit.

APPENDIX B

WASTE FEED CHARACTERIZATION

Waste Item: 20mm M96
Cartridge Weight: 4000 grains (estimated)*
PEP Weight: 638.6 grains
Heat of Combustion (entire round): 750-1000 Btu/lb (estimated)*
Target Item Feed Rate: 566 lb/hr*

COMPOUND	Component Concentration (grains/item)	Component Feed Rate (lb/hr)
Antimony Sulfide	0.26	0.04
Calcium Resonate	3.19	0.44
Diphenylamine	3.77	0.52
Lead Sulfocyanate	0.51	0.07
Magnesium Aluminum	78.10	10.86
Nitrocellulose	459.22	63.84
PETN	0.19	0.03
Potassium Chlorate	1.09	0.15
Potassium Sulfate	3.51	0.49
Potassium Perchlorate	86.53	11.85
Tin Dioxide	3.51	0.49

* Round not produced at LCAAP, all data not available.

Waste Item: Primer, 5.56mm FA-956
Item Weight: 2.84 grains
PEP Weight: 0.365 grains
Heat of Combustion: 1084 Btu/lb
Target Item Feed Rate: 120 lb/hr

COMPOUND	Component Concentration (grains/item)	Component Feed Rate (lb/hr)
Aluminum	0.025	1.06
Antimony Sulfide	0.054	2.27
Barium Nitrate	0.115	4.84
Lead Styphnate	0.146	5.74
PETN	0.018	0.76
Tetracene	0.018	0.76

Waste Item: Hi-Skor 700X
Heat of Combustion: 6498-6994 Btu/lb
Target Item Feed Rate: 80 lb/hr

COMPOUND	Component Concentration (%)	Component Feed Rate (lb/hr)
Calcium Carbonate	0.3	0.24
Dibutylphthalate	1.0	0.80
Diphenylamine	0.8- 1.5	0.64- 1.20
Graphite	0.4	0.32
Nitrocellulose	55.0-56.0	44.00-44.80
Nitroglycerine	40.0-45.0	32.00-36.00
Potassium Nitrate	0.1	0.08
Potassium Sulfate	0.1	0.08
Sodium Sulfate	0.5	0.40
Tin Dioxide	0.1	0.08

Waste Item: IMR 5010
Heat of Combustion: 4156-4653 Btu/lb
Target Item Feed Rate: 200 lb/hr

COMPOUND	Component Concentration (%)	Component Feed Rate (lb/hr)
Dinitrotoluene	6.5-10.0	13.00- 20.00
Diphenylamine	0.5- 1.3	1.00- 2.60
Graphite	0.4	0.80
Nitrocellulose	83.8-92.5	167.60-185.00
Potassium Sulfate	0.1- 1.0	0.20- 2.00

APPENDIX C

SAMPLING EQUIPMENT AND PROCEDURES

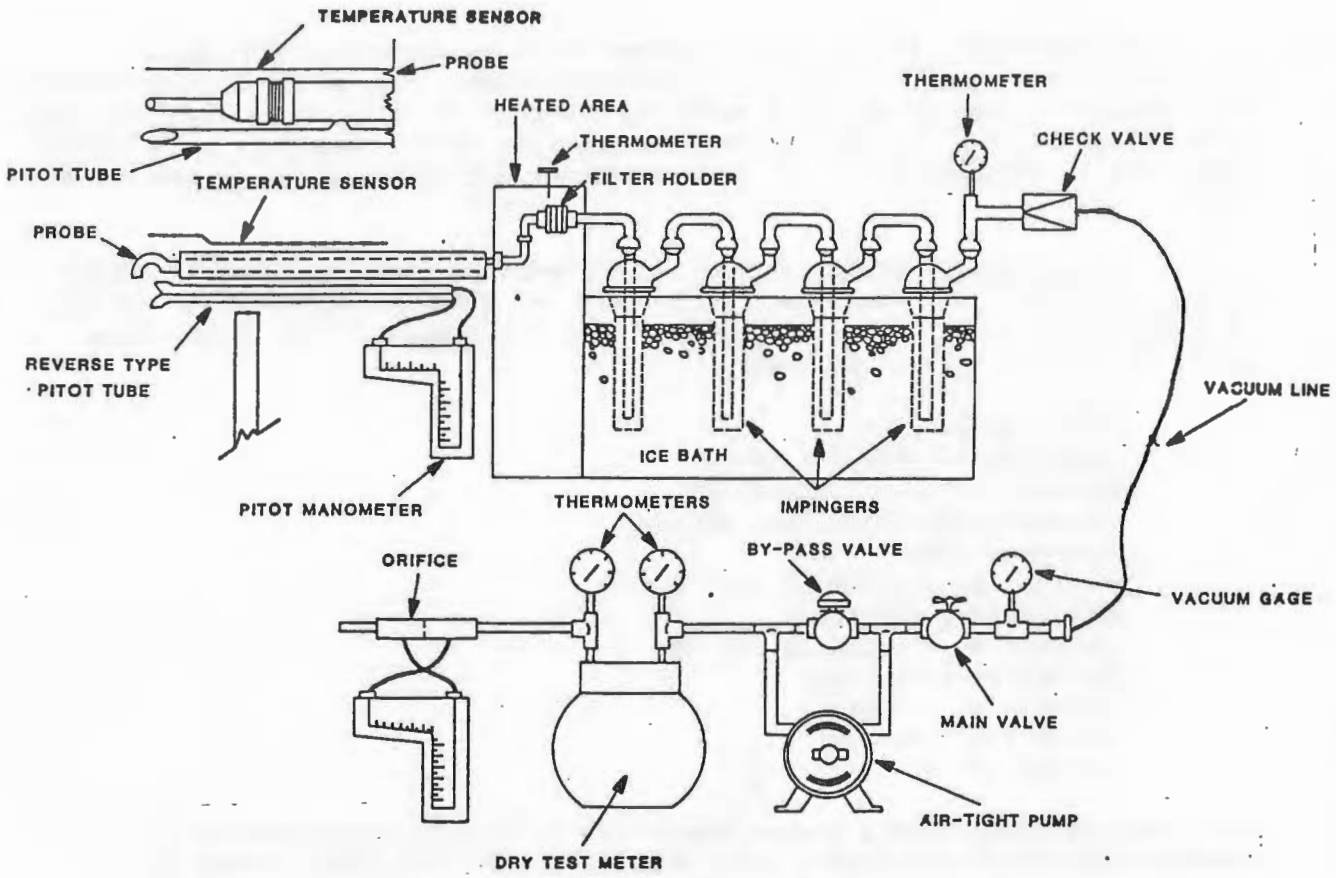
1. STACK SAMPLING. Due to the different types of emissions that were measured, three separate sampling trains were used. The particulate emissions were measured using an EPA RM 5 sampling train (M5). Metals emission sampling were measured using the EPA recommended multiple metals sampling train (MeM5) described in reference 10. The POHC emissions were measured using the USAEHA STEM.

a. Particulate Sampling Train. An M5 sampling train was used to obtain particulate emission samples. The M5 train, as shown in Figure C-1, consists of components specified by reference 3. The components of the train (from inlet to outlet) were as follows:

Sampling nozzle
Pyrex® lined sampling probe
Modified 90° glass connecter
4-inch filter with glass housing
90-degree elbow
Impinger No.1 - 100 mL (d/d H_2O)
180-degree connector
Impinger No.2 - 100 mL d/d H_2O
180-degree connector
Impinger No.3 - dry
180-degree connector
Impinger No.4 - silica gel

The sampling probe used a heated Pyrex liner. S-type pitot tubes and thermocouples were attached to the sampling probe. The pitot tubes were 0.75-inch from the probe nozzles, and the thermocouples were placed to eliminate any disturbance in the velocity measurements. The probe was attached to a sampling box containing a tared particulate filter and the impingers. The glass filter was enclosed in a chamber heated to 248 $\pm$ 25 °F. The impingers were packed in an ice bath to cool the gas and to remove the moisture from the gas sample. The sample box was connected to an umbilical cord which contained the vacuum line, pitot lines, the electrical connections and thermocouple wires. The meter box has a calibrated dry gas meter and a calibrated orifice. A vacuum pump was used to draw the sample through the sampling equipment.

®Pyrex is a registered trademark of Corning Glass Works, Houghton Park, Corning, New York



Impinger Contents

Impinger 1 - dry
Impinger 2 - 100 mL d/d H_2O
Impinger 3 - 100 mL d/d H_2O
Impinger 4 - silica gel

FIGURE C-1. PARTICULATE SAMPLING TRAIN

Two manometers, mounted on the meter box, measured the velocity pressure in the stack and the pressure differential across the meter box orifice.

b. Metals Sampling Train. The MeM5 was used to sample for metals emissions. The train configuration, as shown in Figure C-2, is an M5 sampling train with different impinger contents. This train is the EPA recommended train for metal emissions (reference 10). The train configuration is as follows:

Sampling Nozzle
Pyrex-lined sampling probe
Modified 90° glass connecter
4-inch filter with glass housing
90-degree elbow
Impinger No.1 - dry
90-degree elbow
Impinger No.2 - 100 mL of 5% HNO_3/10 % H_2O_2 solution
180-degree connector
Impinger No.3 - 100 mL 5% HNO_3/10% H_2O_2 solution
180-degree connector
Impinger No.4 - 100 mL 1.5% $KMnO_4$/10% H_2SO_4
180-degree connector
Impinger No.5 - silica gel

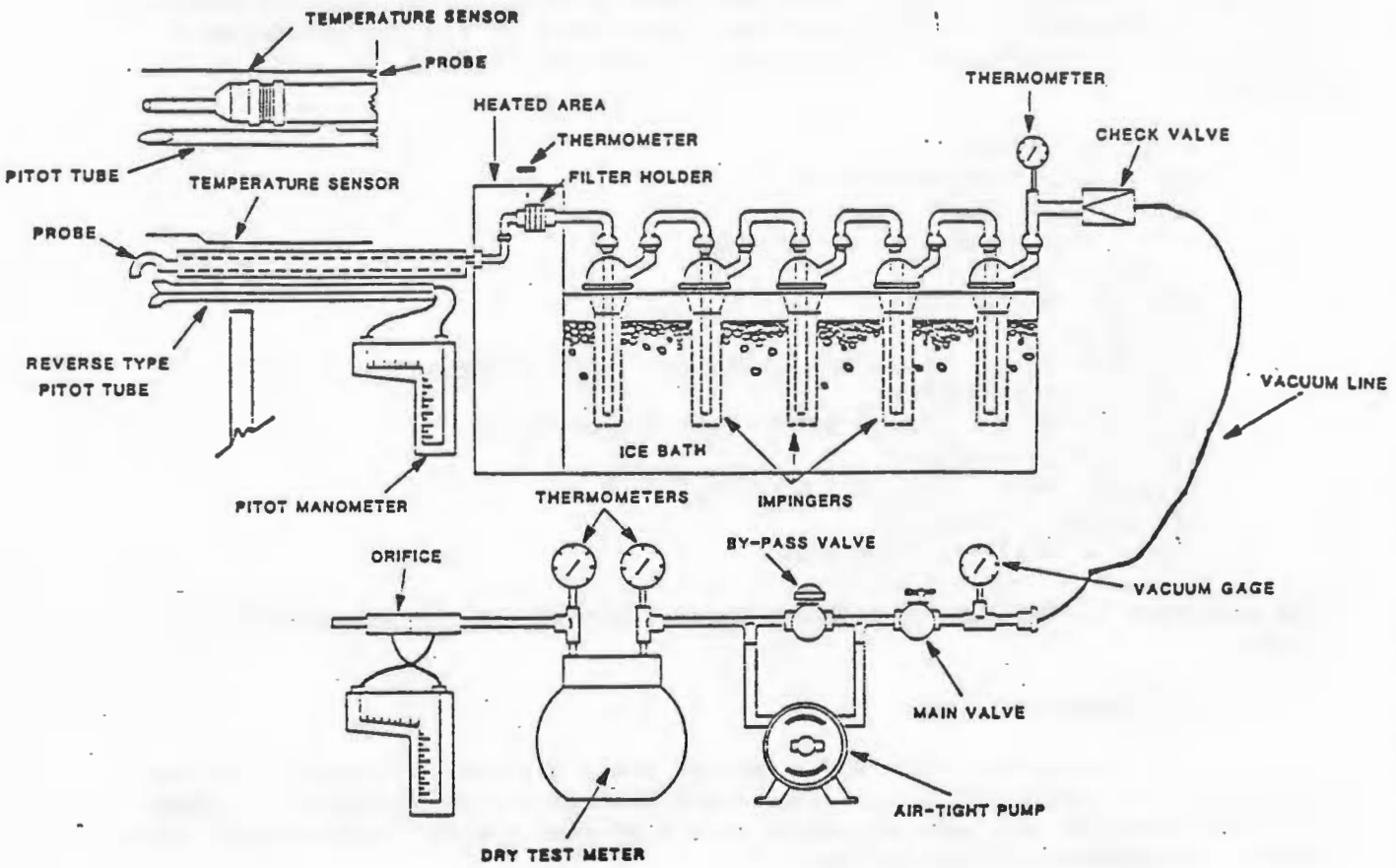
The remainder of the sampling equipment is identical to the M5 (particulate) train.

c. POHC Sampling Train.

(1) Equipment. The STEM sampling train was used to sample for the energetic POHC stack emissions. The train configuration, as shown in Figure C-3, is a modified M5 sampling train with a 20 gram XAD-2® resin module. The train configuration is as follows:

Sampling nozzle
Pyrex-lined sampling probe
Modified 90° glass connecter
4-inch filter with glass housing
90-degree elbow
Impinger No.1 - 50 mL d/d H_2O (to support surrogate spike)
180-degree connector
Impinger No.2 - dry
180-degree connector
Impinger No.3 - dry
180-degree connector
Resin Tube - 20 g XAD-2 resin

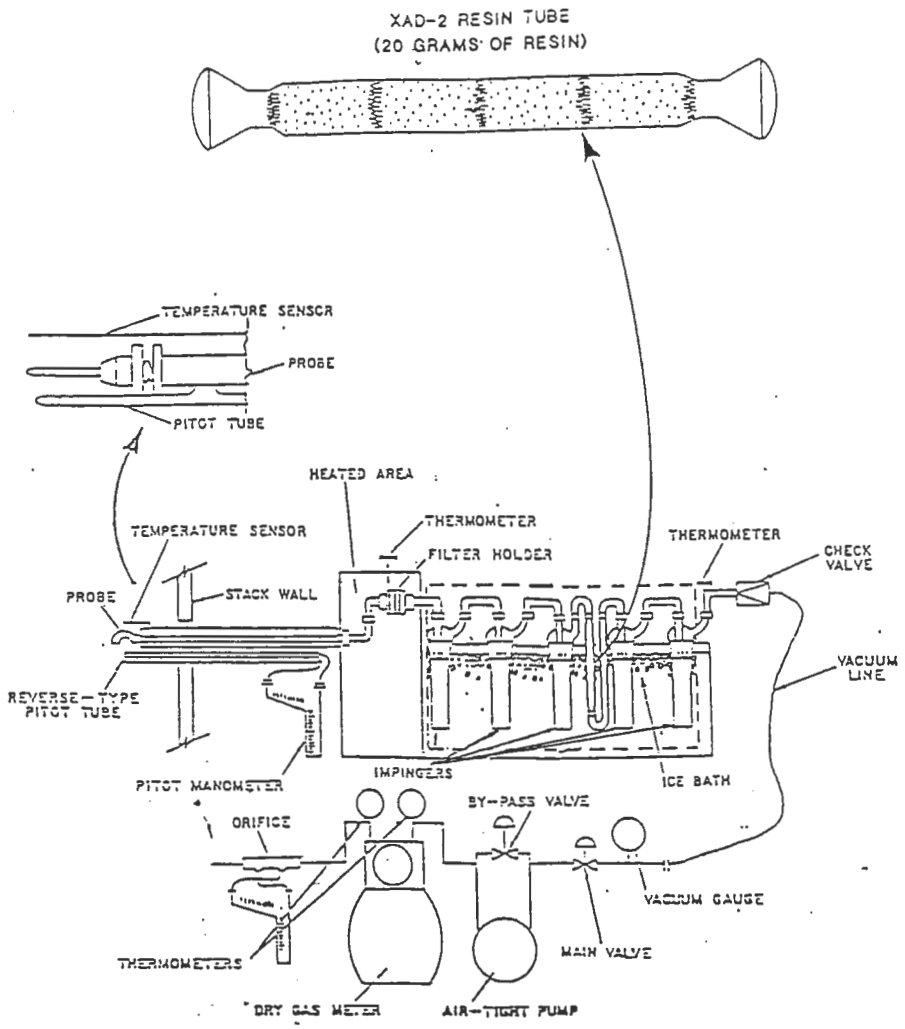
® XAD is a registered trademark of Rohm and Haas Corp., Philadelphia, Pennsylvania.



Impinger Contents

Impinger 1 - dry
Impinger 2 - 100 mL HNO_3/H_2O_2
Impinger 3 - 100 mL HNO_3/H_2O_2
Impinger 4 - 100 mL $KMnO_4/H_2SO_4$
Impinger 5 - silica gel

FIGURE C-2. EPA MULTIPLE METALS TRAIN



IMPINGER CONTENTS

Impinger 1 - 50 mL d/d H_2O
Impinger 2 - dry
Impinger 3 - dry
Resin Tube - 20 g XAD-2
Impinger 4 - dry
Impinger 5 - silica gel

FIGURE C-3 POHC SAMPLING TRAIN

180-degree connector
Impinger No.4 - dry
180-degree connector
Impinger No.5 - silica gel

The resin tube and the return flow tube were housed in a dry compartment to avoid potential water migration through glassware connections. The remaining equipment for this sampling train is identical to that used for the M5 train.

(2) Surrogates. The first impinger and the first section of the resin module were spiked with a surrogate solution. The surrogate for the POHC of NG was ethylene glycol dinitrate (EGDN) while the surrogate for the POHC of 2,4-DNT and DPA was 3,4-DNT. The use of POHC surrogates in the sampling train provides an indication of the recovery of the POHC's (see Appendix E).

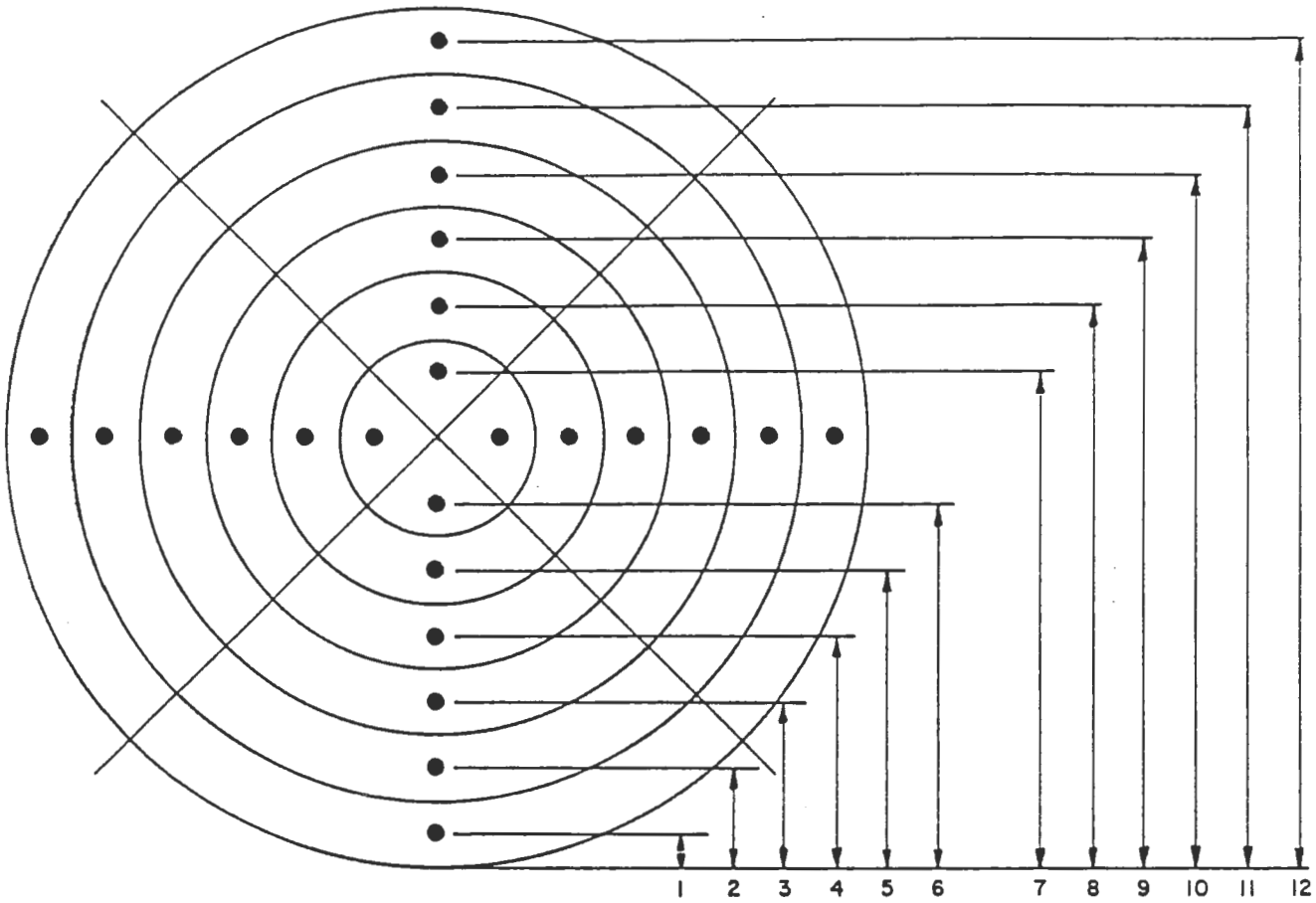
2. STACK SAMPLING TECHNIQUE. The M5, MeM5 and the STEM sampling trains were operated isokinetically. The stack sampling was performed by controlling the sampling flow rates so the velocities of the gases entering the sampling nozzle are equal to those of the undisturbed stack gas stream at the sample points. The gas flow in the stack was continuously monitored by an S-type pitot tube. Stack gas temperature was determined by a thermocouple potentiometer assembly. Integrated gas samples were taken each sampling run per RM 3 (reference 3) at a constant rate using a sample tube attached to the probe assembly, a vacuum pump, and a Teflon® collection bag.

3. TEST POINTS. The number of points per traverse was determined by RM 1 (reference 3). There were 24 sampling points (12 per traverse) on the duct. Figure C-4 indicates the locations within the stack.

4. STACK GAS MOISTURE. Moisture was collected from the sampled stack gas by Greenburg-Smith impingers in the sampling train. All impingers were kept in an ice bath so that the final impinger stack gas exit temperature did not exceed 68 °F. Total moisture was determined by weighing the impingers and contents before and after each run. The weight in grams gained by the impingers is equal to the volume of liquid, in mL, collected during the test. The impingers were weighed on a top-loading balance, accurate to 0.1 gram.

5. STACK GAS COMPOSITION. The stack gases were sampled per RM 3 of reference 3 to determine CO_2, CO, and O_2. The stack gases were collected as previously described.

® Teflon is a registered trademark of E.I. duPont de Nemours & Co., Inc., Wilmington, Delaware.



Point No.	Percentage of Stack Diameter	Distance From Stack Wall
1	2.1	1/2"
2	6.7	1 1/4"
3	11.8	2 1/4"
4	17.7	3 3/8"
5	25.0	4 7/8"
6	35.6	6 7/8"
7	64.4	12 1/2"
8	75.0	14 1/2"
9	82.3	16"
10	88.2	17 1/8"
11	93.3	18 1/8"
12	97.9	18 7/8"

FIGURE C-4. TRAVERSE POINTS WITHIN 19 3/8-INCH EXHAUST STACK

6. CLEANUP REQUIREMENTS.

a. Particulate (M5). The glassware for these trains was cleaned using clean soapy tap water, and when necessary, a nylon bristle brush to remove any visible residue. The glassware was rinsed thoroughly with tap water before being place in a sonic bath containing d/d H_2O and Chem-Solve®. Following sonication, the glassware was rinsed with d/d H_2O and allowed to air dry.

c. Metals Sampling Train (MeM5). The glassware for these trains was cleaned using clean soapy tap water, and when necessary, a nylon bristle brush to remove any visible residue. This was followed by rinsing three times with tap water followed by three additional rinses with water. All glassware was then soaked in 10 percent (v/v) HNO_3 for a minimum of 4 hours, rinsed three times with d/d H_2O, rinsed a final time with acetone and air dried.

b. Energetic POHC Sampling Train (STEM).

(1) Glassware Cleanup. Cleanup of the glassware began with an acetone rinse. The glassware will then be placed in a sonic bath containing d/d H_2O and Chem-Solve. Following sonication, the glassware will be rinsed with d/d H_2O and air dried.

(2) Resin Cleanup. The XAD-2 resin is purchased by USAEHA in a purified form (previously cleaned by Soxhlet extraction).

® is a registered trademark of Mallinckrodt.

APPENDIX D

VELOCITY TRAVERSE AND CYCLONIC FLOW DATA

TRAVERSE POINT LOCATION FOR CIRCULAR STACKS

INSTALLATION Lake City AAP

DATE 21 Feb 1991

SAMPLING LOCATION Exhaust Stack - DF Bldg 97

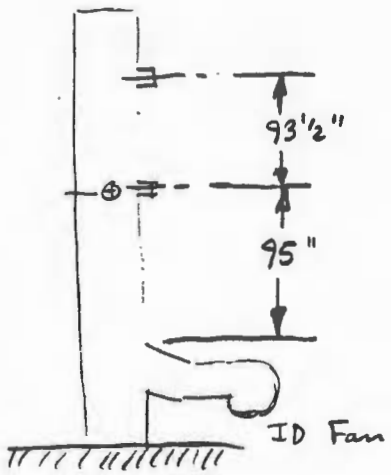
INSIDE OF FAR WALL TO OUTSIDE OF NIPPLE (DISTANCE A) $22\frac{7}{8}$

INSIDE OF NEAR WALL TO OUTSIDE OUTSIDE OF NIPPLE (DISTANCE B) $3\frac{1}{2}$

STACK I.D. (A - B) $19\frac{3}{8}$

NEAREST UPSTREAM DISTURBANCE CO/O_2 Monitor Probe $93\frac{1}{2}$" (4.83 dd)

NEAREST DOWNSTREAM DISTURBANCE Inlet Duct - ID Fan 95" (4.90 dd)



SCHEMATIC OF SAMPLING LOCATION

PITOT TUBE BLOCKAGE CORRECTION FACTOR:

External Sheath and Z Blockage > 3Z K = 1.0197 - 0.0098 (Z Blockage)

No External Sheath and Z Blockage > 2Z K = 1.0132 - 0.0101 (Z Blockage)

Z Blockage = (Stack Dia/2 - Nozzle Length)(Sheath Dia)/Stack Area X 100

$C_{p_{corr}} = 0.84\ K$

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1, 13	.021	$19\frac{3}{8}$	.500	3.500	4"
2, 14	.067	↑	1.250	↑	$4\frac{3}{4}$"
3, 15	.118		2.250		$5\frac{3}{4}$"
4, 16	.177		3.375		$6\frac{7}{8}$"
5, 17	.250		4.875		$8\frac{3}{8}$"
6, 18	.356		6.875		$10\frac{3}{8}$"
7, 19	.644		12.500		16"
8, 20	.750		14.500		18"
9, 21	.823		16.000		$19\frac{1}{2}$"
10, 22	.882		17.125		$20\frac{5}{8}$"
11, 23	.933	↓	18.125	↓	$21\frac{5}{8}$"
12, 24	.979	$19\frac{3}{8}$	18.875	3.500	$22\frac{3}{8}$"

ENGINEERING PLANNING SHEET

For use of this form, see AEHA Form 51 SOP; the proponent is HSHE-EW.

SUBJECT:	COMPUTED BY:	DATE:	FILE NO.
STACK GAS VELOCITY AND CYCLONIC FLOW DATA	RHW	21 Feb 91	0475
	CHECKED BY:	DATE:	SHEET NO.

INSTALLATION: LCAAP

LOCATION: OF STACK (BLDG 97)

Time - 1445 hrs.

Tamb - 78°F

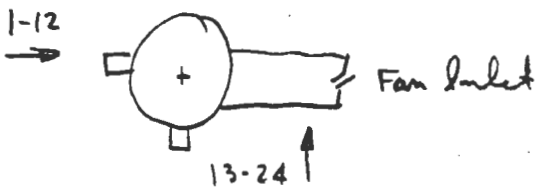
$P_{static} = -.23$

$P_{bar} = 30.01$

$V_s = (85.48)(.84)(.611)\sqrt{\frac{683}{(29)(29.99)}} = 38.88$ fps

$Q_a = 4775$ acfm

TRAVERSE POINT NUMBER		STACK VELOCITY HEAD (ΔP)		STACK TEMPERATURE (T_s)		YAW ANGLE	
1-12	13-24	1-12	13-24	1-12	13-24	1-12	13-24
1	13	.30	.30	226	205	10°	10°
2	14	.33	.33	225	215	8°	9°
3	15	.35	.35	224	220	5°	5°
4	16	.37	.37	227	223	5°	5°
5	17	.37	.39	227	223	2°	5°
6	18	.37	.39	226	223	0°	5°
7	19	.39	.39	225	223	-2°	2°
8	20	.40	.40	226	224	-2°	2°
9	21	.41	.40	225	224	-2°	0°
10	22	.41	.39	226	224	0°	0°
11	23	.39	.40	224	224	0°	-2°
12	24	.39	.39	224	222	0°	-3°
AVERAGE		$\sqrt{\Delta P_{avg}} = .611$	$\bar{\Delta}_p = .374$	223°F		3.5°	



Replaces USAEHA Form 67, 7 Feb 79, which will be used.

AEHA FORM 51, 1 Nov 80

ENGINEERING PLANNING SHEET

For use of this form, see AEHA Form 51 SOP, the proponent is HSHR-EW.

SUBJECT: Stack Gas Velocity And Cyclonic Flow Data	COMPUTED BY:	DATE: 22 Feb	FILE NO. 0475
	CHECKED BY:	DATE:	SHEET NO.

Time - 0945

INSTALLATION: LCAAP

$T_a = 57°F$

LOCATION: STACK- BLDG 97

Verification Traverse

TRAVERSE POINT NUMBER		STACK VELOCITY HEAD (ΔP)		STACK TEMPERATURE (T_s)		YAW ANGLE
1	13		.30		-	
2	14		.33		202	
3	15		.35		211	
4	16		.38		214	
5	17		.38		214	
6	18		.40		214	
7	19		.40		214	
8	20		.41		214	
9	21		.40		213	
10	22		.41		213	
11	23		.41		212	
12	24		.38		209	
AVERAGE						

Replaces USAEHA Form 67, 7 Feb 79, which will be used.

AEHA FORM 51, 1 Nov 80

ENGINEERING PLANNING SHEET

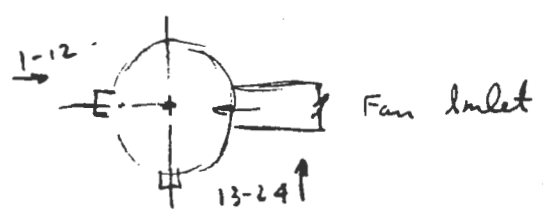
For use of this form, see AEHA Form 51 SOP, the proponent is HSHB-EW.

SUBJECT:	COMPUTED BY:	DATE:	FILE NO.
STACK GAS VELOCITY AND CYCLONIC FLOW DATA	RJW	2/23/91	0475
	CHECKED BY:	DATE:	SHEET NO.

INSTALLATION: LCAAP

LOCATION: DF STACK - BLDG 97

TRAVERSE POINT NUMBER 1-12	TRAVERSE POINT NUMBER 13-24	STACK VELOCITY HEAD (ΔP) 1-12	STACK VELOCITY HEAD (ΔP) 13-24	STACK TEMPERATURE (Ts) 1-12	STACK TEMPERATURE (Ts) 13-24	YAW ANGLE
1	13	.29	.29	189	193	
2	14	.36	.35	207	207	
3	15	.39	.36	210	211	
4	16	.41	.39	211	212	
5	17	.42	.40	212	213	
6	18	.43	.41	212	213	
7	19	.43	.41	212	213	
8	20	.45	.40	212	213	
9	21	.45	.42	212	212	
10	22	.45	.41	211	212	
11	23	.45	.41	210	211	
12	24	.43	.40	205	208	
AVERAGE		.400		209 °F		



Replaces USAEHA Form 67, 7 Feb 79, which will be used.

AEHA FORM 51, 1 Nov 80

APPENDIX E

SAMPLE RECOVERY AND ANALYSIS

1. STACK GAS.

a. Stack Gas Composition. The stack gases were sampled in accordance with RM 3 to determine CO_2, CO and O_2 concentrations. The stack gases were collected in conjunction with the sampling runs.

b. Stack Gas Moisture Determination. Moisture was collected from the stack gas by the impingers in the sampling train. The total moisture was determined by weighing the impingers and their contents before and after each test. The weight in grams gained by the impingers is equal to the volume of the liquid, in mL, collected during the run. All impingers were weighed on a top-loading balance, accurate to 0.1 gram.

2. PARTICULATE DETERMINATION.

a. Particulate Recovery. The probe and nozzle of the M5 sampling train were rinsed with acetone followed by scrubbing with a probe brush. The probe wash was collected in a tared container. The front half of the sampling train was also rinsed with acetone and this rinse combined with the probe wash. The filter was placed in a petri dish.

b. Particulate Analysis. The probe wash and front half rinse were dried and weighed. The filter was desiccated and weighed to a constant weight. The total particulate weight was determined by adding the probe wash residue to the weight gained by the filter, less the acetone blank. All weights were determined on an analytical balance, accurate to 0.01 mg.

3. METALS DETERMINATION.

a. Metals Recovery.

(1). Sampling Train. The probe and nozzle of the MeM5 sampling train were rinsed and brushed first using acetone followed by an HNO_3 rinse. Each rinse was placed in a separate container. The front half of the train was then rinsed with acetone followed by an HNO_3 rinse. These rinses were combined with the corresponding probe/nozzle rinse. The filter was place in a sample container.

(2). Process and Waste Streams. Grab samples were recovered from all process and waste streams. These included the auxiliary fuel (oil), the HTHE ash, and the baghouse ash as described in Appendix E. The total quantity of ash was determined gravimetrically.

b. Metals Analysis. All samples were analyzed per reference 10. The appropriate method of SW-846 (reference 9) was performed. The appropriate atomic absorption spectrometry (AA) or inductively coupled argon plasma emission spectrometry (ICP) technique was used for all metals except Hg. The mercury analysis was by cold vapor atomic absorption (CVAA).

4. POHC DETERMINATION.

a. POHC Sample Recovery.

(1) STEM Sampling Train. The recovery of the STEM train is completed in two discrete segments. These are as follows: the train prior to the resin tube, and the resin tube itself. The recovery procedures for each segment are as follows:

(a) Train and Impinger Recovery. The probe and nozzle are rinsed and brushed several times with toluene and the rinse placed in a sample container. The procedure is repeated using acetone, and that rinse placed in a separate container. The filter is recovered and placed in the toluene rinse container. The front half of the filter housing is rinsed with toluene and then with acetone. These rinses were placed in the appropriate probe rinse sample container. A 250 microliter (μL) spike of the surrogate solution was placed in the toluene rinse/filter container (see QA/QC in Appendix M). After the impingers were weighed for moisture determination, the condensate from the impingers (prior to the resin tube) and the d/d H_2O rinses of the impingers and connecting glassware were combined. This condensate was extracted three times with 50 mL of toluene using a separatory funnel and manual shakeout. Each extraction was placed in a separate container. The separatory funnel was then rinsed with toluene followed by an acetone rinse. The impingers were then rinsed with acetone. These acetone rinses were placed in separate sample containers. (Final acetone rinses of the components are used as a QA check on the rinse/recovery procedure.) All samples were refrigerated until they reached the analytical laboratory.

(b) Resin Section Recovery. Each 5 gram resin section and its glass wool plug were combined with 30 mL of toluene and subjected to 30 minutes of mechanical shakeout. After the shakeout, 10 mL of toluene was removed and became the first extraction of that section. An additional 10 mL of fresh toluene was then placed in the container to replace the toluene that was removed. Each section was then subjected to a second 30-minute shakeout. Again, 10 mL of toluene was removed and became the second extraction of the resin section. Once again, 10 mL of fresh toluene was added. Following a third 30-minute shakeout, the third extraction was completed. The solvent, resin and glass wool were left combined. (The third extraction is done to verify the extent of recovery completion.) The resin tube was then rinsed with toluene followed by an acetone rinse and the rinses placed in separate sample containers. All samples were kept refrigerated until they reached the analytical laboratory.

(2) Process and Waste Streams. To determine the mass balances of the POHC's, grab samples were recovered from all process and waste streams. These included the auxiliary fuel (oil), the HTHE ash, and the baghouse ash as described in Appendix E. The total quantity of ash was determined gravimetrically.

(3) Waste Feed. The waste feeds for the POHC runs was bulk propellant. Five grab samples were taken from the feed during each run. A quantity was measured gravimetrically and then dissolved in a known quantity of solvent. All waste feed samples were refrigerated until they reached the analytical laboratory.

b. POHC Analysis.

(1) Sampling Train Samples. All samples were analyzed per Method 8090 of reference 9. The EGDN and DNT samples were analyzed using the gas chromatograph/electron capture (GC/ECD) technique. The DPA and NG samples were analyzed using the gas chromatograph/nitrogen-phosphorus technique (GC/NP).

(2) Process Waste Streams. The samples were Soxhlet-extracted and analyzed per paragraph 4b(1).

(3) Waste Feed. The analysis of the waste feed samples was per paragraph 4b(1).

5. TCLP DETERMINATION.

a. Sample Recovery. The system ash was recovered as per paragraph 3a(2).

b. TCLP Analysis. The ash was analyzed for TCLP (metals) per the method described in reference 4.

6. QA/QC PROCEDURES.

a. General. In order to provide data of acceptable quality, QA/QC procedures were implemented throughout the trial burn. The goals of the QA/QC procedures were to ensure that the accuracy, precision, completeness, representativeness and quality of the data are within accepted tolerance limits. Quality assurance checks involve, in general terms, the determination of percent recovery of surrogate compounds from spiked samples and the analysis of replicate samples. Quality control checks involve ensuring the accuracy of sampling equipment and the analyzing of blind performance samples, calibration standard solutions and blank samples from the compounds of interest.

b. Data Completeness. During this trial burn, the completeness objective

was to obtain analytical results for at least 95 percent of the samples collected during testing.

c. Analysis.

(1) General. All calibration standards, surrogate compounds and organic solvents were of the highest purity practical for the analysis. All samples were processed through an independent QA/QC coordinator who renumbered the samples to ensure sample number singularity in the laboratory.

(2) POHC/Surrogate. The QA/QC procedures for the sampling of the stack gas for energetic compounds are discussed in this section.

(a) All first resin section/first extraction samples and all first extractions of the combined impinger contents samples were split for quadruple analysis to provide precision data on the analysis of surrogates and native POHC's in the group found to contain any of these items. The target precision for these samples was a relative standard deviation (RSD) $\leq$ 30 percent.

(b) Blind QA samples of the target compounds were inserted for analysis. The number of samples was 10 percent of the total number of field samples. Target accuracy for the blind insert samples was a recovery of 100 $\pm$ 30 percent with a standard deviation of $\leq$ 30 percent. Target precision of these samples was a RSD of $\leq$ 30 percent.

(c) The first resin section and the first impinger were spiked with a surrogate solution prior to each sampling run. Target accuracy for the surrogate recovery was 100 $\pm$ 30 percent with a standard deviation of $\leq$ 30 percent.

(d) Daily calibration curves for the energetic and surrogate compounds were prepared by the GC or gas chromatography/mass spectrophotometry (GC/MS) operator. The correlation coefficient for each calibration curve was $\geq$ 0.95. This daily calibration curve was used to ensure instrument performance.

(e) Ten percent of all positive analyses were submitted to the GC/MS laboratory for confirmation of the GC analysis. The GC/MS instrument was calibrated daily with a single point standard.

(f) Field laboratory blanks of all types of solvents, the resin extract, extraction of the field laboratory water and the filter extract were provided along with the samples for analysis in the laboratory. These samples were used to assess the level of contamination from the sample handling in the field laboratory.

(g) The QA/QC objectives for POHC sampling and analysis are summarized in the Table.

TABLE. MATRIX OF QA/QC OBJECTIVES FOR POHC/SURROGATE DETERMINATION

Type of Procedure	Determination	Goal
1. Analytical.		
a. Use of reference materials (calibration standards, surrogates, etc.).	Accuracy	Highest practical purity commercially available.
b. Renumbering of trial burn samples.	N/A	Ensure sample number singularity.
c. Insert blind QA samples. Quantity = 10 percent of total POHC field samples.	Accuracy	Mean recovery 100 ± 30 percent. Recovery standard deviation ≤ 30 percent.
	Precision	Relative Standard Deviation (RSD) ≤ 30 percent.
d. Quadruple analysis for POHC and surrogates in first resin section/first extraction sample and the first extraction of impinger condensate.	Precision	RSD ≤ 30 percent.
e. Daily calibration of analytical instrument; GC/ECD or GC/NPD - multipoint GC/MS - single point	Accuracy	Ensure peak performance of instrument.
	Precision	Correlation coefficient for calibration curve ≥ 0.95.
f. Submission of POHC positive analysis for GC/MS confirmation. Quantity = 10 percent of positive field samples.	Accuracy	POHC confirmation.
g. Analysis of laboratory and method blanks.	Level of Contamination	Miminimize contamination.
2. Extraction - Field extraction	N/A	Place POHC in a more stable matrix.
3. Sampling.		
a. Equipment calibrations	N/A	Meet EPA 600/4-77-026 requirements.
b. Background Run.	N/A	Assess background levels of POHC or interferences.
c. Surrogate spike of resin, impinger and filter/toluene probe wash.	Accuracy	Mean recovery 100 ± 30 percent. Recovery standard deviation ≤ 30 percent.
d. Analysis of field blanks.	Level of Contamination	Minimize contamination.

APPENDIX F

CALIBRATION PROCEDURES

1. PRETEST CALIBRATION SUMMARY. The pretest calibration procedures are summarized in the following Table.

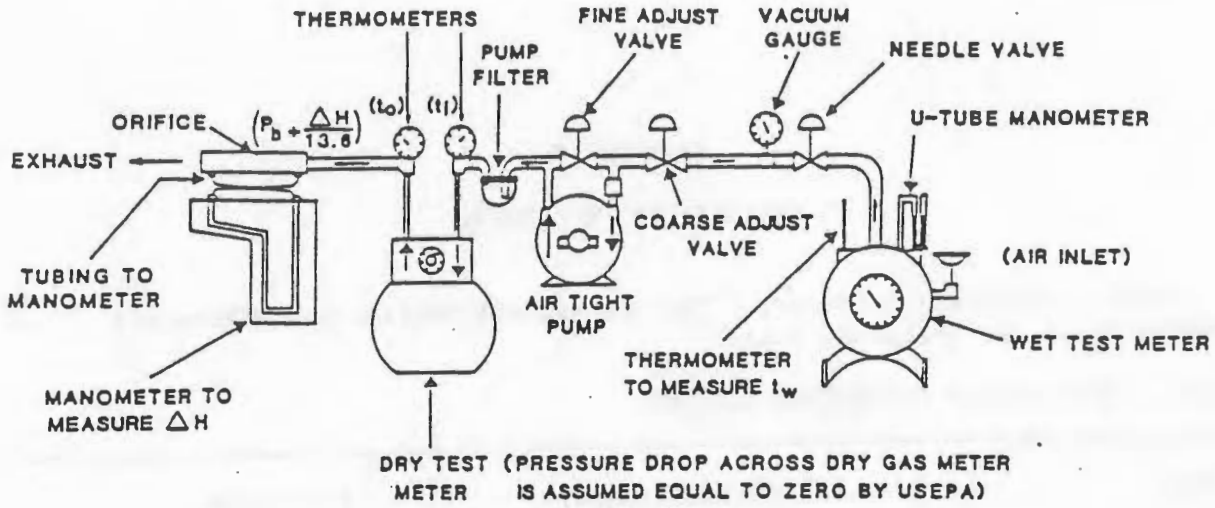
TABLE. CALIBRATION PROCEDURES SUMMARY

Device	Method/Standard	Reference
Meter Box Orifice	Wet Test Meter	APTD-0576*
Dry Gas Meter	Wet Test Meter	APTD-0576*
Pyrometer	NBS Reference Pyrometer	EPA RM 5†
Pitot Tube	Geometry	EPA RM 2†
Thermometer/Thermocouple	Reference Pyrometer	EPA RM 2†
Nozzle	Micrometer	EPA RM 5†
Orsat Analyzer	Calibration Gases	EPA-600/4-77-027b‡

* Reference 8
† Reference 3
‡ Reference 7

2. DRY GAS METER. The dry gas meters were calibrated prior to the assessment using a wet test meter (Figure F-1) in accordance with EPA approved procedures. The average dry gas meter coefficient prior to the assessment was 1.009 for meter box 3077, 1.006 for meter box 3076, and 1.003 for meter box 2942. The posttest calibration check was performed with the orifice setting at the $\triangle H$ that the box experienced during the test and with the vacuum settings at the highest vacuum that was experienced by that meter box. All posttest calibration values were within the allowable 5-percent variation of the pretest value.

3. ORIFICE. Prior to testing, the orifice of the dry gas meter systems were calibrated at the orifice manometer settings of 0.3 to 5.0 inches of water. The posttest calibration values were within the allowable 5-percent variation limit.



$$Y = \frac{V_w \; P_b \; (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right) \; (t_w + 460)}$$

$$\Delta H@ = \frac{0.0317 \; (\Delta H)}{P_b \; (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w}\right]^2$$

WHERE:

ΔH = ORIFICE PRESSURE DROP (in H_2O)

V_w = GAS VOLUME THROUGH WET TEST METER (ft^3)

V_d = GAS VOLUME THROUGH DRY GAS METER (ft^3)

t_w = WET TEST METER TEMP. (°F)

t_d = AVERAGE DRY TEST METER TEMP. (°F) $\left(t_d = \frac{t_i + t_o}{2}\right)$

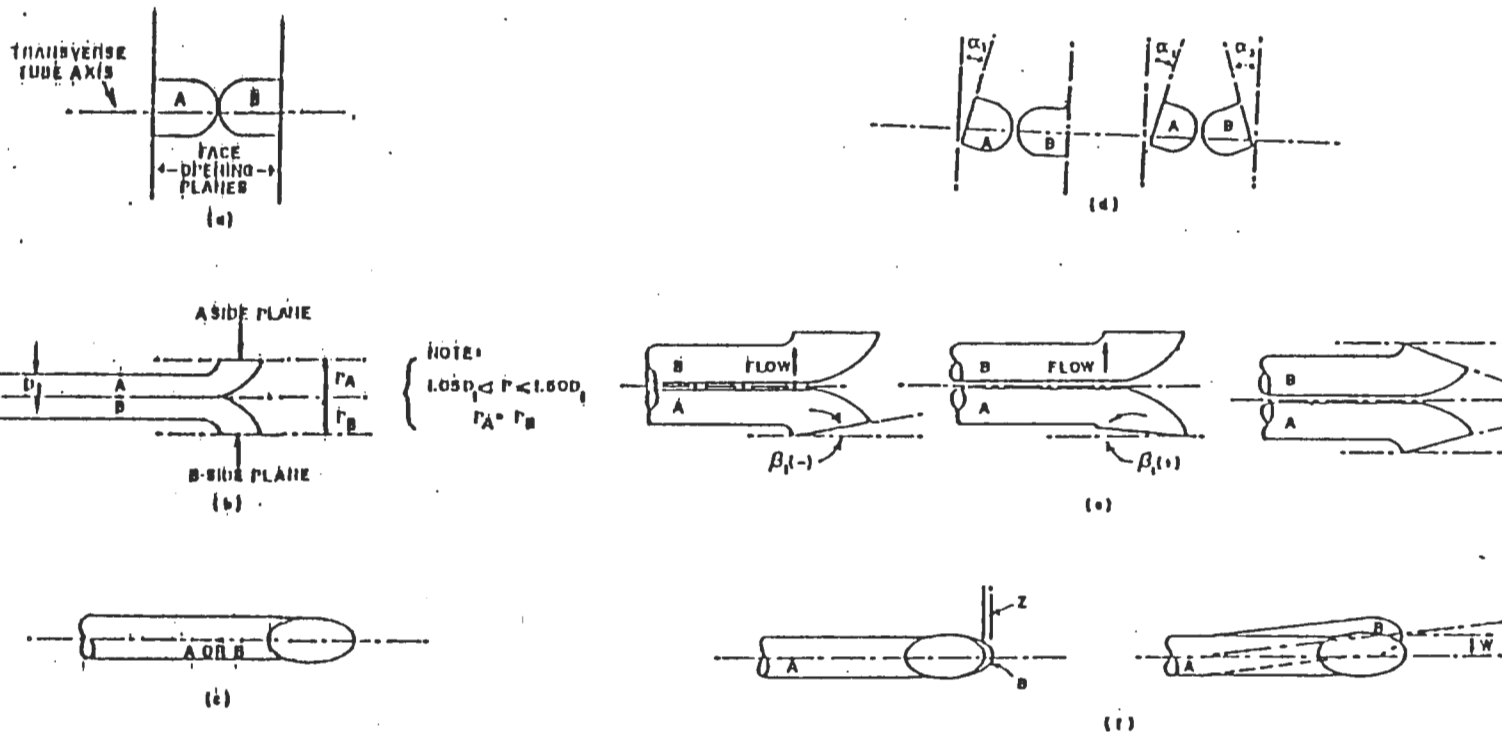
P_b = BAROMETRIC PRESSURE (in Hg)

θ = TIME (min)

$\Delta H@$ = ORIFICE PRESSURE DROP THAT GIVES 0.75 ft^3/min at 70°F, 29.92 in Hg (in H_2O)

Y = DIMENSIONLESS DRY GAS METER CALIBRATION COEFFICIENT

FIGURE F-1. DRY GAS METER CALIBRATION



BASELINE C_p COEFFICENTS OF 0.84 MAY BE ASSIGNED TO PROPERLY CONSTRUCTED PITOT TUBES SHOWN IN (a) END VIEW: FACE OPENING PLANES PERPENDICULAR TO TRANSVERSE AXIS; (b) TOP VIEW: FACE OPENING PLANES PARALLEL TO LONGITUDINAL AXIS; (c) SIDE VIEW: BOTH LEGS OF EQUAL LENGTH AND CENTERLINES COINCIDENT. THIS BASELINE C_p WILL NOT BE AFFECTED BY FACE-OPENING MISALIGNMENT PROVIDED THAT (d) α_1 AND $\alpha_2 < 10°$; (e) β_1 AND $\beta_2 < 5°$; (f) $Z <$ 0.32 cm (1/8 in) AND $W <$ 0.08 cm (1/32 in).

4. PITOT TUBE. The pitot tubes, located on the sampling probe assembly, were calibrated using the geometric standard (Figure F-2) noted in EPA RM 2 (reference 3). Since the pitot tubes met the geometric standard, a calibration coefficient of 0.84 was assigned to each tube.

5. NOZZLE. The sampling nozzles used were measured with a micrometer accurate to 0.001 inch. Three measurements of each nozzle were made showing a difference between the high and low measurement of less than the maximum allowable tolerance of 0.004 inch. These were used in establishing isokinetic procedures.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Annual Calibration

Date 22 Jan 91 Meter box number 2942

Barometric pressure, P_b = 29.657 in. Hg Calibrated by L Q

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
0.5	5	5.109	79.5	104	98	96	42.50	1.002	1.75
1.0	5	5.122	79.5	104	98	96	8.93	1.004	1.78
1.5	10	10.254	79.5	106	89	97.5	15.36	1.004	1.97
2.0	10	10.258	79.5	105	89	97.0	13.18	1.002	1.94
3.0	10	10.259	79.5	106	90	98	10.75	1.001	1.93
4.0	10	10.284	79.5	108	91	99.5	9.36	.999	1.95
							Avg	1.003	1.89

Vacuum 3 in. Hg

$\frac{\Delta H}{13.6}$ = $\frac{\Delta H}{13.6}$

$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$

$\Delta H@_i = \frac{0.0317 \, \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w} \right]^2$

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$
0.5	0.0368
1.0	0.0735
1.5	0.110
2.0	0.147
3.0	0.221
4.0	0.294

Meter Box

Under Half Leak Check OK

Back Half Leak Check OK

Vacuum Gauge Check OK

Thermometer Check (±)3°F

of ASTM Eg) In OK Out OK

Wet Test Meter

Meter No. 11AL4

Capacity 1 CF/Rev

Calibration Data 30 Nov 90

Leak Check OK

Water Level Check OK

a If there is only one thermometer on the dry gas meter, record the temperature under t_d.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Post Calibration

Date 14 Mar 91 Meter box number 2942

Barometric pressure, P_b = 29.65 in. Hg Calibrated by DEK

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter $(V_w)xY_{wt}$, ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
.33	5	5.071	75.0	81	64	72.5	15.14	.981	1.73
.33	5	5.083	75.0	81	65	73	15.06	.979	1.72
.33	5	5.094	75.0	82	66	74	15.08	.979	1.72
							Avg	.980	1.72

Vacuum _____ in. Hg

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)} \qquad \Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$$

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	Meter Box	Wet Test Meter
.33	0.0243		
		Front Half Leak Check ok	Meter No. 11 AL 4
		Back Half Leak Check ok	Capacity 1 CF/Rev
		Vacuum Gauge Check ok	Calibration Data 9 Jan 91
		Thermometer Check (± 3°F	Leak Check ok
		of ASTM Hg) In ok Out ok	Water Level Check ok

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

Quality Assurance Handbook M5-2.3A (front side)

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Annual Calibration

Date 28 Jan 91 Meter box number 3076

Barometric pressure, P_b = 29.875 in. Hg Calibrated by DEK

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter Inlet (t_{d_i}), °F	Temperatures: Dry gas meter Outlet (t_{d_o}), °F	Temperatures: Dry gas meter Avg (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
0.5	5	5.028	77.5	93	83	88	12.77	1.013	1.82
1.0	5	5.048	77.5	95	84	89.5	9.16	1.010	1.87
1.5	10	10.123	77.5	96	84	90	15.13	1.007	1.88
2.0	10	10.154	77.5	97	85	91	13.21	1.005	1.94
3.0	10	10.166	77.5	97	86	91.5	10.80	1.002	1.95
4.0	10	10.172	77.5	97	86	91.5	9.42	.999	1.97
							Avg	1.006	1.91

Vacuum ____ in. Hg

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
0.5	0.0368	Meter Box	Wet Test Meter
1.0	0.0735	Pump Pulf Leak Check OK	Meter No. 11414
1.5	0.110	Back Pulf Leak Check OK	Capacity 1 CF/Rev
2.0	0.147	Vacuum Gauge Check OK	Calibration Data 7 Jan 91
3.0	0.221	Thermometer Check (±)3°F	Leak Check OK
4.0	0.294	of ASTM Hg) In OK Out OK	Water Level Check OK

a If there is only one thermometer on the dry gas meter, record the temperature under t_d.

(English units)

Post Calibration

Date 21 MAR 91 Meter box number 3076

Barometric pressure, P_b = 29.925 in. Hg Calibrated by CJM

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w) x Y_{wt}, ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
1.4	10	10.045	76	90	81	85.5	15.63	1.009	1.90
1.4	10	10.010	76	90	82	86	15.65	1.014	1.91
1.4	10	10.034	76	91	82	86.5	15.63	1.012	1.90
				-					
							Avg	1.011	1.90

Vacuum 11 in. Hg

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
1.4	0.1029	Meter Box	Wet Test Meter
		Front Half Leak Check OK	Meter No. 11 ALH
		Back Half Leak Check OK	Capacity 1 CF/Rev
		Vacuum Gauge Check OK	Calibration Data 7 Jun 91
		Thermometer Check(± 3°F	Leak Check OK
		of ASTM Hg) In OK Out OK	Water Level Check OK

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

Quality Assurance Handbook M5-2.3A (front side)

(English units)

Post Calibration

Date 21 MAR 91 Meter box number 3076

Barometric pressure, P_b = 29.925 in. Hg Calibrated by DQm

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter $(V_w)xY_{wt}$ ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
3.4	10	10.067	75.5	92	83	87.5	10.33	1.007	1.97
3.4	10	10.030	75.5	94	83	88.5	10.22	1.013	1.97
3.4	10	10.047	75.5	95	84	89.5	10.20	1.012	1.96
							Avg	1.011	1.97

Vacuum 7 in. Hg

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)} \qquad \Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w} \right]^2$$

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	Meter Box	Wet Test Meter
3.4	0.2500		
		Front Half Leak Check OK	Meter No. 11AL4
		Back Half Leak Check OK	Capacity 1 CF/REV
		Vacuum Gauge Check OK	Calibration Data 7 Jan 91
		Thermometer Check(± 3°F	Leak Check OK
		of ASTM Hg) In OK Out OK	Water Level Check OK

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

METER BOX CALIBRATION DATA AND CALCULATIONS

(English units)

Annual Calibration

Date 28 Jan 91 Meter box number 3077

Barometric pressure, P_b = 29.875 in. Hg Calibrated by DFK

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter Inlet (t_{d_i}), °F	Temperatures: Dry gas meter Outlet (t_{d_o}), °F	Temperatures: Dry gas meter Avg (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
0.5	5	5.010	78	93	85	89	12.49	1.017	1.75
1.0	5	5.036	78	94	85	90	9.12	1.013	1.86
1.5	10	10.081	78	94	85	90	14.86	1.010	1.85
2.0	10	10.099	78	94	85	90	12.86	1.007	1.85
3.0	10	10.102	78	94	85	90	10.57	1.005	1.87
4.0	10	10.097	78	93	85	89	9.21	1.001	1.90
							Avg	1.009	1.85

Vacuum ____ in. Hg

$\frac{\Delta H}{13.6}$, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
0.5	0.0368	Meter Box	Wet Test Meter
1.0	0.0735	Front Half Leak Check OK	Meter No. 11AH8
1.5	0.110	Back Half Leak Check OK	Capacity 1 CF/Rev
2.0	0.147	Vacuum Gauge Check OK	Calibration Date 30 Nov 90
3.0	0.221	Thermometer Check (±)3°F	Leak Check OK
4.0	0.294	of ASTM E_8) In OK Out OK	Water Level Check OK

If there is only one thermometer on the dry gas meter, record the temperature under t_d.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Post Calibration

Date 14 Mar 91 Meter box number 3077

Barometric pressure, P_b = 29.651 in. Hg Calibrated by DEK

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w)xY_{wt}, ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter Inlet (t_{d_i}), °F	Temperatures: Dry gas meter Outlet (t_{d_o}), °F	Temperatures: Dry gas meter Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
3.2	10	10.000	76.0	91	79	85	10.17	1.009	1.87
3.2	10	10.043	76.0	91	80	85.5	10.18	1.005	1.87
3.2	10	10.024	76.0	91	81	86	10.18	1.008	1.87
							Avg	1.007	1.87

Vacuum _____ in. Hg

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)} \qquad \Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$$

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	Meter Box	Wet Test Meter
3.2	0.2353		
		Front Half Leak Check ok	Meter No. 11 AH 8
		Back Half Leak Check ok	Capacity 1 CF/Rev
		Vacuum Gauge Check ok	Calibration Data 30 Nov 90
		Thermometer Check(± 3°F	Leak Check ok
		of ASTM H_g) In ok Out ok	Water Level Check ok

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

Quality Assurance Handbook M5-2.3A (front side)

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Post Calibration

Date 14 Mar 91 Meter box number 3077

Barometric pressure, P_b = 29.651 in. Hg Calibrated by DEK

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter $(V_w)xY_{wt}$, ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$, in. H_2O
.43	5	5.005	76.0	90	81	85.5	13.39	1.016	1.74
.43	5	5.004	76.0	90	82	86	13.37	1.017	1.73
.43	5	5.008	76.0	90	82	86	13.39	1.016	1.73
							Avg	1.016	1.73

Vacuum _____ in. Hg

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
1.43	.0316	Meter Box	Wet Test Meter
		Front Half Leak Check ok	Meter No. 11 AH8
		Back Half Leak Check ok	Capacity 1 CF/Rev
		Vacuum Gauge Check ok	Calibration Data 30 Nov 90
		Thermometer Check(± 3°F	Leak Check ok
		of ASTM H_g) In ok Out ok	Water Level Check OK

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

Quality Assurance Handbook M5-2.3A (front side)

PITOT NUMBER: 2.1

INSPECTOR: DZK

DATE: 2/12/91 RUN: _____

INSTALLATION: LCAAP

PITOT - NOZZLE - THERMOCOUPLE - PROBE CONFIGURATION

Verify the following dimensions before and after sampling:

(See Figures 2.2 to 2.8 of EPA Method 2)

1. External Tubing Diameter, D_t (3/16" to 3/8") = 3/8

2. Base of Pitot to Opening Plane Distance, Impact, P_A (1.05 to 1.5 D_t) = .510
   .3938 - .5625 Static, P_B (1.05 to 1.5 D_t) = .510

3. Angle between plane of impact fact of pitot tube and transverse tube axis, α_1, (< 10°) = 1°

4. Angle between plane of static pitot tube face and transverse tube axis, α_2 (<10°) = 1°

5. Angle between plane of impact pitot tube face and longitudinal axis, β_1 (< ± 5°) = 0

6. Angle between plane of static pitot tube face and longitudinal axis, β_2 (< ± 5°) = 0

7. Distance between leading tip of the impact and static tubes, Z (< 1/8") $\gamma = 4°$ (.125) = .0625

8. Distance between the transverse axes for the impact and static pitot faces, w (< 1/32") $\theta = 1°$ (.0313) = .0156

9. Pitot - Nozzle Separation, x (> 3/4") = 7/8"

10. Pitot plane above nozzle entry (yes) = Yes

11. Nozzle type (button hook) = Yes

12. Distance between thermocouple and pitot, Z (> 3/4") = 7/8"

13. Distance between tangent to thermocouple body and centerline of impact opening, w (>3") = 73"

14. Distance between ~~thermocouple tip~~ gas line and centerline of impact opening, Z (>2") = 72"

15. Distance between sample probe ferrule and centerline of impact opening, Y (>3") = 3 1/4"

PITOT NUMBER: 2-2

INSPECTOR: DEK

DATE: 2/12/91 RUN: _____

INSTALLATION: LCAAP

PITOT - NOZZLE - THERMOCOUPLE - PROBE CONFIGURATION

Verify the following dimensions before and after sampling:

(See Figures 2.2 to 2.8 of EPA Method 2)

1. External Tubing Diameter, D_t (3/16" to 3/8") = 3/8"

2. Base of Pitot to Opening Plane Distance, Impact, P_A (1.05 to 1.5 D_t) = .559
   Static, P_B (1.05 to 1.5 D_t) = .559

3. Angle between plane of impact fact of pitot tube and transverse tube axis, α_1, (< 10°) = 1°

4. Angle between plane of static pitot tube face and transverse tube axis, α_2 (<10°) = 3°

5. Angle between plane of impact pitot tube face and longitudinal axis, β_1 (< ± 5°) = 0

6. Angle between plane of static pitot tube face and longitudinal axis, β_2 (< ± 5°) = 1°

7. Distance between leading tip of the impact and static tubes, Z (< 1/8") $\gamma = 1°$ (.125) = .0204

8. Distance between the transverse axes for the impact and static pitot faces, w (< 1/32") $\theta = 1°$ (.0313) = .0199

9. Pitot - Nozzle Separation, x (> 3/4") = 1"

10. Pitot plane above nozzle entry (yes) = Yes

11. Nozzle type (button hook) = Yes

12. Distance between thermocouple and pitot, Z (> 3/4") = 7/8"

13. Distance between tangent to thermocouple body and centerline of impact opening, w (>3") = 73"

14. Distance between ~~thermocouple tip~~ probe line and centerline of impact opening, Z (>2") = 72"

15. Distance between sample probe ferrule and centerline of impact opening, Y (>3") = 3 1/4"

APPENDIX G

CONTINUOUS MONITORS

1. CO/O_2 CONTINUOUS MONITOR SYSTEM.

a. General. The CO continuous monitor is a dual range monitor with a low range of 0-200 ppm and a high range of 0-3000 ppm. The O_2 monitor has a range of 25 percent. The monitoring equipment has the capability to monitor all required gases simultaneously and provides a record of the acquired data. The monitoring equipment provides a compatible output of the CO and O_2 readings that run through a math function and provide a corrected CO concentration. The system consists of a Beckman® Industrial Model 880 Nondispersive Infrared (NDIR) Analyzer and a Beckman Industrial Model 755 O_2 Analyzer.

b. Calibration. The system is equipped with an automatic calibration that occurs once in a 24-hour period. For the trial burn, the system was calibrated before and after each sampling run.

2. THC CONTINUOUS MONITORING SYSTEM.

a. General. The THC monitor used for the trial burn was a Beckman Model 402 Hydrocarbon Analyzer. This monitor is a flame ionization detector. The HC sensor is a burner where a regulated flow of sample gas passes through a flame sustained by regulated flows of a fuel gas and air. The sample collection and measurement were done in accordance with EPA RM 25A of reference 3. The gas sample was extracted from the stack, passed through a heated filter and condensing system, and pumped to the analyzer. The data was recorded on both a strip chart and a data logger. The fuel gas and air for the burner were as follows:

(1) Flame Ionization Fuel - Linde LQL #922-1007-02, 40% H_2/60% N_2, <0.5 ppm total hydrocarbon.

(2) Air - Linde LQL #922-1016-02, Hydrocarbon free.

b. Calibration. The system was calibrated before and after each sampling run. A high-level, mid-level, low-level, and a zero calibration gas were used to calibrate the monitor before the first run. After the first run, the THC levels were such that only the zero and low-level calibration gases were used. The instrument was calibrated before and after each sampling run. The calibration gas used were as follows:

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(1) High Level - Scott Protocol Gas, 796 ppm methane/balance N_2, Cylinder No. Bal-5137.

(2) Mid Level - Scott Protocol Gas, 399 ppm methane/balance N_2, Cylinder No. Bal-5202.

(3) Low Level - Scott Protocol Gas, 79 ppm methane/balance N_2, Cylinder No. Bal-5244.

APPENDIX H

NOMENCLATURE AND EQUATIONS

1. ABSOLUTE PRESSURE, P_m and P_s (inches Hg).

$$P_m = P_{bar} + \frac{\Delta H}{13.6}$$

$$P_s = P_{bar} + \frac{P_{static}}{13.6}$$

2. DRY GAS METER VOLUME, STANDARD CONDITIONS, $V_{m_{std}}$ (dscf).

$$V_{m_{std}} = \frac{17.65\ V_m\ \gamma_m P_m}{T_m}$$

3. WATER VAPOR VOLUME, STANDARD CONDITIONS, $V_{w_{std}}$ (scf).

$$V_{w_{std}} = 0.04707\ V_{lc}$$

4. MOISTURE CONTENT, B_{wo} (percent).

$$B_{wo} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}}$$

5. STACK GAS MOLECULAR WEIGHT, M_s (lb/lb-mole).

$$M_s = (1-B_{wo})\ [0.44\ (\%\ CO_2) + 0.32\ (\%\ O_2) + 0.28\ (\%\ N_2 + \%\ CO)] + 18\ B_{wo}$$

6. AVERAGE STACK GAS VELOCITY, V_s (ft/sec).

$$V_s = 85.48\ C_p\ (\triangle P)^{0.5}_{avg}\ (T_s / P_s M_s)^{0.5}$$

7. AVERAGE STACK GAS VOLUMETRIC FLOW RATE, Q_s (dscf/hr).

$$Q_s = \frac{63{,}529\ (1-B_{wo})\ V_s\ A_s\ P_s}{T_s}$$

8. ISOKINETIC SAMPLING RATE, I (percent).

$$I = \frac{1.667\ T_s\ [0.00267\ V_{lc} + (V_m\ \gamma_m\ P_m / T_m)]}{\theta\ V_s\ P_s\ A_n}$$

9. PARTICULATE CONCENTRATION (Corrected to 7% O_2), C_7 (gr/dscf).

$$C_7 = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{21-O_2}$$

10. METAL CONCENTRATION AT STACK, C_m (mg/dscf)

$$C_m = \frac{M_m}{V_{m_{std}}}$$

11. METALS EMISSION RATE AT STACK, W_m (lb/hr).

$$W_m = \frac{C_m Q_s}{453,600}$$

12. INCINERATOR POHC MASS FEED RATE, W_{in} (lb/hr).

$$W_{in} = C_{pr} W_{pr}$$

13. STACK POHC MASS EMISSION RATE, W_{out} (lb/hr).

$$W_{out} = \frac{M_{POHC} Q_s}{V_{m\,std} \quad 453,600,000}$$

14. DESTRUCTION AND REMOVAL EFFICIENCY, DRE (%)

$$DRE = \frac{W_{in} - W_{out}}{W_{in}} \times 100$$

NOMENCLATURE USED IN EQUATIONS

Symbol	Units	Description
A_n	ft^2	Cross-sectional area of nozzle
A_s	ft^2	Cross-sectional area of stack
B_{wo}	decimal	Mole fraction of stack gas water content
C_M	mg/dscf	Metal concentration of stack gas
C_p	-	S-type pitot tube coefficient
C_{pr}	%	POHC concentration in propellant
C_7	gr/dscf	Particulate matter concentration of stack gas corrected to 7 percent oxygen
CO	%	Concentration of carbon monoxide in gas stream as measured by an Orsat, dry basis
CO_2	%	Concentration of carbon dioxide in gas stream as measured by an Orsat, dry basis
DRE	%	Destruction and removal efficency of POHC
$\triangle H$	inch H_2O	Average pressure drop across orifice meter
I	%	Ratio to which sampling velocity approaches stack velocity, and is 100 percent when the two are equal
M_m	mg	Total metal collected
M_n	mg	Total particulate matter collected
M_{POHC}	μg	Total POHC collected
M_s	lb/lb mole, wet	Molecular weight of stack gas
N_2	%	Concentration of nitrogen in stack gas, as measured by an Orsat, dry basis
O_2	%	Concentration of oxygen in stack gas, as measured by an Orsat, dry basis
$\triangle P$	inch H_2O	Velocity head of stack gases

P_{bar}	inch Hg	Barometric pressure at local elevation
P_m	inch Hg	Absolute pressure (barometric + $\triangle$H) at meter
P_s	inch Hg	Absolute pressure (barometric + P_{stat} in stack)
P_{stat}	inch H_2O	Static pressure in stack
Q_s	dscf/hr	Average stack gas volumetric flow rate, dry, at standard conditions
T_m	^oR	Average dry gas meter temperature (^oF + 460)
T_s	^oR	Average stack gas temperature (^oF + 460)
T_{std}	^oR	Standard absolute temperature, 528 ^oR
V_{lc}	g	Total mass of liquid collected in impingers and silica gel
V_m	ft^3	Volume of gas through dry gas meter at meter conditions
$V_{m\ std}$	scf	Volume of dry gas sampled at standard conditions
V_s	ft/sec	Average stack gas velocity at sampling site
$V_{w_{std}}$	scf	Water vapor volume at standard conditions
W_{in}	lb/hr	Mass feed rate of POHC to the incinerator
W_m	lb/hr	Mass emission rate of metal at the stack
W_{out}	lb/hr	Mass emission rate of POHC at the stack
W_{pr}	lb/hr	Mass feed rate of propellant
θ	min	Total sampling time
γ_m	-	Dry gas meter coefficient

APPENDIX I

ASSESSMENT PERSONNEL

		Entrance Briefing	Exit Briefing
1.	USAEHA		
	Robert Wishart, Project Engineer	X	X
	Parrish Galusky, Chemical Engineer		
	Philip Mulrine, Chemical Engineer		
	Donald Keesee, Engineering Technician		
	Coleman Moore, Engineering Technician		
	Emery Thompson, Physical Science Technician		
2.	LCAAP		
	CPT Tom Negus		X
	Bill Melton, Plant Engineer		X
	Gary Kelso, Environmental Staff	X	X
3.	OLIN, INC.		
	Ron Langevin, Manager of Engineering		X
	Ken Cox, Supervisor, Civil/Structural Enginering	X	
	John Hosman, Senior Engineer	X	X
	John Bus, General Foreman	X	
	Chris Coen, Production Foremen, Explosives Area	X	X
	Huy Huynh, Engineer, Electrical Engineering	X	
	Keenan Curry, Engineer, Environmental Engineering	X	
	Glenn Hamilton, Senior Explosive Safety Engineer	X	
	Mark Wingate, Explosive Safety Engineer	X	
4.	AED		
	Jerry Miller, Chief, APE Engineering Division		X
5.	EPA		
	Gene Evans		X
6.	Missouri Department of Natural Resources		
	Wane Roberts, Onsite Observer		
	Kyle Russell, Onsite Observer		

APPENDIX J

SAMPLING TRAIN DATA SUMMARY

TABLE J-1. DATA SUMMARY - RUN NO. 1 - 20mm M-96 CARTRIDGE FEED*

	1 M5 22 Feb 91	1 MeM5 22 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	495.33	495.33
Est PEP Feed Rate (lb/hr)	79.08	79.08
Auxillary Fuel Rate (gal/hr)	38.28	38.28
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.32	30.32
Static Pressure (in. H_2O)	-0.23	-0.23
Average Stack Gas Temperature (^oF)	210	210
Stack Gas Moisture Content (%)	3.4	3.4
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	40.19	41.50
Volumetric Flow Rate (dscf/hr)	228,200	235,900
CO_2 Concentration (%, dry)	3.40	3.40
O_2 Concentration (%, dry)	16.60	16.60
N_2 Concentration (%, dry)	80.00	80.00
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.82	28.83
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	55.794	57.890
Dry Gas Volume (dscf)	57.807	59.730
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.034	3.340
Average Dry Gas Meter Temperature (^oF)	65	66
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.639	0.660
Total Liquid Collected (mL)	43.7	44.3
Isokinetic Sampling Rate (%)	99.2	99.8

* Fugitive emissions during run.

TABLE J-2. DATA SUMMARY - RUN NO. 2 - 20mm M-96 CARTRIDGE FEED*

	2 M5 22 Feb 91	2 MeM5 22 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	410.48	410.48
Est PEP Feed Rate (lb/hr)	65.53	65.53
Auxillary Fuel Rate (gal/hr)	38.28	38.28
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.32	30.32
Static Pressure (in. H_2O)	-0.23	-0.23
Average Stack Gas Temperature (^oF)	213	213
Stack Gas Moisture Content (%)	3.4	3.4
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	43.48	44.30
Volumetric Flow Rate (dscf/hr)	246,100	250,700
CO_2 Concentration (%, dry)	3.40	3.40
O_2 Concentration (%, dry)	16.60	16.60
N_2 Concentration (%, dry)	80.00	80.00
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.83	28.83
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	57.172	59.011
Dry Gas Volume (dscf)	59.532	60.898
Total Sampling Time (min)	57.5	57.5
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.529	3.787
Average Dry Gas Meter Temperature (^oF)	83	87
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.690	0.703
Total Liquid Collected (mL)	43.9	45.1
Isokinetic Sampling Rate (%)	98.9	99.9

* Fugitive emissions druing run.

TABLE J-3. DATA SUMMARY - RUN NO. 3 - HI SKOR 700X PROPELLANT FEED

	3 M5 23 Feb 91	3 STEM 23 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	43.42	43.42
Auxillary Fuel Rate (gal/hr)	43.03	43.03
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.96	29.96
Static Pressure (in. H_2O)	-0.25	-0.25
Average Stack Gas Temperature (°F)	212	210
Stack Gas Moisture Content (%)	4.0	4.0
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	42.08	43.60
Volumetric Flow Rate (dscf/hr)	234,100	243,300
CO_2 Concentration (%, dry)	3.86	3.86
O_2 Concentration (%, dry)	15.96	15.96
N_2 Concentration (%, dry)	80.18	80.18
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.81	28.81
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	65.430	120.240
Dry Gas Volume (dscf)	65.812	120.900
Total Sampling Time (min)	180	180
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.417	1.500
Average Dry Gas Meter Temperature (°F)	71	71
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.664	0.689
Total Liquid Collected (mL)	58.2	106.0
Isokinetic Sampling Rate (%)	101.7	100.8

TABLE J-4. DATA SUMMARY - RUN NO. 4 - HI SKOR 700X PROPELLANT FEED

	4 M5 25 Feb 91	4 STEM 25 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	40.18	40.18
Auxillary Fuel Rate (gal/hr)	44.13	44.13
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.32	30.32
Static Pressure (in. H_2O)	-0.27	-0.27
Average Stack Gas Temperature (°F)	201	200
Stack Gas Moisture Content (%)	3.8	3.7
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.46	42.23
Volumetric Flow Rate (dscf/hr)	237,700	242,800
CO_2 Concentration (%, dry)	4.00	4.00
O_2 Concentration (%, dry)	16.00	16.00
N_2 Concentration (%, dry)	80.0	80.0
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.85	28.86
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	43.402	74.603
Dry Gas Volume (dscf)	46.089	79.637
Total Sampling Time (min)	120	120
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.419	1.368
Average Dry Gas Meter Temperature (°F)	49	46
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.664	0.677
Total Liquid Collected (mL)	38.9	65.1
Isokinetic Sampling Rate (%)	105.2	99.8

TABLE J-5. DATA SUMMARY - RUN NO. 5 - 20mm M-96 CARTRIDGE FEED*

	5 M5 25 Feb 91	5 MeM5† 25 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	558.23	558.23
Est PEP Feed Rate (lb/hr)	89.12	89.12
Auxillary Fuel Rate (gal/hr)	44.03	44.03
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.32	30.32
Static Pressure (in. H_2O)	-0.27	-0.27
Average Stack Gas Temperature (°F)	203	201
Stack Gas Moisture Content (%)	3.9	3.8
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.32	42.81
Volumetric Flow Rate (dscf/hr)	236,000 †	245,400 †
CO_2 Concentration (%, dry)	4.20	4.20
O_2 Concentration (%, dry)	16.00§	16.00§
N_2 Concentration (%, dry)	79.80	79.80
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.87	28.88
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	57.273	57.511
Dry Gas Volume (dscf)	61.347	61.572
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.185	3.403
Average Dry Gas Meter Temperature (°F)	48	47
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.661	0.686
Total Liquid Collected (mL)	53.0	52.3
Isokinetic Sampling Rate (%)	101.9	98.9

* Fugitive emissions
† Metals train failed the posttest leak check. Assumed values, bad gas bag.
§ Average value from CEM data.

TABLE J-6. DATA SUMMARY - RUN NO..6 - 20mm M-96 CARTRIDGE FEED

	6 M5 26 Feb 91	6 MeM5 26 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	579.20	579.20
Est PEP Feed Rate (lb/hr)	92.47	92.47
Auxillary Fuel Rate (gal/hr)	41.54	41.54
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.19	30.19
Static Pressure (in. H_2O)	-0.24	-0.24
Average Stack Gas Temperature (^oF)	210	210
Stack Gas Moisture Content (%)	3.9	4.0
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.85	42.14
Volumetric Flow Rate (dscf/hr)	235,300	237,000
CO_2 Concentration (%, dry)	4.20	4.20
O_2 Concentration (%, dry)	16.00	16.00
N_2 Concentration (%, dry)	79.80	79.80
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.88	28.86
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	57.670	57.340
Dry Gas Volume (dscf)	59.406	60.172
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.194	3.362
Average Dry Gas Meter Temperature (^oF)	66	55
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.664	0.669
Total Liquid Collected (mL)	51.7	53.1
Isokinetic Sampling Rate (%)	98.9	100.1

TABLE J-7. DATA SUMMARY - RUN NO. 7 - HI SKOR 700X PROPELLANT FEED

	7 M5 26 Feb 91	7 STEM 26 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	37.82	37.82
Auxillary Fuel Rate (gal/hr)	39.88	39.88
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	30.19	30.19
Static Pressure (in. H_2O)	-0.24	-0.24
Average Stack Gas Temperature (°F)	217	212
Stack Gas Moisture Content (%)	3.9	3.8
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.84	42.83
Volumetric Flow Rate (dscf/hr)	240,200	246,100
CO_2 Concentration (%, dry)	3.60	3.60
O_2 Concentration (%, dry)	16.20	16.20
N_2 Concentration (%, dry)	80.20	80.20
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.80	28.80
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	43.494	74.925
Dry Gas Volume (dscf)	45.810	78.725
Total Sampling Time (min)	120	120
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.428	1.469
Average Dry Gas Meter Temperature (°F)	51	52
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.670	0.686
Total Liquid Collected (mL)	39.2	65.8
Isokinetic Sampling Rate (%)	103.5	97.3

TABLE J-8. DATA SUMMARY - RUN NO. 8 - FA-956 PRIMER FEED

	8 M5 27 Feb 91	8 MeM5 27 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	90.75	90.75
PEP Feed Rate (lb/hr)	11.66	11.66
Auxillary Fuel Rate (gal/hr)	33.90	33.90
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.90	29.90
Static Pressure (in. H_2O)	-0.25	-0.25
Average Stack Gas Temperature (^oF)	205	221
Stack Gas Moisture Content (%)	3.4	3.5
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.45	41.65
Volumetric Flow Rate (dscf/hr)	241,200	236,400
CO_2 Concentration (%, dry)	3.40	3.40
O_2 Concentration (%, dry)	16.53	16.53
N_2 Concentration (%, dry)	80.07	80.07
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.82	28.82
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	59.933	57.941
Dry Gas Volume (dscf)	62.346	58.625
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.333	3.326
Average Dry Gas Meter Temperature (^oF)	53	69
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.003	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.667	0.662
Total Liquid Collected (mL)	46.7	44.7
Isokinetic Sampling Rate (%)	101.3	98.7

TABLE J-9. DATA SUMMARY - RUN NO. 9 - 20mm M-96 CARTRIDGE FEED

	9 M5 27 Feb 91	9 MeM5 27 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	568.02	568.02
Est PEP Feed Rate (lb/hr)	90.68	90.68
Auxillary Fuel Rate (gal/hr)	33.90	33.90
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.90	29.90
Static Pressure (in. H_2O)	-0.25	-0.25
Average Stack Gas Temperature (°F)	205	200
Stack Gas Moisture Content (%)	3.9	4.0
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.95	42.99
Volumetric Flow Rate (dscf/hr)	235,500	243,100
CO_2 Concentration (%, dry)	4.00	4.00
O_2 Concentration (%, dry)	16.00	16.00
N_2 Concentration (%, dry)	80.00	80.00
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.84	28.83
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	59.845	60.714
Dry Gas Volume (dscf)	60.378	61.011
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.250	3.607
Average Dry Gas Meter Temperature (°F)	72	73
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.665	0.684
Total Liquid Collected (mL)	52.6	53.4
Isokinetic Sampling Rate (%)	100.5	98.9

TABLE J-10. DATA SUMMARY - RUN NO. 10 - 20mm M-96 CARTRIDGE FEED

	10 M5 28 Feb 91	10 MeM5 28 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	483.81	483.81
Est PEP Feed Rate (lb/hr)	77.24	77.24
Auxillary Fuel Rate (gal/hr)	44.00	44.00
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.72	29.72
Static Pressure (in. H_2O)	-0.22	-0.22
Average Stack Gas Temperature (°F)	207	197
Stack Gas Moisture Content (%)	4.6	4.5
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	40.22	41.17
Volumetric Flow Rate (dscf/hr)	222,100	231,100
CO_2 Concentration (%, dry)	4.20	4.20
O_2 Concentration (%, dry)	15.53	15.53
N_2 Concentration (%, dry)	80.27	80.27
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.77	28.78
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	56.213	57.285
Dry Gas Volume (dscf)	57.533	58.581
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.022	3.110
Average Dry Gas Meter Temperature (°F)	61	60
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.634	0.654
Total Liquid Collected (mL)	59.6	59.0
Isokinetic Sampling Rate (%)	101.5	99.9

TABLE J-11. DATA SUMMARY - RUN NO. 11 - IMR-5010 PROPELLANT FEED

	11 M5 28 Feb 91	11 STEM 28 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	151.33	151.33
Auxillary Fuel Rate (gal/hr)	40.79	40.79
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.72	29.72
Static Pressure (in. H_2O)	-0.22	-0.22
Average Stack Gas Temperature (°F)	208	207
Stack Gas Moisture Content (%)	4.3	4.2
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	43.28	43.10
Volumetric Flow Rate (dscf/hr)	239,500	242,700
CO_2 Concentration (%, dry)	4.00	4.00
O_2 Concentration (%, dry)	16.00	16.00
N_2 Concentration (%, dry)	80.00	80.00
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.79	28.80
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	45.925	78.464
Dry Gas Volume (dscf)	45.656	77.109
Total Sampling Time (min)	120	120
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.459	1.523
Average Dry Gas Meter Temperature (°F)	63	69
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.682	0.685
Total Liquid Collected (mL)	43.7	72.4
Isokinetic Sampling Rate (%)	103.4	96.67

TABLE J-12. DATA SUMMARY - RUN NO. 12 - IMR-5010 PROPELLANT FEED

	12 M5 2 Mar 91	12 STEM 2 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	199.94	199.94
Auxillary Fuel Rate (gal/hr)	39.53	39.53
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.79	29.79
Static Pressure (in. H_2O)	-0.25	-0.25
Average Stack Gas Temperature (°F)	188	186
Stack Gas Moisture Content (%)	4.0	3.9
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	42.36	41.91
Volumetric Flow Rate (dscf/hr)	242,900	241,300
CO_2 Concentration (%, dry)	4.06	4.06
O_2 Concentration (%, dry)	15.93	15.93
N_2 Concentration (%, dry)	80.01	80.01
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.83	28.84
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	45.028	74.289
Dry Gas Volume (dscf)	48.021	79.340
Total Sampling Time (min)	120	120
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.439	1.413
Average Dry Gas Meter Temperature (°F)	38	37
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.679	0.673
Total Liquid Collected (mL)	42.7	69.0
Isokinetic Sampling Rate (%)	107.2	100.0

TABLE J-13. DATA SUMMARY - RUN 13 - FA-956 PRIMER FEED

	13 M5 2 Mar 91	13 MeM5* 2 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	142.94	142.94
PEP Feed Rate (lb/hr)	18.37	18.37
Auxillary Fuel Rate (gal/hr)	39.53	39.53
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.79	29.79
Static Pressure (in. H_2O)	-0.25	-0.25
Average Stack Gas Temperature (°F)	192	187
Stack Gas Moisture Content (%)	3.4	2.1
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.04	40.78
Volumetric Flow Rate (dscf/hr)	235,400	238,900
CO_2 Concentration (%, dry)	3.40†	3.40†
O_2 Concentration (%, dry)	17.18✝	17.18✝
N_2 Concentration (%, dry)	79.42†	79.42†
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.85	29.00
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	56.984	56.675
Dry Gas Volume (dscf)	60.810	60.419
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.140	3.127
Average Dry Gas Meter Temperature (°F)	41	40
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.656	0.656
Total Liquid Collected (mL)		
Isokinetic Sampling Rate (%)	101.2	99.6

* Sampling train failed posttest leak check.
† Asumed value, bad gas bag.
✝ Value from CEM.

TABLE J-14. DATA SUMMARY - RUN NO. 14 - FA-956 PRIMER FEED

	14 M5 4 Mar 91	14 MeM5 4 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	133.88	133.88
PEP Feed Rate (lb/hr)	17.21	17.21
Auxillary Fuel Rate (gal/hr)	37.83	37.83
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.84	29.84
Static Pressure (in. H_2O)	-0.26	-0.26
Average Stack Gas Temperature (^oF)	206	206
Stack Gas Moisture Content (%)	3.6	3.8
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	42.04	41.74
Volumetric Flow Rate (dscf/hr)	235,900	233,700
CO_2 Concentration (%, dry)	3.60	3.60
O_2 Concentration (%, dry)	16.20	16.20
N_2 Concentration (%, dry)	80.20	80.20
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.82	28.79
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	51.791	56.744
Dry Gas Volume (dscf)	55.038	60.014
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.193	3.264
Average Dry Gas Meter Temperature (^oF)	44	45
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.665	0.660
Total Liquid Collected (mL)	43.9	50.8
Isokinetic Sampling Rate (%)	91.4	101.2

TABLE J-15. DATA SUMMARY - RUN NO. 15 - FA-956 PRIMER FEED

	15 M5 4 Mar 91	15 MeM5 4 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	146.78	146.78
PEP Feed Rate (lb/hr)	18.86	18.86
Auxillary Fuel Rate (gal/hr)	37.83	37.83
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.84	29.84
Static Pressure (in. H_2O)	-0.26	-0.26
Average Stack Gas Temperature (°F)	207	204
Stack Gas Moisture Content (%)	3.6	3.7
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.83	41.75
Volumetric Flow Rate (dscf/hr)	234,600	234,900
CO_2 Concentration (%, dry)	3.40	3.40
O_2 Concentration (%, dry)	16.20	16.20
N_2 Concentration (%, dry)	80.40	80.40
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.80	28.78
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	58.154	56.979
Dry Gas Volume (dscf)	60.596	59.320
Total Sampling Time (min)	60	60
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	3.182	3.250
Average Dry Gas Meter Temperature (°F)	54	53
Sampling Nozzle Area (ft^2)	5.225×10^{-4}	5.196×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.661	0.661
Total Liquid Collected (mL)	47.4	48.10
Isokinetic Sampling Rate (%)	101.2	99.5

TABLE J-16. DATA SUMMARY - RUN NO. 16 - IMR-5010 PROPELLANT FEED

	16 M5 4 Mar 91	16 STEM 4 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb propellant/hr)	194.55	194.55
Auxillary Fuel Rate (gal/hr)	37.83	37.83
Auxiliary Fuel Heating Value (Btu/gal)	137,000	137,000
STACK GAS DATA		
Barometric Pressure (in. Hg)	29.84	29.84
Static Pressure (in. H_2O)	-0.26	-0.26
Average Stack Gas Temperature (°F)	211	208
Stack Gas Moisture Content (%)	4.3	4.0
Stack Area (ft^2)	2.047	2.047
Stack Gas Velocity (ft/sec)	41.38	41.58
Volumetric Flow Rate (dscf/hr)	229,000	231,700
CO_2 Concentration (%, dry)	4.00	4.00
O_2 Concentration (%, dry)	16.20	16.20
N_2 Concentration (%, dry)	79.80	79.80
CO Concentration (%, dry)	<0.05	<0.05
Stack Gas Molecular Weight (lb/lb-mole, wet)	28.81	28.83
SAMPLING EQUIPMENT DATA		
Gas Volume Sampled at Meter Conditions (dcf)	44.171	74.724
Dry Gas Volume (dscf)	44.623	75.381
Total Sampling Time (min)	120	120
Pitot Tube Coefficient	0.84	0.84
Average Pressure Drop Across Meter Orifice (in H_2O)	0.413	1.375
Average Dry Gas Meter Temperature (°F)	65	67
Sampling Nozzle Area (ft^2)	1.887×10^{-4}	3.364×10^{-4}
Dry Gas Meter Coefficient	1.009	1.006
Average Stack Gas Velocity Head (in $H_2O)^{0.5}$	0.652	0.657
Total Liquid Collected (mL)	42.1	67.1
Isokinetic Sampling Rate (%)	105.7	99.0

APPENDIX K

PROCESS DATA SUMMARY

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 1 : 20mm M-96

DATE : 02/22/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	0.20	0.00	4.00
AVERAGE O2 (%) :	16.86	16.60	17.10
AVERAGE CO @ 7% O2 (ppm) :	0.72	0.00	14.26
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	24.13	0.83	39.41
TOTAL WEIGHT PROCESSED (lbs.) :	561.38	-	-
TOTAL TEST TIME (MIN) :	68	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	495.33	-	-
AVERAGE FUEL USAGE (gal/hr) :	38.28	-	-
AVERAGE RETORT INLET TEMP. (F) :	325.09	304.00	341.00
AVERAGE RETORT OUTLET TEMP. (F) :	707.96	671.00	722.00
AVERAGE AFTERBURNER TEMP. (F) :	1301.29	1279.00	1327.00
AVERAGE HTHE TEMP. (F) :	798.16	789.00	809.00
AVERAGE LTHE TEMP. (F) :	295.42	285.00	307.00
AVERAGE BAGHOUSE TEMP. (F) :	264.86	260.00	269.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4547.00	-	-
AVERAGE KILN ROTATIONAL SPEED (RPM) :	2	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 2 : 20mm M-96

DATE : 02/22/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	0.31	0.00	4.00
AVERAGE O2 (%) :	17.09	16.70	20.80
AVERAGE CO @ 7% O2 (ppm) :	1.08	0.00	14.63
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	0.68	0.00	1.49
TOTAL WEIGHT PROCESSED (lbs.) :	547.31	-	-
TOTAL TEST TIME (MIN) :	80	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	410.48	-	-
AVERAGE FUEL USAGE (gal/hr) :	38.28	-	-
AVERAGE RETORT INLET TEMP. (F) :	360.75	302.00	382.00
AVERAGE RETORT OUTLET TEMP. (F) :	710.81	578.00	731.00
AVERAGE AFTERBURNER TEMP. (F) :	1275.59	682.00	1323.00
AVERAGE HTHE TEMP. (F) :	792.27	621.00	809.00
AVERAGE LTHE TEMP. (F) :	295.25	279.00	308.00
AVERAGE BAGHOUSE TEMP. (F) :	267.80	260.00	272.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4545.98	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.4	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 3 : HI-SKOR 700X

DATE : 02/23/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	0.21	0.00	16.00
AVERAGE O2 (%) :	16.13	15.80	17.80
AVERAGE CO @ 7% O2 (ppm) :	0.75	0.00	71.74
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	0.26	0.00	1.95
TOTAL WEIGHT PROCESSED (lbs.) :	155.13	-	-
TOTAL WEIGHT OF HI-SKOR 700X (lbs.) :	134.61	-	-
TOTAL TEST TIME (MIN) :	186.00	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	50.04	-	-
AVERAGE FUEL USAGE (gal/hr) :	43.03	-	-
AVERAGE RETORT INLET TEMP. (F) :	348.56	307.00	386.00
AVERAGE RETORT OUTLET TEMP. (F) :	712.04	667.00	729.00
AVERAGE AFTERBURNER TEMP. (F) :	1448.37	1177.00	1475.00
AVERAGE HTHE TEMP. (F) :	831.73	789.00	838.00
AVERAGE LTHE TEMP. (F) :	294.76	281.00	308.00
AVERAGE BAGHOUSE TEMP. (F) :	267.03	262.00	274.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4325.76	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	2.8	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 4 : HI-SKOR 700X

DATE : 02/25/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	1.46	0.00	9.00
AVERAGE O2 (%) :	16.49	16.20	16.70
AVERAGE CO @ 7% O2 (ppm) :	4.65	0.00	29.09
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	4.45	0.53	9.08
TOTAL WEIGHT PROCESSED (lbs.) :	101.88	-	-
TOTAL WEIGHT OF HI-SKOR 700X (lbs.) :	88.4	-	-
TOTAL TEST TIME (MIN) :	132	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	46.31	-	-
AVERAGE FUEL USAGE (gal/hr) :	44.13	-	-
AVERAGE RETORT INLET TEMP. (F) :	320.97	283.00	351.00
AVERAGE RETORT OUTLET TEMP. (F) :	652.43	627.00	667.00
AVERAGE AFTERBURNER TEMP. (F) :	1449.26	1428.00	1468.00
AVERAGE HTHE TEMP. (F) :	828.17	816.00	837.00
AVERAGE LTHE TEMP. (F) :	294.79	282.00	309.00
AVERAGE BAGHOUSE TEMP. (F) :	263.83	259.00	269.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4462.00	-	-
AVERAGE KILN ROTATIONAL SPEED (RPM) :	2.8	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 5 : 20mm M-96

DATE: 02/25/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	8.20	0.00	75.00
AVERAGE O2 (%) :	16.17	15.70	16.70
AVERAGE CO @ 7% O2 (ppm) :	24.40	0.00	221.81
ACCUM. CO @ 7% O2 HR. ROLLING AVG. (ppm)	31.96	17.63	38.29
TOTAL WEIGHT PROCESSED (lbs.) :	539.63	-	-
TOTAL TEST TIME (MIN) :	58.00	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	558.23	-	-
AVERAGE FUEL USAGE (gal/hr) :	44.03	-	-
AVERAGE RETORT INLET TEMP. (F) :	445.10	422.00	455.00
AVERAGE RETORT OUTLET TEMP. (F) :	942.75	841.00	999.00
AVERAGE AFTERBURNER TEMP. (F) :	1390.32	1312.88	1455.88
AVERAGE HTHE TEMP. (F) :	803.54	793.00	818.00
AVERAGE LTHE TEMP. (F) :	293.64	281.00	307.00
AVERAGE BAGHOUSE TEMP. (F) :	263.42	260.00	267.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4260.54	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 6 : 20mm M-96

DATE : 02/26/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	6.91	0.00	26.00
AVERAGE O2 (%) :	16.29	15.50	16.80
AVERAGE CO @ 7% O2 (ppm) :	21.67	0.00	76.89
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	10.31	1.90	22.64
TOTAL WEIGHT PROCESSED (lbs.) :	617.81	-	-
TOTAL TEST TIME (MIN) :	64	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	579.20	-	-
AVERAGE FUEL USAGE (gal/hr) :	41.54	-	-
AVERAGE RETORT INLET TEMP. (F) :	399.91	386.00	415.00
AVERAGE RETORT OUTLET TEMP. (F) :	916.75	776.00	1090.00
AVERAGE AFTERBURNER TEMP. (F) :	1398.69	1370.00	1430.00
AVERAGE HTHE TEMP. (F) :	804.60	795.00	816.00
AVERAGE LTHE TEMP. (F) :	293.88	282.00	307.00
AVERAGE BAGHOUSE TEMP. (F) :	264.42	261.00	268.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4356.00	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 7 : HI-SKOR 700X

DATE : 02/26/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	3.34	0.00	19.00
AVERAGE O2 (%) :	16.42	16.20	16.70
AVERAGE CO @ 7% O2 (ppm) :	10.57	0.00	62.88
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	10.24	3.22	20.99
TOTAL WEIGHT PROCESSED (lbs.) :	92.25	-	-
TOTAL WEIGHT OF HI-SKOR 700X (lbs.) :	80.05	-	-
TOTAL TEST TIME (MIN) :	127	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	43.58	-	-
AVERAGE FUEL USAGE (gal/hr) :	39.88	-	-
AVERAGE RETORT INLET TEMP. (F) :	382.81	362.00	395.00
AVERAGE RETORT OUTLET TEMP. (F) :	723.55	714.00	730.00
AVERAGE AFTERBURNER TEMP. (F) :	1449.55	1427.00	1475.00
AVERAGE HTHE TEMP. (F) :	805.56	796.00	820.00
AVERAGE LTHE TEMP. (F) :	294.08	282.00	307.00
AVERAGE BAGHOUSE TEMP. (F) :	261.77	256.00	270.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4306.00	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	2.8	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 8 : FA-956 PRIMERS

DATE : 02/27/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	3.44	1.00	8.00
AVERAGE O2 (%) :	16.50	16.30	16.70
AVERAGE CO @ 7% O2 (ppm) :	10.94	3.02	25.86
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	12.25	7.74	16.30
TOTAL WEIGHT PROCESSED (lbs.) :	98.31	-	-
TOTAL TEST TIME (MIN) :	65	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	90.75	-	-
AVERAGE FUEL USAGE (gal/hr) :	33.90	-	-
AVERAGE RETORT INLET TEMP. (F) :	307.36	373.00	404.00
AVERAGE RETORT OUTLET TEMP. (F) :	694.18	725.00	877.00
AVERAGE AFTERBURNER TEMP. (F) :	1349.59	1372.00	1477.00
AVERAGE HTHE TEMP. (F) :	801.33	795.00	831.00
AVERAGE LTHE TEMP. (F) :	293.97	282.00	309.00
AVERAGE BAGHOUSE TEMP. (F) :	263.03	262.00	269.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4261.00	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.7	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 9 : 20mm M-96

DATE : 02/27/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	7.27	1.00	40.00
AVERAGE O2 (%) :	15.99	15.30	16.50
AVERAGE CO @ 7% O2 (ppm) :	20.61	2.57	118.30
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	13.73	2.73	24.47
TOTAL WEIGHT PROCESSED (lbs.) :	681.63	-	-
TOTAL TEST TIME (MIN) :	72	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	568.02	-	-
AVERAGE FUEL USAGE (gal/hr) :	33.90	-	-
AVERAGE RETORT INLET TEMP. (F) :	418.16	399.00	464.00
AVERAGE RETORT OUTLET TEMP. (F) :	845.92	760.00	1016.00
AVERAGE AFTERBURNER TEMP. (F) :	1399.62	1374.00	1429.00
AVERAGE HTHE TEMP. (F) :	803.01	795.00	815.00
AVERAGE LTHE TEMP. (F) :	293.99	283.00	306.00
AVERAGE BAGHOUSE TEMP. (F) :	263.59	260.00	267.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4056.07	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.1	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 10 : 20mm M-96

DATE : 02/28/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	7.61	0.00	22.00
AVERAGE O2 (%) :	15.25	14.90	15.60
AVERAGE CO @ 7% O2 (ppm) :	18.97	0.00	56.63
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	13.65	5.91	20.98
TOTAL WEIGHT PROCESSED (lbs.) :	532.19	-	-
TOTAL TEST TIME (MIN) :	66	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	483.81	-	-
AVERAGE FUEL USAGE (gal/hr) :	44.00	-	-
AVERAGE RETORT INLET TEMP. (F) :	389.64	355.00	429.00
AVERAGE RETORT OUTLET TEMP. (F) :	1052.55	1009.00	1076.00
AVERAGE AFTERBURNER TEMP. (F) :	1399.93	1375.00	1429.00
AVERAGE HTHE TEMP. (F) :	805.09	796.00	815.00
AVERAGE LTHE TEMP. (F) :	292.73	280.00	306.00
AVERAGE BAGHOUSE TEMP. (F) :	263.99	260.00	269.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4143.99	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 11 : IMR-5010

DATE : 02/28/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	8.75	0.00	58.00
AVERAGE O2 (%) :	15.94	15.60	16.40
AVERAGE CO @ 7% O2 (ppm) :	24.03	0.00	164.53
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	21.72	0.41	39.66
TOTAL WEIGHT PROCESSED (lbs.) :	331.81	-	-
TOTAL WEIGHT OF IMR-5010 (lbs.) :	315.28	-	-
TOTAL TEST TIME (MIN) :	125	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	159.27	-	-
AVERAGE FUEL USAGE (gal/hr) :	40.79	-	-
AVERAGE RETORT INLET TEMP. (F) :	653.61	526	730
AVERAGE RETORT OUTLET TEMP. (F) :	731.65	702	747
AVERAGE AFTERBURNER TEMP. (F) :	1399.84	1363	1427
AVERAGE HTHE TEMP. (F) :	803.31	794	815
AVERAGE LTHE TEMP. (F) :	293.36	280	307
AVERAGE BAGHOUSE TEMP. (F) :	264.53	261	270
AVERAGE STACK GAS VELOCITY (ACFM) :	4127.00	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	2.8	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 12 : IMR-5010

DATE : 03/02/91

			MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	4.56		0.00	16.00
AVERAGE O2 (%) :	16.70		16.40	17.00
AVERAGE CO @ 7% O2 (ppm) :	15.28		0.00	57.03
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	11.87		0.65	17.26
TOTAL WEIGHT PROCESSED (lbs.) :	181.31	ERR	-	-
TOTAL TEST TIME (MIN) :	126		-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	86.34	ERR	-	-
AVERAGE FUEL USAGE (gal/hr) :	39.53		-	-

ERR - Due to inoperative scale I/O card, the quantity of the feed material is the different between the mass before and after the duration of the test.

ACTUAL WEIGHT PROCESSED (lbs.) :	464.00		-	-
ACTUAL WEIGHT OF IMR-5010 (lbs.) :	429.87		-	-
TEST DURATION (MIN) :	129.00		-	-
ACTUAL AVERAGE WEIGHT/HOUR (lbs./hr) :	215.81		-	-
AVERAGE RETORT INLET TEMP. (F) :	559.15		432.00	638.00
AVERAGE RETORT OUTLET TEMP. (F) :	666.65		635.00	679.00
AVERAGE AFTERBURNER TEMP. (F) :	1399.49		1368.00	1424.00
AVERAGE HTHE TEMP. (F) :	803.76		795.00	817.00
AVERAGE LTHE TEMP. (F) :	293.67		282.00	306.00
AVERAGE BAGHOUSE TEMP. (F) :	256.45		252.00	262.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4278.35		-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	2.8		-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 13 : FA-956 PRIMERS

DATE : 03/02/91

			MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	1.96		1.00	6.00
AVERAGE O2 (%) :	17.18		17.00	17.30
AVERAGE CO @ 7% O2 (ppm) :	7.38		3.56	23.17
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	4.68		1.45	7.61
TOTAL WEIGHT PROCESSED (lbs.) :	26.91	ERR	-	-
TOTAL TEST TIME (MIN) :	68		-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	23.75	ERR	-	-
AVERAGE FUEL USAGE (gal/hr) :	39.53		-	-

ERR - Due to inoperative scale I/O card, the quantity of the feed material is the different between the mass before and after the duration of the test.

ACTUAL WEIGHT PROCESSED (lbs.) :	162.00		-	-
TEST DURATION (MIN) :	68		-	-
ACTUAL AVERAGE WEIGHT/HOUR (lbs./hr) :	142.94		-	-
AVERAGE RETORT INLET TEMP. (F) :	345.04		342	348
AVERAGE RETORT OUTLET TEMP. (F) :	630.59		599	649
AVERAGE AFTERBURNER TEMP. (F) :	1349.93		1329	1371
AVERAGE HTHE TEMP. (F) :	799.78		790	809
AVERAGE LTHE TEMP. (F) :	294.62		284	305
AVERAGE BAGHOUSE TEMP. (F) :	259.67		257	263

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 14 : FA-956 PRIMERS

DATE : 03/04/91

		MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	3.52	2.00	7.00
AVERAGE O2 (%) :	167.81	16.30	17.20
AVERAGE CO @ 7% O2 (ppm) :	11.92	6.47	25.61
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	6.61	0.41	12.19
TOTAL WEIGHT PROCESSED (lbs.) :	122.19	-	-
TOTAL TEST TIME (MIN) :	63	-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	116.37	-	-
AVERAGE FUEL USAGE (gal/hr) :	37.83	-	-

ERR - Due to inoperative scale I/O card, the quantity of the feed material is the different between the mass before and after the duration of the test.

ACTUAL WEIGHT PROCESSED (lbs.) :	147.27	-	-
TEST DURATION (MIN) :	66	-	-
ACTUAL AVERAGE WEIGHT/HOUR (lbs./hr) :	133.88	-	-
AVERAGE RETORT INLET TEMP. (F) :	301.36	296.00	311.00
AVERAGE RETORT OUTLET TEMP. (F) :	853.27	770.00	943.00
AVERAGE AFTERBURNER TEMP. (F) :	1349.63	1330.00	1368.00
AVERAGE HTHE TEMP. (F) :	801.89	791.00	811.00
AVERAGE LTHE TEMP. (F) :	295.91	284.00	308.00
AVERAGE BAGHOUSE TEMP. (F) :	264.09	260.00	268.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4388.50	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.6	-	-
AVERAGE STACK GAS VELOCITY (ACFM) :	4179.03	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.6	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 15 : FA-956 PRIMERS

DATE : 03/04/91

AVERAGE UNCORRECTED CO (ppm) :	2.72		1.00	5.00
AVERAGE O2 (%) :	17.22		17.00	17.50
AVERAGE CO @ 7% O2 (ppm) :	10.36		3.66	20.44
ACCUM. CO @7% O2 HR. ROOLING AVG. (ppm)	7.13		3.74	10.67
TOTAL WEIGHT PROCESSED (lbs.) :	117.00	ERR	-	-
TOTAL TEST TIME (MIN) :	64		-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	109.69	ERR	-	-
AVERAGE FUEL USAGE (gal/hr) :	37.83		-	-

ERR - Due to inoperative scale I/O card, the quality of the feed material is the different between the mass before and after the duration of the test.

ACTUAL WEIGHT PROCESSED (lbs.) :	156.56	-	-
TEST DURATION (MIN) :	64	-	-
ACTUAL AVERAGE WEIGHT/HOUR (lbs./hr) :	146.775	-	-
AVERAGE RETORT INLET TEMP. (F) :	303.43	298.00	309.00
AVERAGE RETORT OUTLET TEMP. (F) :	684.20	671.00	707.00
AVERAGE AFTERBURNER TEMP. (F) :	1349.75	1330.00	1372.00
AVERAGE HTHE TEMP. (F) :	800.34	788.00	811.00
AVERAGE LTHE TEMP. (F) :	295.86	285.00	308.00
AVERAGE BAGHOUSE TEMP. (F) :	264.46	261.00	269.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4368.91	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	1.7	-	-

LAKE CITY ARMY AMMUNITION PLANT
EXPLOSIVE WASTE INCINERATOR TRIAL BURN TEST

TEST No. 16 : IMR-5010

DATE : 03/04/91

			MINIMUM	MAXIMUM
AVERAGE UNCORRECTED CO (ppm) :	9.09		0.00	27.00
AVERAGE O2 (%) :	16.71		16.40	17.00
AVERAGE CO @ 7% O2 (ppm) :	30.36		0.00	89.36
ACCUM. CO @7% O2 HR. ROLLING AVG. (ppm)	37.22		23.17	62.26
TOTAL WEIGHT PROCESSED (lbs.) :	33.88	ERR	-	-
TOTAL TEST TIME (MIN) :	126		-	-
AVERAGE WEIGHT/HOUR (lbs./hr) :	16.13	ERR	-	-
AVERAGE FUEL USAGE (gal/hr) :	37.83		-	-

ERR - Due to inoperative scale I/O card, the quantity of the feed material is the different between the mass before and after the duration of the test.

ACTUAL WEIGHT PROCESSED (lbs.) :	441.90	-	-
ACTUAL WEIGHT OF IMR-5010 (lbs.) :	408.56	-	-
TEST DURATION (MIN) :	126	-	-
ACTUAL AVERAGE WEIGHT/HOUR (lbs./hr) :	210.43	-	-

AVERAGE RETORT INLET TEMP. (F) :	614.99	373.00	685.00
AVERAGE RETORT OUTLET TEMP. (F) :	721.91	679.00	736.00
AVERAGE AFTERBURNER TEMP. (F) :	1401.20	1377.00	1452.00
AVERAGE HTHE TEMP. (F) :	803.76	794.00	814.00
AVERAGE LTHE TEMP. (F) :	295.02	282.00	308.00
AVERAGE BAGHOUSE TEMP. (F) :	267.13	262.00	272.00
AVERAGE STACK GAS VELOCITY (ACFM) :	4105.22	-	-
AVERAGE RETORT ROTATIONAL SPEED (RPM) :	2.8	-	-

APPENDIX L

POHC DATA SUMMARY

TABLE L-1. NG EMISSION AND DRE DATA SUMMARY - HI SKOR 700X PROPELLANT FEED

Run Number Date	3 STEM 23 Feb 91	4 STEM 25 Feb 91	7 STEM 26 Feb 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lbs/hr)	43.42	40.18	37.82
Average NG concentration (mg NG/mg propellant)	0.4046	0.4030	0.3840
NG Feed Rate (lbs/hr)	17.5677	16.1925	14.5229
STACK GAS DATA			
Volumetric Flow Rate (dscf/hr)	243,300	242,800	246,100
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	120.900	79.637	78.725
Total Sampling Time (min)	180	120	120
Isokinetic Sampling Rate (%)	100.8	99.8	97.3
EMISSION DATA			
Max. NG Collected, Filter and Probe Wash (μg)	10.0	10.0	11.5
Max. NG Collected, Impinger Section (μg)	18.0	18.0	18.0
Max. NG Collected, Resin Section (μg)	23.0	23.0	23.0
Max. Total NG Collected (μg)	51.0	51.0	52.5
Max. NG Concentration (μg/dscf)	0.422	0.640	0.667
Max. NG Emission Rate (lb/hr)	2.263×10^{-4}	3.428×10^{-4}	3.618×10^{-4}
Min. NG DRE (%)	99.9987	99.9979	99.9975
DRE Standard (%)	99.99	99.99	99.99

TABLE L-2. NG FEED CONCENTRATIONS - RUN 3 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0246	105.3	42.0	.3989
42LCAAP0247	105.6	46.0	.4356
42LCAAP0248	112.4	42.0	.3737
42LCAAP0249	106.4	45.0	.4229
42LCAAP0250	102.1	40.0	.3918

TABLE L-3. NG FEED CONCENTRATIONS - RUN 4 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0251	108.5	42.0	.3871
42LCAAP0252	104.9	42.0	.4004
42LCAAP0253	103.5	42.0	.4058
42LCAAP0254	104.5	44.0	.4211
42LCAAP0255	109.8	44.0	.4007

TABLE L-4. NG FEED CONCENTRATIONS - RUN 7 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0256	104.2	40.0	.3839
42LCAAP0257	111.8	44.0	.3936
42LCAAP0258	105.2	38.0	.3612
42LCAAP0259	110.2	43.0	.3902
42LCAAP0260	102.2	40.0	.3914

TABLE L-5. NG/EGDN ANALYTICAL DATA - RUN 3 STEM

Sample No.	Sample Description	Concentration (g/sample) NG	EGDN
42LCAAP0083	Toluene Probe Wash/Filter	10.0*	-
42LCAAP0084	Acetone Probe Wash	-	-
42LCAAP0087	Impinger Water-1st Extraction	5.0*	90.0
42LCAAP0096	Impinger Water-2nd Extraction	5.0*	6.0
42LCAAP0101	Impinger Water-3rd Extraction	5.0*	-
42LCAAP0099	Separatory Funnel Toluene Rinse	3.0*	-
42LCAAP0100	Separatory Funnel Acetone Rinse	-	-
42LCAAP0098	Impinger Acetone Rinse	-	-
42LCAAP0088	Resin-1st Section-1st Extraction	3.0*	-
42LCAAP0092	-2nd Extraction	1.0*	-
42LCAAP0103	-3rd Extraction	1.0*	-
42LCAAP0089	Resin-2nd Section-1st Extraction	3.0*	-
42LCAAP0093	-2nd Extraction	1.0*	-
42LCAAP0105	-3rd Extraction	1.0*	-
42LCAAP0090	Resin-3rd Section-1st Extraction	3.0*	-
42LCAAP0094	-2nd Extraction	1.0*	-
42LCAAP0106	-3rd Extraction	1.0*	-
42LCAAP0091	Resin-4th Section-1st Extraction	3.0*	102.0
42LCAAP0095	-2nd Extraction	1.0*	-
42LCAAP0107	-3rd Extraction	1.0*	1.0
42LCAAP0081	Resin Tube Toluene Rinse	3.0*	-
42LCAAP0082	Resin Tube Acetone Rinse	-	-
	Max Probe Wash Filter Section	10.0	-
	Max Impinger Section	18.0	96.0
	Max Resin Module Section	23.00	103.0
	Max Total Sample Train	51.0	

* Sample Concentration < Method Detection Limit of 0.1 μg/mL, therefore sample concentration assumed to be 0.1 μg/mL.

TABLE L-6. NG/EGDN ANALYTICAL DATA - RUN 4 STEM

Sample No.	Sample Description	Concentration (g/sample) NG	EGDN
42LCAAP0113	Toluene Probe Wash/Filter	10.0*	-
42LCAAP0114	Acetone Probe Wash	-	-
42LCAAP0124	Impinger Water-1st Extraction	5.0*	95.0
42LCAAP0129	Impinger Water-2nd Extraction	5.0*	6.5
42LCAAP0130	Impinger Water-3rd Extraction	5.0*	-
42LCAAP0132	Separatory Funnel Toluene Rinse	3.0*	-
42LCAAP0133	Separatory Funnel Acetone Rinse	-	-
42LCAAP0119	Impinger Acetone Rinse	-	-
42LCAAP0115	Resin-1st Section-1st Extraction	3.0*	-
42LCAAP0120	-2nd Extraction	1.0*	-
42LCAAP0125	-3rd Extraction	1.0*	-
42LCAAP0116	Resin-2nd Section-1st Extraction	3.0*	-
42LCAAP0121	-2nd Extraction	1.0*	-
42LCAAP0126	-3rd Extraction	1.0*	-
42LCAAP0117	Resin-3rd Section-1st Extraction	3.0*	-
42LCAAP0122	-2nd Extraction	1.0*	-
42LCAAP0127	-3rd Extraction	1.0*	-
42LCAAP0118	Resin-4th Section-1st Extraction	3.0*	87.0
42LCAAP0123	-2nd Extraction	1.0*	-
42LCAAP0128	-3rd Extraction	1.0*	2.0
42LCAAP0109	Resin Tube Toluene Rinse	3.0*	-
42LCAAP0110	Resin Tube Acetone Rinse	-	-
	Max Probe Wash Filter Section	10.0	-
	Max Impinger Section	18.0	101.5
	Max Resin Module Section	23.0	89.0
	Max Total Sample Train	51.0	

* Sample Concentration < Method Detection Limit of 0.1 μg/mL, therefore sample concentration assumed to be 0.1 μg/mL.

TABLE L-7. NG/EGDN ANALYTICAL DATA - RUN 7 STEM

Sample No.	Sample Description	Concentration (g/sample) NG	EGDN
42LCAAP0159	Toluene Probe Wash/Filter	11.5*	-
42LCAAP0160	Acetone Probe Wash	-	-
42LCAAP0161	Impinger Water-1st Extraction	5.0*	95.0
42LCAAP0166	Impinger Water-2nd Extraction	5.0*	6.5
42LCAAP0170	Impinger Water-3rd Extraction	5.0*	-
42LCAAP0172	Separatory Funnel Toluene Rinse	3.0*	-
42LCAAP0173	Separatory Funnel Acetone Rinse	-	-
42LCAAP0156	Impinger Acetone Rinse	-	-
42LCAAP0162	Resin-1st Section-1st Extraction	3.0*	-
42LCAAP0174	-2nd Extraction	1.0*	-
42LCAAP0182	-3rd Extraction	1.0*	-
42LCAAP0163	Resin-2nd Section-1st Extraction	3.0*	-
42LCAAP0175	-2nd Extraction	1.0*	-
42LCAAP0183	-3rd Extraction	1.0*	-
42LCAAP0164	Resin-3rd Section-1st Extraction	3.0*	-
42LCAAP0176	-2nd Extraction	1.0*	0.6
42LCAAP0184	-3rd Extraction	1.0*	0.1
42LCAAP0165	Resin-4th Section-1st Extraction	3.0*	90.0
42LCAAP0177	-2nd Extraction	1.0*	-
42LCAAP0185	-3rd Extraction	1.0*	7.3
42LCAAP0152	Resin Tube Toluene Rinse	3.0*	-
42LCAAP0153	Resin Tube Acetone Rinse	-	-
	Max Probe Wash Filter Section	11.5	-
	Max Impinger Section	18.0	101.5
	Max Resin Module Section	23.0	98.0
	Max Total Sample Train	52.5	

* Sample Concentration < Method Detection Limit of 0.1 μg/mL, therefore sample concentration assumed to be 0.1 μg/mL.

NG DRE CALCULATIONS

1. Run 3 STEM: M_{NG} = 51.0 μg , Q_s = 243,300 dscf/hr, $V_{m_{std}}$ = 120.900

a. POHC in (w_{in}):

$$w_{in} = (0.4046)(43.42)$$

$$= 17.56773200 \text{ lb NG/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(51.0)(243,300)}{(453,600,000)(120.900)}$$

$$= 0.00022626 \text{ lb NG/hr}$$

c. DRE:

$$DRE = \frac{17.56773200 - 0.00022626}{17.5677320}$$

$$= 99.9987 \%$$

2. Run 4 STEM: M_{NG} = 51.0 μg , Q_s = 242,800 dscf/hr, $V_{m_{std}}$ = 79.637 dscf

a. POHC in (w_{in}):

$$w_{in} = (0.4030)(40.18)$$

$$= 16.19254000 \text{ lb NG/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(51.0)(242,800)}{(453,600,000)(79.637)}$$

$$= 0.00034279 \text{ lb NG/hr}$$

c. DRE:

$$DRE = \frac{16.19254000 - 0.00034279}{16.1925400}$$

$$= 99.9979 \%$$

3. Run 7 STEM: M_{NG} = 52.5 μg , Q_s = 246,100 dscf/hr, $V_{m_{std}}$ = 78.725 dscf

a. POHC in (w_{in}):

$$w_{in} = (0.3840)(37.82)$$

$$= 14.52288000 \text{ lb NG/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(52.5)(246,100)}{(453,600,000)(78.725)}$$

$$= 0.00036181 \text{ lb NG/hr}$$

c. DRE:

$$DRE = \frac{14.52288000 - 0.00036181}{14.5228800}$$

$$= 99.9975 \%$$

TABLE L-8. 2,4-DNT EMISSION AND DRE DATA SUMMARY - IMR 5010 PROPELLANT FEED

Run Number Date	11 STEM 28 Feb 91	12 STEM 2 Mar 91	16 STEM 4 Mar 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lbs propellant/hr)	151.33	199.94	194.55
Average 2,4-DNT concentration (mg 2,4-DNT/mg propellant)	0.06690	0.06367	0.06447
2,4-DNT Feed Rate (lbs/hr)	10.124	12.730	12.543
STACK GAS DATA			
Volumetric Flow Rate (dscf/hr)	242,700	241,300	231,700
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	77.109	79.340	75.381
Total Sampling Time (min)	120	120	120
Isokinetic Sampling Rate (%)	96.7	100.0	99.0
EMISSION DATA			
Max. 2,4-DNT Collected, Filter and Probe Wash (μg)	5.8	6.0	5.0
Max. 2,4-DNT Collected, Impinger Section (μg)	9.0	9.0	9.0
Max. 2,4-DNT Collected, Resin Section (μg)	11.5	11.5	11.5
Max. Total 2,4-DNT Collected (μg)	26.3	26.5	25.5
Max. 2,4-DNT Concentration (μg/dscf)	0.341	0.334	0.338
Max. 2,4-DNT Emission Rate (lb/hr)	1.825×10^{-4}	1.777×10^{-4}	1.728×10^{-4}
Min. 2,4-DNT DRE (%)	99.9982	99.9986	99.9986
DRE Standard (%)	99.99	99.99	99.99

TABLE L-9. DPA EMISSION AND DRE DATA SUMMARY - IMR 5010 PROPELLANT FEED

Run Number Date	11 STEM 28 Feb 91	12 STEM 2 Mar 91	16 STEM 4 Mar 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lbs propellant/hr)	151.33	199.94	194.55
Average DPA concentration (mg 2,4-DPA/mg propellant)	0.01578	0.01557	0.01575
DPA Feed Rate (lbs/hr)	2.388	3.113	3.064
STACK GAS DATA			
Volumetric Flow Rate (dscf/hr)	242,700	241,300	231,700
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	77.109	79.340	75.381
Total Sampling Time (min)	120	120	120
Isokinetic Sampling Rate (%)	96.7	100.0	99.0
EMISSION DATA			
Max. DPA Collected, Filter and Probe Wash (μg)	5.8	6.0	5.0
Max. DPA Collected, Impinger Section (μg)	9.0	9.0	9.0
Max. DPA Collected, Resin Section (μg)	11.5	11.5	11.5
Max. Total DPA Collected (μg)	26.3	26.5	25.5
Max. DPA Concentration (μg/dscf)	0.341	0.334	0.338
Max. DPA Emission Rate (lb/hr)	1.825×10^{-4}	1.777×10^{-4}	1.728×10^{-4}
Min. DPA DRE (%)	99.9924	99.9943	99.9944
DRE Standard (%)	99.99	99.99	99.99

TABLE L-10. 2,4-DNT FEED CONCENTRATIONS - RUN 11 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0288	6.8	106.9	0.0636
42LCAAP0289	7.2	101.2	0.0711
42LCAAP0290	6.8	109.2	0.0623
42LCAAP0291	7.2	104.7	0.0688
42LCAAP0292	7.6	110.6	0.0687

TABLE L-11. 2,4-DNT FEED CONCENTRATIONS - RUN 12 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0293	6.8	107.4	0.0633
42LCAAP0294	8.4	119.7	0.0702
42LCAAP0295	7.6	113.1	0.0672
42LCAAP0296	6.0	102.6	0.0585
42LCAAP0297	6.4	108.1	0.0592

TABLE L-12. 2,4-DNT FEED CONCENTRATIONS - RUN 16 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0298	6.4	100.3	0.0638
42LCAAP0299	6.8	106.1	0.0641
42LCAAP0300	7.2	108.8	0.0662
42LCAAP0301	6.8	109.4	0.0622
42LCAAP0302	7.2	108.9	0.0661

TABLE L-13. DPA FEED CONCENTRATIONS - RUN 11 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0288	1.7	106.9	0.0159
42LCAAP0289	1.6	101.2	0.0158
42LCAAP0290	1.7	109.2	0.0156
42LCAAP0291	1.7	104.7	0.0162
42LCAAP0292	1.7	110.6	0.0154

TABLE L-14. DPA FEED CONCENTRATIONS - RUN 12 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0293	1.7	107.4	0.0158
42LCAAP0294	2.0	119.7	0.0167
42LCAAP0295	1.8	113.1	0.0159
42LCAAP0296	1.5	102.6	0.0146
42LCAAP0297	1.6	108.1	0.0148

TABLE L-15. DPA FEED CONCENTRATIONS - RUN 16 STEM

Sample No.	Wt of POHC in Sample (mg)	Wt of Propellant in Sample (mg)	POHC Concentration (lb POHC/lb Prop)
42LCAAP0298	1.6	100.3	0.0160
42LCAAP0299	1.7	106.1	0.0160
42LCAAP0300	1.6	108.8	0.0147
42LCAAP0301	1.7	109.4	0.0155
42LCAAP0302	1.8	108.9	0.0165

TABLE L-16. POHC/SURROGATE ANALYTICAL DATA - RUN 11 STEM

Sample No.	Sample Description	Concentration (g/sample) DPA	2,4-DNT	3,4-DNT
42LCAAP0264	Toluene Probe Wash/Filter	5.8*	5.8*	-
42LCAAP0265	Acetone Probe Wash	-	-	-
42LCAAP0270	Impinger Water-1st Extraction	2.5*	2.5*	55.0
42LCAAP0271	Impinger Water-2nd Extraction	2.5*	2.5*	-
42LCAAP0276	Impinger Water-3rd Extraction	2.5*	2.5*	-
42LCAAP0278	Separatory Funnel Toluene Rinse	1.5*	1.5*	-
42LCAAP0279	Separatory Funnel Acetone Rinse	-	-	-
42LCAAP0263	Impinger Acetone Rinse	-	-	-
42LCAAP0272	Resin-1st Section-1st Extraction	1.5*	1.5*	-
42LCAAP0280	-2nd Extraction	0.5*	0.5*	-
42LCAAP0284	-3rd Extraction	0.5*	0.5*	-
42LCAAP0273	Resin-2nd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0281	-2nd Extraction	0.5*	0.5*	-
42LCAAP0285	-3rd Extraction	0.5*	0.5*	-
42LCAAP0274	Resin-3rd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0282	-2nd Extraction	0.5*	0.5*	-
42LCAAP0286	-3rd Extraction	0.5*	0.5*	-
42LCAAP0275	Resin-4th Section-1st Extraction	1.5*	1.5*	45.0
42LCAAP0283	-2nd Extraction	0.5*	0.5*	3.0
42LCAAP0287	-3rd Extraction	0.5*	0.5*	-
42LCAAP0261	Resin Tube Toluene Rinse	1.5*	1.5*	-
42LCAAP0262	Resin Tube Acetone Rinse	-	-	-
	Max Probe Wash Filter Section	5.8	5.8	-
	Max Impinger Section	9.0	9.0	55.0
	Max Resin Module Section	11.5	11.5	48.0
	Max Total Sample Train	26.3	26.3	

* Sample Concentration < Method Detection Limit of 0.05 µg/mL, therefore sample concentration assumed to be 0.05 µg/mL.

TABLE L-17. POHC/SURROGATE ANALYTICAL DATA - RUN 12 STEM

Sample No.	Sample Description	Concentration (g/sample) DPA	2,4-DNT	3,4-DNT
42LCAAP0305	Toluene Probe Wash/Filter	6.0*	6.0*	-
42LCAAP0306	Acetone Probe Wash	-	-	-
42LCAAP0314	Impinger Water-1st Extraction	2.5*	2.5*	45.0
42LCAAP0321	Impinger Water-2nd Extraction	2.5*	2.5*	-
42LCAAP0325	Impinger Water-3rd Extraction	2.5*	2.5*	-
42LCAAP0322	Separatory Funnel Toluene Rinse	1.5*	1.5*	-
42LCAAP0324	Separatory Funnel Acetone Rinse	-	-	-
42LCAAP0307	Impinger Acetone Rinse	-	-	-
42LCAAP0308	Resin-1st Section-1st Extraction	1.5*	1.5*	-
42LCAAP0317	-2nd Extraction	0.5*	0.5*	-
42LCAAP0326	-3rd Extraction	0.5*	0.5*	-
42LCAAP0309	Resin-2nd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0318	-2nd Extraction	0.5*	0.5*	-
42LCAAP0327	-3rd Extraction	0.5*	0.5*	-
42LCAAP0310	Resin-3rd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0319	-2nd Extraction	0.5*	0.5*	-
42LCAAP0328	-3rd Extraction	0.5*	0.5*	-
42LCAAP0311	Resin-4th Section-1st Extraction	1.5*	1.5*	51.0
42LCAAP0320	-2nd Extraction	0.5*	0.5*	-
42LCAAP0324	-3rd Extraction	0.5*	0.5*	2.0
42LCAAP0303	Resin Tube Toluene Rinse	1.5*	1.5*	-
42LCAAP0304	Resin Tube Acetone Rinse	-	-	-
	Max Probe Wash Filter Section	6.0	6.0	-
	Max Impinger Section	9.0	9.0	45.0
	Max Resin Module Section	11.5	11.5	53.0
	Max Total Sample Train	26.5	26.5	

* Sample Concentration < Method Detection Limit of 0.05 μg/mL, therefore sample concentration assumed to be 0.05 μg/mL.

TABLE L-18. POHC/SURROGATE ANALYTICAL DATA - RUN 16 STEM

Sample No.	Sample Description	Concentration (g/sample) DPA	2,4-DNT	3,4-DNT
42LCAAP0367	Toluene Probe Wash/Filter	5.0*	5.0*	-
42LCAAP0368	Acetone Probe Wash	-	-	-
42LCAAP0369	Impinger Water-1st Extraction	2.5*	2.5*	47.0
42LCAAP0370	Impinger Water-2nd Extraction	2.5*	2.5*	-
42LCAAP0371	Impinger Water-3rd Extraction	2.5*	2.5*	-
42LCAAP0373	Separatory Funnel Toluene Rinse	1.5*	1.5*	-
42LCAAP0374	Separatory Funnel Acetone Rinse	-	-	-
42LCAAP0372	Impinger Acetone Rinse	-	-	-
42LCAAP0377	Resin-1st Section-1st Extraction	1.5*	1.5*	-
42LCAAP0381	-2nd Extraction	0.5*	0.5*	-
42LCAAP0385	-3rd Extraction	0.5*	0.5*	-
42LCAAP0378	Resin-2nd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0382	-2nd Extraction	0.5*	0.5*	-
42LCAAP0386	-3rd Extraction	0.5*	0.5*	-
42LCAAP0379	Resin-3rd Section-1st Extraction	1.5*	1.5*	-
42LCAAP0383	-2nd Extraction	0.5*	0.5*	-
42LCAAP0387	-3rd Extraction	0.5*	0.5*	-
42LCAAP0380	Resin-4th Section-1st Extraction	1.5*	1.5*	51.0
42LCAAP0384	-2nd Extraction	0.5*	0.5*	-
42LCAAP0388	-3rd Extraction	0.5*	0.5*	1.0
42LCAAP0375	Resin Tube Toluene Rinse	1.5*	1.5*	-
42LCAAP0376	Resin Tube Acetone Rinse	-	-	-
	Probe Wash Filter Section	5.0	5.0	-
	Impinger Section	9.0	9.0	47.0
	Resin Module Section	11.5	11.5	52.0
	Total Sample Train	25.5	25.5	

* Sample Concentration < Method Detection Limit of 0.05 μg/mL, therefore sample concentration assumed to be 0.05 μg/mL.

DNT DRE CALCULATIONS

1. Run 11 STEM: M_{DNT} = 26.3 μg , Q_s = 242,700 dscf/hr, $V_{m_{std}}$ = 77.109 dscf

a. POHC in (w_{in}):

$$w_{in} = (151.33)(0.06690)$$

$$= 10.12397700 \text{ lb DNT/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(26.3)(242,700)}{(453,600,000)(77.109)}$$

$$= 0.00018249 \text{ lb DNT/hr}$$

c. DRE:

$$DRE = \frac{10.12397700 - 0.00018249}{10.12397700}$$

$$= 99.9982 \%$$

2. Run 12 STEM: M_{DNT} = 26.5 μg , Q_s = 241,300 dscf/hr, $V_{m_{std}}$ = 79.340 dscf

a. POHC in (w_{in}):

$$w_{in} = (199.94)(0.06367)$$

$$= 12.73017980 \text{ lb DNT/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(26.5)(241,300)}{(453,600,000)(79.340)}$$

$$= 0.00017768 \text{ lb DNT/hr}$$

c. DRE:

$$DRE = \frac{12.73017980 - 0.00017768}{12.73017980}$$

$$= 99.9986 \%$$

3. Run 16 STEM: M_{DNT} = 25.5 μg, Q_s = 231,700 dscf/hr, $V_{m_{std}}$ = 75.381 dscf

a. POHC in (w_{in}):

$$w_{in} = (194.55)(0.06447)$$

$$= 12.54263850 \text{ lb DNT/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(25.5)(231,700)}{(453,600,000)(75.381)}$$

$$= 0.00017280 \text{ lb DNT/hr}$$

c. DRE:

$$DRE = \frac{12.54263850 - 0.00017280}{12.54263850}$$

$$= 99.9986 \%$$

DPA DRE CALCULATIONS

1. Run 11 STEM: M_{DPA} = 26.3 μg , Q_s = 242,700 dscf/hr, $V_{m_{std}}$ = 77.109 dscf

   a. POHC in (w_{in}):

   $$w_{in} = (151.33)(0.01578)$$

   $$= 2.38799740 \text{ lb DPA/hr}$$

   b. POHC out (w_{out}):

   $$w_{out} = \frac{(26.3)(242,700)}{(453,600,000)(77.109)}$$

   $$= 0.00017280 \text{ lb DPA/hr}$$

   c. DRE:

   $$DRE = \frac{2.38799740 - 0.00017280}{2.38799740}$$

   $$= 99.9924 \%$$

2. Run 12 STEM: M_{DPA} = 26.5 μg , Q_s = 241,300 dscf/hr, $V_{m_{std}}$ = 79.340 dscf

   a. POHC in (w_{in}):

   $$w_{in} = (199.94)(0.01557)$$

   $$= 3.11306580 \text{ lb DPA/hr}$$

   b. POHC out (w_{out}):

   $$w_{out} = \frac{(26.5)(241,300)}{(453,600,000)(79.340)}$$

   $$= 0.00017768 \text{ lb DNT/hr}$$

   c. DRE:

   $$DRE = \frac{3.11306580 - 0.00017768}{3.11306580}$$

   $$= 99.9943 \%$$

3. Run 16 STEM: M_{DPA} = 25.5 μg , Q_s = 231,700 dscf/hr, $V_{m_{std}}$ = 75.381 dscf

a. POHC in (w_{in}):

$$w_{in} = (194.55)(0.01575)$$

$$= 3.06416250 \text{ lb DPA/hr}$$

b. POHC out (w_{out}):

$$w_{out} = \frac{(25.5)(231,700)}{(453,600,000)(75.381)}$$

$$= 0.00017280 \text{ lb DPA/hr}$$

c. DRE:

$$DRE = \frac{3.06416250 - 0.00017280}{3.06416250}$$

$$= 99.9944 \%$$

TABLE L-19. NG/EGDN ANALYTICAL DATA - METHOD BLANKS AND FIELD SPIKES

Sample No.	Sample Description	Concentration (g/sample) NG	EGDN
BLANKS			
42LCAAP0027	Toluene	*	*
42LCAAP0025	Acetone	*	*
42LCAAP0029	Toluene/Filter	*	*
42LCAAP0031	Water-1st Extraction	*	*
42LCAAP0032	Water-2nd Extraction	*	*
42LCAAP0033	Water-3rd Extraction	*	*
42LCAAP0043	Separatory Funnel Toluene Rinse	*	*
42LCAAP0044	Separatory Funnel Acetone Rinse	*	*
42LCAAP0041	Resin-1st Extraction	*	*
42LCAAP0045	-2nd Extraction	*	*
42LCAAP0046	-3rd Extraction	*	*
FIELD SPIKES			
42LCAAP0055	Toluene/Filter	110.0	100.0
42LCAAP0056	Water-1st Extraction	95.0	90.0
42LCAAP0057	Water-2nd Extraction	3.0	7.6
42LCAAP0058	Water-3rd Extraction	*	*
42LCAAP0062	Separatory Funnel Toluene Rinse	*	*
42LCAAP0063	Separatory Funnel Acetone Rinse	*	*
42LCAAP0059	Resin-1st Extraction	105.0	99.0
42LCAAP0060	-2nd Extraction	2.0	*
42LCAAP0061	-3rd Extraction	3.0	*

* Below Method Detection Limit (0.1 μg/mL for NG and 0.05 μg/mL for EGDN)

TABLE L-20. DPA, 2,4-DNT, AND 3,4-DNT ANALYTICAL DATA - METHOD BLANKS AND FIELD SPIKES

Sample No.	Sample Description	Concentration (g/sample) DPA	2,4-DNT	3,4-DNT
BLANKS				
42LCAAP0028	Toluene	*	*	*
42LCAAP0026	Acetone	*	*	*
42LCAAP0030	Toluene/Filter	*	*	*
42LCAAP0049	Water-1st Extraction	*	*	*
42LCAAP0050	Water-2nd Extraction	*	*	*
42LCAAP0051	Water-3rd Extraction	*	*	*
42LCAAP0052	Separatory Funnel Toluene Rinse	*	*	*
42LCAAP0053	Separatory Funnel Acetone Rinse	*	*	*
42LCAAP0042	Resin-1st Extraction	*	*	*
42LCAAP0047	-2nd Extraction	*	*	*
42LCAAP0048	-3rd Extraction	*	*	*
FIELD SPIKES				
42LCAAP0064	Toluene/Filter	47.0	45.0	48.0
42LCAAP0073	Water-1st Extraction	52.0	50.0	50.0
42LCAAP0074	Water-2nd Extraction	-	-	-
42LCAAP0075	Water-3rd Extraction	-	-	-
42LCAAP0077	Separatory Funnel Toluene Rinse	-	-	
42LCAAP0078	Separatory Funnel Acetone Rinse	-	-	
42LCAAP0076	Resin-1st Extraction	51.0	48.0	48.0
42LCAAP0079	-2nd Extraction	2.0	1.0	4.0
42LCAAP0080	-3rd Extraction	1.0	1.0	1.0

* Below Method Detection Limit (0.1 μg/mL for DPA and 0.05 μg/mL for 2,4 and 3,4-DNT)

APPENDIX M

PARTICULATE DATA

TABLE M-1. PARTICULATE DATA - 20mm M-96 FEED

Run Number Date	1 M5* 22 Feb 91	2 M5* 22 Feb 91	5 M5* 25 Feb 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lb/hr)	495.33	410.48	558.23
Est PEP Feed Rate (lb/hr)	79.08	65.53	89.12
STACK GAS DATA			
O_2 Concentration (%, dry)	16.60	16.60	16.00†
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	57.807	59.532	61.347
Total Sampling Time (min)	60	57.5	60
Isokinetic Sampling Rate (%)	99.2	98.9	101.9
EMISSION DATA			
Particulate Collected, Filter (mg)	1.98	0.87	3.03
Particulate Collected, Probe Wash (mg)	14.74	25.42	17.18
Blank Correction (mg)	1.02	1.02	1.02
Total Particulate Collected (mg)	15.70	25.27	19.19
Corrected Particulate Concentration (gr/dscf)	0.013	0.021	0.014
Particulate Concentration Standard (gr/dscf)	0.080	0.080	0.080

* Fugitive emissions.
† Average value from CEM data.

TABLE M-2. PARTICULATE DATA - 20mm M-96 FEED·

Run Number Date	6 M5 26 Feb 91	9 M5 27 Feb 91	10 M5 28 Feb 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lb/hr)	579.20	568.02	483.81
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24
STACK GAS DATA			
O_2 Concentration (%, dry)	16.00	16.00	15.53
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	59.406	60.378	57.533
Total Sampling Time (min)	60	60	60
Isokinetic Sampling Rate (%)	98.9	100.5	101.5
EMISSION DATA			
Particulate Collected, Filter (mg)	2.04	1.58	4.00
Particulate Collected, Probe Wash (mg)	19.72	24.26	19.42
Blank Correction (mg)	1.02	1.02	1.02
Total Particulate Collected (mg)	20.74	24.82	22.40
Corrected Particulate Concentration (gr/dscf)	0.015	0.018	0.015
Particulate Concentration Standard (gr/dscf)	0.080	0.080	0.080

PARTICULATE CALCULATIONS

20mm M-96 FEED

1. RUN NO. 1-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(15.70)(14)}{(57.807)(4.40)}$$

$$= 0.0133 \text{ gr/dscf}$$

2. RUN NO. 2-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(25.27)(14)}{(59.532)(4.40)}$$

$$= 0.0208 \text{ gr/dscf}$$

3. RUN NO. 5-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(19.19)(14)}{(61.347)(5.00)}$$

$$= 0.0135 \text{ gr/dscf}$$

4. RUN NO. 6-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(20.74)(14)}{(59.406)(5.00)}$$

$$= 0.0151 \text{ gr/dscf}$$

5. RUN NO. 9-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(24.82)(14)}{(60.378)(5.00)}$$

$$= 0.0177 \text{ gr/dscf}$$

6. RUN NO. 10-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(22.40)(14)}{(57.533)(5.47)}$$

$$= 0.0153 \text{ gr/dscf}$$

TABLE M-3. PARTICULATE DATA - HI SKOR 700X PROPELLANT FEED

Run Number Date	3 M5 23 Feb 91	4 M5 25 Feb 91	7 M5 26 Feb 91
OPERATING CHARACTERISTICS			
Propellant Feed Rate (lb/hr)	43.41	40.18	37.87
STACK GAS DATA			
O_2 Concentration (%, dry)	15.96	16.00	16.20
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	65.812	46.089	45.810
Total Sampling Time (min)	180	120	120
Isokinetic Sampling Rate (%)	101.7	105.2	103.5
EMISSION DATA			
Particulate Collected, Filter (mg)	3.20	1.15	4.48
Particulate Collected, Probe Wash (mg)	9.24	26.64	26.42
Blank Correction (mg)	1.02	1.02	1.02
Total Particulate Collected (mg)	11.42	26.77	29.88
Corrected Particulate Concentration (gr/dscf)	0.007	0.025	0.029
Particulate Concentration Standard (gr/dscf)	0.080	0.080	0.080

PARTICULATE CALCULATIONS

HI SKOR 700X PROPELLANT FEED

1. RUN NO. 3-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(11.42)(14)}{(65.812)(5.04)}$$

$$= 0.0074 \text{ gr/dscf}$$

2. RUN NO. 4-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(26.77)(14)}{(46.089)(5.00)}$$

$$= 0.0250 \text{ gr/dscf}$$

3. RUN NO. 7-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(29.88)(14)}{(45.810)(4.80)}$$

$$= 0.0293 \text{ gr/dscf}$$

TABLE M-4. PARTICULATE DATA - FA 956 PRIMER FEED

Run Number Date	8 M5 27 Feb 91	13 M5* 2 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	90.75	142.94
PEP Feed Rate (lb/hr)	11.66	18.37
STACK GAS DATA		
O_2 Concentration (%, dry)	16.53	17.18†
SAMPLING EQUIPMENT DATA		
Dry Gas Volume (dscf)	62.346	60.810
Total Sampling Time (min)	60	60
Isokinetic Sampling Rate (%)	101.3	101.2
EMISSION DATA		
Particulate Collected, Filter (mg)	2.64	3.36
Particulate Collected, Probe Wash (mg)	19.46	14.02
Blank Correction (mg)	1.02	1.02
Total Particulate Collected (mg)	22.10	16.36
Corrected Particulate Concentration (gr/dscf)	0.017	0.015
Particulate Concentration Standard (gr/dscf)	0.080	0.080

* Failed posttest leak check.
† Average value from CEM data.

TABLE M-5. PARTICULATE DATA - FA 956 PRIMER FEED

Run Number Date	14 M5 4 Mar 91	15 M5 4 Mar 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	133.88	146.78
PEP Feed Rate (lb/hr)	17.21	18.86
STACK GAS DATA		
O_2 Concentration (%, dry)	16.20	16.20
SAMPLING EQUIPMENT DATA		
Dry Gas Volume (dscf)	55.038	60.596
Total Sampling Time (min)	60	60
Isokinetic Sampling Rate (%)	91.4	101.2
EMISSION DATA		
Particulate Collected, Filter (mg)	3.46	4.02
Particulate Collected, Probe Wash (mg)	23.45	20.87
Blank Correction (mg)	1.02	1.02
Total Particulate Collected (mg)	25.89	23.87
Corrected Particulate Concentration (gr/dscf)	0.021	0.018
Particulate Concentration Standard (gr/dscf)	0.080	0.080

PARTICULATE CALCULATIONS

FA 956 PRIMER FEED

1. RUN NO. 8-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(22.10)(14)}{(62.346)(4.47)}$$

$$= 0.0171 \text{ gr/dscf}$$

2. RUN NO. 13-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(16.36)(14)}{(60.810)(3.82)}$$

$$= 0.0154 \text{ gr/dscf}$$

3. RUN NO. 14-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(25.89)(14)}{(55.038)(4.80)}$$

$$= 0.0211 \text{ gr/dscf}$$

4. RUN NO. 15-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(23.87)(14)}{(60.596)(4.80)}$$

$$= 0.0177 \text{ gr/dscf}$$

TABLE M-6. PARTICULATE DATA - IMR 5010 PROPELLANT FEED

Run Number Date	11 M5 28 Feb 91	12 M5 2 Mar 91	16 M5 4 Mar 91
OPERATING CHARACTERISTICS			
Propellant Feed Rate (lb/hr)	151.33	199.94	194.55
STACK GAS DATA			
O_2 Concentration (%, dry)	16.00	15.93	16.20
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	45.656	48.021	44.623
Total Sampling Time (min)	120	120	120
Isokinetic Sampling Rate (%)	103.4	107.2	105.7
EMISSION DATA			
Particulate Collected, Filter (mg)	8.10	3.72	2.63
Particulate Collected, Probe Wash (mg)	35.60	20.24	23.10
Blank Correction (mg)	1.02	1.02	1.02
Total Particulate Collected (mg)	42.68	22.94	24.71
Corrected Particulate Concentration (gr/dscf)	0.040	0.020	0.025
Particulate Concentration Standard (gr/dscf)	0.080	0.080	0.080

PARTICULATE CALCULATIONS

IMR 5010 PROPELLANT FEED

1. RUN NO. 11-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(42.68)(14)}{(45.656)(5.00)}$$

$$= 0.0403 \text{ gr/dscf}$$

2. RUN NO. 12-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(22.94)(14)}{(48.021)(5.07)}$$

$$= 0.0203 \text{ gr/dscf}$$

3. RUN NO. 16-M5

Particulate Concentration (Corrected to 7% O_2)

$$C_s = \frac{0.0154\ M_n}{V_{m_{std}}} \times \frac{14}{(21-O_2)}$$

$$= \frac{(0.0154)(24.71)(14)}{(44.623)(4.80)}$$

$$= 0.0249 \text{ gr/dscf}$$

APPENDIX N

METALS DATA SUMMARY

TABLE N-1. METALS EMISSIONS SUMMARY - 20MM M96 FEED

Run Number Date	1 MeM5 22 Feb 91	2 MeM5 22 Feb 91
OPERATING CHARACTERISTICS		
Waste Feed Rate (lb/hr)	495.33	410.48
Est PEP Feed Rate (lb/hr)	79.08	65.53
Min Sb Feed Rate (lb/hr)	0.0227	0.0188
Min Pb Feed Rate (lb/hr)	0.0405	0.0336
STACK GAS DATA		
Volumetric Flow Rate (dscf/hr)	235,900	250,700
SAMPLING EQUIPMENT DATA		
Dry Gas Volume (dscf)	59.730	60.898
EMISSION DATA		
Max Ag Emission Rate (lb/hr)	6.18×10^{-5}	6.63×10^{-5}
Max As Emission Rate (lb/hr)	3.13×10^{-5}*	3.92×10^{-5}
Max Ba Emission Rate (lb/hr)	1.32×10^{-3}	2.85×10^{-3}
Max Be Emission Rate (lb/hr)	6.27×10^{-6}*	6.53×10^{-6}*
Max Cd Emission Rate (lb/hr)	8.71×10^{-5}	1.18×10^{-4}
Max Cr Emission Rate (lb/hr)	8.82×10^{-4}	5.81×10^{-5}
Max Hg Emission Rate (lb/hr)	5.39×10^{-5}	2.89×10^{-5}
Max Pb Emission Rate (lb/hr)	2.53×10^{-2}	1.77×10^{-2}
Max Sb Emission Rate (lb/hr)	6.24×10^{-4}*	7.24×10^{-4}
Max Tl Emission Rate (lb/hr)	6.27×10^{-6}*	6.53×10^{-6}

* All samples below analytical MDL.

TABLE N-2. METALS EMISSIONS SUMMARY - 20MM M96 FEED

Run Number Date	6 MeM5 26 Feb 91	9 MeM5 27 Feb 91	10 MeM5 28 Feb 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lb/hr)	579.20	568.02	483.81
Est PEP Feed Rate (lb/hr)	92.47	90.68	77.24
Min Sb Feed Rate (lb/hr)	0.0265	0.0260	0.0221
Min Pb Feed Rate (lb/hr)	0.0474	0.0465	0.0396
STACK GAS DATA			
Volumetric Flow Rate (dscf/hr)	237,000	243,100	231,100
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	60.172	61.011	58.581
EMISSION DATA			
Max Ag Emission Rate (lb/hr)	5.73×10^{-5}	9.75×10^{-5}	5.57×10^{-5}*
Max As Emission Rate (lb/hr)	2.87×10^{-5}	2.81×10^{-5}	2.78×10^{-5}*
Max Ba Emission Rate (lb/hr)	1.31×10^{-3}	8.89×10^{-4}	2.73×10^{-3}
Max Be Emission Rate (lb/hr)	5.56×10^{-6}*	5.62×10^{-6}*	5.57×10^{-6}*
Max Cd Emission Rate (lb/hr)	1.25×10^{-4}	1.57×10^{-4}	9.13×10^{-5}
Max Cr Emission Rate (lb/hr)	4.17×10^{-5}*	8.87×10^{-5}	6.04×10^{-4}
Max Hg Emission Rate (lb/hr)	4.04×10^{-5}	3.53×10^{-5}	3.34×10^{-5}
Max Pb Emission Rate (lb/hr)	6.07×10^{-3}	1.07×10^{-2}	3.99×10^{-3}
Max Sb Emission Rate (lb/hr)	7.40×10^{-4}	6.82×10^{-4}	6.91×10^{-4}
Max Tl Emission Rate (lb/hr)	5.56×10^{-6}*	5.62×10^{-6}*	5.57×10^{-6}

* All samples below analytical MDL.

TABLE N-3. METALS EMISSIONS SUMMARY - FA 956 PRIMER FEED

Run Number Date	8 MeM5 27 Feb 91	14 MeM5 4 Mar 91	15 MeM5 4 Mar 91
OPERATING CHARACTERISTICS			
Waste Feed Rate (lb/hr)	90.75	133.88	146.78
PEP Feed Rate (lb/hr)	11.66	17.21	18.86
Sb Feed Rate (lb/hr)	1.2291	1.8131	1.9880
Ba Feed Rate (lb/hr)	1.9245	2.8390	3.1127
Pb Feed Rate (lb/hr)	1.9199	2.8322	3.1053
STACK GAS DATA			
Volumetric Flow Rate (dscf/hr)	236,400	233,700	234,900
SAMPLING EQUIPMENT DATA			
Dry Gas Volume (dscf)	58.625	60.014	59.320
EMISSION DATA			
Max Ag Emission Rate (lb/hr)	6.05×10^{-5}	4.89×10^{-5}	6.02×10^{-5}
Max As Emission Rate (lb/hr)	2.76×10^{-5}	2.75×10^{-5}*	2.79×10^{-5}
Max Ba Emission Rate (lb/hr)	7.60×10^{-4}	1.01×10^{-3}	1.33×10^{-3}
Max Be Emission Rate (lb/hr)	5.51×10^{-6}*	5.58×10^{-6}*	5.67×10^{-6}*
Max Cd Emission Rate (lb/hr)	1.06×10^{-4}	1.04×10^{-4}	1.60×10^{-4}
Max Cr Emission Rate (lb/hr)	4.00×10^{-5}	5.75×10^{-5}	9.43×10^{-5}
Max Hg Emission Rate (lb/hr)	3.05×10^{-5}	7.37×10^{-5}	3.61×10^{-5}
Max Pb Emission Rate (lb/hr)	6.87×10^{-3}	6.86×10^{-3}	4.65×10^{-3}
Max Sb Emission Rate (lb/hr)	6.90×10^{-4}	8.77×10^{-4}	6.65×10^{-4}
Max Tl Emission Rate (lb/hr)	5.51×10^{-6}*	5.58×10^{-6}*	5.67×10^{-6}*

* All samples below analytical MDL.

METALS FEED RATE CALCULATIONS

1. 20mm M96 Projectile

a. Sb Feed Rate:

(1) Sb is 71.69 percent of antimony sulfide (Sb_2S_3).

(2) Sb_2S_3 is 0.04 percent of PEP weight.

(3) PEP fraction of entire cartridge is (638.5 gr PEP/4000 gr cartridge).

Sb feed rate (lb/hr) = (0.7169)(0.0004)(638.5/4000)
X projectile feed rate (lb/hr)

= (4.58×10^{-5}) X projectile feed rate (lb/hr)

b. Pb Feed Rate:

(1) Pb is 64.08 percent of lead sulfocyanate ($PbC_2N_2S_2$).

(2) $PbC_2N_2S_2$ is 0.08 percent of PEP weight.

(3) PEP fraction of entire cartridge is (638.5 gr PEP/4000 gr cartridge)

Pb feed rate (lb/hr) = (0.6408)(0.0008)(638.5/4000)
X projectile feed rate (lb/hr)

= (8.18×10^{-5}) X projectile feed rate (lb/hr)

2. FA-956 Primer

a. Sb Feed Rate:

(1) Sb is 71.69 percent of antimony sulfide (Sb_2S_3).

(2) Sb_2S_3 is 14.7 percent of PEP weight.

(3) PEP fraction of entire primer is (0.365 gr PEP/2.84 gr primer).

Sb feed rate (lb/hr) = (0.7169)(0.147)(0.365/2.84)
X primer feed rate (lb/hr)

= (13.54×10^{-3}) X projectile feed rate (lb/hr)

b. Pb Feed Rate:

(1) Pb is 44.25 percent of lead styphnate ($PbC_6H_3N_3O_9$).

(2) $PbC_6H_3N_3O_9$ is 37.20 percent of PEP weight.

(3) PEP fraction of entire cartridge is (0.365 gr PEP/2.84 gr primer)

Pb feed rate (lb/hr) = (0.4425)(0.372)(0.365/2.84)
X projectile feed rate (lb/hr)

= (21.16×10^{-3}) X projectile feed rate (lb/hr)

c. Ba Feed Rate:

(1) Ba is 52.55 percent of barium nitrate $Ba(NO_3)_2$.

(2) $Ba(NO_3)_2$ is 31.40 percent of PEP by weight.

(3) PEP fraction of entire cartridge is (0.365 gr PEP/2.84 gr primer)

Pb feed rate (lb/hr) = (0.5255)(0.314)(0.365/2.84)
X projectile feed rate (lb/hr)

= (21.21×10^{-3}) X projectile feed rate (lb/hr)

BLE N-4. LABORATORY METALS ANALYSIS - RUN 1MeM5 - 20mm M96 PROJECTILE

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ONT HALF ANALYSIS										
x Filter Catch (mg) LCAAP0003	0.002*	0.001	0.1306	0.0002*	0.002*	0.1080	0.00008	2.318	0.020*	0.0002*
x Acetone Probe Wash Catch (mg) LCAAP0004	0.0022	0.0005*	0.0077	0.0001*	0.0025	0.002*	0.00005*	0.1012	0.010*	0.0001*
x HNO_3 Probe Wash Catch (mg) LCAAP0005	0.001*	0.0005	0.0088	0.0001*	0.0023	0.0022	.00005*	0.0631	0.010*	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0629)	-	-
x Front Half Catch (mg)	0.0039	0.002*	0.1295	0.0004*	0.0068	0.0946	0.00018	2.4194	0.040*	0.0004*
CK HALF ANALYSIS										
x Impinger 1-3 Catch (mg) LCAAP0005	0.0032*	0.0016*	0.0234	0.00032*	0.0032*	0.0067	0.00016*	0.5098	0.032*	0.00032*
x Impinger 4 Catch (mg) LCAAP0006	-	-	-	-	-	-	0.00605	-	-	-
ck Half Blank Correction (mg)	-	-	(0.0012)	-	-	-	(0.0002)	(0.0255)	-	-
x Back Half Catch (mg)	0.0032*	0.0016*	0.0222	0.00032*	0.0032*	0.0067	0.00601	0.4843	0.032*	0.00032*
AIN TOTAL										
x Total Train Catch (mg)	0.0071	0.0036*	0.1517	0.00072*	0.0100	0.1013	0.00619	2.9037	0.072*	0.00072*

Below Method Detection Limit

LE N-5. LABORATORY METALS ANALYSIS - RUN 2MeM5 - 20mm M96 PROJECTILE

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
NT HALF ANALYSIS										
Filter Catch (mg) CAAP0011	0.002*	0.001*	0.2836	0.0002*	0.002*	0.0054	0.00012	1.4076	0.0278	0.0002*
Acetone Probe Wash Catch (mg) CAAP0012	0.0024	0.0005*	0.0225	0.0001*	0.0017	0.0022	0.00005*	0.1391	0.010*	0.0001*
HNO_3 Probe Wash Catch (mg) CAAP0013	0.001*	0.00122	0.0176	0.0001*	0.0061	0.0059	0.00005*	0.1930	0.010*	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0629)	-	-
Front Half Catch (mg)	0.0041	0.00272	0.3061	0.0004*	0.0098	-	0.00022	1.6768	0.0478	0.0004*
CK HALF ANALYSIS										
Impinger 1-3 Catch (mg) LCAAP0014	0.0032*	0.0016*	0.0090	0.00032*	0.0032*	0.0064*	0.00016*	0.2822	0.032*	0.00032*
Impinger 4 Catch (mg) LCAAP0015	-	-	-	-	-	-	0.00300	-	-	-
ck Half Blank Correction (mg)	-	-	(0.001)	-	-	-	(0.0002)	(0.0141)	-	-
Back Half Catch (mg)	0.0032*	0.0016*	0.0080	0.00032*	0.0032*	0.0064*	0.00296	0.2681	0.032*	0.00032*
AIN TOTAL										
Total Train Catch (mg)	0.0073	0.00432	0.3141	0.00072*	0.0130	0.0064	0.00318	1.9449	0.0798	0.00072*

Below Method Detection Limit

BLE N-6. LABORATORY METALS ANALYSIS - RUN 6MeM5 - 20mm M96 PROJECTILE

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ONT HALF ANALYSIS										
x Filter Catch (mg) LCAAP0147	0.002*	0.001*	0.1246	0.0002*	0.0052	0.0048	0.0004	0.2852	0.0402	0.0002*
x Acetone Probe Wash Catch (mg) LCAAP0148	0.0025	0.0005*	0.0104	0.0001*	0.001*	0.002*	0.00005*	0.1137	0.011	0.0001*
x HNO_3 Probe Wash Catch (mg) LCAAP0146	0.001*	0.0006	0.021	0.0001*	0.0058	0.0062	0.00005*	0.2312	0.010*	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0315)	-	-
x Front Half Catch (mg)	0.0042	0.0021	0.1384	0.0004*	0.0120	-	0.0005	0.5986	0.0612	0.0004*
CK HALF ANALYSIS										
x Impinger 1-3 Catch (mg) LCAAP0000	0.0024*	0.0012*	0.0130	0.00024*	0.0024*	0.0048*	0.00012*	0.1061	0.024*	0.00024
x Impinger 4 Catch (mg) LCAAP0000	-	-	-	-	-	-	0.00423	-	-	-
ck Half Blank Correction (mg)	-	-	(0.0011)	-	-	-	(0.0002)	(0.0053)	-	-
x Back Half Catch (mg)	0.0024*	0.0012*	0.0119	0.00024*	0.0024*	0.0048*	0.00415	0.1008	0.024*	0.00024
AIN TOTAL										
x Total Train Catch (mg)	0.0066	0.0033	0.1503	0.00064*	0.0144	0.0048	0.00465	0.6994	0.0852	0.00064

Below Method Detection Limit

LE N-7. LABORATORY METALS ANALYSIS - RUN 8MeM5 - FA-956 PRIMER

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
NT HALF ANALYSIS										
Filter Catch (mg) CAAP0190	0.002*	0.001*	0.0596	0.0002*	0.002*	0.0052	0.00042	0.532	0.0356	0.0002*
Acetone Probe ash Catch (mg) CAAP0191	0.0029	0.0005*	0.0149	0.0001*	0.001*	0.002*	0.00005*	0.0474	0.010*	0.0001*
HNO_3 Probe ash Catch (mg) CAAP0192	0.001*	0.0005	0.0237	0.0001*	0.0067	0.004	0.00005*	0.189	0.010*	0.0001*
nt Half Blank orrection (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.03842)	-	-
Front Half atch (mg)	0.0046	0.0020	0.0806	0.0004*	0.0097	-	0.00052	0.7300	0.0556	0.0004*
K HALF ANALYSIS										
Impinger 1-3 atch (mg) CAAP0193	0.0022*	0.0011*	0.0059	0.00022*	0.0022*	0.0045*	0.00011*	0.045*	0.022*	0.00022*
Impinger 4 atch (mg) CAAP0194	-	-	-	-	-	-	0.00300	-	-	-
k Half Blank orrection (mg)	-	-	(0.0010)	-	-	-	(0.0002)	(0.002)	-	-
Back Half atch (mg)	0.0022*	0.0011*	0.0049	0.00022*	0.0022*	0.0045*	0.00291	0.043	0.022*	0.00022*
IN TOTAL										
Total Train atch (mg)	0.0068	0.0031	0.0855	0.00062*	0.0119	0.0045	0.00343	0.7730	0.0776	0.00062*

elow Method Detection Limit

BLE N-10. LABORATORY METALS ANALYSIS - RUN 14MeM5 - FA-956 PRIMER

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ONT HALF ANALYSIS										
x Filter Catch (mg) LCAAP0345	0.002*	0.001*	0.0812	0.0002*	0.002*	0.0130	0.00012	0.5772	0.0318	0.0002*
x Acetone Probe Wash Catch (mg) LCAAP0346	0.001*	0.0005*	0.0196	0.0001*	0.001*	0.0026	0.00005*	0.0654	0.0289	0.0001*
x HNO_3 Probe Wash Catch (mg) LCAAP0347	0.0015	0.0005	0.0234	0.0001*	0.0066	0.0032	0.00005*	0.1480	0.0165	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0395)	-	-
x Front Half Catch (mg)	0.0032	0.002*	0.1066	0.0004*	0.0096	0.0012	0.00022	0.7511	0.0772	0.0004*
CK HALF ANALYSIS										
x Impinger 1-3 Catch (mg) LCAAP0348	0.0025*	0.0012*	0.0120	0.00025*	0.0025*	0.0055	0.00012*	0.050*	0.025*	0.00025*
x Impinger 4 Catch (mg) LCAAP0349	-	-	-	-	-	-	0.00845	-	-	-
ck Half Blank Correction (mg)	-	-	(0.0011)	-	-	-	(0.0002)	(.0025)	-	-
x Back Half Catch (mg)	0.0025	0.0012*	0.0109	0.00025*	0.0025*	0.0055	0.00837	0.0475	0.025*	0.00025*
AIN TOTAL										
x Total Train Catch (mg)	0.0057	0.0032*	0.1175	0.00065*	0.0121	0.0067	0.00859	0.7986	0.1022	0.00065*

Below Method Detection Limit

LE N-11. LABORATORY METALS ANALYSIS - RUN 15MeM5 - FA-956 PRIMER

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
NT HALF ANALYSIS										
: Filter Catch (mg) LCAAP0354	0.002*	0.001*	0.1306	0.0002*	0.0026	0.0086	0.00038	0.2252	0.0312	0.0002*
: Acetone Probe Wash Catch (mg) LCAAP0355	0.0022	0.0005*	0.0109	0.0001*	0.0012	0.002*	0.00005*	0.0614	0.010*	0.0001*
: HNO_3 Probe Wash Catch (mg) LCAAP0356	0.0015	0.0005	0.0211	0.0001*	0.0065	0.0030	0.00005*	0.1644	0.010*	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0226)	-	-
: Front Half Catch (mg)	0.0044	0.0020	0.1450	0.0004*	0.0103	-	0.00048	0.4284	0.0512	0.0004*
CK HALF ANALYSIS										
: Impinger 1-3 Catch (mg) LCAAP0357	0.0025*	0.0012*	0.0090	0.00025*	0.0080	0.0108	0.00012*	0.1095	0.025*	0.00025*
: Impinger 4 Catch (mg) LCAAP0358	-	-	-	-	-	-	0.00374	-	-	-
ck Half Blank Correction (mg)	-	-	(0.0011)	-	-	-	(0.0002)	(0.0055)	-	-
: Back Half Catch (mg)	0.0025*	0.0012*	0.0079	0.00025*	0.0080	0.0108	0.00366	0.1040	0.025*	0.00025*
AIN TOTAL										
: Total Train Catch (mg)	0.0069	0.0032	0.1529	0.00065*	0.0183	0.0108	0.00414	0.5324	0.0762	0.00065*

Below Method Detection Limit

LE N-8. LABORATORY METALS ANALYSIS - RUN 9MeM5 - 20mm M96 PROJECTILE

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
NT HALF ANALYSIS										
Filter Catch (mg) CAAP0203	0.002*	0.001*	0.0738	0.0002*	0.002*	0.0132	0.0001	0.4750	0.0336	0.0002*
Acetone Probe Wash Catch (mg) CAAP0205	0.0030	0.0005*	0.0120	0.0001*	0.0029	0.0026	0.00005*	0.0473	0.010*	0.0001*
HNO_3 Probe Wash Catch (mg) CAAP0204	0.0050	0.0005	0.0228	0.0001*	0.0106	0.0041	0.00005*	0.1323	0.010*	0.0001*
ont Half Blank Correction (mg)	(0.0013)	-	(0.0176)	-	-	(0.0176)	-	(0.0327)	-	-
Front Half Catch (mg)	0.0087	0.0020	0.0910	0.0004*	0.0155	0.0023	0.0002	0.6219	0.0536	0.0004*
K HALF ANALYSIS										
Impinger 1-3 Catch (mg) CAAP0206	0.0024*	0.0012*	0.0113	0.00024*	0.0024*	0.0078	0.00012*	0.6267	0.024*	0.00024*
Impinger 4 Catch (mg) CAAP0207	-	-	-	-	-	-	0.00390	-	-	-
k Half Blank Correction (mg)	-	-	(0.0011)	-	-	-	(0.0002)	(0.0313)	-	-
Back Half Catch (mg)	0.0024*	0.0012*	0.0102	0.0024*	0.0024*	0.0078	0.00382	0.5954	0.024*	0.00024*
IN TOTAL										
Total Train Catch (mg)	0.0111	0.0032	0.1012	0.00064*	0.0179	0.0101	0.00402	1.2173	0.0776	0.00064*

Below Method Detection Limit

LE N-9. LABORATORY METALS ANALYSIS - RUN 10MeM5 - 20mm M96 PROJECTILE

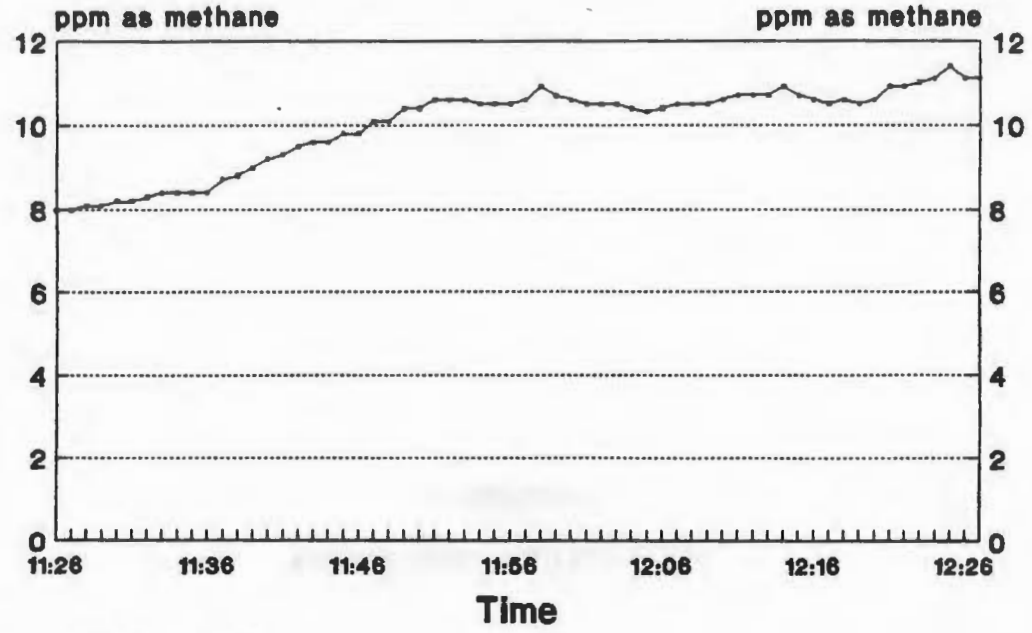
	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
NT HALF ANALYSIS										
Filter Catch (mg)										
CAAP0235	0.002*	0.001*	0.2822	0.0002*	0.002*	0.0704	0.00022	0.2988	0.0322	0.0002*
Acetone Probe										
ash Catch (mg)										
CAAP0236	0.001*	0.0005*	0.0093	0.0001*	0.0019	0.0085	0.00005*	0.020*	0.0132	0.001*
HNO_3 Probe										
ash Catch (mg)										
CAAP0237	0.001*	0.0005*	0.0218	0.0001*	0.0042	0.0035	0.00005*	0.1173	0.010*	0.0001*
nt Half Blank										
orrection (mg)	-	-	(0.0176)	-	-	(0.0176)	-	(0.0218)	-	-
Front Half										
atch (mg)	0.004*	0.002*	0.2957	0.0004*	0.0081	0.0648	0.00032	0.4143	0.0554	0.0004*
K HALF ANALYSIS										
Impinger 1-3										
atch (mg)										
CAAP0238	0.0024*	0.0012*	0.0193	0.00024*	0.0024	0.0047*	0.00012*	0.047*	0.024*	0.00024*
Impinger 4										
atch (mg)										
CAAP0239	-	-	-	-	-	-	0.0036	-	-	-
k Half Blank										
orrection (mg)	-	-	(0.0011)	-	-	-	(0.0002)	(0.002)	-	-
Back Half										
atch (mg)	0.0024*	0.0012*	0.0182	0.00024*	0.0024	0.0047*	0.00352	0.045	0.024*	0.00024*
IN TOTAL										
Total Train										
atch (mg)	0.0064*	0.0032*	0.3139	0.00064*	0.0105	0.0695	0.00384	0.4593	0.0794	0.00064*

Below Method Detection Limit

APPENDIX O

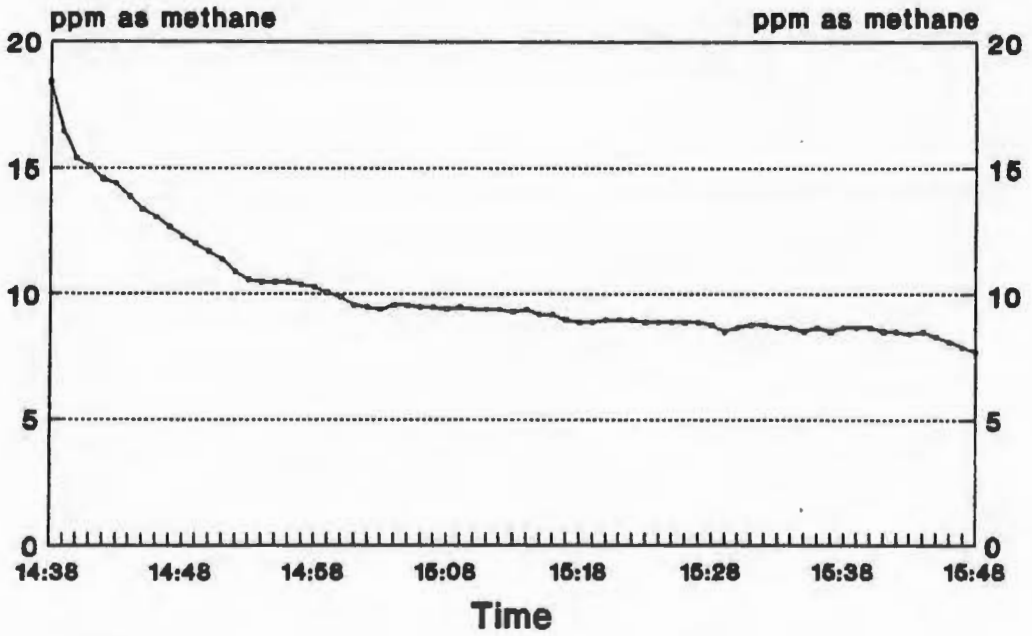
THC CONTINUOUS MONITOR DATA

Run 1 22 Feb 91



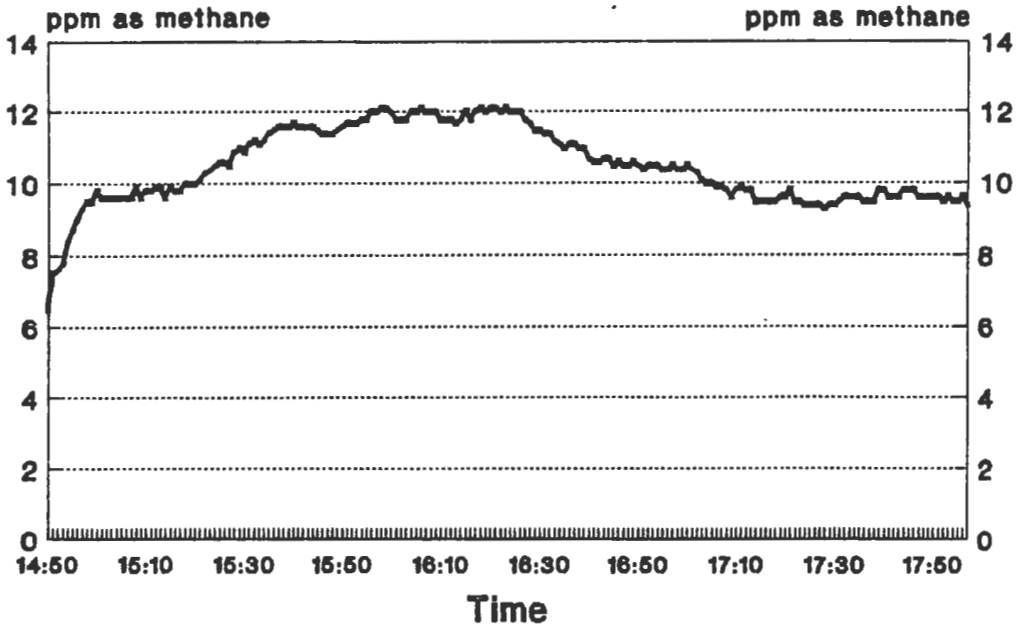
Maximum value - 11.4 ppm

Run 2 22 Feb 91



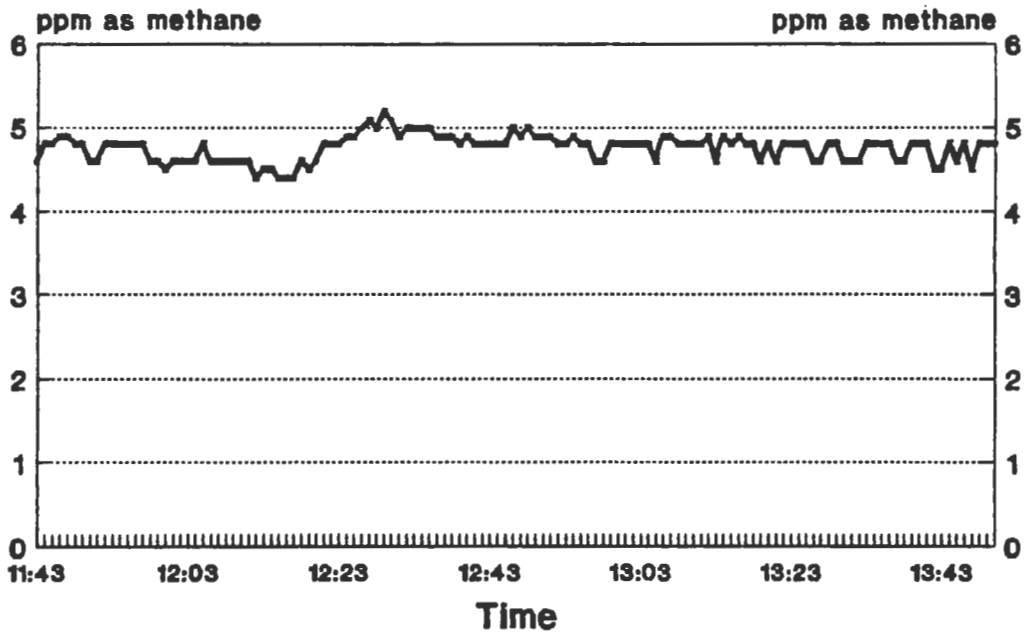
Maximum value - 18.4 ppm

Run 3 23 Feb 91



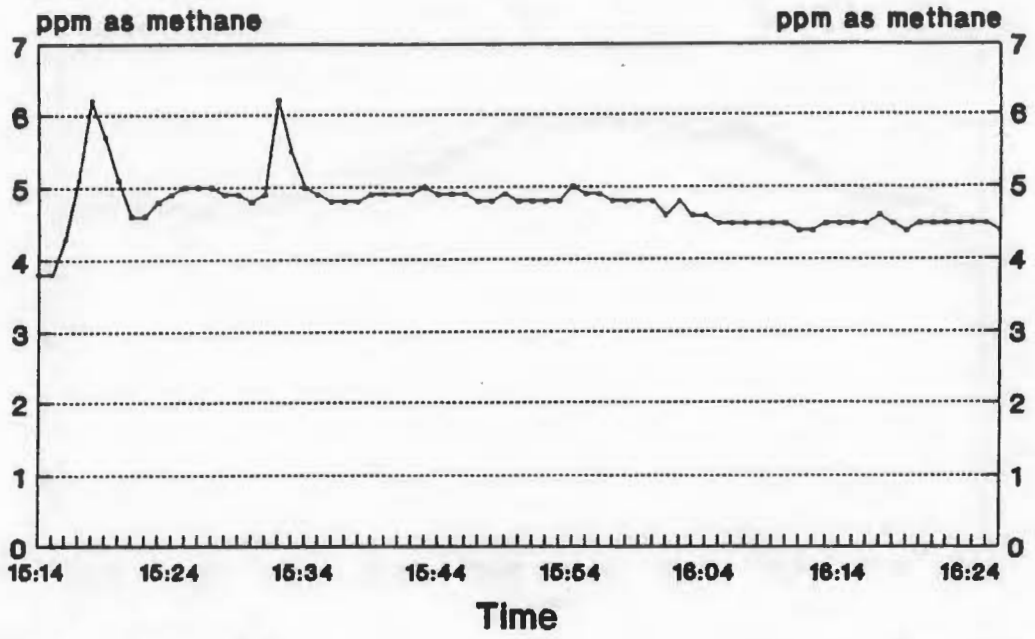
Maximum value - 12.1 ppm

Run 4 25 Feb 91



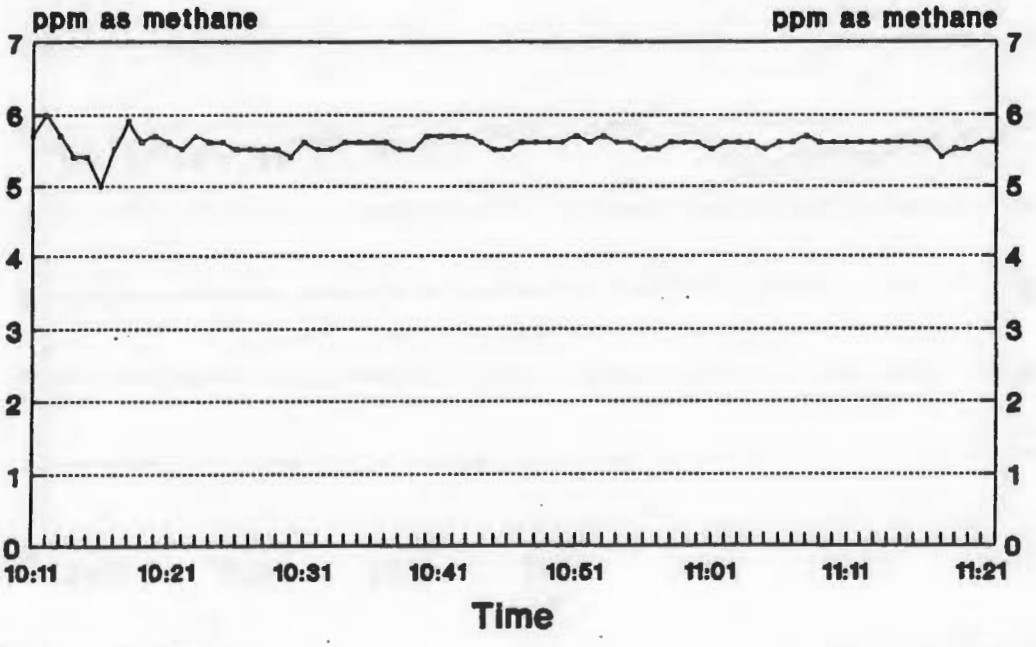
Maximum value - 5.2 ppm

Run 5 25 Feb 91



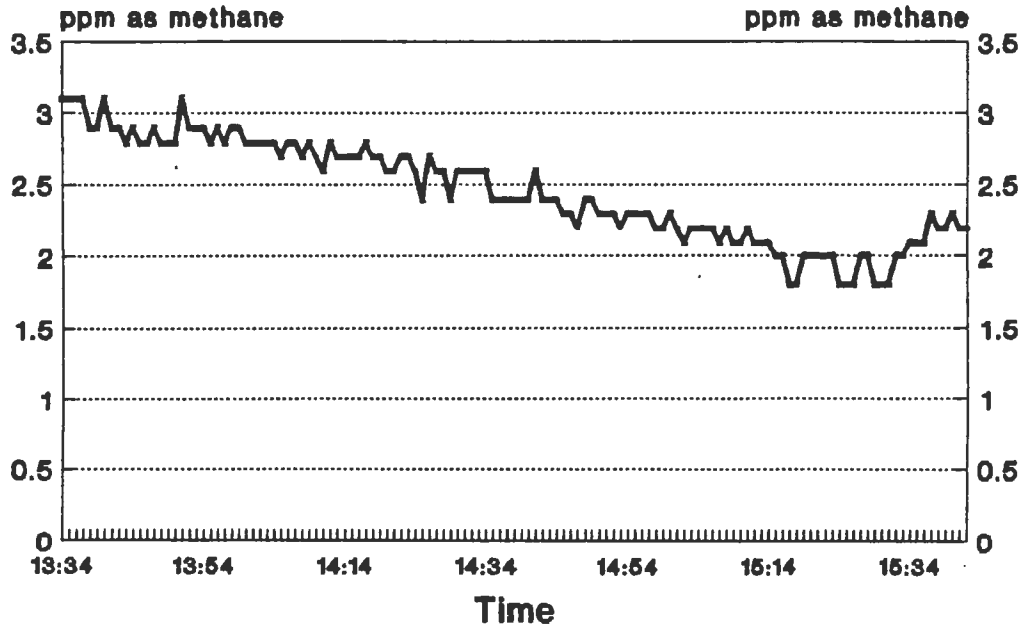
Maximum value - 6.2 ppm

Run 6 26 Feb 91



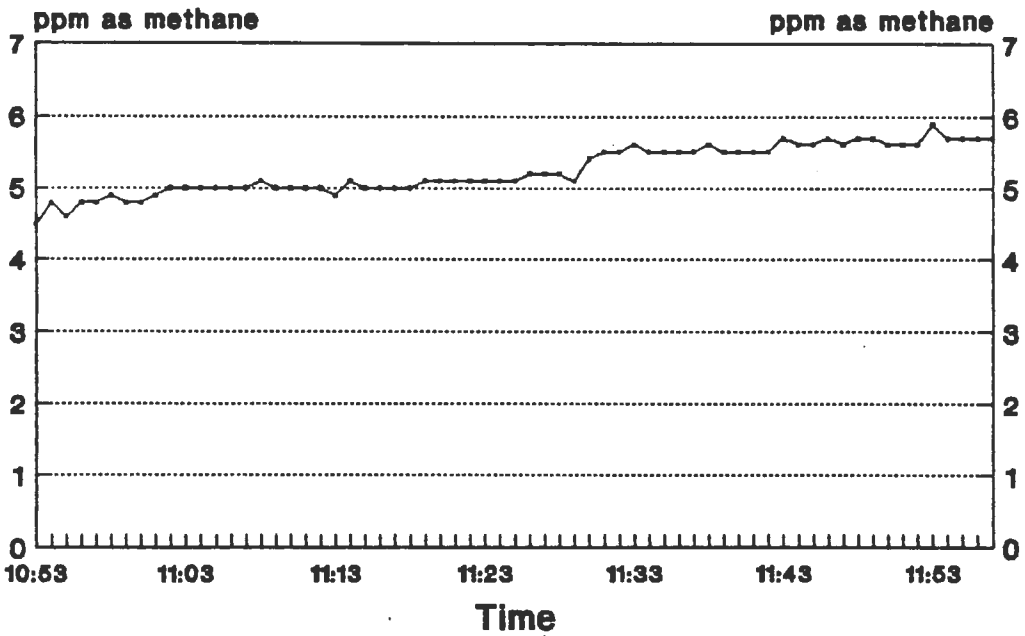
Maximum value - 6.0 ppm

Run 7 26 Feb 91



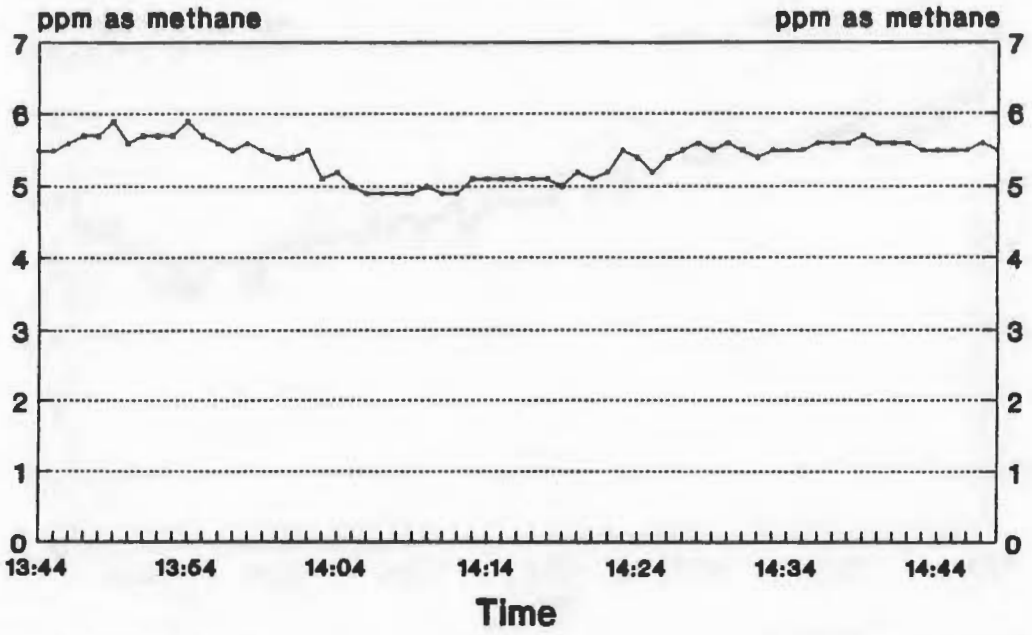
Maximum value - 3.1 ppm

Run 8 27 Feb 91



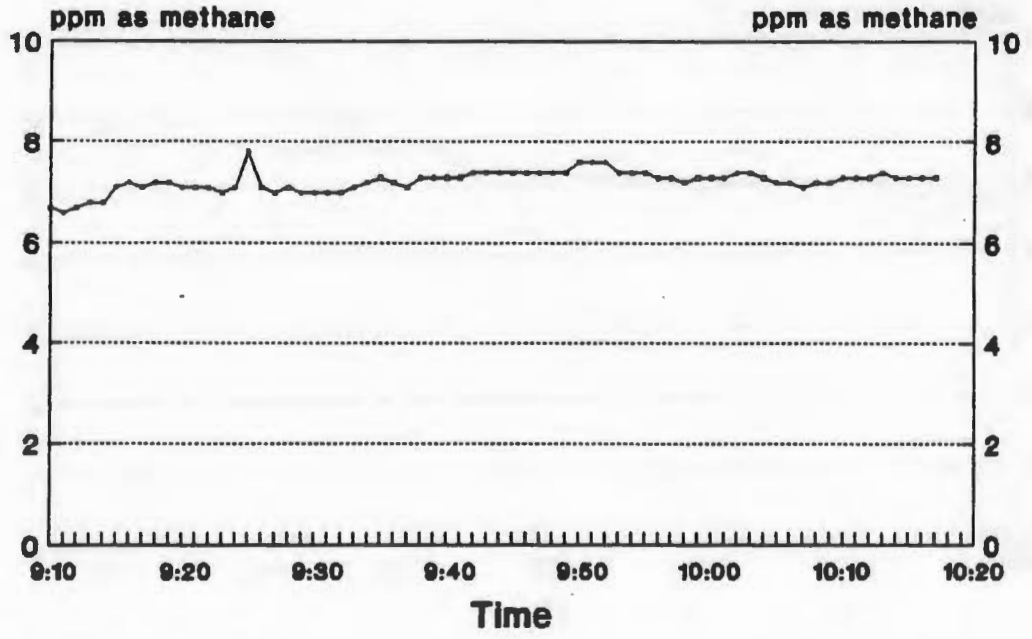
Maximum value - 5.9 ppm

Run 9 27 Feb 91



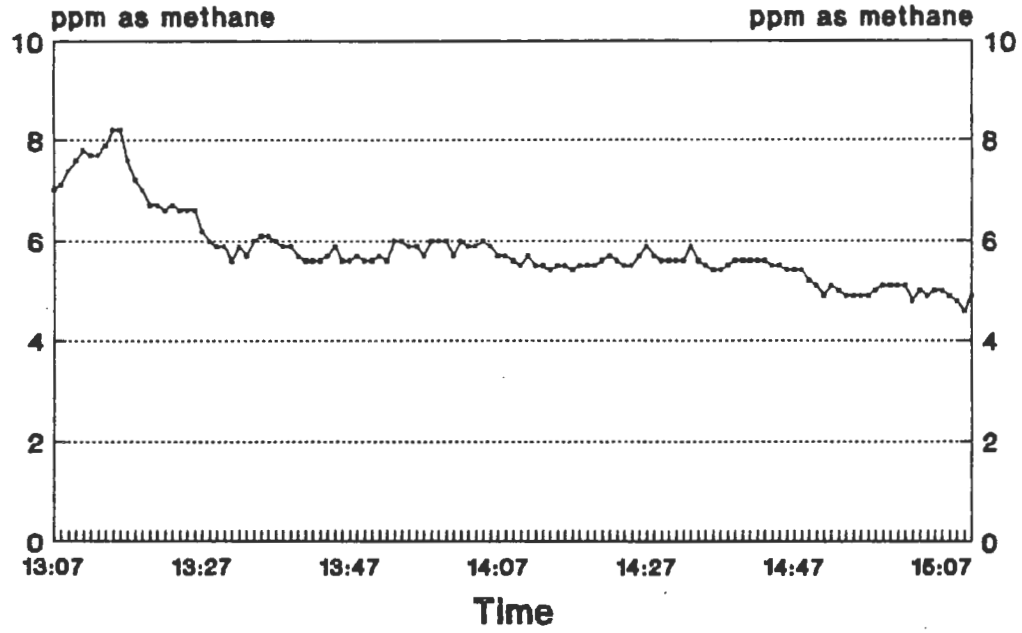
Maximum value - 6.9 ppm

Run 10 28 Feb 91



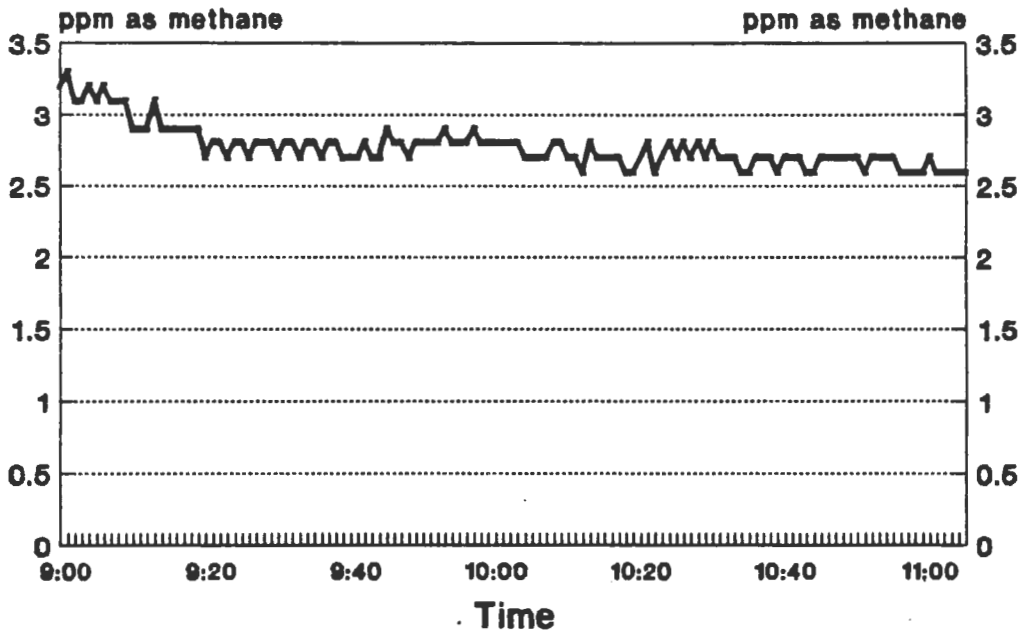
Maximum value - 7.8 ppm

Run 11 28 Feb 91



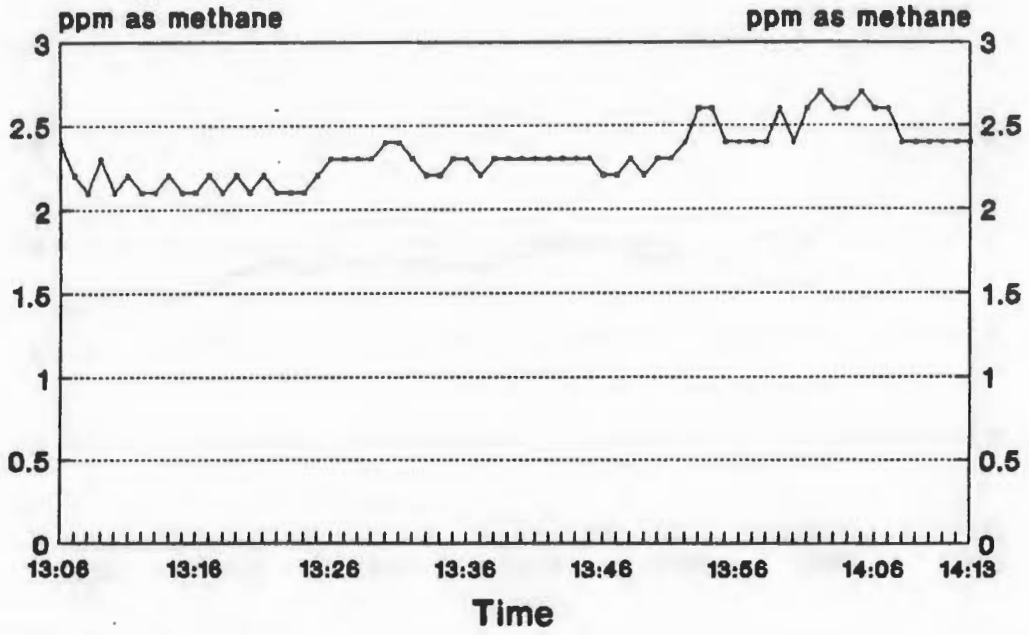
Maximum value - 8.2 ppm

Run 12 2 Mar 91



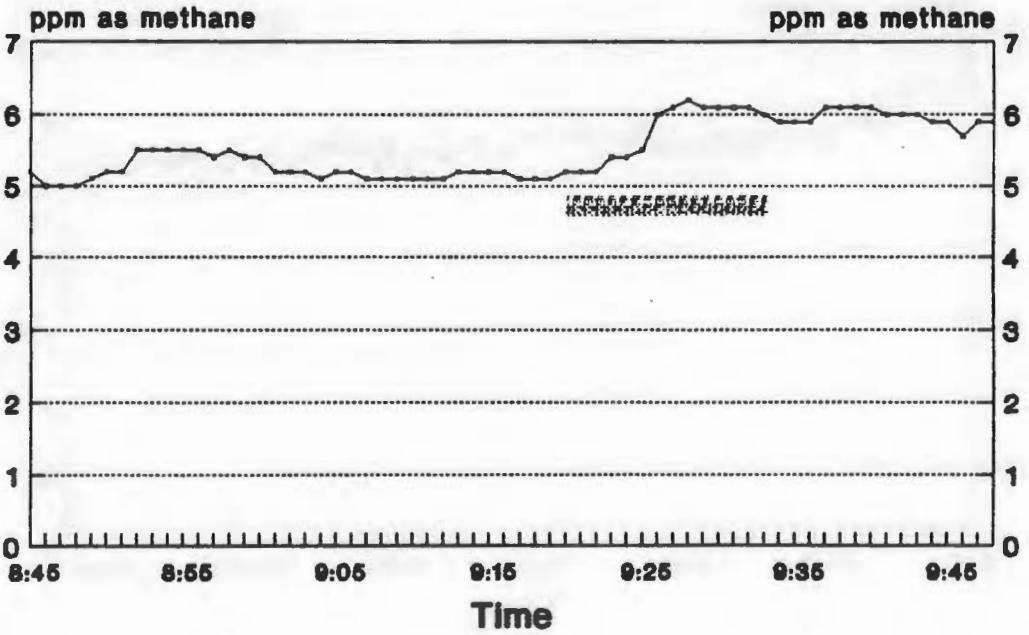
Minimum value - 3.3 ppm

Run 13 2 Mar 91



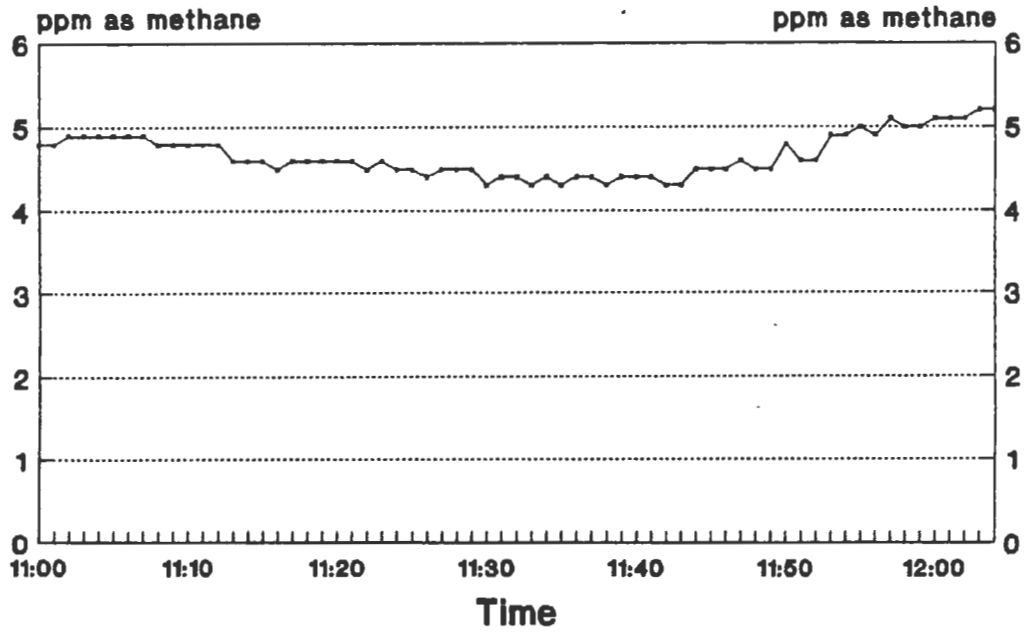
Maximum value - 2.7 ppm

Run 14 4 Mar 91



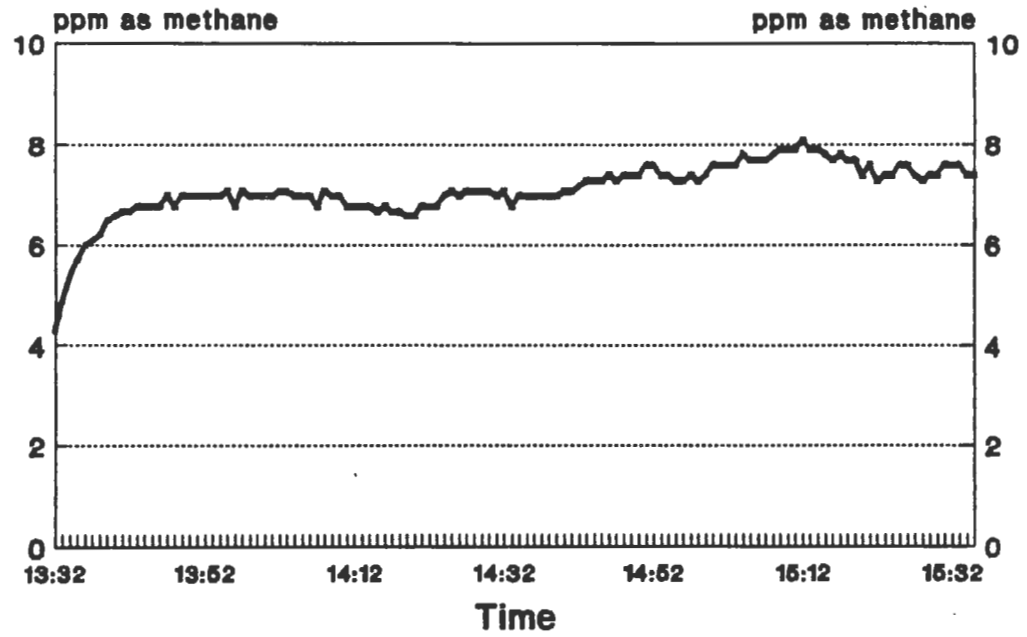
Maximum value - 6.2 ppm

Run 15 4 Mar 91

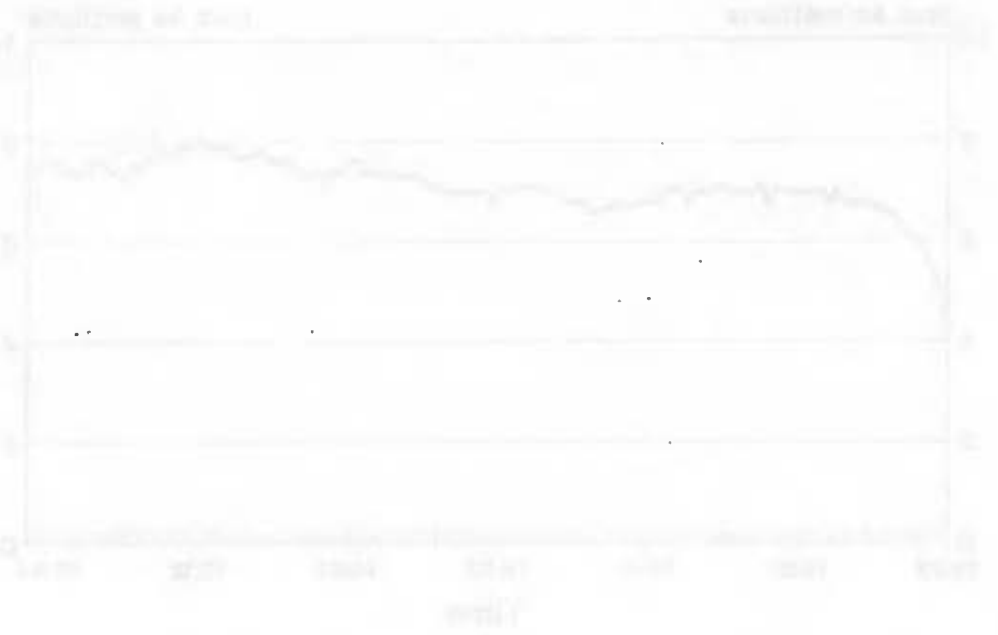


Maximum value - 5.2 ppm

Run 16 4 Mar 91



Maximum value - 8.1 ppm



APPENDIX P

APCS RESIDUE DATA

TABLE P-1. APCS ASH SUMMARY

	Feed	Total HTHE Ash Collected (g)	Total Baghouse Ash Collected (g)
Run 1*	20mm M96	420.3	610.4
Run 2*	20mm M96	47.8	792.5
Run 3	Hi-Skor 700X	28.3	846.9
Run 4	Hi-Skor 700X	244.2	1011.5
Run 5*†	20mm M96	349.7	5284.9
Run 6	20mm M96	150.4	4831.3
Run 7	Hi-Skor 700X	224.8	1944.0
Run 8	FA-956 Primer	113.2	1655.5
Run 9	20mm M96	170.1	4664.7
Run 10	20mm M96	66.4	2926.3
Run 11	IMR-5010	299.4	5285.0
Run 12	IMR-5010	125.4	705.7
Run 13†	FA-956 Primer	101.4	2256.3
Run 14	FA-956 Primer	39.3	1202.6
Run 15	FA-956 Primer	22.2	1656.2
Run 16	IMR 5010	18.6	1656.2

* Fugitive emissions
† MeM5 train failed posttest leak check

TABLE P-2. APCS ASH NG SUMMARY - HI-SKOR 700X PROPELLANT FEED

Run Number Date	3 23 Feb 91	4 25 Feb 91	7 26 Feb 91
HTHE ASH			
Max NG Concentration (μg/g)	0.0351	0.0044	0.0044
Ash Total Weight (g/test)	28.3	244.2	224.8
Max NG Total Weight (μ/test)	1.00	1.08	1.00
BAGHOUSE ASH			
Max NG Concentration (μg/g)	0.0083	0.0086	0.0128
Ash Total Weight (g/test)	846.9	1011.5	1944.0
Max NG Total Weight (μ/test)	7.06	8.69	24.96
TOTAL APCS ASH			
Max NG Total Weight (μ/test)	8.06	9.77	25.96

TABLE P-3. APCS ASH DNT SUMMARY - IMR 5010 PROPELLANT FEED

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
HTHE ASH			
Max DNT Concentration (μg/g)	0.0105	0.0040	0.1163
Ash Total Weight (g/test)	299.4	125.4	705.7
DNT Total Weight (μ/test)	3.14	0.50	9.30
BAGHOUSE ASH			
Max DNT Concentration (μg/g)	0.0159	0.0045	0.0136
Ash Total Weight (g/test)	5285.0	705.7	1656.2
DNT Total Weight (μ/test)	83.89	3.18	22.50
TOTAL APCS ASH			
Max DNT Total Weight (μ/test)	87.03	3.68	31.80

TABLE P-4. APCS ASH DPA SUMMARY - IMR 5010 PROPELLANT FEED

Run Number Date	11 28 Feb 91	12 2 Mar 91	16 4 Mar 91
HTHE ASH			
Max DPA Concentration (μg/g)	0.0209	0.0080	0.2326
Ash Total Weight (g/test)	299.4	125.4	18.6
DPA Total Weight (μ/test)	6.28	1.00	4.33
BAGHOUSE ASH			
Max DPA Concentration (μg/g)	0.0317	0.0090	0.0272
Ash Total Weight (g/test)	5285.0	705.7	1656.2
DPA Total Weight (μ/test)	167.78	6.36	45.01
TOTAL APCS ASH			
Max DPA Total Weight (μ/test)	174.06	7.36	49.34

-5. APCS ASH TOTAL METALS DATA - 20mm M96 CARTRIDGE - RUN 1

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
H - LCAAP0034										
Conc. /kg ash)	10.02	113	70.7	2.60	119	1,320	0.220	130,000	8,730	0.267
otal Metal ight g/test)	4.29	47.5	29.7	1.09	50.0	555	0.09	54,639	3,669	0.112
E ASH - LCAAP0037										
Conc. /kg ash)	10.2	53.4	18.8	4.89	210	162	6.32	118,000	15,300	0.772
otal Metal ight g/test)	6.23	32.6	11.5	2.98	128	99	3.86	72,027	9,339	0.471
PCS ASH										
otal Metal ght /test)	10.52	80.1	41.2	4.07	178	654	3.95	126,666	13,008	0.583

h = 420.3 g
e Ash = 610.4 g

P-6. APCS ASH TOTAL METALS DATA - 20mm M96 CARTRIDGE - RUN 2

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ASH - LCAAP0169										
al Conc. mg/kg)	9.13	5.44	91.3	3.32	94.4	1,780	0.166	144,000	8,560	0.221
Total Metal Weight (mg/test)	0.44	0.26	4.4	0.16	4.5	85	0.008	6,883	409	0.011
USE ASH - LCAAP0068										
al Conc. mg/kg)	10.2	7.50	58.5	4.88	206	184	5.08	191,000	9,920	0.705
Total Metal Weight (mg/test)	8.1	5.94	46.4	3.87	163	146	4.03	151,368	7,862	0.559
APCS ASH										
Total Metal Weight mg/test)	8.54	6.20	50.8	4.03	167.5	231	4.038	158,251	8,271	0.570

Ash = 47.8 g
use Ash = 792.5 g

P-7. APCS ASH TOTAL METALS DATA - 20mm M96 CARTRIDGE - RUN 6

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
SH - LCAAP0180										
l Conc. g/kg)	6.87	3.60	89.4	2.83	62.1	2,600	0.101	87,700	5,480	<0.204
Total Metal eight mg/test)	1.03	0.54	13.4	0.43	9.3	391	0.015	13,190	824	<0.031
SE ASH - LCAAP0181										
l Conc. g/kg)	4.63	6.13	283	2.61	113	463	2.49	1,040	7490	0.305
Total Metal eight mg/test)	22.37	29.62	1,367	12.61	546	2,237	12.03	5,025	36,186	1.474
APCS ASH										
Total Metal ight g/test)	23.40	30.16	1,380.4	13.04	555.3	2,628	12.045	18,215	37,010	1.505

sh = 150.4 g
se Ash = 4831.3 g

E P-8. APCS ASH TOTAL METALS DATA - 20mm M96 CARTRIDGE - RUN 9

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ASH - LCAAP0226										
tal Conc. (mg/kg)	4.42	3.98	44.4	3.62	60.5	1,520	0.100	83,000	7,370	<0.20
t Total Metal Weight (mg/test)	0.75	0.68	7.6	0.62	10.3	259	0.017	14,118	1,254	<0.03
OUSE ASH - LCAAP0229										
tal Conc. (mg/kg)	5.24	5.72	179	1.81	77.9	365	1.51	72,100	8,540	0.304
t Total Metal Weight (mg/test)	24.44	26.68	835	8.44	363.4	1,703	7.04	336,325	39,836	1.418
L APCS ASH										
t Total Metal Weight (mg/test)	25.19	27.36	842.6	9.06	373.7	1,962	7.057	350,443	41,090	1.45

Ash = 170.1 g
ouse Ash = 4664.7 g

P-9. APCS ASH TOTAL METALS DATA - 20mm M96 CARTRIDGE - RUN 10

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
SH - LCAAP0240										
l Conc. g/kg)	12.8	2.29	176	3.85	73.4	3,770	0.122	59,400	5,200	<0.200
Total Metal eight mg/test)	0.8	0.15	12	0.26	4.9	250	0.008	3,944	345	<0.013
SE ASH - LCAAP0242										
l Conc. g/kg)	5.23	3.26	1,320	1.88	83.1	414	1.36	55,800	5,860	0.221
Total Metal eight mg/test)	15.30	9.54	3,863	5.50	243.2	1,211	3.98	163,288	17,148	0.647
APCS ASH										
Total Metal eight g/test)	16.10	9.69	3,875	5.76	248.1	1,461	3.988	167,232	17,493	0.660

sh = 66.4 g
se Ash = 2926.3 g

P-10. APCS ASH TOTAL METALS DATA - FA-956 PRIMER - RUN 8

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ASH - LCAAP0195										
al Conc. mg/kg)	3.94	6.32	79.4	4.14	49.3	1,070	0.104	102,000	5,310	<0.20
Total Metal Weight (mg/test)	0.45	0.72	9.0	0.47	5.6	121	0.012	11,546	601	<0.02
USE ASH - LCAAP0198										
al Conc. mg/kg)	7.77	5.81	65.9	3.27	100	273	3.03	127,000	15,300	0.422
Total Metal Weight (mg/test)	12.86	9.62	109.1	5.41	166	452	5.02	210,249	25,239	0.699
APCS ASH										
Total Metal eight mg/test)	13.31	10.34	118.1	5.88	171.6	573	5.032	221,795	25,840	0.722

Ash = 113.2 g
use Ash = 1655.5 g

P-11. APCS ASH TOTAL METALS DATA - FA-956 PRIMER - RUN 14

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ASH - LCAAP0350										
al Conc. mg/kg)	8.21	1.84	44.9	5.01	63.9	924	0.140	69,400	5,940	<0.20
Total Metal Weight (mg/test)	0.32	0.07	1.8	0.20	2.5	36	0.006	2,727	233	0.008
USE ASH - LCAAP0361										
al Conc. mg/kg)	11.0	2.73	36.4	3.25	125	224	3.72	122,000	4750	0.66
Total Metal Weight (mg/test)	13.2	3.28	43.8	3.91	150	269	4.47	146,717	5712	0.79
APCS ASH										
Total Metal Weight mg/test)	13.52	3.35	45.6	4.11	152.5	305	4.476	149,444	5945	0.80

Ash = 39.3 g
use Ash = 1202.6 g

E P-12. APCS ASH TOTAL METALS DATA - FA-956 PRIMER - RUN 15

	Ag	As	Ba	Be	Cd	Cr	Hg	Pb	Sb	Tl
ASH - LCAAP0359										
tal Conc. (mg/kg)	12.0	3.16	60.6	3.65	59.6	805	0.203	86,500	7,180	<0.20
t Total Metal Weight (mg/test)	0.27	0.07	1.3	0.08	1.3	18	0.005	1,920	159	<0.00
OUSE ASH - LCAAP0363										
tal Conc. (mg/kg)	13.7	1.86	59	2.22	81.8	184	30.3	148,000	3,810	0.60
t Total Metal Weight (mg/test)	22.7	3.08	98	3.68	135.5	305	50.2	245,118	6310	1.00
L APCS ASH										
t Total Metal Weight (mg/test)	22.97	3.15	99.3	3.76	136.8	323	50.205	247,038	6,469	1.00

Ash = 22.2 g
ouse Ash = 1656.2 g

TABLE P-13. TCLP (METALS) HTHE ASH - 20mm M96 CARTRIDGE

Run Number	1	2	6	9	10
Regulatory Ag Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Ag Level (mg/L)	<0.50	*	<0.50	<0.50	*
Regulatory As Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured As Level (mg/L)	<0.50	*	<0.50	<0.50	*
Regulatory Ba Level (mg/L)	100.0	100.0	100.0	100.0	100.0
Measured Ba Level (mg/L)	<10.0	*	<10.0	<10.0	*
Regulatory Cd Level (mg/L)	0.5	0.5	0.5	0.5	0.5
Measured Cd Level (mg/L)	0.664	*	0.545	0.414	*
Regulatory Cr Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Cr Level (mg/L)	<0.50	*	<0.50	<0.50	*
Regulatory Pb Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Pb Level (mg/L)	83.3	*	76.1	55.6	*
Regulatory Hg Level (mg/L)	0.2	0.2	0.2	0.2	0.2
Measured Hg Level (mg/L)	<0.020	0.203	<0.020	<0.020	*
Regulatory Se Level (mg/L)	1.0	1.0	1.0	1.0	1.0
Measured Se Level (mg/L)	<0.100	*	<0.100	<0.100	*

* Insufficent quantity of ash for TCLP analysis.

TABLE P-14. TCLP (METALS) BAGHOUSE ASH - 20mm M96 CARTRIDGE

Run Number	1	2	6	9	10
Regulatory Ag Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Ag Level (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50
Regulatory As Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured As Level (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5
Regulatory Ba Level (mg/L)	100.0	100.0	100.0	100.0	100.0
Measured Ba Level (mg/L)	<10.0	<10.0	<10.0	<10.0	<10.0
Regulatory Cd Level (mg/L)	1.0	1.0	1.0	1.0	1.0
Measured Cd Level (mg/L)	2.17	<0.10	<0.10	<0.10	<0.10
Regulatory Cr Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Cr Level (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50
Regulatory Pb Level (mg/L)	5.0	5.0	5.0	5.0	5.0
Measured Pb Level (mg/L)	44.1	21.8	18.8	1.59	54.3
Regulatory Hg Level (mg/L)	0.2	0.2	0.2	0.2	0.2
Measured Hg Level (mg/L)	0.023	<0.020	<0.020	<0.020	<0.20
Regulatory Se Level (mg/L)	1.0	1.0	1.0	1.0	1.0
Measured Se Level (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100

TABLE P-15. TCLP (METALS) HTHE ASH - FA-956 PRIMER FEED

Run Number	8	14	15
Regulatory Ag Level (mg/L)	5.0	5.0	5.0
Measured Ag Level (mg/L)	<0.50	*	*
Regulatory As Level (mg/L)	5.0	5.0	5.0
Measured As Level (mg/L)	<0.50	*	*
Regulatory Ba Level (mg/L)	100.0	100.0	100.0
Measured Ba Level (mg/L)	<10.0	*	*
Regulatory Cd Level (mg/L)	0.5	0.5	0.5
Measured Cd Level (mg/L)	0.563	*	*
Regulatory Cr Level (mg/L)	5.0	5.0	5.0
Measured Cr Level (mg/L)	<0.50		
Regulatory Pb Level (mg/L)	5.0	5.0	5.0
Measured Pb Level (mg/L)	65.8	*	*
Regulatory Hg Level (mg/L)	0.2	0.2	0.2
Measured Hg Level (mg/L)	<0.020	*	*
Regulatory Se Level (mg/L)	1.0	1.0	1.0
Measured Se Level (mg/L)	<0.100	*	*

* Insufficent quantity of ash for TCLP analysis.

TABLE P-16. TCLP (METALS) BAGHOUSE ASH - FA-956 PRIMER FEED

Run Number	8	14	15
Regulatory As Level (mg/L)	5.0	5.0	5.0
Measured As Level (mg/L)	<0.50	<0.50	<0.50
Regulatory Ba Level (mg/L)	100.0	100.0	100.0
Measured Ba Level (mg/L)	<10.0	<10.0	<10.0
Regulatory Cd Level (mg/L)	0.5	0.5	0.5
Measured Cd Level (mg/L)	<0.10	0.323	<0.10
Regulatory Cr Level (mg/L)	5.0	5.0	5.0
Measured Cr Level (mg/L)	<0.50	<0.50	<0.50
Regulatory Pb Level (mg/L)	5.0	5.0	5.0
Measured Pb Level (mg/L)	12.8	16.6	15.8
Regulatory Hg Level (mg/L)	0.2	0.2	0.2
Measured Hg Level (mg/L)	<0.020	<0.020	<0.020
Regulatory Se Level (mg/L)	1.0	1.0	1.0
Measured Se Level (mg/L)	<0.100	<0.100	<0.100
Regulatory Ag Level (mg/L)	5.0	5.0	5.0
Measured Ag Level (mg/L)	<0.50	<0.50	<0.50