0010582

CORRES. CONTROL
OUTGOING LTR NO
87-2632

DIST	LTR	ENCL
SANCHINI D J	X	X
BADER C P	X	X
CAMPBELL G W	X	X
HOOD R C		
KINZER J E		
KIRBY W A		
LANGHEIM G R		
McNETT J F	X	X
PETERSON R G		
SHANNON, W M		
SMITH R E		
VEJVODA, E		
WEIDNER C W		
WESTON W F		
WILSON G L		
WOZNIAK B D		
YODER R E		
YOUNG E R		
Meyers, G.W	X	X
BETCHER D H		
CHANDA, R. N		
FREIBERG K J		
HARMAN L K		
HEBERT J L		
HOEY J B		
HOFFMAN R B		
KREIG D M		
LIM B W		
LOUDENBURG G E		
NAIMON E R	X	X
NEWBY R L		
TURNER H L		
VELASQUEZ, R N		
CORRES. CONTROL	X	X
Wickland, C	X	X
Ecklin, A	X	X
Hickle, G	X	X
Potter, [redacted]		
Robledo, P	X	X
Ziegler, D	X	X
Aguilar, P	X	X
CLASSIFICATION		
UNCLASSIFIED		
CONFIDENTIAL		
SECRET		

AUTH CLASSIFIER SIG

DATE 5-21-87

IN REPLY TO LTR NO

DEC #

LTR APPROVALS

ORIG & TYPIST INITIALS

ERN:em

RF 46469 (10 86)

Rocky Flats Plant
North American Space Operations
Rockwell International Corporation
P O Box 464
Golden, Colorado 80402-0464
(303) 497-7000
Contractor to U S Department of Energy

Rockwell International

file incinerator

000024438

87-RF-2632

Albert E. Whiteman
Area Manager
DOE, RFAO

FINALIZED RESPONSE TO QUESTIONS ON TRIAL BURN PLAN

Attached herewith are two final copies of responses to questions on the Trial Burn Plan These copies incorporate comments identified by CDH and EPA personnel during informal discussions on May 18, 1987

All the questions originating from a composite of public technical comments, CDH comments, and Region VIII EPA comments have been adequately addressed. I trust this document is now worthy of forwarding to the regulatory authorities.

Dominick J. Sanchini
President

Orig. and 1 cc - A. E. Whiteman
Enc.

ADMIN RECORD
SW-A-003940

1161

COMPOSITE OF TECHNICAL COMMENTS RECEIVED DURING COMMENT PERIOD

Demonstrations Prior to Trial Burn:

1. Comment

Facility representatives have recently acknowledged the previous use of the Fluidized Bed Incinerator to incinerate radioactive materials. This earlier use of the incinerator should be described in detail along with an explanation of why this information was not disclosed initially. The description should include:

- Analysis of all wastes and materials incinerated
- Operating ranges for all process variables
- Results of any emission monitoring conducted during the incineration period
- The purpose of the incineration run
- A summary of the results and conclusions drawn from this incineration

The Trial Burn Plan also references extensive laboratory testing which was used to design the Fluidized Bed Incinerators A summary of the laboratory results should also be included.

Response

The process development of the Fluidized Bed Incinerator (FBI) involved laboratory studies, the use of a pilot plant facility and a large-scale production demonstration unit. The information provided below (laboratory studies, Pilot Plant and Production Unit) is a summarized composite of tests performed on each unit While complete chemical analysis is not available for each of the waste materials fed during this process development phase, a general description of these materials is included. The purpose of the development work was to test and evaluate the various process parameters as well as to define and optimize the process parameters such as operating temperature, fluidizing gas velocity etc. In addition to the following information on the pilot plant and large unit, information has regularly been supplied in publicly available published technical reports. (See Attachment #1 References)

1. LABORATORY BENCH SCALE STUDIES

The initial tests were to verify that the hydrogen chloride (HCl) released during combustion of polyvinyl chloride (PVC) could be neutralized by surrounding sodium carbonate (Na_2CO_3) dry powder. The next task was to construct a quartz unit (2" diameter tube) to give a fluidized bed of Na_2CO_3 in which to test burn PVC containing waste and a second quartz section which contained catalyst to serve as an afterburner. Off-gas from the unit was passed through an aqueous scrubbed as a means of determining HCl in the effluent gas.

Successful operation of the quartz unit was followed by construction of the pilot plant. Laboratory bench scale work is covered in RFP-2016 (June 1973).

2 PILOT PLANT DEVELOPMENT

a An all-metal pilot plant incinerator was constructed in 1973 for testing the Fluidized Bed Incinerator concept and the first testing began on this unit in June 1973. The feed was made up of new

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materials to approximate the waste generated in glovebox operations, it contained 45% polyvinylchloride, 27.5% polyethylene, and 27 5% paper. Individual components were shredded, weighed portions mixed, and then re-shredded to ensure a homogeneous blend. From June 1973, through July 1974, the pilot plant operated approximately 1,100 hours burning about 5,655 kilogram (kg) (12,441 pounds [lb]) of this waste composite. This operating time consisted of many runs varying from 4 hours up to 200 hours of duration. No radioactive waste was burned.

b. The development testing was temporarily halted in July 1974, and the pilot plant was reconstructed into its present configuration. The reconstructed unit was modified to burn both liquid and solid waste. Following is a summary of the waste burned over 1,325 hours of non-continuous operation during this phase of development from February 1975 to December 1976:

- Paint Thinner and General Painting Waste (2,587 liters [683 gal.]) The thinner was mostly from cleaning paint brushes, used in the production buildings. Only a small amount of paint stripper (methylene chloride) was detected in one batch of waste. Analysis indicated this material contained only 10^{-8} grams (g) of plutonium (Pu)/liter (l) of waste.

- Low Specific Activity (LSA)* Solid Waste (5,260 kg [11,572 lb]) This was paper wipes, plastic, and general trash collected from production buildings. All trash was pre-sorted and the trash

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monitored for radioactivity before feeding to the incinerator. Waste that contained sufficient alpha contamination to be measured by a Ludlum alpha monitor was removed and not incinerated.

* LSA is defined as waste containing less than 100 nanocuries of transuranic elements per gram of waste.

- o Sewage Sludge

  Sludge was generated at the plant sewage plant and was burned for an applicability test. (107 kg [235 lb])

c. Four categories of the waste generated at other DOE facilities were simulated and burned to test the effectiveness of fluidized bed incineration for disposal The objective was to provide information to other DOE facilities which might wish to use the FBI at their facilities. These wastes were burned starting from October 18, 1976 through October 25, 1979 resulting in 1,691 non-continuous hours of operation. The four types burned were:

- o LSA Solid Waste 9,992 kg [21,982lb])

  This was general waste that was similar to previous burned LSA solid waste.
- o High Efficiency Particulate Air (HEPA) filters. (546 kg [1,201 lb])

  The filters used during this test were clean damaged filters.
- o Tri-butyl Phosphate (TBP) & Kerosene (2,583 l [682 gal])

  A mixture of 28% TBP in kerosene was prepared from new materials for

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this test burning.

- o Ion Exchange Resin (1,480 kg [3,256 lb])

  The resin burned was spent resin from the boiler plant that was used to clean boiler feed water.

d. Waste chemicals were incinerated in the pilot plant FBI from March 28, 1987 through July 13, 1980. These waste chemicals consisted of naptha, methylene chloride (paint stripper), ultrasonic cleaner and rinse, #6 fuel oil sludge, spent kerosene, benzene, xylene, and color indicators. Total amount burned was 2,272 liters (599 gal).

e A Trial Burn of Polychlorinated Biphenyl (PCB) transformer fluid was conducted in the pilot plant FBI on May 19, 1981. During the four-hour test 12.74 kg (3.57 gal) of a mixture containing 2.1 kg of Aroclor 1254 in kerosene was burned. This Trial Burn was approved and witnessed by the Environmental Protection Agency (EPA) personnel. A complete report of the conditions of the burn and the results is given in RFP-3271. Analysis by the EPA laboratory of collected samples gave a destruction efficiency of 99.99992%.

f <u>Operating Ranges of Process</u>

Typical operating parameters of the pilot plant FBI are given in the following table:

<u>Operating Parameters - Pilot Plant FBI</u>

Primary Bed	
Total Fluidizing Flow (Air $+N_2$)	25 $\pm$ 5 SCFM
Added N_2 Flow	10 $\pm$ 5 SCFM

Bed Temperature	$550^{o} \pm 50^{o}C$
Bed Material	(1,2) 30 Kg Na_2CO_3 + Catalyst
After Burner	
Added Combustion Air	20 $\pm$ 10 SCFM
Bed Temperature	$575^{o} \pm 75^{o}C$
Bed Material	(2) 90 Kg Catalyst

1. Typical bed mixtures: Solid Waste - 10% Catalyst
   Liquid Waste - 50-90% Catalyst
2. Catalyst Used: 20% Cr_2O_3 on alumina

g Results of Emission Monitoring

The pilot plant has in-line off-gas monitors for CO/CO_2 and oxygen. A specific ion electrode was used in a small slip-stream fed scrubber to determine off-gas HCl content.

Typical Values Recorded in Off-gas

Component	Range
CO_2	2.3 - 3.8%
CO	150 - 200 ppm
HCl	<1.5% of added Cl.
O_2	4 - 7%

h. Incineration Runs Were Conducted for the Following Purposes:

1. Determine operating parameters for the waste being incinerated.
2. Determine necessary measures to limit unwanted off-gas values such as high CO or low O_2.
3. Determine the operating effectiveness of equipment components. This included maintenance requirements, expected life, and stability during runs.

i. Incineration Run Protocol for Pilot Plant

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1. Material to be burned during run collected.
2. Specify levels of parameters to be used.
3. Equipment inspected.
4. Instrument standardized.
5. Samples to be collected identified.
6. Utilities and other involved departments notified.

J. Conclusions from Pilot Plant Incineration

1. A fluidized bed of sodium carbonate can effectively neutralize acidic gases generated during combustion of waste. This combined with dry particulate removal equipment eliminates the need for an aqueous scrubber.
2. Low temperature combustion using an oxidation catalyst is effective for destruction of tested organic compounds and was verified by EPA test on PCB.
3. Fluidized bed technology is suitable for processing combustible Rocky Flats Plant waste and the process could be used at other DOE facilities.
4. A demonstration unit able to burn the waste load generated during production operations would be able to confirm the pilot plant results.

3. PRODUCTION FLUIDIZED BED INCINERATOR

Results from pilot plant incineration lead to the design and construction of a unit large enough to handle the combustible waste generated during production operations at this facility. The unit was completed in the fall of 1978 and systems checked-out for operational readiness. The first operation with waste was on November 6, 1978.

a Materials Incinerated

Seven incineration runs were made starting November 6, 1978 and continued through March 2, 1981.

Type of Waste	Amount, Kg	(lb)
Non-contaminated office trash	15,787	(34,731)
Presumed[1] contaminated solid waste	3,487	(7,671)
Presumed[1] contaminated compressor oil	2,844	(6,257)
Total waste incinerated	= 22,118 Kg	(48,660)
Hours of operation	= 517	

[1]These wastes were generated in production areas and for safety considerations were presumed to be contaminated. Much of the waste was not contaminated. The remaining waste, contamination was below detectable levels.

In October 1985, the incinerator was operated for 154 hours burning non-contaminated non-hazardous waste oil to assess the condition of the process equipment for operation. A total of 2,591 kg (5,700 lbs) of oil were burned in the two runs in October 1985.

b. Operating Parameters

Primary Bed

Total fluidizing flow (Air + N_2)	190 SCFM
Added N_2 flow	130 SCFM
Bed Temperature	550 ± 50°C

Bed Material	300Kg $Na_2 CO_3$ + Catalyst
	(25-50% N_aCO_3, 50-75% catalyst)

Afterburner

Added Combustion Air	300 SCFM
Bed Temperature	575 ± 75^{0}C
Bed Material	1050 Kg Catalyst

Catalyst used was 20% Cr_2O_3 on alumina.

c. <u>Typical Emissions</u>

Constituent	Wt. Percent Range
Water	4.0 - 6.0
Hydrocarbons	0.005 - 0.050
Particulate	<0.0010
Oxygen	7 0 - 9.0
Nitrogen	70 - 78
Carbon Dioxide	5.0 - 10.0
Carbon Monoxide	0.008 - 0.050

d <u>Incineration runs were conducted for the following purpose:</u>

1 Verify scale-up operation from pilot plant information.

2. Determine temperature ranges experienced at set feed rates.

3. Determine high and low operational feed rates.

4. Define maintenance requirements and equipment reliability for production operations.

5 Verify off-gas instrumentation reliability

e. Incineration Run Protocol

Same as the pilot plant.

f. Conclusions

1. The process scale-up was tested and successfully verified design expectations.
2. Solid and liquid waste can be incinerated at the production required rates.
3. Good process control was demonstrated which verified the experience with the pilot plant.
4. Improved method of heat removal from the afterburner was tested and found to perform well.
5. Continuous ash cooling and flue gas cooling methods were tested and found to perform well.
6. In general, the system performed well during the tests.
7. Off-gas blowers were tested and proved to be a high maintenance item. An air jet ejector was installed to replace the off-gas blowers.
8. The sintered metal filters, while effective in removing particulate material, presented problems in discharging the particulate into the ash cooling conveyer. The filters were replaced to give greater filtration area and the chambers modified to allow better discharge of particulate into a collection box.

2. Comment

The incinerator should be operated during a"shake-down" period prior to the Trial Burn. During this "shake-down" period the incinerator should only be used for non-hazardous materials. Explain how the incinerator will be tested prior to the Trial Burn to demonstrate operational readiness Describe the length of testing, feed materials, and operating criteria which will be established for the "shake-down" period.

Response

The Fluidized Bed Incineration will undergo a Component check-out and Systems Operational Testing once the modification and upgrade are complete (i.e. automatic waste feed cutoff controls). (This is covered in response to Comments 5 & 7 from CDH Comments of January 22, 1987) SO testing is a sequential testing process which will culminate in an integrated system test from the point of waste introduction to waste packaging. Each component and system will be checked to ensure design compliance and satisfactory performance and operation This check-out period is expected to take five to six weeks. The malfunctions which could affect the Trial Burn, will be identified to the CDH & EPA.

During this period, non-hazardous/non-contaminated paper products, plastic, cloth, diesel oil, and other materials similar to the waste planned for incineration will be processed. This feed is comprised of office waste and unused paper and plastic product. The diesel oil will be from new drums.

The incinerator will be operated and tested under the primary control variables and the cutoff functions associated with each variable as described in the Trial Burn Plan In addition, the data logging/recording system will be operated for calibration and systems operational testing

3. Comment

The ability of the fluidized bed process to destroy hazardous constituents and the ability of the HEPA filtration system to remove radioactive constituents should be supported by existing test data. The facility should provide any information previously collected on the destruction efficiency of the fluidized bed process, and the removal efficiency of the HEPA filtration process. Information is provided in the Trial Burn plan on the previous PCB incineration. However, summaries should also be provided on any Trial Burns conducted at other DOE facilities which relate to the fluidized bed process With regards to HEPA filtration, the facility should provide information from controlled testing of the systems and representative data from other onsite uses of HEPA filtration. What other methods of particulate removal (i.e., scrubbing, electrostatic precipitation) have been evaluated?

Response

We are aware of no other similar Fluidized Bed Incinerators operated at DOE facilities. However, a commercial facility operating a fluidized bed incinerator manufactured by Advanced Process Systems, Inc., Louisville, KY has reported destruction efficiencies in excess of 99.99% While there are some differences from the units at Rocky Flats, they both utilize the concept of fluidized bed combustion. Many of the components used in the Rocky Flats incineration system have been used extensively in other DOE facilities. At the Idaho National Engineering Laboratory, sintered metal filters have been used in fluidized bed waste calcination units. The HEPA filtration equipment, similar to that used at Rocky Flats Plant, is used extensively at many of the DOE sites, Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL) and Hanford.

In the Rocky Flats Fluidized Bed Incinerator, the acid gas is neutralized at the point of generation in the primary bed and the particulate is removed by filtration. These two features negate the need for an aqueous scrubbing system and consequently eliminates the generation of a secondary waste stream (scrub solution). In the development phase, electrostatic precipitators were evaluated and found to be ineffective in removal of the dust from the flue gas stream.

A detailed discussion of the HEPA filter system testing and performance is provided in Attachment 2, "Environmental Analysis & Control Response to Questions from the Colorado Department of Health on the Rocky Flats Plant Fluidized Bed Incinerator HEPA Filter System."

WASTE FEED COMPOSITION

1 Comment

The facility should provide a more detailed description of the waste streams which will be incinerated during on-going operations, including the current backlog and the waste streams proposed to be incinerated during normal production operations What are the chemical compositions of these waste streams? What values exist for key incineration waste parameters such as heat content, chlorine content, radioactive constituents, ash content, solids content, viscosity, etc. What are the expected values for future waste streams and what are the existing values for waste currently being stored for incineration?

Response

The waste streams which are candidate feed materials for the Fluidized Bed Incinerator are listed in the Trial Burn Plan submitted to CDH as a part of the Part B Application for the plant. These data were generated in the waste stream identification program at Rocky Flats. The waste streams considered candidate feed material for the Fluidized Bed Incinerator are listed in Attachment 3. In addition, data on the liquid waste candidate feed material was given in the Trial Burn Plan, Table 9, Page 69. The liquid waste presently in backlog for incineration is contained in two permanent 10,000 gallon tanks. Additional temporary storage containers may be required based on the projected generation of up to 26,000 gallons (total) by July, 1987. The analysis on this material indicates the presence of 8 g/l of trichloroethane (0.766% chloride) in a paraffinic base oil-organic solvent mixture (with some water). The radioactive analysis of each tank is as follows·

	Pu g/l	Am g/l	Depleted U g/l
Tank 102	$<2.73 \times 10^{-6}$	$<1.97 \times 10^{-6}$	0.0072
Tank 103	$<3.82 \times 10^{-6}$	$<1.97 \times 10^{-6}$	0.0299

The accumulated waste in Tanks 102 and 103 are a good indication of the blended waste composition of future waste generation which would be burned in the Fluidized Bed Incinerator. The heat content of the liquid waste stream is approximately 17,500 BTU/lb. As indicated above, Attachment 3 defines the solid waste streams which are candidate waste feed for the Fluidized Bed Incinerator. From historical records and waste sampling, the solid waste feed composition has been defined as follows:

Component	Total Wt. %
Latex	11
Paper	50
PVC	2
Polyurethane	1
Polyethylene	1
Cloth	2
Leather	1
Wood	3
Water	2
Floor Sweepings (non-combustible)	19
Tramp Metal (non-combustible)	8
	100

The calculated heat content of the waste (excluding floor sweepings and tramp metal) is 8,020 BTU/lb. If floor sweepings are included, the heat content is 7,377 BTU/lb The ash content of the combustibles is only 1.8% and if floor sweepings are included, the ash content is 20.5%

The key waste parameters for the Fluidized Bed Incinerator is the organic chloride content of the waste; other parameters have little effect. The variation of heat content of the feed material is automatically accommodated by the system adjusting the feed rate based on afterburner temperature to provide a relatively constant thermal load. Therefore, a nominal value for heat content of the waste streams is adequate for process control. The ash content of the waste feed will have little effect on the operation because the ash is elutriated from the bed as it is produced Variation from a nominal value will have no adverse effects on process performance.

To satisfy the key feed parameter, chloride content, the liquid waste will be analyzed prior to feeding and the solid feed chloride content will be computed based on the feed composition shown above, determined from sampling and historical records.

The normal liquid feed chloride content will be well below the chloride levels present in the Test Burn liquid feeds. All liquid waste will be blended to keep the feed composition within permit limits. For the solid waste, the Trial Burn chloride content (both PVC and POHC) is several times higher than will be encountered during ongoing operations. Historical data provides assurance that the waste chloride content will remain below the Trial Burn chloride concentration.

2. <u>Comment</u>

During the Trial Burn period the incinerator's performance should be demonstrated on worst case streams The facility will not be allowed to incinerate a waste category which has not been demonstrated during the Trial Burn process The waste streams proposed for the Trial Burn do not adequately represent the actual wastes to be incinerated during on-going operations. Specific concerns are.

- <u>Plutonium Content:</u> The Trial Burn process does not include any waste

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tests with plutonium waste streams. If the facility intends to incinerate plutonium-containing wastes in the future these should be included in the Trial Burn. Both liquid and solid waste streams containing radioactive constituents should be run during the Trial Burn. The demonstrations should be performed stepwise, with non-radioactive runs conducted first, followed by runs conducted on uranium-containing wastes. The facility should report results demonstrating the incinerator's ability to successfully handle each step before proceeding on to additional wastes.

- Plastics, PVC, Latex, and Other Solids: The solid materials used to make up the feed composition for the Trial Burn should be representative of actual solid waste streams which will be sent to the incinerator during on-going operations. Paper material is not representative of these wastes. The solid feed should be a composite of plastics, PVC, latex, and other materials which are representative of types of wastes expected to be present during on-going operations.

- Other Radioactive Constituents: If the facility expects other radioactive constituents to be present in on-going operations these should be accounted for during the Trial Burn. The facility should either include these constituents in the Trial Burn feed or explain how these constituents are accounted for by demonstrations with uranium and plutonium.

- Chlorine Content The Trial Burn Plan proposes a maximum carbon tetrachloride content of 19%, and a maximum organic chloride content of 17.5% Are these levels the maximum expected for actual waste streams? Again, the maximum levels should be demonstrated during the Trial Burn.

Response

The Trial Burn runs defined in Table I are selected to demonstrate performance over a wide operating range of process variables, i.e., 40 to 100% of thermal capacity of the system, both solid and liquid feed, both plutonium and uranium contaminated waste and maximum chloride (chlorinated solvent) concentration expected in the blended waste streams. Carbon tetrachloride was chosen as the POHC (Principal Organic Hazardous Constituent) because it is the most difficult chlorinated solvent to destroy. Surrogate waste streams for Trial Burns are appropriate based on recent non-flame thermal decomposition data for several hazardous organic compounds compiled by the University of Dayton (Dellinger, et. al., 1984, 1985, 1986). The Trial Burn Plan specifies a wide variety of liquid waste which will be blended and processed in the Fluidized Bed Incinerator. The liquid waste and solid waste candidate materials for incineration in this process are defined in the submittal of the Part B Permit to CDH. Uranium has not been included in the liquid waste trial runs because the desired concentrations greatly exceed the solubility limit. The amount of depleted uranium to be used in the Trail Burn was based on the detectable concentration anticipated in the off-gas sample train. The amount of uranium needed for the test can not be solublized in the liquid feed The Trail Burn is being conducted with greater concentration of uranium and plutonium in the feed than will be encountered during ongoing operations Successful completion of a representative test burn should allow for treatment by incineration of all waste so listed in the Part B Permit.

PLUTONIUM CONTENT

As shown in Table I, the liquid waste tests will incorporate a plutonium-spiked feed. The Trial Burn Plan is being herein modified to reflect the trail burn conditions as specified in Table I. For the solid waste tests, two runs will be made with uranium-spiked feed and one with plutonium spiked feed. The test burn is to proceed with the two non-contaminated liquid feed runs followed by two solid feed runs with uranium and then the two plutonium runs (one liquid and one solid feed). It is intended to review the on-line instrumentation results from each test run before proceeding to the next test run. The personnel from CDH and EPA will participate in the technical review of the on-line test information. The stack sampler will be analyzed for activity and these results will be reviewed for the uranium bearing runs before proceeding with the tests with plutonium in the feed. No long delay is planned between runs, i.e., upon completion of the non-contaminated feed tests, the uranium test could proceed the next day and on the completion of the technical review for the uranium-spiked runs the plutonium-spiked test could proceed the next day. It is anticipated that three or four runs would be made one week and the remaining runs the following week. Continuous stack

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TABLE I

PROPOSED TEST BURNS FOR VERIFICATION OF THE FLUIDIZED BED INCINERATOR

SOLID FEED RUN #3: 8333 BTU/LB. 2.11% CCl_4, 2.22% PVC, 58.61% PAPER, 18.06 POLYETHYLENE, 18.85% INERT SOLIDS

SOLID FEED RUNS 4 & 5: 8088 BTU/LB. 2.1% CCl_4, 5.4% PVC, 15.1% LATEX, 63.5% PAPER, 1.4% POLYURETHANE, 1.4% POLYETHYLENE, 2.7% CLOTH, 1.4% LEATHER, 4.1% WOOD, 2.7% WATER

LIQUID FEED: 17,000 BTU/LB. 4.61% Cl = 5% CCl_4, 95% DIESEL

TEST	FEED	FEED RATE LB/HR	% OF DESIGN	R1 GAS SCFM	R1-T (°C)	R2-T (°C)	CAT/Na_2CO_3 (Ratio)	FLUE GAS SCFM	U & Pu ADDED*
1	Liquid	60	68	260	575	625	20/80	524	No
2	Liquid	80	91	320	575	625	20/80	682	NO
3	Solids	180	100	320	575	625	20/80	720	0 136% U
4	Solids	125	67.4	300	575	625	20/80	529	0.20% U
5	Solids	125	67.4	300	575	625	20/80	529	0 00014% Pu**
6	Liquid	36	41	150	575	625	20/80	380	0.00014% Pu**

*U Will be added as uranium oxide, Pu will be added as a solution in carbon tetrachloride-methanol
**This is based on 100 nano Ci of transuranic alpha activity per gram of waste (technical definition of low level waste)

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emission sampling will be conducted during the tests; one sample for the two non-contaminated feed tests, one sample for the two uranium spiked feed tests and one sample for the two plutonium feed tests. In the unlikely event that the stack alarms are activated for radioactive emissions, the test burns would be suspended.

PLASTIC, PVC, LATEX, AND OTHER SOLIDS

The composition of the solid feed material for the test burn is shown in Table I. The PVC content of the Trial Burn feed will contribute to the total chloride in addition to the POHC, carbon tetrachloride. Because the floor sweepings are not combustible and should not affect the combustion process, they will not be added to the feed material in Runs 4 & 5. Tramp metal will also not be added because it is separated prior to the combustion process. The solid waste selected for Runs 4 & 5 include the waste components without the inert floor sweepings and the PVC content has been doubled. This feed will demonstrate the equivalent of 10.75% PVC or 3.87% Cl in the feed. For Run 3 the floor sweepings have been added and the polyethylene has been increased to demonstrate 100% of thermal design at a feed rate of 180 lb/hr.

OTHER RADIOACTIVE CONSTITUENTS

The major radioactive constituents of the feed material for the test burn as well as the mixed waste from ongoing operations will be plutonium and uranium. With the plutonium, a small amount of americium (0.2% of the Pu content) will be present. However, the americium content will be too low to be detected in the off-gas sampling equipment during the Trial

Burn or ongoing operations. Other radioactive constituents will consist of daughter products of plutonium and uranium, and the concentration will be several orders of magnitude lower than the plutonium and americium, if present at all. All of the actinide elements, if present, should perform in a similar manner to that of the plutonium and uranium materials used in the tests.

CHLORINE CONTENT - COMMENT

As shown in Table I, the carbon tetrachloride content of the Trial Burn will be 2.1% CCl_4 in the solids and 5% CCl_4 in the liquid feed. The solid waste used in the test will also contain PVC which contributes up to 2% additional chloride. These values are well above the chloride concentrations which will be in the blended waste streams during ongoing operation. Blending of the waste will be used to assure that the waste fed during ongoing operation does not exceed the concentration tested during the Trial Burn.

3. Comment

The feed composition for the Trial Burn runs should be described in detail. What will be the physical nature of the plutonium and uranium to be burned? What will be the radioactive levels and the isotopic distribution for these constituents? What total quantity of plutonium and uranium will be used?

Response

The composition of the solid feed material and liquid feed material to be used in the Trial Burn is shown in Table I. It is proposed that two tests be made with non-contaminated diesel oil spiked with carbon tetrachloride, two test with solid feed (composition specified in Table I) spiked with carbon tetrachloride and uranium oxide, and the remaining tests, one with liquid and one test with solid feed, spiked with a solution of plutonium in carbon tetrachloride-methanol. The amount of plutonium contained in the solid feed (4 hr. at 125 lb/hr.) will be 0.317 g. The amount of plutonium contained in the liquid feed (4 hr. at 36 lb/hr.) will be 0.091 g. Each of the other solid waste feeds will contain 444 g. of uranium (4 hr. at 125 and 180 lb/hr.). The sources of the plutonium and uranium are the process streams at Rocky Flats and therefore would be of the same isotopic composition as the waste to be processed in normal operation. (See Final Environmental Impact Statement Rocky Flats plant site, April, 1980)

4 Comment

During the feed process non-combustibles are sorted out and removed prior to the waste entering the incinerator. Describe how these non-combustibles are identified and where they are sent.

Response

During ongoing operations the non-combustibles which would be introduced to the system would be removed by three methods: hand sorting of the bulk feed material by visual identification, air classification of the shredded waste by material density, and tramp metal removal from the bottom of the primary reactor segregated from the bed by density The

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non-combustibles removed will be primarily metal objects The hand sorting will remove larger bolts, wrenches, metal cans, etc The air classifier will remove nails, nuts, small bolts, etc. The non-combustibles removed from the reactor would consist of snaps, metal buttons, and small clips that may have been attached to the combustible material and settled out from the bed when the combustible material is burned. The tramp metal will be packaged in drums and stored on plantsite for future disposition. Trial Burn tests will be conducted without tramp metal contained in the feed.

DESIGN

1. Comment

The facility should describe the original design basis for the Fluidized Bed Incinerator. What criteria were established for construction, materials, and performance? What quality control/quality assurance was used during design and construction?

Response

The objectives of the development of the Fluidized Bed Incineration process were as follows.

a To provide a high degree of combustion efficiency and minimize problems associated with cleaning of the gas stream.

b. To provide a low temperature process that would eliminate the need to use refractory lined equipment.

c. To provide in-process neutralization of acid gases, thereby minimizing equipment corrosion and eliminating the need for an

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aqueous scrubbing system and the secondary waste scrub solution generation.

d To provide a safe and economical process with minimal secondary waste generation.

These development objectives were demonstrated in approximately 4,400 hours of pilot plant operation. The data generated on the pilot plant were used in design of the production-scale Fluidized Bed Incinerator. The production scale incinerator was designed to accommodate waste feed totaling a heat release of 1,500,000 BTU/hr. Facilities Quality Assurance (FQA) Program for all construction provides the control and verification necessary for safe, reliable, and economical operation of facilities at the Rocky Flats Plant. This quality assurance program ensured compliance with applicable requirements and regulations of government agencies and Rockwell International. The engineering, construction, testing, operation, and maintenance of new and modified facilities were subjected to an implementation of the FQA Program and the appropriate FQA records are retained on plantsite. The Quality Assurance personnel are independent of the design and construction functions. The quality assurance includes inspection and testing equipment procured and constructed to assure that it meets the design requirements. Quality Assurance personnel provide inspection of new or modified structures. Calibration of instruments used and approval of component check-out and system operational testing documents.

2 <u>Comment</u>

The rationale behind the selection of certain process features should be presented. Specifically:

- Catalyst: Why is chromic oxide on alumina selected as the oxidation catalyst?
- Air Pollution Control: Why was the air pollution control system consisting of cyclones, a sintered metal filter, and a series of HEPA filters selected? Why does the system not include any wet scrubbing?

Response

- Catalyst: The chromic oxide on alumina catalyst was selected on the basis of the high degree of reactivity at low temperatures and its high resistance to poisoning from any of the components of the waste stream. The catalyst operates at approximately 550°C, a temperature that does not favor catalyst reaction with sulfur or halogen species. Five other commercial oxidation catalyst materials were evaluated for destruction efficiency at various temperatures and the chromic oxide catalyst exhibited the best efficiency at lower temperatures. (See Reference 1 in Attachment 1)

- Air Pollution Control: One of the main benefits of this system compared to a conventional incinerator is that this incinerator eliminates the need for an aqueous scrubbing system and thereby eliminates the generation of a secondary radioactive waste stream, the scrub solution. The fact that the acid gases are removed or neutralized in the primary reactor bed eliminates the need for aqueous scrubbing and allows the use of dry off-gas cleaning. The cyclones, sintered metal filter, and HEPA filter usage are consistent with dry off-gas cleaning and the elimination of the scrub solution waste stream. Cyclones are used because of the high degree of reliability and ease of operability. Sintered metal filters are used due to the high efficiency* of particulate capture capability of small particulates and the fact that they provide a fire stop between the process and the HEPA filter system. The HEPA filters are used because of their proven reliability for filtration of very small particulates from a wide variety of air cleaning applications in the nuclear industry. Each stage of the HEPA filters are capable of removing a minimum of 99.95% of the 0.3 micron diameter particles. Particles larger or smaller than the 0.3 micron diameter are captured at higher filtration efficiencies. A total of six stages of HEPA filtration are used to clean the off-gas from the Fluidized Bed Incineration system. (See Attachment 2 for calculated values of filtration efficiency for the HEPA filter plenum)

*Manufacture specifications rate the filters for 98% removal of 4 micron diameter particles from a gas stream.

OPERATION

1. <u>Comment</u>

The Trial Burn process proposes an operating temperature range of 500 to 610 degrees Centigrade in the primary reactor and 475 to 650 degrees Centigrade in the afterburner reactor. The Trial Burn Plan explains that the incinerator is designed to achieve the required destruction at these lower operating temperatures. What design considerations have been chosen to allow for this lower temperature range? Specifically, the effects of catalytic oxidation and fluidization turbulence should be explained in order to support these lower temperatures.

Responses

In a fluidized bed reactor, the gas or air flows up through solid material (bed material) to provide good contact between the gas and the bed material. There is movement of the bed material due to the gas flow

In this system the bed material contains sodium carbonate which removes the acid gases. It contains catalyst which promotes combustion of the waste introduced in the bed in contact with the catalyst and air at a lower temperature The use of lower temperatures in incineration provides advantages in terms of variety of acceptable materials of construction, equipment reliability and equipment maintainability. The use of an oxidation catalyst allows completion of the combustion reactions at a lower temperature than required in a conventional incinerator. A complete rationale and the data to support the selected operating temperature range are provided in the Trial Burn Plan. The use of a fluidized bed process provides a better uniform gas-solid contact for reaction than is obtained in other types of units such as fixed bed reactors (i.e , burning waste on a hearth plate or grate)

2 Comment

The Trial Burn Plan does not clearly state whether the cooling water

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system is isolated from the incinerator waste and emissions. Is the cooling water a closed system?

Response

The cooling water system is a closed-loop system. This system prevents any direct contact between the process (flue gas, feed, ash, etc.) and the cooling waste. The cooling water in the closed-loop is further isolated from the cooling tower water. This system provides two degrees of isolation (two metal walls) between the process and the cooling tower.

3 Comment

The Trial Burn should provide an estimate of the residence time in both the primary and secondary reactors.

Response

For the test burn runs as specified in Table I, the following will be the gas residence time in the primary and secondary reactors.

		Residence Time	
Run #	Feed Rate	Primary	Secondary
1	60 lb/hr (Liquid)	2.7 sec	6 0 sec
2	80 lb/hr (Liquid)	2.2 sec	4.6 sec
3	180 lb/hr (Solid)	2 2 sec	4.4 sec
4	125 lb/hr (Solid)	2.3 sec	6.0 sec
5	125 lb/hr (Solid)	2.3 sec	6.0 sec
6	36 lb/hr (Liquid)	4.7 sec	8.3 sec

It should be noted that these are very long residence times compared to

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conventional incineration systems where total residence time is about two seconds. Long residence time is beneficial in obtaining a high destruction efficiency.

4. Comment

The Trial Burn should justify the use of 100% excess air. Additional air serves as an added dilution to the process and should be taken into account when calculating the destruction removal efficiency.

Response

It is common practice to use up to 200% excess air in an incinerator where high destruction efficiency is desired. Completion of a chemical reaction is improved by providing an excess of reacting components. In this case an excess of air promotes complete destruction of the waste components. The destruction efficiency calculation involves the relative amounts of carbon monoxide and carbon dioxide formed, not the amount of air. During the Trial Burn the destruction efficiency will be determined based on the amount of POHC feed versus the POHC & PIC (Products of Incomplete Combustion) in the off gas, not on the amount of air present.

CONTROL SYSTEM

1 Comment

The HEPA filters should be continuously monitored for failure or build up. An indicator such as pressure drop across the HEPA filter should be monitored as a measure of the filter's performance. Monitoring of the filter system should be connected to the automatic waste feed cutoff system.

Response

During the Trial Burn, the pressure drop of the HEPA Filter, downstream of the flue gas cooler, will be monitored. A high pressure drop would indicate a plugged filter and a very low pressure drop could indicate a major failure of the filter. For normal operation the pressure drop will be used to automatically cut off both the liquid and solid waste feed on a high (> 6 in., H_2O) and a low (< 0.1 in., H_2O) condition.

2 Comment

The automatic waste feed cutoff system should fail closed so that if any of the monitoring devices should fail then the feed should shut off. The facility should explain how the control system is set to fail safe.

Response

The waste feed cut-off system is designed to fail-safe and will be tested as part of the Trial Burn. The cutoff systems will be tested when non-hazardous feed is being burned prior to actual Trial Burn tests. When a component of the system is designed to be fail safe, any loss of power or instrument air returns that component to a safe condition for the process. As an example, the valve on the liquid waste feed would close and the screw feed motor would stop to prevent hazardous waste feed if a power failure should occur (See response to comment #5 from CDH comments of January 22, 1987.)

3 Comment

CO monitoring and control should be clearly explained What will be the set points for two stages of CO control? What CO levels are expected based on previous demonstration of the incinerator.

Response

The Trial Burn Plan specifies that the data generated on CO concentration will be used to set acceptable CO limits for permit conditions using the two tier system with a moving window for the upper tier. The present regulations do not require the CO level to be set at 100 PPM average over 60 minutes and 500 PPM over ten minutes. These proposed limits are a measure of destruction efficiency on-line during operation During the Trial Burn the destruction efficiency will be determined from the EPA approved off-gas sample train. The objective of the Trial Burn is to test the system for destruction efficiency, and therefore, the CO limit during the Trial Burn should be set high (1500 PPM) to prevent premature shutdown during the tests. Based on development tests the CO should be in the range of 500-600 PPM. The 1500 PPM CO limit is reasonable due to the fact that during the Trial Burn, EPA and/or CDH personnel will be present to observe CO concentrations actually detected. Further the off-gas sampling trains will collect samples which will be analyzed to determine the actual destruction efficiencies obtained in the test. The final permit limit of CO concentration in the off-gas system should be based on the results obtained during the Trial Burn and are expected to be lower than 1500 PPM for final permit

4 Comment

The Trial Burn Plan states that waste is not allowed to be fed to the incinerator until the bed temperature has reached the allowable operating range. Explain how the feed to the bed is restricted during startup and shutdown periods.

Response

For solid waste feed the material must flow through the screw feed conveyer. The drive to the conveyer is activated only when all the required operating (cut-off) parameters are within specified limits. For liquid waste feed, a cut-off valve must be open to let the liquid flow to the feed pump. This valve can only be opened when all the required operating (cut-off) parameters are within specified limits. To start the unit and to satisfy the cut-off parameters, only diesel oil, methanol and electrical preheating of air can be used. No waste can be fed during either startup or shutdown conditions due to physical interlocks.

MONITORING

1. Comment

The facility should calculate mass balances on the complete incinerator system as a check on the monitoring and analysis. In particular, component mass balances should be conducted on uranium and plutonium to assure that the radioactive constituents are completely tracked.

Response

The plutonium and uranium fed during operation will be in the residue generated as cyclone ash and sintered metal filter ash (more detail on this subject will be included in comment #2 below). The off-gas sampling trains will provide an accurate assessment of any potential radioactive release into the off-gas filtration system during the Trial Burn and therefore accurate tracking of the radioactive material will occur. Using the off-gas sampling and analysis is a direct and accurate method of determining radioactive material release to the HEPA filter plenum from the process during the Trial Burn. The true off-gas concentration will not be accurately calculated by a mass balance technique. The inherent and unavoidable inaccuracy of the sampling and analysis involved with the feed material and ash could overshadow the small amount which would be calculated in the off-gas stream.

The plant will pursue discussions with EPA and CDH on the use of incineration material balance as applicable to the Fluidized Bed Incineration after the completion of the Trial Burn tests.

2 Comment

The analysis of ash and residues plays a key role in monitoring the incinerator's performance Does the predicted ash level of 17 1 lb/hr represent strictly residues from the solid waste runs or are the liquid runs averaged with the solid runs? What hazardous and radioactive constituent levels are expected in the ash, cyclone residues, and filters? What parameters will the ash, cyclone residues, and filters be analyzed for?

Response

The predicted ash level of 17.1 lb/hr. represents an average of both solid and liquid feeds at a feed rate of about 70 percent of thermal design capacity. At 100 percent feed capacity, the expected ash generation rate will be 29 lb/hr. While operating at steady state conditions, all of the plutonium and uranium for practical considerations will be present in both the cyclone and the sintered filter ashes. During the runs, minute quantities of plutonium and uranium may become entrapped within the bed itself, which will continue to be elutriated into the ash generated during standby operation between test runs. All of the hazardous constituents in the feed material will be destroyed during the process. However, the ash from the cyclones and sintered metal filters will be analyzed for hexavalent chromium, CCl_4, PICs, dioxins and furans in addition to plutonium and uranium. For the runs with plutonium in the feed, the PICs, POHC, dioxins, and furans will not be determined in the ash mixture because of limited instrumentation in a lab equipped to handle plutonium. However, the off-gas samples from all runs will be analyzed for PICs, POHC, dioxins and furans.

3. Comment

The Trial Burn Plan references that some waste streams will produce acidic compounds and must be neutralized in the bed. Acidic compounds formed during the incineration are neutralized in the bed material with sodium carbonate. Identify the waste components which can result in acid corrosion, and explain how the completeness of the neutralization process will be monitored. How will these waste components be identified and managed during on-going operations?

Response

A gaseous hydrogen chloride analyzer will be added to the off-gas monitoring system. Specifications are now being prepared for procurement of this analyzer. Because of the long delivery time for this instrumentation, it will not be installed prior to the trial, but will be installed for on-going operations. During the Trial Burn the HCl will be detected in the off-gas sample trains. The bed reactions are capable of removing phosphate as well as the halogens. (See reference #1 to #6 from Attachment #1 for chemical reactions involved)

The waste feed components which could potentially cause corrosion would be those that can produce an acid gas such as HCl from PVC or chlorinated organics. The chlorinated solvents and PVC are the only components of the Rocky Flats waste stream which can contribute to a significant amount of acid gas. The chloride content of the liquid waste will be analyzed prior to incineration and the chloride content of solid waste will be assessed based on knowledge of the composition of the waste materials Blending of waste during on-going operations will be used to assure that the chloride content will not exceed the chloride content of Trial Burn conditions. In fact the waste chloride concentration during on-going operations will normally be approximately a factor of five below that used in the Trial Burn. The neutralization of the acid gas generation will be monitored during the Trial Burn through the off-gas sampling trains. For production operations a Hydrogen chloride analyzer will be installed, standardized and inspected prior to implementation to continuously monitor the off-gas

4. Comment

Radioactive monitoring should be described in more detail. What is the accuracy of the uranium monitoring and the plutonium monitoring? Have more accurate methods been investigated? What continuous radioactive monitoring is available and what type of continuous monitoring is in place? Will the off-gas radioactive monitoring detect radionuclides in all forms? What monitoring is in place after all the HEPA filters?

Response

Two types of instrumentation are used; one is a Selective Alpha Air Monitor (SAAM) which provides a real time,on-line alarm for radioactivity. The alarm set point 23.6 pico curie of activity per cubic meter of gas over a one hour period. The accuracy of the SAAM is ± 20%. The other is a sample which provides an integrated analysis over a sampling period. All effluent air monitoring data is derived from samplers located down-flow from the final stage of HEPA filters. In the case of the Fluid Bed Incinerator exhaust air plenum, two particulate filter paper samplers continuously extract a portion of the air effluent from the exhaust duct through 0.5" ID stainless steel sampling tubes The sampled air is extracted at the rate of 56.6 liters per minute (2 cfm). The sampled air passes through a Whatman 2000 filter media, retaining the entrained particulates from the airstream. The vacuum source for the samples is provided by a centrally located pump. The filter media is exchanged three times each week on Monday, Wednesday and Friday for subsequent direct counting, analysis, processing and storage at a central laboratory facility. The laboratory inspects the samples for nonconformance prior to initiating the chain of custody documentation. The samples are submitted to an alpha counting facility for direct radiometric analysis using solid-state alpha particle detectors. These detectors are calibrated to discriminate against naturally-occurring, short-lived isotopes of radon and thorium. The result of this direct filter analysis is a "total long-lived alpha" concentration for each sample filter. Results of this analysis are available within 36 hours following the sample exchange. The detection limit for this direct counting analysis is 10% of the Derived Concentration Guide (DCG) for plutonium and 2% of the DCG for uranium. If the long-lived alpha concentration exceeds 0.02 picocuries per cubic meter, an investigation into the causes is made and corrective actions are taken. Following the radiometric analysis, the samples are returned to the central facility for storage until the completion of the sampling month At the conclusion of the sampling month, the particulate filters are composited into individual samples representing each exhaust system.

Each composited sample is subject to specific radionuclide analyses, including plutonium 238, plutonium 239+240, uranium 233+234, and uranium 238. Samples that are analyzed for plutonium isotopes also are screened for americium 241. The detection limit for specific uranium analysis is 0.1% of the DCG. An aliquot of each composite sample is analyzed for stable beryllium using a flameless, atomic absorption spectrometer

Table II shows the analytical detection limits and concentration guides for each of the materials being sampled in the air effluents from the Fluid Bed Incinerator.

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TABLE II

FBI SAMPLE DETECTION LIMITS AND GUIDES

Material	Sample Volume (m3)	Detection Limit (pCi/m3)	DCG* (pCi/m3)
Radioactive:			
Americium	4890	0.00005	0.02
Plutonium	4890	0.00006	0.02
Total long-lived Alpha	163	0.002	----
Tritium	0.14	40	200,000
Uranium	4890	0.00009	0.09
Nonradioactive:			
Beryllium	4890	0.00005 ug/m3	NA

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* Derived Concentration Guide (DCG), is the concentration in air from which, under conditions of continuous exposure (365 d/y), a member of the public inhaling 8400 m3 of air would receive an effective dose equivalent of 100 mrem. DCG's apply to specific radionuclide concentrations only.

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Adjacent to the sampling probes a flowmeter is installed to measure the total airflow rate through the duct. These vortex shedding flowmeters are accurate to velocities as low as 0.5 m/sec, and based on the assumption of a constant Strouhal number over a wide Reynold's number range, are insensitive to variations in density, temperature and pressure.

A selective alpha air monitor (SAAM) is located in the exhaust duct downstream of the HEPA filtration to provide real-time sampling, detection and alarming capabilities for plutonium. The SAAM produces an audible alarm should the concentration exceed a pre-set alarm point. These devices are designed to extract a portion of the air from the exhaust duct through a filter that is continuously monitored by a solid-state alpha particle detector. Should the alpha particle activity being monitored exceed a preset amount, an audible alarm is sounded to alert the local operating personnel. A simultaneous alarm also is transmitted to the Utility Control Room and Radiation Monitoring office When an alarm is activated, Utilities and Radiation Monitoring personnel immediately investigate the cause. The Utilities personnel will immediately notify operation personnel in the FBI area and request shutdown of the process The selective alpha air monitors are sensitive to alpha particle radiation and are routinely tested and calibrated to maintain their sensitivity to plutonium.

Whatman 2000 is a glass-fiber filter media with a retention efficiency of 99.99% used for particulate sampling The particulate filter media was

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selected because of its high collection efficiency, good tensile strength, low trace element content (notably beryllium), availability, and compatibility with existing analytical laboratory procedures.

The sample flow is calibrated monthly, using instruments whose calibrations are traceable to National Bureau of Standards. The sample flow through the SAAM's, their detection efficiency and alarm threshold also are calibrated on a monthly frequency.

Samplers employing filter media are capable of retaining particles on which radionuclides (or other pollutants) may be absorbed on the surface. Analysis of material retained by the filter media would not indicate the presence of radionuclides that are present in a true gaseous state. No gaseous forms of radionuclides are expected to be present in the incinerator operation. However, the off-gas sample train would detect gaseous radionuclides during the Trial Burn. The vapor pressure for both plutonium and uranium are very low and the operating temperature of the incinerator is well below the boiling point for either radionuclide.

5. Comment

The Trial Burn Plan should explain how all monitoring will be documented so that a future record will exist for independent scrutiny.

Response

A data recording system comprised primarily of an IBM PC/XT computer will be installed. The computer will have access to the data presented from field instruments, including all critical instruments which define the safe operating envelope and which are monitored by the automatic waste feed cutoff system.

The data from these instruments will be read at intervals not to exceed one (1) minute. Every five (5) minutes, the data read previously will be averaged and stored on a standard 5-1/4" double-sided, double-density, PC DOS/MS DOS diskette. In addition to these normal recordings, every unusual event (failure of electrical power to the incinerator, activation of the automatic waste feed cutoff system. starting or stopping the hazardous waste feed, etc.) will also cause a complete data record to be entered into the data log.

All entries will be identical in structure, differing only in the values of the data recorded. Each entry will be tagged with the time and date that the entry was made and the reason for the entry (normal, power failure, etc.)

The computer will be interlocked with the automatic waste feed cutoff system such that hazardous waste feed cannot begin until the data recording system is properly activated. Also, hazardous feed will be stopped if the computer fails, if it detects any failures of other components of the data recording system, or if it detects any unauthorized modification of the values which define the safe operating envelope Each batch of hazardous material incinerated will be identified by a unique identification code. Thus, the disk can and will be tagged, both on the recording medium and on an external label, with the identification code, thereby identifying the source of the data on the disk.

At the completion of incineration of a batch of material, the data on the disk will be used by another computer program to produce a report containing the minimum, maximum, and average of the 5-minute average values of all critical parameters, and a chronological record of incinerator operation. The data on the disk will not be destroyed by this program. Thus, the reports will be available for later review.

All analytical laboratory data derived from effluent air monitoring are retained in a computer database. Sample flow calibrations for both the SAAM and particulate flowmeter readings are retained by Radiation Monitoring in the respective buildings SAAM detector efficiency and alarm threshold calibration data are retained by Radiation Monitoring department. Summarized forms of all the data are retained by Environmental Analysis and Control department in permanent computer files. Working standard flowmeter calibration data are permanently retained by the RF Standards Laboratory department Primary and secondary standards calibration data traceable to National Bureau of Standards (NBS) also are retained in the Standards Laboratory department

6 <u>Comment</u>

All off-gas analysis should be conducted by an EPA-approved laboratory The facility should identify the laboratories which will be conducting the analysis.

Response

Rockwell has selected Roy F. Weston, Inc. as an independent contractor to support the Trial Burn Tests. The use of Roy F. Weston, Inc., an EPA approved laboratory, for off-gas analysis is a condition of the contract.

EMISSIONS

1. Comment

The facility should explain the HEPA filtration system in more detail. What are the limitations of the HEPA filters? How efficient is the filter system in removing particulates less than 0.3 microns? How are the filters tested? As stated previously, the efficiencies of the filter system should be backed by actual data.

Response

See Attachment 2.

2 Comment

The facility should document the expected composition, levels, and rates of the incinerator emissions These estimated emission levels should include calculations and assumptions. If dispersion is taken into account, the air dispersion model and assumptions should be clearly explained. Air modeling should be based on conservative assumptions Are gaseous radioactive constituents expected to be present? If so, how will their release be prevented? How do these expected emission levels compare to background, total plant emissions, and established standards

Response

See Attachment 2.

3. Comment

More information should be included on the particulate cyclones and the sintered metal filters. What is the expected particulate distribution and efficiency of each device? What is the pressure drop across each device?

Response

The cyclones are designed to remove particles larger than approximately 5 microns. In general, the cyclones remove about 90% of the particulate from the process stream. The clean sintered metal filters have a rated capability of 98% capture of 4-micron diameter particles. When the filters have been conditioned by being subjected to fine particle dust loading, they are capable of capturing much smaller diameter particles and the filtration efficiency increases considerably. The pre-Trial Burn testing of the filters will provide the necessary conditioning (dust loading) to improve the filtration performance well above the manufacturer's specifications. The expected pressure drop on the sintered metal filters will be 20-40 inches of water column and for the cyclones will be 5-10 inches of water column.

ONGOING OPERATIONS

1 Comment

The long-term operations of any hazardous or mixed waste unit at the Rocky Flats Plant will be covered under a Colorado Hazardous Waste Permit. However, the Fluidized Bed Incinerator is currently regulated as an interim status unit. The facility has expressed a need to begin on-going incineration after the Trial Burn, but prior to the issuance of the hazardous waste permit under the interim status provisions. The facility should provide the rationale for the need to conduct this incineration under interim status. The facility should also provide a complete waste analysis of the materials which will be incinerated during this period and a complete description of how the incinerator will be operated. This description should include operating ranges for the incinerator control variables, operating protocols, the frequency of operation, and the monitoring and sampling which will be conducted This incineration should not proceed until all information from the Trial Burn has been evaluated and the incinerator has demonstrated that it operates in accordance with all applicable standards. Provided this demonstration is made, the incinerator should operate as stringently as the conditions which are established in the Trial Burn.

Response

The Rocky Flats Plant has limited storage capacity that is specifically designed for liquid mixed hazardous wastes. At present generation rates, these storage facilities will be nearing capacity in approximately 2-3 months, at which time alternative storage methods will have to be sought. Therefore, it is necessary that the Fluidized Bed Incinerator start

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processing this waste backlog under interim status.

The operating ranges of the process variables are defined by the conditions for waste feed cut off as described in response to Comment Number 5 of the CDH Comments of January 22, 1986 on the Trial Burn Plan Submittal of October 22.

The FBI will be used to incinerate liquid and solid hazardous wastes generated at the Rocky Flats Plant. The liquid wastes are composed of various organic solvents, degreasing fluids, lubricating oils, cutting oils, and various chemical reagents coming from laboratory and production areas. These wastes are collected in small containers, which will be transferred to the feed tanks. The waste collected in 55-gallon drums may be transferred to the tanks or may be fed directly The candidate wastes are identified by stream number and typical waste composition is included in Attachment 3. (See response to Comment #1, Waste Feed Composition)

The Fluidized Bed Incinerator can be operated up to 30 days per month. The process design requires continuous 24 hour operation during an incineration run for efficiency However, runs are not expected to occur without some interim downtime for maintenance or other production reasons. The incinerator will be operated within the parameters established and demonstrated during the Trial Burn Tests. The incinerator operating conditions and protocol for production operations will be the same as those specified for the Trial Burn tests. Any

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variation in the operating/control variables will be as a result of the Trial Burn Test and the new conditions established at that time. The monitoring will include temperatures, pressures, flow rates, feed rates and concentration of hydrocarbons, carbon dioxide, carbon monoxide, hydrogen chloride, and oxygen. Liquid waste will be sampled for chloride content. During on-going operation of the Fluidized Bed Incinerator, control variable and emission monitoring will not include, nor do the regulations require all the test burn off-gas sampling trains (the MM5, MM 12, VOST or ORSAT)

Solid waste composition is established through historical information by specific waste streams and will be only analyzed for total alpha and beryllium during on-going operations.

2. Comment

The amount of waste proposed for incineration which is currently being stored should be clarified. As specified above, these wastes should be completely characterized.

Response

Based on current generation rates, it is estimated that 1500 cubic feet of solid and 26,000 gallons of liquid combustible waste will be in storage by July, 1987. (Refer to Question 1, under "Ongoing Operations" from the Composite of Technical Comments received during the comment period for waste characterization information)

3 Comment

The facility has proposed that the incinerator be used for hazardous waste and low-level mixed waste and only for wastes produced onsite. The facility has not specified use of the incinerator for transuranic wastes or offsite wastes. The facility should clearly state whether or not they will request use of the Fluidized Bed Incinerator for either transuranic wastes or any offsite wastes.

Response

The Trial Burn Plan identifies the solid and liquid waste generated at Rocky Flats which are to be processed in the Fluidized Bed Incinerator. The waste stream candidate materials for processing in the Fluidized Bed Incinerator were identified in the submittal to CDH as a part of the Part B Application for the plant. A summary of these waste streams to be incinerated are listed in Attachment #3. No waste will be processed from offsite generating facilities. Transuranic waste is not presently proposed to be processed in the Fluidized Bed Incinerator and therefore, it is not addressed in the Trial Burn Plan.

4. Comment

How will incineration residues (including ash, HEPA filters, waste drums, etc), be handled?

Response

The incinerator ash produced in the Fluidized Bed Incinerator will be considered a mixed waste or a hazardous waste, and will be stored at

Rocky Flats until it can be delisted or shipped to a permitted mixed waste storage facility or a permitted hazardous waste storage facility To meet the shipping requirements the mixed waste ash must be immobilized prior to shipment. The used HEPA filters will be disposed of in accordance with applicable regulations. The drums containing waste feed to the incinerator will be decontaminated to a level low enough to allow for reuse on plantsite.

5. Comment

The incinerator and air pollution control equipment should be inspected after the Trial Burn for any signs of degradation. These procedures should be specified

Response

As stated in response to Question Number 1 (Composite of Technical comments Received During Comment Period), the production incinerator has been operated over 500 hours and no visual degradation of the equipment has been observed. Some minor modifications have been made to specific equipment to improve performance and normal expected maintenance has been performed. Specific process equipment is on a preventative maintenance program where service, adjustment, and repair are performed on a periodic basis as determined appropriate for the type of service. After the Trial Burn the process equipment will be inspected in accordance with the Part B Application.

CONTINGENCY MEASURES

1 <u>Comment</u>

The facility should describe the contingency measures which are in place to respond to any emergency situations. What are the response steps which will be taken to respond to a fire, spill, release, or other emergency?

<u>Response</u>

In the event of a fire in the operating area of the FBI, personnel will respond by pushing the emergency stop button which will shut down the incinerator. The Rocky Flats fire Department, which is fully equipped to handle such emergencies, will be notified by a phone call and will extinguish the fire. The response to a fire is covered by a series of standard procedures depending on the extent of the fire which could include personnel evacuation, notification of the public, and plant shutdown. In addition, there is in existence a State of Colorado Emergency Response Plan for the Rocky Flats Plant covering any radiological release from the plant

Any spills of liquid within the building will be cleaned per Rocky Flats standard procedures for hazardous and radioactive waste The critically safe design of the floors precludes an occurrence of nuclear criticality

In the event of a radioactive release in the workplace, Selective Alpha Air Monitors (SAAMs) will alarm. The SAAM monitors sample continuously on a 24-hour basis and are sensitive to the maximum permissible concentration in the work place of 2 picocurie per cubic meter. This

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alarm instructs operating personnel to don their respirators. After the alarm has sounded, Radiation Monitoring personnel are responsible for determining and correcting the cause as soon as possible When determined safe, respirators are no longer required. Again, standard emergency procedures are in-place if the condition should require personnel evacuation, public notification, or plant shutdown.

2. Comment

What precautions have been taken in the design and operation of the incinerator to prevent an emergency incident? Specifically, a past fire at the facility was related to an incineration operation. What procedures have been established with the fluidized bed to prevent such a reoccurrence?

Response

The solid and liquid waste feed areas are provided with a sprinkler system for control of possible fire Gloveboxes are used to control contamination once the waste has been introduced into the system. Radiation Monitoring personnel are present when waste is being introduced into the system and airlocks are used to control contamination during transfer of waste material. The Fluidized Bed Incinerator provides two safety features which are not common to a conventional incinerator· a) The flameless combustion minimizes the possibility of a fire caused by flame spreading into the off-gas cleaning equipment (cyclones & filters), b) the use of sintered metal filter provides a fire stop between the incinerator and the HEPA filtration equipment. The temperature control system automatically reduces the feed as the temperature increases in the secondary reactor (afterburner). Also, an excessive temperature or pressure in the primary or secondary reactor provides for automatic emergency shutdown of the system. The hazardous waste feed (both solid and liquid) will be stopped by the upper temperature limit in the permit conditions and all fuel feed will be cut off when the temperature of the incinerator reaches the emergency shutdown condition. See Attachment #2 for information concerning fire protection of the HEPA filter system.

3. Comment

What fail safe measures are in place regarding the filter system? Will the filter system remain effective during an emergency?

Response

Two exhaust fans serve the FBI plenum. One of the fans is on emergency power which allows operation on generator produced power within minutes if standard building power is lost. All utilities controls and monitoring are on emergency power; this includes fans and their controls, radioactive sampling and monitoring systems, and the plenum heat detection alarm systems. The system is designed with redundancy in filtration capability such that a loss of one stage would not result in an insult to the environment The plenum is equipped with a high temperature alarm on the heat chamber ahead of the plenum which is activated at 120^{o}F. When this alarm sounds, a temperature recorder is automatically activated. The Utilities personnel will inspect the heat chamber to verify the high temperature condition and will notify the operating personnel at the

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Fluidized Bed Incinerator. If the temperature in the heat chamber continues to increase, an alarm will sound at 190°F, a water sprinkler will be automatically activated in the chamber, and the Fire Department automatically notified. Either the Fire Department personnel or Utilities personnel can also activate a sprinkler system to protect the first bank of HEPA filters in the plenum. Utilities supervisory and operating personnel are on duty at all times and procedures are in place to address personnel evacuation, public notification, and plant shutdown, as necessary.

Alternatives to Incineration of Mixed Waste at the Rocky Flats Plant

1 Comment

Incineration is the facility's proposed alternative to the practices of land disposal which have been used in the past. What other alternatives to Fluidized Bed Incineration have been evaluated, and what are the long and short term results? The facility should evaluate both short term alternatives such as storage or other existing onsite treatment, and long term alternatives such as offsite treatment, other forms of incineration, recycling, waste reduction, or other onsite treatment.

Response

The Rocky Flats Plant is not a permanent disposal site for radioactive or hazardous waste. Further, no site in the United States has received RCRA approval for disposal of mixed waste. Incineration of low level radioactive and hazardous combustible mixed waste in the Fluidized Bed Incinerator is being proposed as the safest, most efficient and viable method to destroy the hazardous constituents or characteristics. The volume of mixed waste is greatly reduced and the resulting ash containing the radioactive consituent will be immobilized into a solid block. The immobilized waste will remain on plantsite until mixed waste disposal facility is available or until a petition for delisting is approved. If delisted it would then be shipped to a low level radioactive disposal facility.

One alternative is to ship the mixed waste to another DOE facility which has a permitted incinerator. However, the U S. Department of Transportation (DOT) prohibits the transport of radioactive liquids by public carrier in currently approved packages [49 CFR 173.412(n)(3)(i)(ii) and 49 CFR 173.466]. Since much Rocky Flats mixed waste is liquid, this alternative is not viable It is possible to immobilize the liquid organics in a solidified combustible matrix which would allow for transport. However, immobilization of such waste makes subsequent treatment by incineration difficult, if not impossible. Furthermore, land disposal of this immobilized liquid waste is prohibited by the 1984 RCRA Amendment.

Another alternative is to separate hazardous constituents from radioactive constituents. Highly sophisticated technology to remove minute amounts of radioactivity from liquid organic has not been developed. Also, the law does not limit the amount of radioactive constituents which would be allowed to be eliminated from classification as a mixed waste. From a technical and legal point of view this alternative does not appear feasible.

A third alternative is to immobilize the liquid waste with Envirostone or other suitable immobilizer and store the waste on plantsite until a mixed waste disposal site is permitted. However, from a safety point of view, storage of immobilized liquid in Envirostone is less preferable to storage of immobilized ash because of the large relative volumes of waste and inherent potential for spills, fires, and explosions. As mentioned above, immobilization of the waste liquid would still pose a disposal problem since the 1984 RCRA Amendments would prohibit land disposal.

The EPA, CDH, and DOE all concur in the philosophy that incineration offers one of the best method of dealing with hazardous combustible waste materials. Incineration has been extensively tested at this facility since 1973, and the Fluidized Bed Incineration is the best current method

CDH COMMENTS OF JANUARY 22, 1987 ON THE

TRIAL BURN PLAN SUBMITTAL OF OCTOBER 22, 1986

DESIGN COMMENTS

1. Comment

(Thermal Capacity) The design thermal capacity of the incinerator is listed at 1.5 million BTU/hr. Feed rates for the trial burn are set at 60 lbs/hr. for liquid waste tests and 150 lbs/hr. for solid waste tests. How were these feed limits set? They do not appear to correspond directly to the design thermal capacity. What is the incinerator's minimum thermal feed rate?

Response

The 1.5 million BTU/hr. is the maximum design capacity. The actual operating thermal capacity of the incinerator can be varied by volume of air (or air-nitrogen) introduced into each reactor, the amount of spray cooling on the afterburner, and by utilizing preheated air inlet streams The feed rates of 60 lbs/hr. and 150 lbs/hr. are nominal values within the operating range. The incinerator's minimal thermal feed rate is approximately 40% of the design value The liquid and solid waste runs, as identified in Table I will be used to verify operability and performance at the maximum and minimum operating conditions for the Fluidized Bed Incinerator. The liquid feed rate of 36 lb/hr. will represent performance at 41% of the design thermal capacity. The composition of the solid waste feed will be adjusted to reflect the

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normal waste composition and rate will be adjusted to test the system at the maximum thermal capacity. The liquid waste feed composition, as shown in Table I, and the solid waste feed, adjusted to reflect the normal feed composition, will be used to test the incinerator system As a result of the waste identification program at Rocky Flats a more accurate assessment has been made of the organic chloride content of the composite waste which is a candidate for incineration in the FBI system. Therefore, the carbon tetrachloride content has been adjusted in the liquid and solid feed to be more representative of the mixed waste to be burned during Production use of the incinerator. The blending of compatible waste streams and waste analysis during ongoing operations will insure that the chloride content will not exceed that used in the trial burns.

2. <u>Comment</u>

(Turbulence) The gas flow rate to the primary reactor is maintained at 250 CFM (p. 8). What is the allowable range for this rate? What rate is necessary to achieve fluidization and sufficient turbulence? How is residence time in the reactor affected by increases in the gas flow?

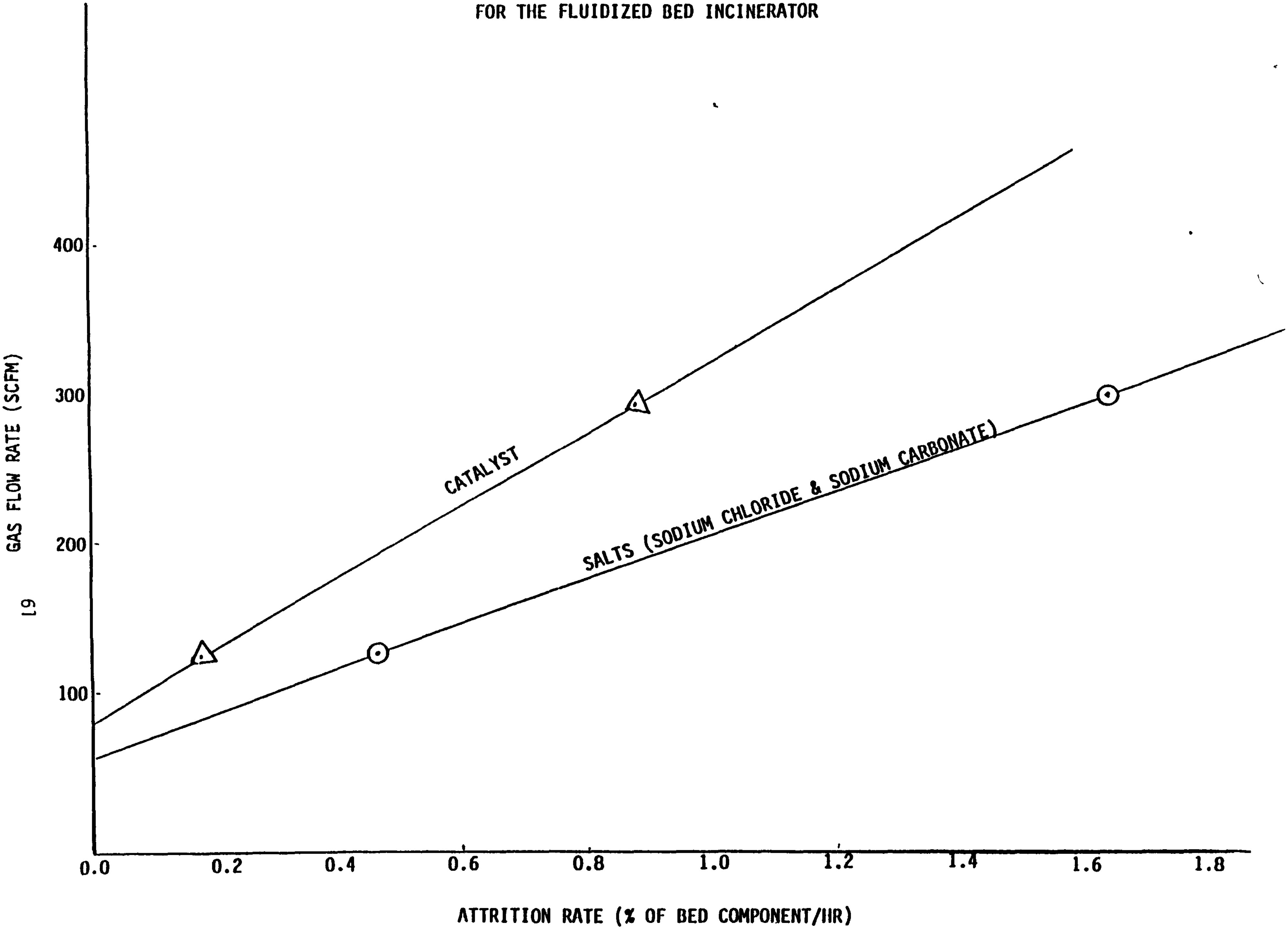
<u>Response</u>

The amount of turbulence required in the primary reactor is set based on the amount of chloride in the waste feed which has to be reacted and thereby the amount of salt which has to be removed from the bed material In addition, the gas feed rate has to be sufficient to provide minimum fluidization for mixing and acceptable gas solid contact. The minimum gas rate for fluidization is about 120 SCFM, the maximum flow rate is about 360 SCFM. The value of 250 SCFM was selected as a nominal value for feed rates of 150 lb/hr. for solid waste and 60 lbs/hr. for liquid waste. The test run conditions proposed in Table I will demonstrate operation from 150 SCFM to 320 SCFM. The range of gas flow rate was established through sodium salts and catalyst attrition experiments on the FBI. The correlation of attrition rate with gas flow rate is presented in Figure I. The actual value to be used during normal operation with hazardous waste will be set by the chloride content, feed rate, and amount of salts in the bed. (See the discussion below under response to comment number 3 from CDH Comments of January 22, 1987). While residence time in the primary reactor is expected to have a minor effect on performance, this variable will be tested by the run conditions specified in Table I. The proposed tests will evaluate destruction efficiency over the ranges of gasflow within the range of acceptable fluidization conditions which will be used in production operations.

3. <u>Comment</u>

(Sodium Carbonate) Sodium carbonate is consumed through the formation of halogen, sulfur, and phosphorus salts and by loss through the outgas from the first reactor. How, and at what rate must the sodium carbonate be replaced? How is the replacement rate monitored? How are the salts that are formed separated from the bed solution? How are they carried off by the offgas while the bed mixture remains behind? Does buildup of these salts occur in the bed mixture?

FIGURE I
ATTRITION RATE OF BED MATERIAL
FOR THE FLUIDIZED BED INCINERATOR



Response

As indicated, the sodium carbonate is being depleted through the formation of halogen, sulfur, and phosphorous salts. These reactions occur primarily on the surface of the bed particles. As a result of the attrition due to the movement of bed particles against each other, the reacted material is ground off as a very fine particulate. If little reaction has occurred, the carbonate particles will undergo attrition with the release of some fine sodium carbonate. The amount of sodium salts (sodium halide and sodium carbonate) which must be removed is defined by the chloride content of the feed versus the amount of bed material subject to attrition and the gas velocity required to obtain sufficient attrition. The amount of attrition which will take place is defined by the relationship of gas velocity to the bed attrition rate as provided in Figure I. Therefore, the sodium carbonate addition will be set by the attrition rate and addition will be made daily to the bed. The addition will be accomplished by pneumatic transfer from the bed material feed box. The catalyst attrition rate is also defined in Figure I and additions will be made daily on these values obtained from Figure I. A further check of appropriate attrition rate and addition rate can be obtained through visual observation of bed level through view ports in the primary chamber.

The ash produced from combustion and attrited material is very small particulate, about 10-100 micron diameter; the bed material, the sodium carbonate added and the catalyst are 500-1000 microns. The fine particulate becomes entrained in the gas stream, where the settling velocity of the bed material is sufficient to fall from the gas and remain in the bed. Therefore, the ash and reacted salts are removed from the bed by elutriation and entrainment in the flue gas stream. It is then removed through the cyclones and the filtration system.

4. Comment

(Oxidation Catalyst) At what rate must the oxidation catalyst be replaced? What chemicals must be screened for as inhibitors to the catalyst? The catalyst percentage can range from 10%-90%; at what level will the catalyst percentage be set for the trial burn?

Response

As discussed in Item 3 above (response to comment number 3 from the CDH Comments of January 22, 1987), the rate of catalyst loss from the bed is determined by the gas flow rate and attrition rate as defined in Figure I. Adjustment of the catalyst concentration would then be made by adding catalyst to the primary bed on a daily basis by pneumatic transfer from the bed material feed box. The chromic oxide catalyst has not exhibited deactivation in this application for the following reasons:

1. The catalyst consists of 20 percent by weight of chromic oxide on an alumina substrate. The fluidization process results in the abrasion of the catalyst surface, thereby exposing a fresh surface and removing any material that may have coated the catalyst surface and thereby reduced its catalytic activity.

2. The catalyst operates at 550°C, a temperature that does not favor catalyst reactions with sulfur and halogen species. In addition, sulfur and halogens react very efficiently with the sodium carbonate in the primary reactor to form stable salts that do not interact with the catalyst.

The trial burn will be started with a bed containing 80% sodium carbonate and 20% catalyst. On a daily basis the catalyst and carbonate additions will be made based on data provided in Figure I. The catalyst addition to the afterburner will be made based on the attrition rate data. Catalyst addition to the afterburner will be made weekly. The catalyst will be added by pneumatic transport from the bed material feed box.

CONTROL AND MONITORING.

5. Comment

(Afterburner Control) The afterburner temperature is controlled by a spray cooling system and waste feed to the primary incinerator, but it is unclear how the waste feed is changed in response to a temperature variation. In addition, does this control system prevent the possibility of a run-away response? How will these control responses be monitored during the trial burn?

To address these issues, the trial burn should identify all parameters which are to be recorded and identify those parameters which will be recorded continuously. In addition, the trial burn should identify which

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variable indicators are displayed at the control panel, which will be printed out on a chart, and which will be recorded on disk This information can then be used to evaluate control/response performance.

Response

The amount of spray cooling to the afterburner is set manually. It can be varied to the maximum throughput of the nozzles at the pump discharge pressure. The temperature control of the afterburner is obtained through sensing the temperature and using that value to modulate the waste feedrate. As the temperature rises above the set point, the waste feedrate is reduced; as the temperature falls below the set point, the feedrate will be increased. For liquid waste operation, the constant displacement feed pump rate would be varied; for solid waste operation the feed screw speed would be varied. If a run were being made with concurrent liquid and solid feed, the temperature controller would regulate or modulate the liquid feed rate. Additional control instrumentation will be installed for production use as identified in the tabulation as a part of this response. An adder will combine the solid rate, based on screw feeder RPM, and liquid mass flow rate and both streams will be modulated based on the secondary reactor temperature. The ratio of the individual waste feed would be manually set. Waste feed will be automatically cut off if the temperature exceeds the upper or lower temperature limits. If a sensor failure should occur, the failsafe condition of the control valves would shut off feed to the system, thereby eliminating a runaway

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condition. During the trial burn, the temperature in the afterburner will be continuously recorded and for liquid waste runs, the feed rate of the waste feed will be continuously recorded. The air flow to the afterburner is set by flow control and will be indicated in the control room through a mass flow sensor. In addition, the total off-gas from the system will also be an indicator of the flow and is measured by a mass flow meter. The following table provides an indication of the primary control variables and how they will be indicated and recorded, as well as the cutoff function associated with each variable.

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	Parameter	Recording	Indicating	Automatic Solid & Liquid Cutoff
1	Primary bed high and low temperature	Continuous strip chart and information fed to disk	Digital readout in control room	Yes High=610°C Low=500°C
2.	Afterburner bed high and low temperature	Continuous strip chart and information fed to disk	Digital readout in control room	Yes High=650°C Low=475°C
3.	Primary reactor high pressure	Continuous strip chart and information fed to disk	Gauge reading pressure reference to the canyon	Yes High=0"H_2O (when R1 pressure is equal to feed hopper pressure)
4.	Afterburner high pressure	Continuous strip chart and information fed to disk	Gauge reading pressure referenced to canyon	Yes High=0"H_2O (when R2 pressure is equal to the canyon pressure)
5.	Liquid waste feed rate high	Continuous strip chart of mass flowrate and information fed to disk	Digital readout of mass rate and totalizer for accumulated total mass fed	Yes* High = 88 Lb/Hr
6.	Solid waste feedrate high	Screw Feed RPM will be manually recorded. The Drum weights will be manually recorded and the data will be manually input into the disk	No gauge reading on canyon wall & data feed to disk.	Yes* High = 180 Lb/Hr
7.	Gas flowrate to primary reactor high & low (air-nitrogen mixture)	Information fed to desk	Flow controller indicator and gauge indicator on canyon wall	No
8.	Offgas flowrate, Flue gas exit from heat exchange as high and low flow	Continuous strip chart of mass flow rate and information fed to disk	Digital readout in control room.	Yes High = 800 SCFM No Low Limit

	Parameter	Recording	Indicating	Automatic Solid & Liquid Cutoff
9	Air flowrate blended at exit of heat exchanger, high and low rate	Continuous strip chart on mass flowrate (for test burn only) and information fed to disk.	Flow indicating gauge	No
10.	Oxygen concentration in flue gas prior to the heat exchanger low concentration	Continuous strip chart recording and information fed to disk	Indicating gauge on instrument next to canyon wall	No Not required because of off gas flow measurement
11	Carbon monoxide concentration in flue gas prior to heat exchanger	Continuous strip chart recording and information fed to disk	Indicating gauge on instrument next to canyon wall	Yes High** No low This is a two tier system with time delay to return in specification
12	Carbon dioxide concentration in flue gas prior to heat exchanger	Continuous strip chart recorder and information fed to disk	Indicating gauge on instrument next to canyon wall	No
13.	Total hydrocarbon concentration in flue gas prior to heat exchanger	Continuous strip chart recording and information fed to disk	Indicating gauge on instrument next to canyon wall	No
14	Temperature of inlet and outlet of each catalyst chamber	Information fed to disk only	Digital readout in Control Room	No
15.	Pressure drop on process HEPA filter	Information fed to disk	Gauge on canyon wall	Yes* High = 6" H_2O Low = 0 1" H_2O

*Automatic cutoff instrumentation may not be installed prior to trial burn
**This information will be obtained from trial burn data

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It is intended that the data fed to disk will be once a minute and averaged over a five-minute period Therefore, the data stored in the disk during a run will be five-minute averages At the end of the normal production run (not trial burn) data will be reduced to a summarized hard copy. It is intended that the hard copy summary, for normal operation burning of hazardous waste, would consist of an average, maximum and minimum value of each of the control variables only. The waste material being burned, and the start and stop times, would be included on the summary. If, at any time, any control variable exceeds the limits and shuts off the waste feed, the time would be recorded and the variable identified. When the system has been returned to desired operating conditions and waste feed reinitiated, the time would be recorded. This summarized sheet would be kept for reporting requirements. For the Trial Burn a complete technical report will be prepared and submitted to CDH and EPA. All the data from the strip chart recorders, data from the disk and manually recorded information will be used in preparation of the trial burn report.

6 Comment

(Monitoring of Feed Rate) The feed rate to the incinerator is an important variable for controlling such factors as the total loadings of halogens, ash, BTUs, etc. which are allowable. The trial burn plan should specify how both solid and liquid feed rates will be monitored, and the frequency of monitoring.

Response

During the trial burn, the liquid waste feedrate will be monitored by a mass flow meter, recorded on a strip chart recorder and the information fed to the disk. During the trial burn, solid waste feed will be controlled by the weight of waste in each drum fed and the rate of addition of these drums to the system. Screw conveyor RPM will be monitored for future maximum flow rate cutoff control. The BTU content of the feed material used in the Trial Burn will be determined by submitting a sample for analysis described in the Trial Burn Plan. (See response to comment 13 from CDH Comments of January 22, 1987)

7 Comment

(Automatic Waste Feed Cutoff) The automatic waste feed cutoff system should be tested during the trial burn for each of the cutoff parameters These tests should be included in the overall schedule.

All cutoff parameters should be connected to both the solid waste feed and the liquid waste feed. This action is unclear in the plan.

The following variables should be added as automatic waste feed cutoff variables.

- Primary Bed Reactor Temperature (Both high and low set points)
- Combustion Gas Velocity (The combustion gas velocity should be measured more directly though a mass flow rate monitoring device instead of indirectly through the measurement of oxygen concentration

Response

The Automatic Waste Feed Control (AWFC) system is operative during both liquid and solid waste feed modes of incinerator operation. A solenoid valve in the liquid waste feed line will shut off hazardous liquid flow. Power to the screw drive in the solid waste feed system will be shut off to terminate solid waste feed. Both solid and liquid feed is cut off when either waste type is being fed or when both waste types are being fed concurrently.

The AWFC system will be expanded to include low and high temperature cutoff in the primary and catalytic afterburner reactors. A mass flow measurement system has also been added to the incinerator and this parameter is incorporated into the automatic waste feed cutoff system.

A test of the system will be conducted prior to the trial burns. The incinerator will be operating on diesel fuel alone during this test. The AWFC will be tested when non-hazardous solid or liquid materials are being fed by altering the parameters outside of the proposed permit conditions. The proposed cutoff conditions for the process variables are as follows:

Process Variable	Cutoff Conditions
Primary Reactor Temperature	<500°C, >610°C
Catalytic Afterburner Temperature	<475°C, >650°C
Combustion Gas Velocity (Off-gas Mass Flow Rate)	>800 SCFM
Carbon Monoxide Concentration in Off-gas	Based on Trial Burns

Loss of Negative Pressure in Primary & Afterburner Reactors	Loss of Negative Pressure
Pressure Drop on Process HEPA Filter*	<0.1" H_2O, >6" H_2O
High Liquid Feed Rate Cutoff*	>88 Lbs/Hr
High Solid Feed Rate Cutoff*	>180 Lbs/Hr

*Automatic cutoff instrumentation may not be installed prior to trial burn.

8. <u>Comment</u>

(Manual Versus Automatic Control) The trial burn states that the incinerator control system is a combination of both manual and automatic control. Some variables may be controlled by either mechanism. The automatic waste feed cutoff system should generally not be overridden by manual control. A description of how access to manual override of the automatic waste feed cutoff system is restricted and controlled should be provided.

<u>Response</u>

The control system on the incinerator will be set up such that it will be unnecessary to override the solid or liquid waste cutoff. only the use of electrical preheat of air to the primary, electrical preheat and methanol combustion preheat of air to the afterburner, diesel oil feed to the primary and methanol feed to the afterburner can be used to operate the system during startup or to bring the system into the specified operating conditions for waste burning This is accomplished by

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providing the capability of feeding diesel oil without going through the hazardous liquid waste cutoff valve. The capability of feeding solid material will not be possible because of deactivation of the screw feed This screw feed will be activated only when the incinerator system is within the specified operating conditions. The normal process control instrumentation will be active during startup to prevent unsafe operation such as overheat or overpressurization.

9. Comment

(Sampling Locations) Some amount of dilution is introduced into the out gas flow system upstream of the sampling points through the canyon air inputs. The amount of dilution should be accurately monitored and accounted for in emission calculations. This procedure should be described in the trial burn plan along with the specific information on the flow rate monitoring equipment.

Response

The flue gas sampling points are located downstream of the heat exchanger. A mass flow meter will be used to measure the combustion gas velocity. A change in the system, as described in the test burn plan, has been made to improve the offgas sampling-a high efficiency particulate air (HEPA) filter has been installed just downstream of the flue gas cooler (heat exchanger). This will allow the MM5, MM12, and VOST (methods are described in the Trial Burn Plan) samples to be taken on a

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gas stream where the flow will be measured through the use of the mass flow meter The capability for air dilution remains just before the HEPA filter. Air dilution would be used only in the event of an excessive flue gas temperature entering the HEPA filter. If this air addition is required the flow will be measured. The capability will remain and be used to protect the HEPA filter against excessive temperatures. The mass flow of the flue gas and the canyon air dilution will be continuously recorded on a strip chart recorder.

10. Comment

(CO Monitoring) CO monitoring occurs after the catalytic reactor. Consequently, CO upsets in the primary and secondary reactors could be buffered by the catalytic reactor. In other words, placing the CO monitoring equipment after the catalytic reactor results in a less sensitive monitoring of CO changes from upset in the primary and secondary reactors. The trial burn should investigate if the difference in the location of monitoring is significant The sensitivity of the CO monitor in its proposed location, and any operating variable changes on the catalytic reactor, should be evaluated.

Response

Because of the physical location of the catalytic chambers at the exit of the sintered metal filters, it is physically difficult to get a gas sample upstream of the two catalytic chambers.

The sampling points for continuous CO monitoring of the incinerator are based on two considerations. First, the monitoring point must be selected to effectively monitor the incineration process to satisfy performance standards. Secondly, the monitoring of CO will show incinerator performance trends and allow for corrective action to be taken to prevent any possible incinerator upsets.

The dead volume of the entire incinerator is approximately 680 cubic feet. Therefore, any event in the primary reactor bed would be sensed in one minute or less. An event in the afterburner resulting in a CO change would be sensed by the CO monitor in approximately 50 seconds. Sampling prior to the catalytic chamber would reduce the time delay by only two seconds or the time delay would be approximately 48 seconds. The catalytic reactors will be fitted with temperature sensors that will also be indicators of how much additional hydrocarbon and CO oxidation, if any, is taking place in the catalytic off-gas polisher. An increase in the catalyst reactor temperature will indicate that complete oxidation is not taking place in the catalytic afterburner reactor.

As the incineration system is presently configured the catalytic chambers, as well as the flue gas cooler and HEPA filters, are an integral part of the system. Analysis of the system performance will incorporate the benefits in combustion efficiency of the catalytic chamber and the particulate control of the HEPA filters

ADDITIONAL COMMENTS

11 Comment

(Design Feed Limitations) Limitations on the feed systems with regards to such parameters as viscosity, particle size, etc. should be described.

Response

The system is designed to accept solid waste as packaged in 55-gallon drums. This material will be manually fed to the shredding system where it is size reduced in preparation for introduction into the primary reactor. Items that are visually identified as unacceptable for shredding or incinerating will be removed in the manual feeding operation. Also, if items enter the shredder and cannot be shredded, a torque-sensing device will stop the shredder and the item can be removed. The feeder and incinerator are designed to accept the material once it has passed through the shredder and air classifier. The air classifier separates dense material such as metal objects from the combustible material (paper, plastic, cloth, etc.) in the feed stream. The variability in the composition of the solid waste stream does not exceed the combustion capabilities of the incineration system. Sampling of the solid waste feed for chloride content or heat content is not practical. The chloride content will be assigned based on knowledge of the composition from normal operations at the plant. During feeding some blending can be accomplished due to introduction of up to three drums into the feeding area. The incinerator will automatically adjust the feed rate by adjusting the screw conveyor speed to meet the temperature control conditions in the primary reactor and therefore small variations of heat content in the feed material are accommodated

The liquid waste feed material will be analyzed for chloride content and blended as necessary to provide feed within the permit limits. The chloride content will be used to specify operating conditions within the permitted conditions. The incinerator automatically adjusts feed rate to accommodate variable heat content waste to maintain the desired operating temperature and therefore heat content analysis of the feed is not required. The viscosity of the liquid waste feed would only be a concern as to the ability of the pumps to transfer the liquid to the incinerator. Where possible, the liquids will be blended to alleviate the potential viscosity problem. Only oils with high viscosity would be subjected to viscosity analysis. The vast majority of the waste solvents should present no problem in the waste feed system.

12 Comment

(Uranium Analysis) The trial burn plan proposes uranium as one of the constituents of the solid waste feed. Uranium is selected as a relatively safe means of demonstrating how the incinerator and associated stack gas cleaning system can remove radioactive constituents. However, the trial burn plan should describe how exactly the trial burn will make this demonstration. The trial burn should include:

- An estimation of the expected radioactive emission concentrations.
- An explanation of how the test burn information for uranium removal will be used to demonstrate the systems ability to remove other radioactive particulates.
- An estimation of the maximum radioactive constituent concentrations to be accepted at the incinerator during ongoing operations.
- A description of testing and monitoring which has been conducted at the site, or elsewhere, which demonstrates the effectiveness of the air pollution control system on removing radioactive constituents.

Response

To demonstrate the system's ability to process plutonium contaminated waste as well as uranium contaminated waste the proposed trial burn plan is being modified herein to incorporate testing with plutonium as well as uranium. One of the three test runs with solid waste will contain 0.136% U and one with 0.2% U. The other solid waste test and one of the liquid waste tests will contain 100 nanocuries of Pu/g of waste It is proposed that in each of the tests the flue gas be analyzed for POHC & PICs. A mass spectrometer is not available in a laboratory which is equipped to handle the plutonium ash samples. Therefore, the ash samples from the plutonium contaminated runs will not be analyzed for PICs and POHCs

Only the ash from uranium tests and the non-contaminated tests will be analyzed for POHCs and PICs.

The calculated maximum radioactive concentration in the flue gas during the test using 444 grams of natural uranium in the feed is provided in Attachment Number 1. The amount of plutonium fed during a four hour test at 125 lb/hr. feed rate is 0.317 grams and for the test at 36 lb/hr. is 0.091 grams.

After the test burn has been completed the incinerator would be used to burn waste containing up to 100 nanocuries of transuranic radionuclides per gram of waste. Principal radionuclides will be uranium, plutonium, and very small amounts of americium (0.2% of Pu content). The plutonium used in the tests will contain the normal concentration of americium which would be associated with plutonium in the waste stream.

HEPA filtration is the primary control system for removing radioactive constituents. Use of these filters is common at Rocky Flats and throughout DOE operations. Quality control and testing of the filters are done by the manufacturer, at its facility and by Rockwell upon receipt and after installation Years of operations have demonstrated the effectiveness of these filters to control radioactive emissions originating from facilities processing radioactive materials. Testing procedures and filtration efficiency information on HEPA filter is discussed in Attachment 2

13 Comment

(Identification of PICs) The Trial Burn Plan should clearly specify which products of incomplete combustion (PICs) will be analyzed for during the trial burn. The plan implies that dioxins, furans, dibenzodioxins, and dibenzofurans, will be analyzed for possible PICs. We commend the decision of analyzing samples for these constituents; we are simply requesting that these be clearly identified.

Response

The following sampling and analysis schedule will be conducted during the trial burns. The EPA and ASTM standard methods that will be used are referenced in the trial burn plan.

I. Feed Stock for Test Burn

A. Liquid Waste

3 Test Burns

3 Samples
3 Duplicates
1 Field Blank
1 Trip Blank

Analysis

Heat Value
Viscosity
CCl_4
VOA (GC/MS Scan)
BNA

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B. Solid Waste

Rather than rely on analysis of a sample taken from the solid waste feed mixture each drum will be made up from a weighed amount of paper, polyethylene, and CCl_4, etc. The radionuclide addition will also be made to each drum by the weight of a solution containing the specified amount of Pu solution or g of uranium oxide.

Each of the feed components (paper, polyethylene, CCl_4, etc.) will be blended to make an analytical sample for heat value determination. The CCl_4, Pu & U, will all be determined by the amount added to each drum of solid feed material.

II. Incinerator Off-gas Analysis after HEPA filter

A. Six Test Burns

6 Samples
6 Trip Blanks

1. Method 12 - Solid Waste Analytes

TSP, total and filterable
Total Cr.
Hexavalent Cr.
Cl
Water Vapor
Uranium
Plutonium

2. Method 5 and VOST

Analytes

CCl_4
Cl
VOST (PIC's), Dioxin 2378
Congeners, Furans
VOST-BNA

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III. Incinerator Ash

A. Six Test Burns x 2 Cyclones

Six Trip Blanks
Six Duplicates

1. Weigh Ash for each stream and for each test burn - at incinerator facility

2. Ash Analysis

Analytes

Plutonium - performed by Rockwell
Uranium - performed by Rockwell
Hex Cr
CCl_4*
PIC's* (GC/MS Scan)
Dioxins 2, 3, 7, 8 TCPD TCDF
Congeners
Furans
VOA + BNA*

*These values will only be determined on samples produced where plutonium is not present. Therefore, these analyses will be done on 4 trip blanks and 4 duplicates.

IV. Sintered Metal Filter Ash

A. Six Test Burns

6 Samples
6 Duplicates
6 Trip Blanks

1. Weigh Ash from Sintered Metal Filter Housing for each trial burn - performed by Rockwell.

2. Ash Analysis

Plutonium - performed by Rockwell
Uranium - performed by Rockwell
Hex Cr'
CCl_4*
PIC's - Dioxins 2, 3, 7, 8
Congeners
VOA GC/MS Scan*
BNA GC/MS*

*These analyses will not be made on runs where plutonium is present. Therefore, only 4 samples and 4 duplicates will be analyzed.

14 Comments

(Air Pollution Control Permit) The proposed trial burn and future operation of the incinerator may require modification to the existing Air Pollution Control Permit. DOE/Rockwell should contact the Air Pollution Control Division of CDH to determine whether any modification is necessary.

(Contact - John Plog, X 331-8500).

Response

Permit #C-13022 covers the Trial Burn and subsequent ongoing operation. Under Attachment A of the Permit, RFP is allowed to burn Type 5 and Type 6 wastes, which include solvents. However, per request of the Stationary Sources Section (CDH), a Revised Air Pollution Emission Notice (APEN) has been submitted to CDH Air Pollution Control Division. This Notice allows updating of CDH files to indicate the increase in the liquid feed rate anticipated for the incinerator. The original permit application and APEN listed process liquid feed rate at 3,000 gallons per year; the new feed rate is 15,000 gallons per year.

REGIONAL VIII EPA - ROCKY FLATS TRIAL BURN COMMENTS

MARCH 9, 1987

1. <u>Comment</u>

DOE's Trial Burn Plan for the production unit is comprehensive and well organized. The strongest areas in the plan are the analytical testing, sampling, and calibration methodologies and the quality assurance/quality control procedures outlined by DOE's contractor, Roy F. Weston, Inc.

Also submitted in the Part B permit application, is a trial burn plan for the pilot plant incinerator (see Appendix D-4 of the permit application). The pilot plant is a scaled down version of the "production" unit for which DOE is seeking approval of a trial burn. DOE's expressed intention is to show the two units are equivalent as far as operational characteristics are concerned (see Page D-4-1). DOE then plans to use the pilot plant for future research to obtain data for additional and/or new waste streams which DOE would consider as candidates for waste reduction in the "production" unit incinerator.

It is widely accepted by EPA incinerator experts that no two incinerators (thermo/chemical processes) are exactly the same, even if they are the same size, built by the same company, at the same location and processing the same waste streams Therefore, should DOE prove this technology on some other incinerator, in some other location, EPA and CDH would require that trial burns be conducted for any on-site units, addressing specific waste streams to be burned.

*Guidance on Trial Burn Reporting and Setting Permit conditions
Under preparation for EPA by Acurex Corp.

Guidelines for Continuous Monitoring of Carbon Monoxide at Hazardous Waste Incinerators
Under preparation for EPA by Pacific Environmental Services

EPA has published requirements and guidance for permitting Research, Demonstration and Development (RD&D) permits. Should DOE desire a RD&D permit, they should clearly identify this intent. If it is DOE's intent to obtain an operational Part B permit for the pilot unit, DOE should clearly state this.

Response
A permit for the pilot plant will be necessary for testing of new sodium carbonate and catalyst bed materials. The sodium carbonate is not available from previous suppliers and the physical characteristics from new suppliers will need to be evaluated Work on the pilot plant is needed also to evaluate attrition rate improvement and slurry feed of neutralization media. A decision will be made prior to the trial burn on the pilot plant to decide whether an RD&D or operating permit is desired for that unit. The present supply of carbonate and catalyst will be used for ongoing operations.

2. Comment

DOE gives a design thermal capacity for the incinerator of 1,500,000 BTU/Hr. (see Page D-3-4 of the Trial Burn Plans). The plan also gives temperature ranges within which the incinerator will be operated, but this is not enough information for a permit writer to base operating condition decisions on. A correlation between operating temperature, feed rates, feed BTU rates and optimum and minimum thermal capacity should be calculated and reported in order to allow CDH and EPA to establish, agree to and/or set testing and/or permit operating conditions. These minimum or optimum thermal capacities will remain fairly constant during incinerator operation and would be controlled by several factors. The main influential parameters which effect these thermal capacities would be process temperatures, gas flow rates, and waste feed/fuel blending.

DOE should submit a minimum or optimum thermal capacity which would indicate the appropriate operation parameters, under all waste feed conditions, for efficient chemical/thermal reaction. Further information requirements regarding the process unit design could be satisfied by submitting a mass/energy balance for the unit (also see Comment #26).

Response

The proposed test burn with varied parameters as defined in Table I should provide adequate evidence of performance over a wide operating range (see response to Comment Number 1 and Number 5 of CDH comments of

January 22, 1987 for further discussion of the variables). The range of operating temperature variable is supported by data supplied in the Trial Burn Plan.

The Rocky Flats Plant will pursue discussions with the EPA and the CDH on the use of an incinerator material balance as applicable to a Fluidized Bed Incinerator after the completion of the Trial Burn.

3. Comment

Fluid bed technology is significantly influenced by gas flow rates. Attrition of the bed material and, therefore, particulate carryover, is influenced by characteristic flow rates of the units. Superficial gas velocity of the incinerator (primary reactor) is approximately 0.6 meters/second (2 ft/s). Gas velocity entering the cyclone separator is 30.5 m/s The increased velocity of gas flow to the separators is due to restricted volumes in the piping under the relatively stable vacuum provided by the air ejector. The general gas flow rate has been expressed as 680 cu. ft./min downstream of the afterburner (see page D-3-79 of the plan).

DOE should supply available calculations for relative retention times in each reactor. Also, a maximum gas flow rate, which influences undesirable rates of bed attrition, should be indicated. DOE should provide information on where and how gas flow will be measured. Gas flow parameters should not be based on measured O_2 concentration alone, but by direct mass flow measurement as well (also see Comment #25)

Response

The gas retention time in the primary and secondary reactor are supplied in response to Comment Number 3, under "Operations", in composite of technical comments received during comment period. The rate of attrition is controlled by the gas velocity in each reactor and a nominal gas flow rate to each reactor will be specified by supervision during operation. The gasflow rates will be set based on the chloride content of the feed, the feed rate and the attrition rate data from Figure 1. (See response to Comments Number 2 and 3 of the CDH comments of January 22, 1987 for further discussion). The total off-gas flow and the gas flow to the primary will be measured directly by mass flow instrumentation. (See response to CDH Comments of January 23, 1987, numbers 2 and 5 for further discussion.)

4. Comment

As indicated in the plan, the fluid bed media of the primary reaction chamber consists of sodium carbonate and oxidation catalyst [i e., chromic oxide on alumina oxidation catalyst (Al_2O_3)]. The secondary reaction chamber (catalytic afterburner) consists of a fluid bed media of chromic oxide on alumina oxidation catalyst.

DOE should identify under what specific conditions the percentage of catalyst is changed in order to address various waste feed streams. If the catalyst concentration is varied for different levels of feed

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material concentrations, then DOE should present information which would allow CDH and EPA to determine whether or not a specific catalyst permit condition for effective destruction removal efficiency (DRE) is warranted.

The concentration of catalyst in the trial burn runs should be such that everyday operations will be more conservative toward the destruction of hazardous wastes that the test conditions (if catalyst concentration is truly a major operation parameter). It is noted here that the trial burn plan states bed material is attritioned and/or allutriated. This indicates that standard operating conditions, where in catalyst is added to the bed material, is a routine operation. If this operation significantly influences the effectiveness of the unit, EPA and CDH would consider setting a standard permit condition based on this parameter.

Response

The proposed trial burn as defined in Table I indicate that 20% catalyst will be used in the trial burn. Daily additions will be made to the primary bed based on the attrition rate data provided in Figure 1. It is anticipated that a minimum of 20% catalyst will be used in the bed during waste operations. Because the salt attrition is greater than that for the catalyst the bed composition should always be 20% or greater. A further check of appropriate attrition rate and addition rate can be obtained through visual observation of bed level through view ports in the reactor. The catalyst addition to the afterburner will also be made based on attrition rate data. Catalyst addition to the afterburner will be made weekly

5. Comment

DOE should include a waste feed cutoff system(s) test during the trial burn. Operating parameters during waste feed cutoff conditions should be recorded and reported in the trial burn report. DOE identifies five control parameters for waste feed cutoff (see Page D-3-12 of the Trial Burn Plan). Each of these control modes should be tested in order to determine their effectiveness. Should there be a waste feed cutoff based on a change in pressure differential across the HEPA filter bank(s)? Is the pressure dependent waste feed cutoff device, which monitors the secondary reaction chamber, capable of adequately detecting back pressure changes within the HEPA filters?

Response

Each of the waste feed cutoffs will be tested during the trial burn prior to initiation of the first trial burn test. Each parameter will be taken beyond the cutoff point to demonstrate that the valve will close on the liquid feed and the drive for the solid waste screw feeder will stop Two additional cutoff features will be added to the system prior to operation but will not be installed prior to the trial burn: maximum waste feed (solid & liquid) rate and a high and low pressure

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drop on the in-line process HEPA filter. Both feed rate (solid and liquid) and the pressure drop on the in-line process HEPA filter will be displayed during the trial burn.

6. Comment

DOE should describe how all unit temperature indicators and controllers will be recorded and tied into the waste feed cutoff systems (i.e., primary, secondary reactors, catalytic combustor and heat exchanger temperatures).

DOE should also indicate whether or not a high temperature cutoff is needed. One reason for this is the concern for the potential that metal and radioactive materials could be oxidized or entrained in gaseous waste streams and carried into the various pollution control devices. At the maximum temperatures of operation, $610^{0}C$ ($1136^{0}F$), and $650^{0}C$ ($1128^{0}F$), there may be a potential for radioactive materials being oxidized. However, within the temperature ranges and flow rates, it is more likely that a potential exists for these radioactive materials to be entrained in gaseous waste streams.

Response

The radioactive materials and metals will form a solid particulate such as oxides, which are removed from the bed by elutriation with the off-gas. The particulate material is then removed from the gas stream by the cyclones and sintered metal filters into the ash discharge drums.

Only trace levels of particulate will remain in the gas stream after the sintered metal filter. The total of six stages of HEPA filtration remove the remaining particulate. Please refer to the table provided in response to Comment #5 of the CDH Comments of January 22, 1987 for a description of indicating and controlling instrumentation.

7 Comment

Studies have indicated that trace metals emissions can pose a greater health hazard than organic or acid emission currently regulated under RCRA. DOE proposes that total chromium will be tested in the emissions analyses (see page D-3-38 of the Plan). Chromium is an obvious candidate due to bed material.

DOE should address whether or not there are any other metals of concern in emissions based on solid waste feed streams, and ash particulate entrainment (i.e., beryllium, tritium, cadmium, mercury, silver, arsenic, nickel, lead, etc.).

The processes involved in the generation of trace element emissions from high temperature incineration are very complex. Metals exposed to hot, oxygen-depleted zones, following burnout of organic matter can be involved in several potential paths. In responding to this issue, DOE should address each of the following concerns relative to their specific process:

- o Vaporization of metals at sufficiently high temperatures (EPA notes that DOE's process occurs at relatively low temperatures)
- o Melting of metals to form a liquid and removal or entrainment of particles in the inorganic portion of the waste effluents (i.e., gas waste streams and ash)
- o Reaction with other species (e g., Cl, F, etc.) to form other compounds which can vaporize, melt, or remain unchanged.

Depending on the paths, metals may be either discharged with the ash residue or condensed into fine particles. DOE should estimate the particle sizes of these metals and present how they are or are not effectively removed by their air pollution control equipment.

Response

Any trace metals which may be present in the incinerator feed will be so only in extremely minute quantities. Trace metals could include beryllium, lead, nickel, and silver. The only mechanism for these to be present is via incidental contact with the wastes. Since the FBI operates at much lower temperatures than conventional incinerators, any trace metals which may be present will not be exposed to temperatures high enough to cause vaporization. The flue gas is cooled to 50°C or lower prior to the HEPA filtration which will further reduce any vaporization problems with metals.

The trace metals will be oxidized in the incinerator and therefore, only a metal oxide which can be volitilized below 50°C has the potential for escape from the system. In addition, the HEPA filters are designed to capture any particle, including trace metals, which may be found in the exhaust. The particle size of materials in the exhaust stream will range from 1 to 100 microns, with each HEPA filter bank capable of removing a minimum of 99.95% of 0.3 micron particles. The capture capability of the HEPA filter for particles longer or smaller than 0.3 micron is better than that for 0.3 micron particles. (See Reference #5 in Attachment #2).

Reaction of the metals with other species such as Cl and F should not be a problem because the sodium carbonate bed material is more likely to react with Cl and F than are the metals.

8. <u>Comment</u>

The current RCRA Standard for Potentially Organic Hazardous Constituent (POHC) destruction is air emission based. In calculating POHC DRE, DOE will be given credit for unburned/unreacted POHCs in the ash residues. Excessive transfer of waste feed POHCs into ash negates the benefit of the thermal treatment process. Considering the relatively low operation temperatures at which this system will be operated, the potential for this type of carryover into ash is high. With the recent land disposal restrictions, DOE will be required to closely and accurately analyze the ash content for organics, as well as metals and radioactive materials. DOE should provide any information which would address the potential for carryover or particle adsorption and absortion of organics moving into the ash systems.

Response

The Fluidized Bed Incinerator operates at a lower temperature than conventional incinerators. However, the use of a catalyst causes the same combustion reaction to occur at these lower temperatures, In general, the catalyst allows even better destruction efficiencies. The Trial Burn Plan indicates that the ash and the offgas will be analyzed for POHCs and other constituents.

9. Comment

DOE should monitor and record the pressure drops across all the pollution control equipment and ash collection equipment as an indicator of pollution control efficiency. From DOE's flow diagram (page D-3-24), the following pressure indicators should be monitored and recorded.

Primary reaction chamber: PI-2 & PI-3

Primary cyclone: PI-4 & PI-5

Secondary reaction chamber PI-6 & PI-7

Secondary cyclone. PI-8 & PI-9

Sintered metal filters: PI-9 & PI-10

Catalytic reactor and heat exchanger: PI-10 & PI-11

DOE should explain why there isn't another pressure sensor between the catalytic convertor and heat exchanger.

Response

The pressure tap PI-11 is downstream of the sintered metal filter and the catalytic chambers. Because of the minor pressure drop (less than 2 in.

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H_2O) on the catalytic chambers compared to the DP of the filter, there is no operational need or environmental need to monitor the DP across the sintered metal filters independent of the catalytic chambers.

10. Comment

DOE should report what special procedures are practiced at the facility to prevent inadvertent or unintentional operator error, such as, the manual override of automatic controls while operations are within permitted ranges.

Response

For the Trial Burn, no manual overrides will exist; therefore, the operator cannot intentionally or unintentionally defeat the automatic waste feed cutoff system. Thus it would be impossible for the operator to defeat the automatic system.

11 Comment

DOE's Trial Burn Plans need to identify and justify the locations of the CO continuous emissions monitors (CEMs) more clearly. DOE does refer to EPA's standards for location (see Page D-3-33 and Figure 10 of the Trial Burn Plan) by restating EPA's Reference Method 1 for effective location based on stack diameter distance (40 CFR Title 60, Appendix A). However, DOE's description and justification for the CEM sampling locations is incomplete when considering other concerns for obtaining a representative sample.

The most important factor for accurate CO monitoring is the assurance that a representative sample is collected. To achieve this, there should be minimum stratification of gas-phase pollutants, in the effluent (i.e., concentrations must be uniform across the stack system at the point(s) of sampling). The proposed sampling/monitoring locations in the Trial Burn Plan, 1 and 2 (see Figure 9), could be inadequate. It could prove quite costly if DOE, EPA, or CDH determine that stratification testing should have been conducted at sampling locations prior to the trial burn and CO data is considered invalid after the trial burn has already been conducted.

For sample location 2 (Figure 11 was not provided in the Trial Burn Plan), DOE needs to justify why stratification testing data is not collected and/or reported. This is important in sampling/monitoring location 2 due to the fact that room air is introduced upstream from the sampling/monitoring location.

The location of sampling/monitoring at Point 1 appears more appropriate for meeting EPA's criteria (from a representative gas stream aspect). A diagram for the location of sampling point one is given and is based on EPA's stack diameter criteria. However, Sample Point 1 may subject sampling probes to adverse operational conditions as well as adverse stratification effects from "canyon air" (see the process flow diagram on Page D-3-24 and Figure 10 of the Trial Burn Plan). The Trial Burn Plan does state that acidic gases are neutralized by the reactor bed materials.

DOE should submit information explaining whether or not there are any acidic gases or adverse temperatures present in the exhaust which would adversely effect sample probes. Also, information should be submitted regarding how the catalytic reactor, "canyon air" and the process heat exchanger, impact CO concentrations and/or gas stream stratification.

Response

The acid gases are removed by reaction with the bed material in the primary reactor by design and the flue gas is cooled prior to the point where the sample probes are installed. Therefore, acid gas and temperature should have no adverse affect on the sample probes.

A velocity profile of the stack will be obtained prior to initiating the trial burn. All the off-gas sampling will be done in a duct where velocity will be measured by a mass flow meter; a separate sample downstream of the air dilution point will be eliminated.

In addition to the off-gas sampling trains downstream of the process HEPA filter, the CO will be continuously monitored upstream of the heat exchanger (cooler). This will measure CO and CO_2 concentration at the point where the combustion reaction should be completed. This includes the reactions in the primary reactor, afterburner, and the catalytic chambers at the exit of the sintered metal filters

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12 Comment

It is not exactly clear what DOE's intentions for these two sampling points are. DOE should clarify whether or not these sampling points will be redundant sampling/monitoring ports or are included only in the trial burn to determine which monitoring location is better. DOE should also define whether or not normal operation CEMs will extract samples from both locations.

To further clarify the intended use of these sampling ports, DOE should specify which of the parameters tested for in Table 2 (Page D-3-38) will be used as CEM sampling parameters after the trial burn.

Response

The second sample point downstream of the main air ejector and HEPA filter plenum has been eliminated because of dilution with canyon air and compressed air in the ejector. The plan is only to sample the flue gas line downstream of the flue gas heat exchanger (cooler). A HEPA filter has been installed between the flue gas heat exchanger (cooler) and the sampling point. This filter will remain as an integral part of the process and all sample trains will sample the flue gas at a single point. A mass flow meter has been installed to measure the flue gas stream which is being sampled. The pollutants listed on Page D-36 for Sample Location 1 plus particulate and total chromium will be sampled at Location 1. In addition, these samples will be analyzed for plutonium or uranium when runs are made with feed containing plutonium or uranium. It should be emphasized that Sample Location 1 is upstream of five (5) additional

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stages of HEPA filter banks which serve the incinerator gaseous effluent. Radioactivity measurement at Location 1 does not reflect the radioactivity that will be released to the environment. Only measurements taken after the last stage of the six banks of HEPA filters will reflect the release to the environment.

13. Comment

DOE should supply a more complete list of parameters which will be directly monitored as well as continuous emissions monitors (CEMs), tests, calibrations, repairs, and checks on CEMs are subject to reporting requirements for HWIs. These instrument inspections and testings are subject to daily, weekly, monthly, and/or yearly reporting requirements

Response

The following items will be monitored and/or recorded during normal operations:

	Parameter	Recording
1	Primary bed temperature	Continuous strip chart and information fed to disk
2	Afterburner bed temperature	Continuous strip chart and information fed to disk
3	Primary reactor pressure	Continuous strip chart and information fed to disk

4	Afterburner pressure	Continuous strip chart and information fed to disk
5.	Liquid waste feed rate	Continuous strip chart of mass flow-rate and information fed to disk
6.	Solid waste feedrate	Screw feed RPM will be manually recorded. Drum weights will be manually recorded and the data will be manually input into the disk.
7.	Gas flowrate to primary reactor (air-nitrogen mixture)	Continuous strip chart and information fed to disk
8.	Offgas flowrate, flue gas exit from heat exchanger	Continuous strip chart on mass flowrate and information fed to disk
9.	Air flowrate blended at exit of heat exchanger	Continuous strip chart on mass flowrate (for test burn only)and information fed to disk
10	Oxygen concentration in flue gas prior to the heat exchanger	Continuous strip chart recording and information fed to disk
11.	Carbon monoxide concentration in flue gas prior to heat exchanger	Continuous strip chart recording and information fed to disk
12.	Carbon dioxide concentration in flue gas prior to heat exchanger	Continuous strip chart recording and information fed to disk
13	Total hydrocarbon concentration in flue gas prior to heat exchanger	Continuous strip chart recorder and information fed to disk
14.	Temperature of inlet and outlet of each catalyst chamber	Information fed to disk only

All of the above instruments will be calibrated on an annual basis except for the CEM's (10 through 13 above), which will be calibrated every 24 hours. Inspection and calibration will be made in accordance with appropriate regulations.

14. Comment

40 CFR 264.343(b) requires that an incinerator burning hazardous waste and producing stack emissions of more than 1.8 kilograms per hour (4 pounds per hour) of hydrogen chloride (HCl) must control HCl emissions such that the rate of emission is no greater than the larger of either 1.8 kilograms per hour or 1% of HCl in stack gas prior to entering any pollution control equipment. DOE should be prepared to address the concern that HCl is being measured after air pollution control equipment in the trial burn. This is due to practical sampling concerns and may be justified by the expected low level of acid gases.

Response

During the Trial Burn off-gas sampling trains will be used to determine the HCl emissions. For the production operation, it is planned to install hydrogen chloride continuous monitoring instrumentation. It should also be noted that the 1.8 kg/hr and 1% HCl in the stack would not be exceeded even if all of the chloride in the feed were emitted to the stack under production operations because the feed chloride content is low. Since the halogen is reacted at the point of generation, the only way one can monitor the halogen production is to analyze the flue gas stream In a conventional incineration process, the HCl is monitored in the offgas from the incinerator. The same methodology is proposed for the Fluidized Bed Incinerator. The purpose is to demonstrate that the HCl is removed in the incineration process, and therefore, no scrubbing system is required. In fact, one of the benefits of the Fluidized Bed Incinerator is that no contaminated waste scrub solution will be generated.

15 Comment

During the January 8, 1987, meeting, Nathaniel Miullo of EPA suggested that DOE do one of two things with relation to radioactive materials in the trial burn. Either test an actual amount of plutonium (spiked amount) as a trial burn waste stream, or use only uranium and provide information which would adequately describe the thermo/chemical relationship between plutonium and uranium. If enough correlation can be shown between uranium processing and plutonium processing, then it may be possible to justify allowing the permitted waste feeds to contain limited amounts of plutonium (from depleted sources). However, Mr. Miullo strongly urged that actual plutonium be included in the test waste stream in order to determine the specific amount which would be present in the exhaust gases for this system.

On February 24, 1987, during the Data Exchange Meeting, DOE announced that it planned to use plutonium in the trial burn waste feed stream. CDH urged that uranium be used first If no uranium is indicated by stack emissions tests, then the plutonium tests could be conducted. CDH's approach should be implemented. However, it will impact DOE's proposed trial burn schedule (see Page D-4-74 of the Trial Burn Plan) The plutonium related runs of the second and third weeks may need to be delayed so that analytical results from the uranium test runs can be reviewed.

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Response

As identified in Table I, the trial burn will incorporate two runs using plutonium spiked feed (one solid and one liquid) and uranium spiked feed will be used for two of the solid feed runs. As indicated by run number in Table I, the proposed sequence of runs will be the two non-contaminated runs, then the two uranium spiked runs followed by the two plutonium spiked runs. It is intended to review the on-line instrumentation results from each test run before proceeding to the next test. Personnel from CDH And EPA will participate in the technical review of the on-line instrumentation results. Stack samples will be analyzed for activity and these results will be reviewed for the uranium bearing runs before proceeding with the tests with plutonium in the feed. There is no intent to provide long delays between runs. However, the first three or four runs probably will occur in one week and the remaining runs the following week. The multiple stage HEPA filtration used on the Fluidized Bed Incinerator will provide adequate control to prevent emissions of plutonium and uranium. The continuous stack monitoring downstream of all the HEPA filtration provides real-time detection and alarm for elevated radioactive emissions.

16. Comment

Colorado is the first state to have received authorization for mixed wastes and the potential endangerment and/or health risk is of particular concern while dealing with radioactive materials such as plutonium. It is expected, by considering the small amounts of depleted uranium and plutonium which are predicted to be in the waste feed, that the amounts in the emissions will not be detectable, DOE should provide calculations for the expected amounts of plutonium and uranium which would be emitted from the stack during full load conditions, normal conditions, a HEPA filter failure mode (breakthrough), and an expected exposure rate for various locations downwind of the operations. all calculations and assumptions, including a complete description of dispersion models used, should be presented.

Along these lines, trial burn tests should be conducted during optimum meteorological conditions. DOE should propose what conditions it plans to operate the trial burn under

Response

Projected radioactivity air emissions and concentrations and radiation doses are described in Attachment 2 The basis for all calculations is described in this attachment. Assumptions (including the use of the Gaussian Model) that were used in the calculations were generally conservative, overestimating any resulting adverse impact from the trial burn or routine operations. Newer dispersion models which incorporate dilution due to air mixing predict a lower dose than that predicted through the use of the Gaussian Model. Even under the assumed adverse meteorological conditions this impact would be negligible and no restriction on meteorological conditions is warranted. Calculations were done assuming that effluent air would pass through five (5) stages of HEPA filtration prior to exiting the building. Six stages will actually be used; therefore, the calculations already assume loss of one stage. Since the assumed filtration efficiencies are given for each HEPA stage, impacts from loss of any number of stages can be calculated simply by dividing the emissions by (1 - filtration efficiency) for each stage assumed to be lost.

17 <u>Comment</u>

DOE's plan includes a complicated processing and conveyor system for solid wastes. One of the major permit conditions will set the maximum feed rates.

For liquids, measuring and recording amounts fed into the incinerator should be uncomplicated. DOE specifies the waste feed mixing practices (i.e., Table 8 of the Trial Burn Plan). However, DOE has not provided specific analytical results of the liquid mixed waste stream. This places a substantial verification and recording burden upon DOE to assure that a specified BTU level, or BTU range, is met at all times during actual operation.

Unless a specific analytical test on all waste feed streams is performed and results submitted, DOE should explain why knowledge of waste streams, in lieu of analytical data, is sufficient information for issuance of a draft permit. A trial burn, however, can use a surrogate waste stream, as is proposed by DOE.

For solids, DOE proposes that the rotational speed of the screw conveyor, feeding the primary reaction chamber, be dependent upon O_2 level, pressure in the secondary reaction chamber CO level, temperature, and gas velocity. EPA believes that DOE's intent is to indicate waste feed cutoff is dependent upon those factors, and not screw rotational speed.

The primary feed rate indicator for the solids can be based on volumetric, weight, or mass flow measurements. The most accurate method of waste feed monitoring would involve measurements taken prior to the introduction of the solid waste stream to the shredding and conveyor systems [minus the amount removed in the disposal bag and tramp metal drum (see Figure 2 on Page D-3-8)].

Another method for solid waste feed measurement is based on calculations of the volumetric flow rate of the screw. DOE would need to include a tachometer to measure and record the rpm rate of the screw feeder, and multiply this by the volume fed by one complete revolution of the screw. The tachometer method is desirable due to the fact that it gives a "real time" indication of the solids being introduced into the primary combustion chamber at any given point in the process This is provided that the tachometer and volumetric calculations are calibrated properly for accurate measurements.

DOE should explore the following types of flow meter technologies and present which option would best suit their specific needs:

SOLIDS	LIQUIDS
Level Indicators: Ultrasonic, Nuclear and Radio Frequency	Rotameter
Stationary Weight Indicators	Orifice Meter
Conveyor Weight Systems	Positive Displace Meter
Impact and/or Momentum Flow Meters	Coriolis Flow Meter

Response

The rotational speed of the solid waste feed conveyor and liquid feed rate are controlled or modulated by the temperature sensor in the afterburner, R2, not oxygen level, R2 pressure, or CO level. The waste feed cutoff system is specified in the response to comment #5 of the CDH comments, January 22, 1987.

The RPM of the solid waste feed screw will be used for indicating the volumetric rate and will be tied into the feed cutoff system. Present plans are to install additive feed rate control instrumentation which would modulate the total (solid and liquid) feed to the incinerator based on the afterburner bed temperature A manually set ratio controller will regulate the proportions of solid and liquid feed in any combination up to 0% of one and 100% of the other stream. This adding device would be set with the nominal values for BTU content of the streams and would use the volumetric solid feedrate and liquid on mass flow rate combinations for cutoff purposes. The 100% liquid feedrate will be limited to a high of 88 lb/hr. and the 100% solid feed rate will be limited to a high of 180 lb/hr. When both waste streams are being fed, the high will automatically be limited to the % of the feed composition. For example, a feed of 50% solids and 50% liquid would automatically cut off both hazardous waste feeds if they exceeded 50% of the maximum (50% of 88 lb/hr. liquid + 50% of 180 lb/hr. solid) feed rate. All of the alternate metering technologies were considered during the development work which led to the selection of the present system.

18 Comment

EPA supports DOE's use of surrogate organic waste streams for the trial burn. DOE's justification is based on incinerability criteria for the difficult to destroy, carbon tetrachloride, spiked waste stream. Surrogate waste streams for trial burns is further justified based on recent non-flame thermal decomposition data for several hazardous organic compounds compiled by the University of Dayton (Dellinger , et al., 1984, 1985, 1986). This data not only gives indications that heat of combustion is an important consideration, but shows that CO emissions may be a good indicator for the efficiency of the overall thermal/chemical removal system

Formation of products of incomplete combustion, and therefore emissions, may be indicated by high levels of CO. Recording CO concentration levels,

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during a trial burn, and using a difficult to burn surrogate material, which has experimental data verifying residence times and temperatures for effective destruction and removal efficiency (such as carbon tetrachloride) is a good way to assure other organic compounds will be effectively destroyed (see Tables 9 and 10 of the Trial Burn Plan).

Response

The use of carbon tetrachloride as the POHC surrogate is supported by EPA, we agree with the EPA comment.

19 Comment

CO levels proposed by DOE are not within proposed limits EPA will publish prior to issuance of the permit. DOE has proposed a two-tier CO level. Although this is a good approach to assuring undesired shutdown due to upset conditions, the levels which DOE proposes are beyond that which EPA will publish in guidance documents now being developed. EPA's standards indicate that the upper CO limit is not to exceed 100 ppm averaged over 60 minutes and 500 ppm over 10 minutes. DOE's proposed method of measuring these "windows", or time weighted averages, is appropriate due to the desire for avoiding extraneous upset conditions from excessive waste feed shutdowns However, if the trial burn data show that the unit has capability to operate at lower levels and meet the DRE and other standards, the permitted waste cutoff levels should be lower than the above guideline levels.

DOE has proposed an "upper tier" or upper limit of 1,500 ppm for the duration of the "moving window". This is 1,000 ppm above suggested guideline amounts. Final determination of exact CO limits will be determined by the trial burn results and due consideration must be given to minimization of excessive shutdown conditions. This will assure effective reduction of undesirable emissions (i.e., high concentration "poofs" from upset conditions). However, a CO limit must be set for the trial burn. Unless DOE can provide adequate justification, EPA and CDH will require the use of the 100 and 500 ppm levels.

Response

The Trial Burn Plan specifies that the data generated on CO concentration will be used to set acceptable CO limits for permit conditions using the two tier system with a moving window for the upper tier. The present regulations do not require the CO level to be set at 100 PPM average over 60 minutes and 500 PPM over ten minutes. These proposed limits are a measure of destruction efficiency on-line during operation During Trial Burn the destruction efficiency will be determined from the EPA approved off-gas sample train. The objective of the Trial Burn is to test the system for destruction efficiency; therefore, the CO limit, during the trial burn should be set high (1500 ppm) to prevent premature shutdown during the tests. Based on development testing, the CO concentration is expected to be in the range of 500-600 PPM. The 1500 PPM CO concentration limit is reasonable due to the fact that, during the trial burn, EPA and/or CDH personnel will be present to observe CO concentrations actually detected and the off-gas sampling trains will collect samples which will be analyzed to determine the actual destruction efficiencies obtained in the test. The final permit limit of CO concentration in the off-gas system should be based on the results obtained during the trial burn and are expected to be lower than 1500 PPM for the final permit.

20. Comment

DOE should report the following parameters regarding the continuous emissions monitors:

- Zero drift over sample time and total test time;
- Span drift over sample time and total test time;
- Precision;
- Linearity;
- Above listed parameters for each of the double-range readouts.

DOE did report some percentage ranges on the flue gas monitors (see page D-3-30 of the Trial Burn Plan), but it is not clear what these ranges are referring to.

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Response

The following are the continuous emissions monitors parameters·

Instrument	Oxygen	Carbon Monoxide	Carbon Dioxide	Hydrocarbon
Parameters				
Zero Drift Sample Time	0.3%	1%	1%	1%
Zero Drift Test Time	Test Time is One Minute - No Detectable Drift			
Span Drift Sample Time	0.3%	1%	1%	1%
Span Drift Test Time	Test Time is One Minute - No Detectable Drift			
Precision	0-2.5% 0.05% 0-10% 0.2% 0-25% 0.5%	0-2000 50ppm 0-6000 100ppm	0-6% 0.05% 0-20% 0.1%	0-1 0 01ppm 0-10 0 1ppm 0-100 1.0ppm 0-1000 10ppm
Linearity	N/A	1%	1%	1%

21. <u>Comment</u>

DOE has not identified whether or not continuous emission monitors for radioactive materials are available. If such technology exists, an in-stack application of this technology would be appropriate.

DOE does employ ambient air monitors for radioactive airborne elements at various building locations, as well as throughout the facility. These monitors are not "real time" alarms, but may have some application to monitor stack emissions within Building 776.

DOE should present information on whether or not ambient air monitors will be used in the area. A discussion of what localized "real time" radioactive alarm systems are available would also be useful in determining whether or not in-stack radioactive monitors will be required.

<u>Response</u>

Continuous in-stack emission monitors for particulate radioactive materials (SAAM's) are operating in the exhaust duct serving the Fluid Bed Incinerator. The SAAM provides real-time sampling, detection and alarming capabilities producing an audible alarm should the concentration exceed a pre-set amount. Should this alarm be activated, Utilities, Radiation Monitoring, and Environmental Analysis personnel would immediately respond, investigate, and take corrective action. Continuous sampling for later radiometric screening and specific radiochemical analysis also is performed for the air effluent following the final stage of HEPA filters.

A network of ambient air samplers is operated, both on and around the Rocky Flats Plant This network consists of 51 total particulate filter samplers, of which 23 are located onsite (within the security fence), 14 are placed around the plant perimeter (within two miles), and 14 are located within the surrounding communities.

All ambient air samples are collected biweekly, with selected onsite samples being composited for plutonium analysis. Plutonium analysis of perimeter and community samples are made from four-week composites.

22. Comment

Due to the predicted low levels of radioactive waste feed material there is little concern for a nuclear reaction which would lead to a critical mass event in the reactors However, since radioactive materials will be handled in various storage and transportation vessels, and/or pollution control devices, as well as the reactor vessels, DOE should discuss whether or not there is any chance of a critical mass occurrence in these units. This submittal should include information regarding design and operational measures DOE has taken to assure this situation won't occur.

Response

The nuclear criticality safety of the FBI has been extensively studied and is continually reviewed. Every waste drum input to the FBI must be certified as containing less than or equal to 100 nano-curies of transuranic radio- nuclides per gram of waste. This also limits the fissile material content to no more than 100 nano-curies per gram. Fissile material is defined to be uranium 235 and Plutonium 239.

The wastes to be processed in the FBI are of two forms: solid and liquid. The solid waste will be contained in 55-gallon drums before being directly placed in the FBI. The liquid waste will be pumped into two large, critically safe holding tanks prior to incineration.

The solid waste drums must be examined by "drum counters" specifically designed to determine if the material can be processed in the FBI. These detectors serve as non-destructive assay devices whereby each drum containing fissile concentrations are confirmed to be below the 100 nano-curie of fissile material per gram of waste. All other drums, greater than 100 nano-curies per gram of waste will not be processed in the FBI

The liquid wastes will be stored in raschig ring filled holding tanks just prior to incineration Before the liquids can be placed in the holding tanks, the solution is sampled and analyzed for fissile material. Again, no fissile material is permitted in the tanks above the 100 nano-curies per gram limit. The presence of raschig rings (a neutron absorbing material) adds an even greater margin of safety to the system since raschig ring filled tanks can safely hold solutions containing relatively high concentrations of fissile material. In addition, these tanks are periodically gamma-scanned for fissile material holdup.

Finally, recognizing that minute, trace amounts of fissile material will be placed in the FBI, two additional steps have been taken to monitor fissile accumulation within the FBI equipment itself. The FBI equipment will be gamma-scanned after every 200 hours of operation, until a local background level is established. These scans detect the gamma radiation emitted from the fissile material and serve as an indicator of any accumulation. The bed material from the reactors will also be sampled and analyzed for fissile material content. This sampling procedure will initially be performed after every 200 hours of operation. No accumulation of fissile material is expected. If any accumulation occurs, it will be detected and removed.

All personnel operating the FBI equipment receive extensive training in nuclear criticality safety. Each employee must be recertified in nuclear safety every two years.

The FBI is an extremely safe operation from a nuclear criticality safety standpoint. There is no credible scenario that could produce a critical mass within the FBI.

23 Comment

DOE should explore the possibility and feasibility of installing a parallel, redundant stack system (from before the HEPA filters on), in order to provide an immediate backup should break-through of the HEPA filters occur. DOE should compare this option to the protection that the

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automatic waste feed cutoff technology presently built into the system offers.

Response

A backup HEPA filtration system is not required because operation of the incinerator can be cut off if malfunction of the filter occurs. This shutdown is of little hazard because of the very low in-process inventory of combustible material during operation. There is an inherent redundancy already existing for the HEPA filter system. In the highly unlikely event of process gases not exhausting through the incineration plenum, any excess air or gas would exhaust through the building plenum system.

24. Comment

The Trial Burn Plan identifies Roy F. Weston employees as Rockwell's contractors given responsibility for the trial burn (see Section 4, Pages D-3-95 through D-3-99) EPA's experience has been that a limited number of contractors in the nation have adequate experience to perform the delicate and complicated sampling and analyses tasks involved in HWI trial burns. EPA recognizes the sampling and analyses methodologies and QA/QC procedures sections of the Trial Burn Plan as very well prepared. Further defining the background and capabilities of the sampling contractors and the contract lab will help to assure that the actual work performed is adequate to meet the Trial Burn Plan's specifications.

DOE should define the past HWI experience and qualifications of the individuals listed in Section 4 of the Trial Burn Plan.

Response

A contractor with extensive experience in technical evaluations of conceptual design alternatives, process design, construction, operation and testing of hazardous waste incinerators has been selected for the Trial Burn effort. The contractors previous experience played an important part in the selection process. The contractor will utilize an EPA-approved laboratory for off-gas and ash analysis.

25. Comment

DOE has stated that process checkouts have been conducted or will be conducted by using diesel oil and/or sawdust. DOE should present significant problems or findings to EPA and CDH discovered during these pre-trial burn phases.

Response

The equipment will be checked out using diesel oil and non-hazardous solid waste materials to verify operability of the system including the instrumentation and control systems. It is intended to correct any malfunctioning equipment during the system operational testing and check out. If any equipment malfunction remains after this period of testing which could affect the Trial Burn, these significant malfunctions will be identified for the EPA & CDH.

26. Comment

In order to assist permit writers in their determination as to whether or not the incinerator unit can achieve the DRE at the set flow rates and temperatures, DOE should submit complete energy and mass balance calculations on the system. The primary objective the energy and mass balance should be to clearly show calculations of excess air levels, temperatures, residence times, and total volumetric flows for each unit of the incineration system. A unit consists of a separate combustion or thermal chamber.

Inputs to the mass and energy balance procedure include feed rate, temperature, heating value, and composition of all input streams to each unit including: waste, fuel, water, air, and oxygen, incineration design specifications including the thickness and conductivity of the refractory, the volume of the unit, the area of the refractory and any cooled surfaces, and the outer shell temperature; and the Air Pollution Control Design (APCD) specifications including gas to volumetric capacity, acid capacity, flow restrictions, and temperature reductions or increases. If unknown, many of these quantities can be estimated based on common incineration practices and sound engineering judgment.

The mass balance should be based on simple stoichiometric calculations. Complete combustions can be assumed with the only products being CO_2, H_2O, HCl, SO_2, ash, N_2, NO_2, and excess O_2. The mass balance determines if

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sufficient oxygen is available for complete combustion, calculates the composition of the combustion products, and calculates the total mass flow through the incinerator.

The energy balance solves three equations simultaneously: (1) balancing sensible heat, heat of vaporization, and chemical heat with radiation and convection; (2) balancing radiation and convection to the walls, with conduction through the walls; and (3) balancing conduction through the walls, with convection and radiation from the outer shell of the unit to the ambient surroundings.

Response

Nominal flow rates for the test burn are identified for each of the runs in Table I. The actual feed rates, fluidizing gas flow to the primary, off-gas flow and ash generation (residue form cyclones and sintered metal filters) will be determine during the Trial Burn runs. The process vessels are not refractory lined. A considerable effort would be required if a mass/energy balance were to be supplied because a balance is valid only for one set of run conditions and the Trial Burn and ongoing operations involve variable operating conditions. The variable operating conditions are necessary during the Trial Burn to establish performance under various operating conditions. In addition, the oxygen concentration in the off gas will be continuously monitored during operation as will the CO and CO_2. During the Trial Burn the off-gas sampling trains are intended for analysis of performance (destruction efficiency) of the system.

27 Comment

DOE has identified thirteen operation parameters which it expect to be permit operating conditions (see Pages D-3-78, and D-3-79, of the Trial Burn Plan). Depending on the outcome of the trial burn, CDH and EPA may want to implement further permit conditions for operation parameters such as maximum draft or pressure in reaction chambers, temperature in the catalytic reactor, minimum oxygen at each reaction chamber exit, reactor bed catalyst feed rates, maximum hydrocarbon concentration at the stack, and minimum and/or maximum pressure drop across the catalytic reactor and/or HEPA filters.

DOE should operate the trial burn conditions within various operational ranges for which they wish to be permitted. Unless the specific waste streams and/or other operation parameters are demonstrated during the Trial Burn, DOE will not be allowed to change operations for such untested conditions unless a permit modification is sought.

Response

The Trial Burn tests as indicated in Table I are designed to evaluate performance of the system under various operating conditions The performance with respect to operating temperature is supported by data supplied in the Trial Burn Plan. Data are also supplied to relate attrition of the material to the gas flow rate in Figure 1. These data and information obtained during the Trial Burn should establish a wide range of suitable operating conditions. The waste streams which are candidate feed materials for the Fluidized Bed Incinerator are listed in the submittal to CDH as a part of the Part B appliction for the plant. These waste streams are also listed in Attachment 3.

28. Comment

Several comments and questions have been raised regarding the effectiveness and historical performance of this particular type of thermo/chemical technology. To EPA's knowledge, fluid bed technology has been effectively used throughout the nation for several years for destruction of industrial and hazardous waste streams. The advantage of this specific fluid bed technology is that it will deal effectively with both liquid and solid waste streams unique to the Rocky Flats Plant. Another positive aspect of fluid bed technology is the ability to adjust flow rates, and increase residence time for more efficient thermo/chemical destruction of organics and ash removal. Also, the thermal inertia of a fluid bed system lends very well to stable operating conditions. Stable operating conditions are desirable for both organic destruction and radioactive material removal.

During several brief discussions EPA staff has had with various representatives of government and industry, we have been unable to identify any other system that is exactly like the one Rockwell has developed (i.e., there are fluid bed reactors that process radioactive wastes and hazardous wastes, but it is uncertain that they are of the nature of Rockwell's reactors. They do not process the same amount and types of waste streams and they do not use the same type of air pollution control equipment).

DOE and Rockwell should define steps it has taken to explore other technology alternatives for management and volume reduction of these waste streams. The possibility of discovering or developing a less turbulent particle design is conducive to these types of waste streams. Due to the precedent setting nature of this activity under RCRA, DOE and Rockwell should provide information to identify ongoing, or developmental mixed waste recovery, volume reduction, and/or destruction technologies world-wide, while CDH and EPA support them in development of this fluid bed technology.

Response

A Fluidized Bed Incineration process is being commercially marketed for use in the nuclear industries. While there are some differences from the unit at Rocky Flats they both utilize the concept of fluidized bed combustion Many of the components used in the Rocky Flats incineration system have been used extensively in other DOE facilities. At the Idaho National Engineering Laboratory sintered metal filters have been used in fluidized bed combustion and waste calcination units. The HEPA filtration equipment is used extensively at many DOE sites (INEL, LANL, HO, etc.) In the general commercial industry there is a wide variety of application of fluidized bed technology, shredding, screw conveying, and particulate removal using cyclones and filtration equipment.

Rocky Flats has a continuing program to reduce waste generation, waste volume reduction and waste form improvement. Personnel try to remain aware of industrial waste management practices in general. The DOE has technology exchange agreements with many foreign governments (FRG, France, Japan, UK etc.) to provide access to foreign technology.

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ATTACHMENT 2

ROCKY FLATS PLANT FLUIDIZED BED INCINERATOR

RADIOACTIVE EMISSIONS AND HEALTH RISKS

REVISION 6 MAY 1987

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ENVIRONMENTAL ANALYSIS & CONTROL RESPONSE TO QUESTIONS

FROM THE COLORADO DEPARTMENT OF HEALTH

ON THE ROCKY FLATS PLANT FLUIDIZED BED INCINERATOR

HEPA FILTER SYSTEMS

14 April 1987

INTRODUCTION

Projected air emissions, air concentrations, and radiation dose at the Plant boundary from both the Trial Burn (verification run) and routine operations of the Rocky Flats Fluidized Bed Incinerator are calculated in the "Rocky Flats Plant Fluidized Bed Incinerator Radioactive Emissions and Health Risks" report.(RO87) Included in the report are proposed waste feeds for the Trial Burn and projected feeds for routine operations. The amount of radioactive material in the Trial Burn feed will be controlled for the runs involved; radioactive materials in routine operations feed are conservatively estimated to overestimate the resulting emissions, concentrations, and radiation doses. Both uranium and plutonium will be included in Trial Burn runs, with uranium runs preceding the plutonium runs.

Calculated radioactive emissions, air concentrations, and offsite radiation doses are based on the assumption of a minimum of five stages of High Efficiency Particulate Air (HEPA) filters which would filter particulates from any air leaving the FBI. The assumed filtration efficiencies for the HEPA filters are 99.95% for the first stage and 99.8% for each of the subsequent four stages. The total reduction factor for the five stages of filters is 8×10^{-15}. The assumed efficiencies are considered to be conservatively low, based on extensive experience which the Department of Energy and the Rocky Flats Plant have with HEPA systems.

SPECIFICATIONS AND TESTING

The HEPA filters currently used at the Rocky Flats Plant in the FBI are of the 5% Nomex^R type, size 5 filter, rated at 1,000 cfm. The basic standard for HEPA filters at Rocky Flats is found in SMU-401. "Standard for HEPA Filter, General Purpose.(RO82) Filters are ordered according to specifications found in Department of Energy (DOE) Nuclear Standard NE F 3-45, "Specifications for HEPA Filters Used by DOE Contractors."(US86a) Department of Defense (DOD) Military Specification MIL-F-51079, "Military Specification: Filter Medium, Fire-Resistant, High-

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Efficiency," is the basic standard for HEPA filter media and DOD Military Specification MIL-F-51068, "Military Specification: Filter, Particulate, High-Efficiency, Fire Resistant," specifies required qualification tests on the filters.(DD80, DD81) Both of these specifications are referenced in NE F 3-45.

Other applicable DOE Nuclear Standards include NE F 3-42, "Operating Policy of DOE Filter Test Program," NE F 3-43, "Quality Assurance Testing of HEPA Filters," and NE F 3-44, "DOE Filter Test Facilities Quality Program Plan."(US86b, US86c, US86d)

The Rocky Flats Plant follows the American National Standard/American Society of Mechanical Engineers standard ANSI/ASME N509, "Nuclear Power Plant Air Cleaning Units and Components," regarding design, size, construction, and radiation resistance of its HEPA systems.(AM76)

Vendor qualification testing of filters is conducted at Edgewood Arsenal in accordance with requirements in MIL-F-51068. MIL-F-51068 includes performance requirements on DOP smoke penetration, resistance to airflow, resistance to rough handling, resistance to pressure, conditioning, resistance to heated air, spot flame resistance, resistance to environmental exposure, and workmanship.

Additionally, candidate filters are tested by Underwriters Laboratory (UL) for UL approval under the American National Standards Institute (ANSI) standard ANSI/UL-586, "Standard for Test Performance of High Efficiency, Particulate, Air Filter Units."(UL77) Tests are for efficiency, DOP (Dioctyl phthalate) penetration, moist air, heated air, spot flame, and low temperature performance.

Upon arrival at Rocky Flats, each individual HEPA is tested prior to use to ensure that its particulate filtration efficiency is at least 99.97%. Testing is performed in accordance with Plant Services Department Procedure FILT. CERT-SOP-1, "HEPA Filter Testing, Q107 DOP Penetrometer."(RO85)

In actual experience, most filters meet or exceed a filtration efficiency of 99.99%. Testing is performed with monodispersed DOP particles of 0.3 um NMD (Number Mean Diameter), measured with a Q107 DOP penetrometer. An NMD of 0.3 um is the ANSI/ASME-recognized nominal particulate size for minimum filter efficiency. The actual size which is most penetrating through a filter may differ somewhat from this value. Particulates larger than this size are filtered more efficiently because of increased occurrence of impaction and interference; particulates smaller than this size are filtered more efficiently because of increased diffusion into the filter and increased electrostatic precipitation.

Two out of every 350 filters received at Rocky Flats also are tested for compliance with MIL-F-51068 heated air and high

resistance specifications. The heated air test is conducted at ≥700 ±50 degrees F. Experience has shown very little filter deterioration. Filters often retain a filtration efficiency of ≥99.97%, even though only 97% is required by this test.

ANSI/ASME N510, "Testing of Nuclear Air-Cleaning Systems," provides the basis for the field testing of the Rocky Flats HEPA filter systems.(AM80) Installed filter banks are tested in place to meet a minimum overall 99.95% filtration efficiency for the bank. In actual experience, most meet or exceed 99.97%. For this test, polydispersed DOP particles are used of 0.7 um NMD, having a size range of 0.1 to 3 um. Each filter within the bank is tested individually in place. The overall efficiency of the bank is then tested to ensure ≥99.95% performance.

Other DOE facilities besides Rocky Flats use HEPA filters for particulate emissions control. Los Alamos Scientific Laboratory (LASL) has conducted research on the performance of multiple stages of HEPA filters against plutonium oxide aerosols of varying particle sizes. A LASL report issued in 1976 concludes, "Although penetration increased at each succeeding stage and the aerosol size distribution was modified to a more penetrating range. mean penetration of each stage remained generally below 0.0002 [filtration efficiency of 99.98%] under half- and full-flow conditions."(GO76)

No gaseous radioactive constituents are anticipated in the FBI operation. The primary and secondary reaction chambers will operate at about 1000 degrees F. Effluent air will pass through a heat exchanger which will lower the temperature to less than 125 degrees F before it reaches the FBI HEPA prefilters. The boiling points of plutonium and uranium metal are much higher than these temperatures - 5800 and 7500 degrees F, respectively. The vapor pressure of the oxide forms which will be generated in the FBI are even lower than those of the metals.

MAINTENANCE AND SECURITY

Pressure differentials across each filter bank are measured continuously using Magnehelic® gauges. Readings on the gauges are inspected at the plenum and recorded monthly. Filters are changed when visual inspection or DOP testing indicate that change is appropriate or when the pressure differential reaches 5 inches of water. The manufacturer certifies filter performance for a differential of up to 5 inches of water. In general, filter efficiency improves as filter loading occurs, within the filter design criteria. A continuous flow recorder for the exiting air stream from the FBI plenum has a readout in the Building Utilities Control Room. Damage to filter banks which results in significant filter penetration, as well as particulate loading on the filters, will be indicated by changes in the flow readings, as well as in the measured pressure differentials. Redundant filter banks provide for backup filtration capability should a filter bank be damaged, but even damaged filter banks

can provide significant filtration capability, depending on the extent of the damage.

The filter plenum which houses the last four filter banks serving the FBI is kept locked when unattended. Only authorized personnel may sign out the key to the plenum, and a log is kept of those personnel. The fourth filter stage and the plenum air lock are monitored monthly for radioactivity contamination by the Radiation Monitoring group at the Plant.

Two exhaust fans serve the FBI plenum. One operates continuously; the other serves as a standby unit. One of the fans is on emergency power, which allows operation on generator-produced power if standard building power is lost. All utilities controls and monitoring is on emergency power; this includes fans and their controls, radioactivity sampling and monitoring systems, and the heat detector alarm systems.

The filters themselves are fire resistant - as demonstrated in the heated air and spot flame tests - and combustible materials are not stored in the plenum area. A Temperature Indicating and Recording Alarm (TIRA) system activates an alarm and recorder in the Building Utilities Control room when air temperature in the FBI plenum reaches 120 degrees F. An inspection by the Utilities Operator would then determine the cause of the alarm and any corrective action. In addition, the plenum is equipped with two sprinkler deluge systems. The first is installed prior to a fire metal screen that precedes the 1st stage of the HEPA filters. This sprinkler system activates automatically (190 degrees F activation point) from a heat detector located in the ductwork prior to the fire metal screen. The screen prevents water carryover to the first HEPA stage. The second sprinkler system is located immediately before the 1st HEPA stage and is manually activated. HEPA filter requirements mandate a minimum 99.97% filtration efficiency for 1 hour even when filters are in an atmosphere of 100% relative humidity and under a pressure differential of 10 inches of water. The 190 degree heat detector triggers audible alarms in the building, at the Fire Department, at Plant Security, and audible and visual alarms at the Building Utilities Control Room. The building has its own Building Emergency Support Team, trained in immediate response to an alarm, and the Plant has a fully trained and equipped Fire Department which can respond within minutes of an alarm.

Spills of radioactive material within the building would remain contained in the building. Any aerosols would be subject to HEPA filtration in the exiting air stream. The plenum has a dedicated drain system that is part of the Plant Process Waste system. Plant surface water control includes a system of holding ponds for retention onsite of any outdoor liquid releases of materials which might ultimately be subject to surface water runoff.

The Rocky Flats Plant has an onsite Emergency Response Plan, as well as a Radiological Emergency Response Plan developed by the State of Colorado Division of Disaster Emergency Services

(DODES). The State Plan is exercised annually and onsite emergency procedures are exercised frequently.

PROJECTED RADIOACTIVITY EMISSIONS AND RADIATION DOSES

Projected air emissions from the Trial Burn are calculated as 3×10^{-10} uCi of plutonium and 3×10^{-12} uCi of uranium. From routine operations, estimated emissions are 1×10^{-7} uCi per year for plutonium and 1×10^{-11} uCi per year for uranium. These emissions were calculated using assumptions that would tend to overestimate the emission values. For comparison, total Plant emissions for a year are typically about 10 - 20 uCi of plutonium and 20 - 40 uCi of uranium.

Projected radiation doses to a member of the public are 2×10^{-15} rem (50-year committed effective dose equivalent) from the Trial Burn and 7×10^{-13} rem per year from routine operations. These values may be compared with the radiation dose standard for public protection of 0.1 rem per year for continuous exposure. Radiation dose received by Denver area residents from naturally-occurring radiation is about 0.26 rem per year. The radiation dose standard is for doses received from sources other than natural background radiation and medical sources of radiation exposures.

SUMMARY

Calculated air emissions, air concentrations, and radiation doses at the Rocky Flats Plant boundary from both the Trial Burn and routine operations of the Fluidized Bed Incinerator are negligible. These calculations include particulate emissions reduction using High Efficiency Particulate Air (HEPA) filters for the air effluent from the FBI.

Adherence to stringent standards concerning HEPA filter design, construction, installation, maintenance, security, and testing ensures the proper performance of the HEPA filter system. Extensive experience at the Rocky Flats Plant and at other facilities has shown HEPA filter technology to be dependable and effective for the removal of airborne particulates.

Efficiency," is the basic standard for HEPA filter media and DOD Military Specification MIL-F-51068, "Military Specification: Filter, Particulate, High-Efficiency, Fire Resistant," specifies required qualification tests on the filters.(DD80, DD81) Both of these specifications are referenced in NE F 3-45.

Other applicable DOE Nuclear Standards include NE F 3-42, "Operating Policy of DOE Filter Test Program," NE F 3-43, "Quality Assurance Testing of HEPA Filters," and NE F 3-44, "DOE Filter Test Facilities Quality Program Plan."(US86b, US86c, US86d)

The Rocky Flats Plant follows the American National Standard/American Society of Mechanical Engineers standard ANSI/ASME N509, "Nuclear Power Plant Air Cleaning Units and Components," regarding design, size, construction, and radiation resistance of its HEPA systems.(AM76)

Vendor qualification testing of filters is conducted at Edgewood Arsenal in accordance with requirements in MIL-F-51068. MIL-F-51068 includes performance requirements on DOP smoke penetration, resistance to airflow, resistance to rough handling, resistance to pressure, conditioning, resistance to heated air, spot flame resistance, resistance to environmental exposure, and workmanship.

Additionally, candidate filters are tested by Underwriters Laboratory (UL) for UL approval under the American National Standards Institute (ANSI) standard ANSI/UL-586, "Standard for Test Performance of High Efficiency, Particulate, Air Filter Units."(UL77) Tests are for efficiency, DOP (Dioctyl phthalate) penetration, moist air, heated air, spot flame, and low temperature performance.

Upon arrival at Rocky Flats, each individual HEPA is tested prior to use to ensure that its particulate filtration efficiency is at least 99.97%. Testing is performed in accordance with Plant Services Department Procedure FILT. CERT-SOP-1, "HEPA Filter Testing, Q107 DOP Penetrometer."(RO85)

In actual experience, most filters meet or exceed a filtration efficiency of 99.99%. Testing is performed with monodispersed DOP particles of 0.3 um NMD (Number Mean Diameter), measured with a Q107 DOP penetrometer. An NMD of 0.3 um is the ANSI/ASME-recognized nominal particulate size for minimum filter efficiency. The actual size which is most penetrating through a filter may differ somewhat from this value. Particulates larger than this size are filtered more efficiently because of increased occurrence of impaction and interference; particulates smaller than this size are filtered more efficiently because of increased diffusion into the filter and increased electrostatic precipitation.

Two out of every 350 filters received at Rocky Flats also are tested for compliance with MIL-F-51068 heated air and high

resistance specifications. The heated air test is conducted at ≥700 ±50 degrees F. Experience has shown very little filter deterioration. Filters often retain a filtration efficiency of ≥99.97%, even though only 97% is required by this test.

ANSI/ASME N510, "Testing of Nuclear Air-Cleaning Systems," provides the basis for the field testing of the Rocky Flats HEPA filter systems.(AM80) Installed filter banks are tested in place to meet a minimum overall 99.95% filtration efficiency for the bank. In actual experience, most meet or exceed 99.97%. For this test, polydispersed DOP particles are used of 0.7 um NMD, having a size range of 0.1 to 3 um. Each filter within the bank is tested individually in place. The overall efficiency of the bank is then tested to ensure ≥99.95% performance.

Other DOE facilities besides Rocky Flats use HEPA filters for particulate emissions control. Los Alamos Scientific Laboratory (LASL) has conducted research on the performance of multiple stages of HEPA filters against plutonium oxide aerosols of varying particle sizes. A LASL report issued in 1976 concludes, "Although penetration increased at each succeeding stage and the aerosol size distribution was modified to a more penetrating range. mean penetration of each stage remained generally below 0.0002 [filtration efficiency of 99.98%] under half- and full-flow conditions."(GO76)

No gaseous radioactive constituents are anticipated in the FBI operation. The primary and secondary reaction chambers will operate at about 1000 degrees F. Effluent air will pass through a heat exchanger which will lower the temperature to less than 125 degrees F before it reaches the FBI HEPA prefilters. The boiling points of plutonium and uranium metal are much higher than these temperatures - 5800 and 7500 degrees F, respectively. The vapor pressure of the oxide forms which will be generated in the FBI are even lower than those of the metals.

MAINTENANCE AND SECURITY

Pressure differentials across each filter bank are measured continuously using Magnehelic[R] gauges. Readings on the gauges are inspected at the plenum and recorded monthly. Filters are changed when visual inspection or DOP testing indicate that change is appropriate or when the pressure differential reaches 5 inches of water. The manufacturer certifies filter performance for a differential of up to 5 inches of water. In general, filter efficiency improves as filter loading occurs, within the filter design criteria. A continuous flow recorder for the exiting air stream from the FBI plenum has a readout in the Building Utilities Control Room. Damage to filter banks which results in significant filter penetration, as well as particulate loading on the filters, will be indicated by changes in the flow readings, as well as in the measured pressure differentials. Redundant filter banks provide for backup filtration capability should a filter bank be damaged, but even damaged filter banks

can provide significant filtration capability, depending on the extent of the damage.

The filter plenum which houses the last four filter banks serving the FBI is kept locked when unattended. Only authorized personnel may sign out the key to the plenum, and a log is kept of those personnel. The fourth filter stage and the plenum air lock are monitored monthly for radioactivity contamination by the Radiation Monitoring group at the Plant.

Two exhaust fans serve the FBI plenum. One operates continuously; the other serves as a standby unit. One of the fans is on emergency power, which allows operation on generator-produced power if standard building power is lost. All utilities controls and monitoring is on emergency power; this includes fans and their controls, radioactivity sampling and monitoring systems, and the heat detector alarm systems.

The filters themselves are fire resistant - as demonstrated in the heated air and spot flame tests - and combustible materials are not stored in the plenum area. A Temperature Indicating and Recording Alarm (TIRA) system activates an alarm and recorder in the Building Utilities Control room when air temperature in the FBI plenum reaches 120 degrees F. An inspection by the Utilities Operator would then determine the cause of the alarm and any corrective action. In addition, the plenum is equipped with two sprinkler deluge systems. The first is installed prior to a fire metal screen that precedes the 1st stage of the HEPA filters. This sprinkler system activates automatically (190 degrees F activation point) from a heat detector located in the ductwork prior to the fire metal screen. The screen prevents water carryover to the first HEPA stage. The second sprinkler system is located immediately before the 1st HEPA stage and is manually activated. HEPA filter requirements mandate a minimum 99.97% filtration efficiency for 1 hour even when filters are in an atmosphere of 100% relative humidity and under a pressure differential of 10 inches of water. The 190 degree heat detector triggers audible alarms in the building, at the Fire Department, at Plant Security, and audible and visual alarms at the Building Utilities Control Room. The building has its own Building Emergency Support Team, trained in immediate response to an alarm, and the Plant has a fully trained and equipped Fire Department which can respond within minutes of an alarm.

Spills of radioactive material within the building would remain contained in the building. Any aerosols would be subject to HEPA filtration in the exiting air stream. The plenum has a dedicated drain system that is part of the Plant Process Waste system. Plant surface water control includes a system of holding ponds for retention onsite of any outdoor liquid releases of materials which might ultimately be subject to surface water runoff.

The Rocky Flats Plant has an onsite Emergency Response Plan, as well as a Radiological Emergency Response Plan developed by the State of Colorado Division of Disaster Emergency Services

(DODES). The State Plan is exercised annually and onsite emergency procedures are exercised frequently.

PROJECTED RADIOACTIVITY EMISSIONS AND RADIATION DOSES

Projected air emissions from the Trial Burn are calculated as 3×10^{-10} uCi of plutonium and 3×10^{-12} uCi of uranium. From routine operations, estimated emissions are 1×10^{-7} uCi per year for plutonium and 1×10^{-11} uCi per year for uranium. These emissions were calculated using assumptions that would tend to overestimate the emission values. For comparison, total Plant emissions for a year are typically about 10 - 20 uCi of plutonium and 20 - 40 uCi of uranium.

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SUMMARY

Calculated air emissions, air concentrations, and radiation doses at the Rocky Flats Plant boundary from both the Trial Burn and routine operations of the Fluidized Bed Incinerator are negligible. These calculations include particulate emissions reduction using High Efficiency Particulate Air (HEPA) filters for the air effluent from the FBI.

Adherence to stringent standards concerning HEPA filter design, construction, installation, maintenance, security, and testing ensures the proper performance of the HEPA filter system. Extensive experience at the Rocky Flats Plant and at other facilities has shown HEPA filter technology to be dependable and effective for the removal of airborne particulates.

Efficiency," is the basic standard for HEPA filter media and DOD Military Specification MIL-F-51068, "Military Specification: Filter, Particulate, High-Efficiency, Fire Resistant," specifies required qualification tests on the filters.(DD80, DD81) Both of these specifications are referenced in NE F 3-45.

Other applicable DOE Nuclear Standards include NE F 3-42, "Operating Policy of DOE Filter Test Program," NE F 3-43, "Quality Assurance Testing of HEPA Filters," and NE F 3-44, "DOE Filter Test Facilities Quality Program Plan."(US86b, US86c, US86d)

The Rocky Flats Plant follows the American National Standard/American Society of Mechanical Engineers standard ANSI/ASME N509, "Nuclear Power Plant Air Cleaning Units and Components," regarding design, size, construction, and radiation resistance of its HEPA systems.(AM76)

Vendor qualification testing of filters is conducted at Edgewood Arsenal in accordance with requirements in MIL-F-51068. MIL-F-51068 includes performance requirements on DOP smoke penetration, resistance to airflow, resistance to rough handling, resistance to pressure, conditioning, resistance to heated air, spot flame resistance, resistance to environmental exposure, and workmanship.

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INTRODUCTION

Total emissions, air concentrations, and projected radiation doses were calculated for both the verification run and for expected routine operations for the Rocky Flats Plant Fluidized Bed Incinerator (FBI). While these calculations do not represent as comprehensive a pathway analysis as has been done previously for all Plant emissions in the Rocky Flats Environmental Impact Statement (EIS), they do include the major contributions to radiation dose and provide estimates of the general significance of the FBI operation on public health.(US80) Several assumptions were incorporated into the calculations which would tend to overestimate the resulting emissions, concentration, and dose values. Results of the calculations indicate that concentrations and projected radiation doses would be far below applicable radiation protection standards. Radiation doses would be insignificant in comparison to those received by Denver area residents from exposure to naturally occurring radiation and radioactive materials.

BASIS OF THE CALCULATIONS AND ASSUMPTIONS MADE

Verification Run -

Six individual runs currently are proposed for the FBI verification run. This report revision includes some changes in waste feed rates and constituents since the original version of March 9, 1987. However, the resulting changes in radioactivity emissions, air concentrations, and radiation doses are insignificant. Three of the runs will be for liquid waste and three for solid waste. Each run will last for 4 hours. Two of the liquid waste runs will contain no radioactivity contamination. Two of the solid runs will contain waste contaminated with depleted uranium. One of the solid waste runs and one of the liquid waste runs will include plutonium-contaminated waste. Specific information on the six runs is given in the accompanying tables.

The depleted uranium concentration in the verification runs will be 0.136 and 0.20 weight percent. The plutonium concentration will be 100 nanocuries (nCi) per gram of waste. The alpha-radiation specific activity of depleted uranium is 3.8×10^{-7} Curies per gram and of plutonium is 0.0732 Curies per gram. Beta radiation was not included in these specific activities because beta radiation is a relatively insignificant contributor to dose and omitting it in the specific activity values tends to overestimate the calculated concentrations and doses. Additional information on isotopic composition and specific activity may be found in the Rocky Flats Plant Environmental Impact Statement (EIS).(US80)

The air emission flow rate used for the building exit is 8636 cubic meters per hour. This is based on the average flow rate for the ventilation system serving the FBI in 1986. It is used to calculate the radioactivity concentration of air at the point it exits the building.

The relative concentration of radioactivity at the Plant boundary (X/Q) (from a unit concentration release) downwind from the emission point is calculated using the Gaussian form of solution to diffusion equations. The symbol, X, represents the concentration (in picocuries per cubic meters) and the symbol, Q, represents the radioactivity emission rate (in picocuries per second). The Gaussian distribution yields a peak value along the centerline of the emitted plume with the values falling off exponentially in both directions normal to the wind direction.

For the calculations in this report, the following assumptions were made, many of which tend to maximize the calculated concentrations:

1) Releases are at ground-level from a point source;

2) There is no depletion of the airborne effluent by washout, settling, or surface deposition;

3) There are no significant terrain changes near the Plant site;

4) Plume centerline concentrations are calculated;

5) No reduction in concentration is made for building wake dilution;

6) Wind speed is 3 meters per second, atmospheric stability corresponds to a Pasquill category E;

7) The hypothetical individual receiving the dose was located at the nearest Plant boundary (1.2 miles) and was impacted by the centerline effluent plume concentration throughout all incinerations performed. In fact no one resides at this location.

The resulting equation for relative concentration, is

$$X/Q = 1/(\pi \sigma_y \sigma_z \bar{u}) = 3.5 \times 10^{-5} \text{ s/m}^3$$

as defined in the Rocky Flats Environmental Impact Statement. (US80)

The breathing rate assumed for the postulated impacted individual was 2.66 X 10^2 milliliters per second.

A minimum a five stages of High Efficiency Particulate Air (HEPA) filters will be used to filter particulates from the FBI air effluent prior to its exiting the building. Each of the HEPA filters is individually tested and certified to provide a minimum filtration efficiency of 99.97%. Once installed the HEPA bank is tested to assure a filtration efficiency of 99.95% or more. For these calculations, it was assumed that the first bank of HEPA filters provides a filtering efficiency of 99.95% and that the subsequent four banks provide an efficiency of 99.8% each. The resulting HEPA filter reduction factor is 8×10^{-15}. This is consistent with the assumptions made in the EIS.

It also was assumed in the calculations that no plutonium and uranium remain trapped in the incinerator fluidized bed ash and that all of the radioactivity is contained in the exiting incinerator air stream. This assumption maximizes the radioactivity which challenges the HEPA filters.

Radiation dose conversion factors for uranium and plutonium are 50-year committed effective dose equivalent conversion factors calculated from radiation dosimetry data provided in Publication No. 30 of the International Commission on Radiological Protection.(IN79) Uranium-238 was used to represent depleted uranium and plutonium-239 was used for plutonium. These isotopes are the major constituents of the isotopic mixtures of these materials and the most significant contributors to radiation dose from them. The 50-year committed effective dose equivalent conversion factor for uranium is 1.2×10^{2} rem per microcurie inhaled and for plutonium is 5.1×10^{2} rem per microcurie inhaled. Inhalation is the predominant pathway for radiation dose for both of these materials; all other pathways are insignicant in comparison.

Routine Operations -

For emission, concentration and dose calculations for routine operations of the FBI, the plutonium concentration in the waste was assumed to be 100 nanocuries per gram of waste. During routine operations, actual plutonium concentrations should be much less than this maximum. For these calculations the uranium concentration was assumed as 1×10^{4} picocuries per liter of waste. This is at the high end of the concentrations currently measured in candidate liquid waste streams for the FBI. This concentration was assumed for both liquid and solid waste. It is expected that the solid waste concentration would be lower.

It was assumed that 200 tons of low level waste would be incinerated per year, although current expectations are somewhat lower than this. The maximum feed rate of waste would be 150 pounds per hour for solids and 60 pounds per hour for liquids. For these calculations, a feed rate of 150 pounds per hour was used for all of the waste, because this rate tended to overestimate resulting concentrations and doses.

Specific activities, air emission flow rate, X/Q, HEPA filtration efficiency, breathing rate, and radiation dose conversion factors all were the same as those assumed for the verification run.

RESULTS

Calculated radioactive emissions from the verification run are 3 X 10^{-10} microcuries for plutonium and 3 X 10^{-12} microcuries for uranium. Calculated air concentrations at the exit point from the building are 5 X 10^{-9} picocuries per cubic meter for plutonium and 4 X 10^{-11} picocuries per cubic meter for uranium. At the Plant boundary, verification run air concentrations are 4 X 10^{-13} picocuries per cubic meter for plutonium and 4 X 10^{-15} picocuries per cubic meter for uranium. For comparison, the Department of Energy Derived Concentration Guide for protection of the public is 0.02 picocuries per cubic meter for plutonium and 0.1 picocuries per cubic meter for uranium and assumes a continuous intake. The Colorado Department of Health concentration limit is 0.02 picocuries per cubic meter for plutonium and 1 picocurie per cubic meter for uranium, assuming continuous intake.

Calculated radioactive emissions for routine operations are 1 X 10^{-7} picocuries per cubic meter for plutonium and 1 X 10^{-11} picocuries per cubic meter for uranium. Air concentrations at the exit point from the building are 6 X 10^{-9} picocuries per cubic meter for plutonium and 6 X 10^{-13} picocuries per cubic meter for uranium. At the Plant boundary, routine operations air concentrations are 5 X 10^{-13} picocuries per cubic meter for plutonium and 5 X 10^{-17} picocuries per cubic meter for uranium. Again for comparison, the Department of Energy Derived Concentration Guide for protection of the public is 0.02 picocuries per cubic meter for plutonium and 0.1 picocuries per cubic meter for uranium.

Calculated radiation doses to a hypothetical individual located at the nearest Plant boundary were 2 X 10^{-15} rem from the verification run and 7 X 10^{-13} rem per year of routine operations. These values may be compared with the radiation dose standard for public protection of 0.1 rem per year for continuous exposure. Radiation dose received by Denver area residents from naturally-occurring radiation is about 0.26 rem per year. The radiation dose standard is for doses received from sources other than natural background radiation and medical sources of radiation exposures.

DISCUSSION

In the preceding assessment, assumptions were made to simplify calculations while still providing a general indication of the magnitude of impact on public health which could be associated with the Fluidized Bed Incinerator operations. Many of the assumptions tended to overestimate the resulting emissions, concentrations, and dose values.

Plutonium is the most significant contributor to projected offsite doses, and the assumption of the amount of plutonium that would be involved in routine incinerator operations is greatly overestimated. Radiation doses were calculated for an individual residing continuously at the Plant boundary, impacted by the highest air concentrations in the emission plume during all periods of incineration. No individual would actually experience that much exposure.

Calculated air concentrations and resulting radiation doses are many orders of magnitude below radiation protection standards which have been adopted by the Department of Energy, the Colorado Department of Health, and the Environmental Protection Agency. The estimated radiation doses are well below the radiation doses received from natural background radiation, even using the overestimating assumptions made in this assessment. Radiation protection standards are established on the basis of comprehensive health studies and recommendations made by such scientific advisory organizations as the National Academy of Sciences, the National Council of Radiation Protection and Measurements, and the International Commission on Radiological Protection. The standards are set at levels which would result in a negligible health risk to members of the public who might be exposed to these levels. Actual radiation doses which might be received by the public as a result of the Rocky Flats Plant Fluidized Bed Incinerator operation are far below these levels.

FLUIDIZED BED INCINERATOR

PROPOSED VERIFICATION PLAN

REVISION 6 MAY 1987

					DEPLETED URANIUM					PLUTONIUM				
								Air Concentration					Air Concentration	
Run #	Type	Waste Rate Per Run (lbs/hr)	Total Waste Per Run (lbs)	CCl4 Per Run (lbs)	(lbs)	(g)	(Ci)	at Bldg. Exit (pCi/m^3)	at Plant Boundary (pCi/m^3)	(lbs)	(g)	(Ci)	at Bldg. Exit (pCi/m^3)	at Plant Boundary (pCi/m^3)
1	Liquid	60	240	12.0										
2	Liquid	80	320	16.0										
3	Solid	180	720	15.2	1.0	454	$2X10^{-4}$	$4X10^{-11}$	$4X10^{-15}$					
4	Solid	125	500	10.5	1.0	454	$2X10^{-4}$	$4X10^{-11}$	$4X10^{-15}$					
5	Solid	125	500	10.5						$6X10^{-4}$	0.27	0.02	$5X10^{-9}$	$4X10^{-13}$
6	Liquid	36	144	7.2						$2X10^{-4}$	0.089	0.007	$2X10^{-9}$	$1X10^{-13}$

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FLUIDIZED BED INCINERATOR - VERIFICATION RUN

PLUTONIUM INCINERATION

2 runs; 4 hours per run; 144 lbs waste per liquid run; 500 lbs waste per solid run; 100 nCi Pu per gram of waste; 0.0732 Ci alpha activity per gram Pu; 8636 cubic meters per hour air emission flow rate; HEPA filter reduction factor = 8 x 10^{-15}; X/Q = 3.5 x 10^{-5} seconds per cubic meter

<u>Plutonium incinerated per run</u> -

SOLID: (500 lbs waste/run)(454 g waste/lb waste)(100 nCi Pu/g waste)(1 X 10^{-9} Ci/nCi) = 0.02 Ci Pu/solid run

LIQUID: (144 lbs waste/run)(454 g waste/lb waste)(100 nCi Pu/g waste)(1 X 10^{-9} Ci/nCi) = 0.007 Ci Pu/liquid run

<u>Conversion to grams and pounds of plutonium incinerated per run</u> -

SOLID: (0.02 Ci Pu/run)/(0.0732 Ci Pu/g Pu) = 0.31 grams Pu/solid run
(0.31 grams Pu/solid run) (0.00220 lb/g) = 6.8 X 10^{-4} lb Pu/solid run
LIQUID: (0.007 lb U/run)/(0.0732 Ci Pu/g Pu) = 0.089 grams Pu/liquid run
(0.089 grams Pu/liquid run) (0.00220 lb/g) = 2.0 X 10^{-4} lb Pu/liquid run

<u>Total plutonium emissions</u> -

SOLID: (0.02 Ci Pu/run)(1 run)(1 X 10^{6} µCi/Ci)(8 X 10^{-15}) = 2 X 10^{-10} uCi plutonium emissions
LIQUID: (0.007 Ci Pu/run)(1 run)(1 X 10^{6} uCi/Ci)(8 X 10^{-15}) = 5 X 10^{-11} uCi plutonium emissions
TOTAL PLUTONIUM EMISSIONS = 3 X 10^{-10} uCi

<u>Air effluent concentration at building exit</u> -

SOLID: (0.02 Ci Pu/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})/((8636 m^3/hr)(4 hrs/run)) = 5 X 10^{-9} pCi/m^3
LIQUID: (0.007 Ci Pu/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})/((8636 m^3/hr)(4 hrs/run)) = 2 X 10^{-9} pCi/m^3

<u>Air concentration at Plant boundary</u> -

SOLID: (0.02 Ci Pu/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})(3.5 X 10^{-5} s/m^3)/((4 hr/run)
(60 min/hr)(60 s/min)) = 4 X 10^{-13} pCi/m^3 at Plant boundary
LIQUID: (0.007 Ci Pu/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})(3.5 X 10^{-5} s/m^3)/((4 hr/run)
(60 min/hr)(60 s/min)) = 1 X 10^{-13} pCi/m^3 at Plant boundary

FLUIDIZED BED INCINERATOR - VERIFICATION RUN

URANIUM INCINERATION

2 solid runs; 4 hours per run; 720 lbs waste per first run; 500 lbs waste per second run; 0.136% depleted uranium by weight for first run; 0.20% depleted uranium by weight for second run; 3.8 X 10^{-7} Ci alpha activity per gram U; 8636 cubic meters per hour air emission flow rate; HEPA filter reduction factor = 8 x 10^{-15}; X/Q = 3.5 x 10^{-5} seconds per cubic meter

Uranium incinerated per run -

FIRST: (720 lbs waste/run)(0.00136 lb U/lb waste) = 1.0 lb U/ first run
SECOND: (500 lbs waste/run)(0.0020 lb U/lb waste) = 1.0 lb U/second run

Conversion to grams and Curies of uranium incinerated per run -

(1.0 lb U/run)(454 g U/lb U) = 454 grams U/run

(454 g U/run)(3.8 X 10^{-7} Ci U/g U) = 2 X 10^{-4} Ci U/run

Total uranium emissions -

(2 X 10^{-4} Ci U/run)(2 runs)(1 X 10^{6} uCi/Ci)(8 X 10^{-15}) = 3 X 10^{-12} uCi total uranium emissions

Air effluent concentration at building exit -

(2 X 10^{-4} Ci U/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})/((8636 m^3/hr)(4 hrs/run)) = 4 X 10^{-11} pCi/m^3

Air concentration at Plant boundary -

(2 X 10^{-4} Ci U/run)(1 X 10^{12} pCi/Ci)(8 X 10^{-15})(3.5 X 10^{-5} s/m^3)/((4 hr/run)
(60 min/hr)(60 s/min)) = 4 X 10^{-15} pCi/m^3 at Plant boundary

FLUIDIZED BED INCINERATOR - VERIFICATION RUN

RADIATION DOSE AT PLANT BOUNDARY

Breathing rate = 2.66×10^2 milliliters per second; dose conversion factors = 5.1×10^2 rem per microcurie, plutonium, and 1.2×10^2 rem per microcurie, uranium

DOSE FROM PLUTONIUM:

$(4 \times 10^{-13}$ pCi/m^3)$(1 \times 10^{-6}$ uCi/pCi)$(2.66 \times 10^2$ ml/s)$(5.1 \times 10^2$ rem/uCi)(8 hr/2 runs)(60 min/hr)(60 s/min)/$(1 \times 10^6$ ml/m^3) = 2×10^{-15} rem/2 runs plutonium dose at Plant boundary

DOSE FROM URANIUM:

$(4 \times 10^{-15}$ pCi/m^3)$(1 \times 10^{-6}$ uCi/pCi)$(2.66 \times 10^2$ ml/s)$(1.2 \times 10^2$ rem/uCi)(8 hr/2 runs)(60 min/hr)(60 s/min)/$(1 \times 10^6$ ml/m^3) = 4×10^{-18} rem/2 runs uranium dose at Plant boundary

Note: The uranium dose is an insignificant contributor to total dose from plutonium and uranium.

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FLUIDIZED BED INCINERATOR - ROUTINE OPERATIONS

PLUTONIUM INCINERATION

200 tons of waste incinerated per year; 100 nCi Pu per gram of waste; 0.0732 Ci alpha activity per gram of waste; 8636 cubic meters per hour air emission flow rate; feed rate of waste = 150 lbs per hour; HEPA filter reduction factor = 8×10^{-15}; X/Q = 3.5×10^{-5} seconds per cubic meter

<u>Plutonium incinerated per year</u> -

(200 tons waste/year)(2000 lbs/ton)(454 g/lb)(100 nCi Pu/g waste)(1×10^{-3} uCi/nCi) = 1.8×10^{7} uCi maximum Pu incinerated per year

<u>Plutonium air emissions per year</u> -

(1.8×10^{7} uCi Pu/year)(8×10^{-15}) = 1×10^{-7} uCi Pu/year air emissions

<u>Air effluent concentration at building exit</u> -

(150 lbs waste/hr)(454 g/lb)(100 nCi Pu/g waste)(1×10^{3} pCi/nCi)(8×10^{-15})/(8636 m^3/hr) = 6×10^{-9} pCi/m^3 at building exit

<u>Air concentration at Plant boundary</u> -

(150 lbs waste/hr)(454 g/lb)(100 nCi Pu/g waste)(1×10^{3} pCi/nCi)(8×10^{-15})(3.5×10^{-5} s/m^3) /((60 min/hr)(60 s/min)) = 5×10^{-13} pCi/m^3 at Plant boundary

FLUIDIZED BED INCINERATOR - ROUTINE OPERATIONS

URANIUM INCINERATION

200 tons of waste incinerated per year; 100 nCi Pu per gram of waste; 8636 cubic meters per hour air emission flow rate; feed rate of waste = 150 lbs per hour; concentration of uranium = 1×10^{4} picocuries per liter; HEPA filter reduction factor = 8×10^{-15}; X/Q = 3.5×10^{-5} seconds per cubic meter

Uranium incinerated per year -

(200 tons waste/year)(2000 lbs/ton)(1×10^{4} pCi U/1 waste)(1×10^{-6} uCi/pCi)/((0.264 gal/1)(8.5 lbs/gal)) = 1.78×10^{3} uCi uranium incinerated per year

Uranium air emissions per year -

(1.78×10^{3} uCi U/year)(8×10^{-15}) = 1×10^{-11} uCi/year air emissions

Air effluent concentration at building exit -

(150 lbs waste/hr)(1×10^{4} pCi U/1 waste)(8×10^{-15})/((8.5 lb/gal)(0.264 gal/1)(8636 m^3/hr) = 6×10^{-13} pCi/m^3 at building exit

Air concentration at Plant boundary -

(150 lbs waste/hr)(1×10^{4} pCi U/1 waste)(8×10^{-15})(3.5×10^{-5} s/m^3)/((8.5 lb/gal)(0.264 gal/1)(60 min/hr)(60 s/min)) = 5×10^{-17} pCi/m^3 at Plant boundary

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FLUIDIZED BED INCINERATOR - ROUTINE OPERATIONS

RADIATION DOSE AT PLANT BOUNDARY

Breathing rate = 2.66×10^{2} milliliters per second; dose conversion factors = 5.1×10^{2} rem per microcurie, plutonium, and 1.2×10^{2} rem per microcurie, uranium

<u>Hours of incineration operation per year</u> -

(200 tons waste/year)(2000 lb/ton)/(150 lb/hr) = 2667 hours/year incinerator operating

Dose from <u>plutonium</u> -

(5.3×10^{-13} pCi/m^3)(2667 hr/year)(60 min/hr)(60 s/min)(2.66×10^{2} ml/s)(1×10^{-6} uCi/pCi) (5.1×10^{2} rem/uCi)/(1×10^{6} ml/m^3 = 7×10^{-13} rem/year plutonium dose at Plant boundary

<u>Dose from uranium</u> -

(5.2×10^{-17} pCi/m^3)(2667 hr/year)(60 min/hr)(60 s/min)(2.66×10^{2} ml/s)(1×10^{-6} uCi/pCi) (1.2×10^{2} rem/uCi)/1×10^{6} ml/m^3 = 2×10^{-17} rem/year uranium dose at Plant boundary

Note: The uranium dose is an insignificant contributor to total dose.

FLUIDIZED BED INCINERATOR

REFERENCES

US80 U.S. Department of Energy, April 1980, Environmental Impact Statement, Rocky Flats Plant Site, DOE/EIS-0064, Washington, D.C.

In79 International Commission of Radiological Protection, 1979, Annals of the ICRP: ICRP Publication 30, Limits for Intakes of Radionuclides by Workers, Pergamon Press Ltd., Oxford, England.

ATTACHMENT #3

WASTE STREAMS THAT ARE CANDIDATES FOR FBI INCINERATION

BUILDING	WASTE STREAM ID	GEN/RATES	WASTE DESCRIPTION
371	13170	30 gal/yr	Machine oil
371	11630	76 gal/yr	Lubricating oil
444	14080	5000 lbs/yr	Kimwipes (Industrial Paper Wipes)
444	14140	5000 lbs/yr	Kimwipes
444	14220	5000 lbs/yr	Kimwipes
444	14290	5000 lbs/yr	Kimwipes
444	14510	(Not Avail)	Chlorinated Solvent
444	14320	2750 gal/yr	Cutting oil
528	15360	10 lbs/yr	Kimwipes
559	16360	7 gal/yr	Solvent and organic lab waste (from infrared analysis)
559	16530	9 gal/yr	Organic waste from liquid extraction process
559	16100	1433 gal/yr	Organic/aqueous lab waste
559	17140	1 gal/yr	Vacuum pump oil
559	17190	1 gal/yr	Vacuum pump oil
559	17230	1 gal/yr	Vacuum pump oil
559	13880	100 lbs/yr	Solvent containing Kimwipes
559	16170	15,840 lbs/yr	Represent 23
559	17000	15,840 lbs/yr	Non-line combustibles
559	17410	15,840 lbs/yr	Suspect are Rad. rather than mixed
707	13520	5000 lbs/yr	Represents to non-line combustibles
707	13670	1200 gal/yr	Oil/solvent (maybe TRU)
707	13700	550 gal/yr	Vacuum pump oil (non-line)
708	10590	100 gal/yr	Oil
708	10690	200 lbs/yr	Rags with chlorinated solvent
729	13860	100 lbs/yr	Solvent containing wipes
771	21530	3000 lbs/yr	
771	22420	2496 lbs/yr	Listed as non-line combustible
771	22460	5000 lbs/yr	Suspect are rad. rather than mixed

771	22560	450 lbs/yr	
771	22790	100 lbs/yr	
771	22430	120 gal/yr	Oil/Coolant from machining oper.
771	22610	400 gal/yr	Lubrication oil
774	09280	10964 gal/yr	Oil from 444 machining & lub oper.
774	09310	500 lbs/yr	Non-line combustibles (? rad. waste)
776	12120	365 lbs/yr	Kimwipes with solvents (Freon, Trich)
776	12050	360 gal/yr	Cutting oil & lub oil
777	12190	100 lbs/yr	Gauze and Kimwipes (Methanol,Trich)
777	12340	480 lbs/yr	Gauze and Kimwipes (Methanol, Trich)
777	12370	100 lbs/yr	Kimwipes (Trich)
777	11520	480 lbs/yr	Gauze and wipes (Trich)
777	11540	400 lbs/yr	Rags, and wipes (Freon & Chlor. Solv)
777	12230	1080 gal/yr	Trichlorethane solvent
777	12420	25 gal/yr	Calibration oil
779	15780	100 lbs/yr	Solvent containing wipes
779	15400	480 lbs/yr	Kimwipes solvents
779	19740	60 gal/yr	Cutting oil
779	19220	10 gal/yr	Hydraulic oil
779	15770	500 gal/yr	Oil
865	04140	600 gal/yr	Cutting Oil
865	04210	1 gal/yr	Cutting oil
865	05170	1 lb/yr	Composite oils from building
865	04190	75000 lbs/yr	Kimwipes (Uranium & Trich)
881	03290	80 gal/yr	Organic lab waste (Xylene)
881	04620	200 lbs/yr	Kimwipes
881	04750	100 lbs/yr	Kimwipes/ethanol
881	04760	100 lbs/yr	Kimwipes/solvents
883	04880	5000 gal/yr	Oil/solvents
886	05130	300 gal/yr	Paints & solvents
111	06630	240 lbs/yr	Kimwipes & rags
111	06690	240 lbs/yr	Kimwipes & rags
111	06800	100 lbs/yr	Kimwipes & film packs
121	04780	50 lbs/yr	Gun patches
123	02800	100 gal/yr	Toluene waste bottle
123	02830	3 gal/yr	Waste resin

123	02860	100 gal/yr	Toluene Waste bottle
123	02880	50 lbs/yr	Waste resin
123	02930	5 lbs/yr	Waste resin
123	03010	100 gal/yr	Scintillation cocktail (organic solvent in analytical samples)
123	03060	3 gal/yr	Used oil
125	02550	100 lbs/yr	Kimwipes
125	02570	1000 gal/yr	Cleaning Waste
125	02590	1 gal/yr	Waste oil
125	02720	2 gal/yr	Waste oil
125	02740	50 gal/yr	Oil from dividers
125	02750	50 gal/yr	Oil bath dump
125	02760	100 gal/yr	Freon
127	04930	4 gal/yr	Oil
130	07330	100 lbs/yr	Polaroid film backing
130	07390	100 lbs/yr	Kimwipes
331	06420	600 gal/yr	Cleaning solvent
333	06130	300 lbs/yr	Rags
334	07150	100 gal/yr	Cutting & gear box oils
334	07620	500 gal/yr	Waste oils
334	07650	500 gal/yr	Degreasing solvents
334	07220	5000 gal/yr	Waste oil
334	07240	480 gal/yr	Waste solvent
335	07020	200 gal/yr	Waste solvent
377	09950	100 gal/yr	Waste oil
439	00080	100 gal/yr	Solvent from cleaning bath
439	00090	200 lbs/yr	Kimwipes
439	01670	300 gal/yr	Composite oil/solvent
440	01430	200 gal/yr	Waste oil
440	00150	100 lbs/yr	Paints & solvents
440	00200	500 lbs/yr	Kimwipes & rags
440	01950	200 gal/yr	Solvents & thinners
440	01390	500 lbs/yr	Kimwipes
440	01480	500 lbs/yr	Kimwipes
440	00120	600 lbs/yr	Kimwipes
440	01680	660 gal/yr	Solvent

443	00310	20 gal/yr	Trichloroethylene
443	00320	200 lbs/yr	Rags
449	11070	200 gal/yr	Rags
449	11090	660 lbs/yr	Misc. Trash
449	11100	1 gal/yr	Oil
460	00480	150 gal/yr	Used isopropyl alcohol
460	00490	110 lbs/yr	Kimwipes
460	00420	200 gal/yr	Ice & freon
460	00440	125 gal/yr	Cec bee 105HF and Alcohol
460	01540	50 gal/yr	Freon
460	00570	100 lbs/yr	Nuocure
460	00650	1800 gal/yr	Freon, Alcohol, Water
460	00730	100 gal/yr	Petroleum coolant
460	02020	100 gal/yr	Oil
460	02070	100 gal/yr	Oil
460	02120	100 gal/yr	Transultex A (mineral oil)
460	02130	100 gal/yr	Transultex A
460	02140	100 gal/yr	Transultex A
460	02150	100 gal/yr	Oil
460	02160	100 gal/yr	Transultex A
460	02170	100 gal/yr	Transultex A
460	02180	100 gal/yr	Transultex A
460	00850	25 gal/yr	Oil
460	00860	100 gal/yr	Coolant petroleum based
460	01040	55 gal/yr	Oil
460	01070	48 lbs/yr	Kimwipes
460	01080	150 lbs/yr	Kimwipes
460	01100	165 lbs/yr	Kimwipes & rags
460	01120	165 lbs/yr	Kimwipes & rags
460	01140	165 lbs/yr	Kimwipes & rags
460	01160	100 gal/yr	Cutting oil
460	01230	165 lbs/yr	Kimwipes
460	01250	165 lbs/yr	Kimwipes
460	01260	30 gal/yr	Oil
460	01270	40 lbs/yr	Kimwipes
460	01280	40 lbs/yr	Kimwipes

460	01290	20 gal/yr	Oil
460	01310	50 lbs/yr	Kimwipes
460	01330	50 gal/yr	Solvent
460	01360	20 lbs/yr	Kimwipes and floor dry
460	01870	20 gal/yr	Alcohol
460	01940	5500 gal/yr	Oil from central fuge
515	09860	10 gal/yr	Oil
516	09890	10 gal/yr	Oil
517	09910	10 gal/yr	Oil
518	09930	10 gal/yr	Oil
528	15360	10 lbs/yr	Kimwipes
551	06300	300 lbs/yr	Kimwipes
562	09810	20 gal/yr	Oil
562	09840	20 lbs/yr	Kimwipes
662	04010	30 gal/yr	TCE
662	04020	40 gal/yr	Freon
662	04060	55 gal/yr	Oil
664	17520	140 gal/yr	Oil
664	17550	30 gal/yr	Machining oil
664	17600	6 gal/yr	Compressor oil
668	09570	50 lbs/yr	Rags & alcohol
702	11740	20 gal/yr	Oil
705	20180	15 lbs/yr	Kimwipes
705	20210	5 lbs/yr	Kimwipes
705	20250	3 lbs/yr	Kimwipes
705	20280	1 lb/yr	Kimwipes
709	11690	20 gal/yr	Oil
711	20520	20 gal/yr	Oil
715	09770	100 gal/yr	Oil
715	09800	100 lbs/yr	Oily rags
715	13850	500 gal/yr	Waste oil & coolant
727	09500	20 gal/yr	Oil
727	09520	100 lbs/yr	Kimwipes & solvent
729	10730	20 gal/yr	Oil
750	09090	100 lbs/yr	Kimwipes
750	09110	100 lbs/yr	Kimwipes

770	22650	4700 lbs/yr	Combustibles
770	22570	365 lbs/yr	Rags
780	09590	50 lbs/yr	Rags & TCE
782	13870	100 lbs/yr	Wipes & solvent
788	06070	120 gal/yr	Oil
800	05000	75 gal/yr	Oil
800	05260	5500 gal/yr	Oil
850	04950	1 gal/yr	Oil
928	06860	2 gal/yr	Engine oil
980	06510	1480 lbs/yr	Rags & solvent
980	06520	1000 lbs/yr	Fiberglas resin & catalyst
980	06980	900 lbs/yr	Sawdust & oil
980	06540	100 gal/yr	Oil
980	06550	1500 lbs/yr	Kimwipes
980	06560	1000 gal/yr	Oil
980	06570	480 lbs/yr	Rags & oil
980	06580	480 lbs/yr	Rags & oil
980	06600	1500 gal/yr	Oil & solvents
988	06890	6 gal/yr	Oil
988	06900	5 gal/yr	Oil
991	07480	580 lbs/yr	Kimwipes
991	13840	100 gal/yr	Solvent & wipes
T-750	06020	100 lbs/yr	Kimwipes
T-750	06040	100 lbs/yr	Kimwipes