DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES

MASON & HANGER - SILAS MASON CO., INC.
PANTEX ERDA PLANT

DEVELOPMENT DIVISION

PROGRESS REPORT
JULY - SEPTEMBER 1975

MASTER

For

U.S. Energy Research and Development Administration
Albuquerque Operations Office
Albuquerque, New Mexico

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ABSTRACT

Progress in the development of the closed-pit batch-type incinerator is reported. Phase II, the study of temperature and pressure effects caused by large mass-flow-rates from burning explosives is complete and the data are presented. Based upon these findings this incinerator concept is technically feasible and the present incinerator design, with minor modifications, can meet the requirements of the future HE waste disposal plan at the Pantex Plant.

Future work concerning the pollution aspects of this incinerator design is discussed.

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I. INTRODUCTION

The present research and development effort for the disposal of high explosives (HE) is being conducted for ERDA/ALO by the Mason & Hanger - Silas Mason Co., Inc. The project began January 1971. The objectives of this effort have been: (1) to assess the magnitude of the problem which will exist at ERDA facilities in meeting the new environmental regulations, (2) to determine methods for disposal and (3) to select the best methods and develop pilot-scale processes. This effort has been conducted at the Burlington and Pantex ERDA Plants.

Previous progress reports(1,2) have summarized the quantities and types of waste HE generated at ERDA facilities. Disposal methods—including open burning, detonation, incineration, deep-well injection, ocean dumping, biochemical decomposition and chemical recovery—were surveyed(2). Detonation and combustion products of HE were also measured and results have been presented in previous reports(2,3,4,5,6,7,8). These investigations indicated low concentration levels of primary air pollutants.

Further progress in developing new disposal methods and measuring air pollutants from burning HE have been reported in nine progress reports (3,4,5,6,7,8,9,10,11). After reviewing all methods, incineration has been selected as the best presently known method of disposal and biodegradation was selected as the most feasible long-range recycle method. Development is continuing at Pantex on a closed-pit, batch-type incinerator. A final report has been issued on the Burlington investigation of a rotary incinerator(12).

II. CLOSED-PIT, BATCH-TYPE, FULL-SCALE TEST INCINERATOR

The full-scale test (FST) facility, Fig. 1, was completed in July 1974. The facility is, in essence, an enclosure in which HE can be burned. The present closed-pit incinerator concept is shown in Fig. 2. The facility is located in a remote area (Zone 5) at the Pantex Plant and uses Firing Site No. 21 as the remote control point.

The purpose of the facility is to provide design data for the proposed construction of an incinerator complex at Pantex. This incinerator complex must be capable of processing as much as 250,000 kg (1/2-million lbs) of HE and HE-contaminated material per year. The waste material will consist of a variety of sizes, shapes and types of explosives.

The closed-pit incinerator developmental program consists of four phases. The definition of each phase and the respective time schedule are shown in Fig. 3. Most of the design criteria for the incinerator complex has been determined—Phase II has been completed. The results of Phase II are given in this report.

Fig. 1. Full-Scale Test Facility

Fig. 2. Closed-Pit, Batch-Type Incinerator Concept

	FY 75				FY 76				FY 76A
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	Quarter 1st
I									
II									
III									
IV									

PHASE I Determine feasibility of burning a large quantity of explosive in a closed pit-incinerator.

PHASE II Establish basic design information for the incinerator structure, maximum number of burns per day, and limitation of burn conditions.

PHASE III Define pollution conditions and establish abatement requirements.

PHASE IV Develop burning procedures and safety requirements for the incinerator complex.

Fig. 3. Planned Development Schedule for the Closed-Pit, Batch-Type Incinerator Project

Phase II was the study of temperature and pressure effects caused by large mass flow-rates developed during burning. The temperature and pressure also depend on the thickness of sand used in the overhead filter. In Phase II a systematic variation of both mass flow-rate of HE gases and thickness of sand was conducted. The important design criteria to be realized from Phase II are air temperatures and pressures, overhead I-beam temperatures, air flow requirements, flame containment, wall temperature and I-beam deflection. The data were obtained using thermocouples, temperature sensitive pellets(13) and pressure transducers (Validyne Engineering Corp., Model No. DP15TL). The location of each thermocouple is shown in Fig. 4. Flame containment was evaluated from 16 mm film records. Gas sampling and particulate sampling will be emphasized in Phase III.

Gas generation rates vary widely for the variety of explosive waste anticipated for the disposal program. Burn rates will differ markedly between burns that consume the same total HE weight but contain pieces of different shapes and sizes. Burn rates also depend on the moisture content of the explosive.

Gas generation rates, varied in Phase II, may be categorized as follows: large billet type pieces exhibiting a low exposed surface-area, e.g. 25 kg hemispheres; high-surface-area machining waste with varying moisture content; and a medium-area waste such as pressed pieces a few centimeters in size. Dry machining waste will generate the highest mass flow-rate whereas damp machining waste will produce the lowest rate. The large billets and small pieces develop intermediate flow rates. Explosives, prior to processing (molding granules), burn at a rate between that of dry machining waste and billet-type pieces.

A. PHASE II: RESULTS

A total of 24 burns (Burn Nos. 9 - 32) were conducted during the study. Differing amounts of HE and a variety of exposed surface area conditions, as discussed above, were used. The thickness of the porous flow-filter of sand (8-12 grade) atop the incinerator was varied between 5.1 cm to 12.7 cm. These results (temperatures, pressures, etc.) are given in Tables I and II.

A brief explanation of Tables I and II follows with a detailed analysis given later in the report.

Temperature sensitive pellets(13) were used at the beginning of Phase II mainly to locate hot spots on the bottom side of the I-beams. No serious hot spots were found and thermocouples were used exclusively for the remainder of the investigation. These thermocouples (I-1 and I-2) respond to an average I-beam temperature. The location of all thermocouples is shown in Fig. 4.

Thermocouple Legend:

- Location of I-Beam Deflection Measurement
- A1-A6 --- Air Thermocouples (~ 20 cm below ceiling)
- ⊗ I1-I2 --- I-Beam Thermocouples
- × Floor Thermocouples
- △ W1, W2 --- Wall Thermocouples (1/2, 1 cm deep, respectively)

Fig. 4. Instrumentation Layout

Table I. Phase II - Results

Burn No.	Greatest Pellet Temperature (K)		Maximum Temperature from Thermocouples (K)							
			Air						I-Beam	
	I-Beam	Air	A1	A2	A3	A4	A5	A6	I-1	I-2
9	<480	590	680	720	620	720	780	600	390	370
10	<480	700	900	880	820	950	850	800	-	-
11	<480 >480, <590	810		1050	990	1180	1070	920	560	560
12	None	None	1220	1080	960	1230	1210	980	410	370
13			1140	1110	1000	1200	1080	910	660	590
14			← L O S T →							
15			980	1250	1040	1250	1230	1110	350	350
16			1120	1270	1380	1200	1270	1230	540	540
17			1030	980	920	1150	1140	840	-	-
18			1160	1100	970	1210	1080	1000	710	680
19			1350	-	1510	1370	-	1280	520	-
20			1470	-	1080	1430	-	1270	740	630
21			780	760	690	770	-	720	480	460
22			1280	-	930	1130	-	950	-	610
23			1250	-	1110	1400	-	1140	580	630
24			1250	-	960	1160	-	970	650	640
25			-	-	920	1270	-	920	520	-
26			1260	-	990	1200	-	1020	720	640
27			1480	-	-	1190	-	1640	520	500
28			970	-	800	890	-	800	510	480
29			1270	-	1040	1210	-	1060	720	650
30			1250	-	1060	1190	-	1020	660	640
31			1380	-	1040	1380	-	1070	500	440
32			1280	-	-	1330	-	1230	640	590

Table II. Phase II - Results

Burn No.	Amount of HE (kg)	Thickness of Sand (cm)	Pressure (Pa)		Burn Time (s)	Flame Propagation Time (s)	Avg. Burn Rate (kg/s)	Air Flow Setting	Remarks
			Blower	Max					
9	182	5.1 ↓	70	130	200	36	0.9	4 ↓	Billet Type Pieces
10	363		70	110	180	45	2.0		Billet Type Pieces
11	454		70	100	160	55	2.8		Billet Type Pieces
12	227		70	980	20	13	11.0		Dry Machining Waste
13	454		-	-	130	59	3.6		Billet Type Pieces
14	240		← L O S T →						Dry Machining Waste
15	232		70	1050	16	20	14.0		Dry Machining Waste
16	459		70	1050	90	13	5.0		Dry Machining Waste
17	136		70	840	9	14	16.0		Dry Machining Waste
18	454		70	190	134	40	3.4		Billet Type Pieces
19	465	10.2 ↓	70	1960	13	13	36.0	↓	Dry Machining Waste
20	455		70	220	26	36	18.0		Wet Machining Waste
21	272		120	240	180	190	1.5		Billet Type Pieces
22	454		120	230	150	90	3.0		Billet Type Pieces
23	463		120	570	100	30	4.7		Molding Granules
24	454		150	280	120	45	3.9		Billet Type Pieces
25	227		150	820	50	24	4.6		Dry Machining Waste
26	454		130	220	150	65	3.0		Billet Type Pieces
27	472		-	-	7.0	7.4	66.0		Dry Machining Waste
28	272	12.7	-	-	180	50	1.6		Billet Type Pieces
29	454		160	350	160	40	2.9		Billet Type Pieces
30	454		140	280	140	50	3.3		Billet Type Pieces
31	241		160	550	50	34	4.8		Molding Granules
32	495		150	480	70	34	7.0		Molding Granules

The "flame propagation" time is defined as the time required for the air temperature to reach a maximum. The "burn time" is defined as the time from which the air reaches one-half maximum to the time the air begins to cool and the "air flow setting No. 4" is the louvre position on the blower duct for which both air velocity and air flow are maximum (380 m/s and 4.7 m³/s per blower, respectively).

An example of the burn rate varying with different explosives can be found in Table II. LX-04 machining waste (Burn No. 19) burns faster than PBX 9404 machining waste (Burn No. 16).

The effect of moisture in LX-04 machining waste can be seen by comparing Burn No. 19 (dry) with Burn No. 20 ($17 \pm 8\%$ moisture by weight). The addition of moisture to dry machine waste is one method to vary the burn rate. It is desirable to have some control over burn rates for two reasons. First, it will be mentioned later that dry LX-04 machining waste burns so rapidly that large quantities of it can cause flame leakage (venting) through the overhead filter. This fast burn rate is undesirable.

The second reason to have some control over burn rates is that occasionally "long burns" (5 minutes or more) are observed at the outdoor burning grounds. As is discussed later a "long burn" may produce severe temperatures in both the I-beams and the walls and it would be desirable to investigate the effects of "long burns" in a controlled way.

Only limited success has been gained in controlling burn rates by adding moisture. Better control has been attained using partial confinement in a wooden box to change burn times. Fig. 5 shows 227 kg of LX-04 granules in an open box. Boxes with different heights can be used to obtain different burn times. The example shown in Fig. 5 required 15 minutes to burn. The present plan is to use this technique in Phase IV to investigate limitations resulting from "long burns."

1. Air Temperature

The temperature of the air inside the incinerator was measured using thermocouples A1 through A6 (Fig. 4). These values are given in Table I and also are plotted in Fig. 6. The range of values shown in Fig. 6 indicate the degree of uniformity throughout the incinerator. Slower burn rates produce more uniform air temperatures within the incinerator. Higher burn rates, for a given amount of explosive, produces higher air temperatures, and the larger the amount of explosive the higher the temperature.

Fig. 5. "Long Burn" Test

Fig. 6. Air Temperature in the Incinerator as a Function of HE Weight

No dependence was detected on filter (sand) thickness for the inside air temperature, and the values plotted in Fig. 6 include all of those given in Table I. This insensitivity to filter thickness is in agreement with the predictions of the calculational model presented in Ref. 14. This model predicts that the rise in air temperature, ΔT_{∞} , for a constant burn rate is given by

$$\Delta T_{\infty} = \frac{k}{\beta C_p}$$

where k is the rate of energy release (cal/s), β is the outside air flow (g/s) and C_p is the average specific heat of the air and gases within the incinerator (cal/g °C). If porous-flow is maintained through the filter an increase in thickness of the filter will only result in an increase in pressure inside the incinerator. The temperature will be unchanged if the flow through the filter is unchanged.

It was mentioned in the last quarterly report(15) (Fig. 19, p. 28) that heat radiation is an important heat transfer mechanism within the incinerator. Radiation causes very high instantaneous surface temperatures on the walls and I-beams. One-fourth to one-third of the temperature measured by a thermocouple may be due to heat radiation. Heat radiation is not penetrating radiation and can be very effectively reduced, if need be, by shielding.

Air temperatures in the neighborhood of 1500 - 1600 K have been recorded and the temperature of the fire ball is approximately 1900 K. Chromel-alumel has been used successfully in Phase II. However, at these high temperatures thermocouple instrumentation would have a longer life if a platinum or tungsten base thermocouple was used. Thermocouple signal leads must also be protected from moisture(15).

2. I-beam Temperature, Cooling Times and Deflection

Two I-beams were monitored using a thermocouple (I-1, I-2) attached to the bottom flange of the I-beam on the centerline of the incinerator (Fig. 4). These were recorded as a function of time and the maximum values are listed in Table I.

The maximum I-beam temperatures are plotted in Fig. 7 for the two categories of data in Table III - fast and medium-fast burns. The larger the amount of explosive burned the higher the I-beam temperature and for a given amount of explosive the slower burns heat the I-beams to a higher temperature. For these burn rates and for a capacity-burn (454 kg) or less the temperatures of the I-beams were well below the maximum allowable temperature (810 K or 1000 F).

Fig. 7. Maximum I-Beam Temperature (I-1) Versus Amount of HE Burned for Two Different Burn Rates

Table III. Concrete Wall Temperatures

Burn No.	Amount of HE (kg)	Burn Time (s)	W1 (5 mm Depth)		W2 (10 mm Depth)	
			Maximum Temperature (K)	tMAX (s)	Maximum Temperature (K)	tMAX (s)
15	232	16	540	40	390	230
16	459	90	670	90	480	220
17	136	9	470	50	350	180
18	454	130	720	180	510	350
19	465	13	550	40	370	190
20	455	26	690	70	420	220
21	272	180	390	420	350	550
22	454	150	630	370	420	540
23	463	100	620	200	380	360
24	454	120	-	-	-	-
25	227	49	550	80	400	150
26	454	150	420 (Shielded)	260	400 (Shielded)	360
27	472	7	340 (Shielded)	80	320 (Shielded)	200
28	272	180	570	230	450	320
29	454	160	720	200	530	290
30	454	140	410 (Shielded)	340	380 (Shielded)	400
31	241	50	510	90	380	160
32	495	70	660	110	460	220

Fig. 8 is a graph of I-beam temperature as a function of burn time, in which a fixed amount of HE is burned (454 kg). Even though there is considerable scatter in the data the graph indicates that a slightly longer burn, i.e. 4 or 5 minutes, may heat the I-beams over 810 K. These data, referred to earlier, have generated an interest in investigating "long burns." As stated earlier "long burns" have been observed at the present Pantex Plant burning grounds.

With the aid of the blowers the I-beams can be cooled to within 10 K of ambient temperature(15) two hours after the burn. This makes it possible to reuse the incinerator several times in one work shift. Natural cooling of the I-beams (blowers off) requires 22 hours.

The deflection of the I-beams and the measurement of the deflection was discussed in some detail in Ref. 15. A vertical deflection (sag) of the I-beams at the center of the incinerator during a burn has been measured. A value as high as 35 mm has been observed and the deflection is elastic.

It was surmised(15), based on the temperature dependence of iron and the existing I-beam temperature, that the deflection was not caused by the weakening of the I-beams but that a ΔT between the top and the bottom of the I-beams might cause the deflection. This idea was investigated further.

The same equipment used to measure the I-beam deflection (a bar and pipe combination discussed in Ref. 15) was employed. Instead of mounting the bar and pipe between the I-beam and the concrete floor, a gap (0.6 cm) was left between the bar and the floor. A gap switch was used to record the time behavior of the movement.

Fig. 9 shows the I-beam temperature as a function of time. Superimposed are time markers of other events. Fig. 9 shows that the I-beams begin to move when heat is first applied—long before they reach the maximum temperature. It can be observed that soon after they reach the maximum temperature recovery of the deflection begins. Seemingly, the deflection begins when the I-beams are cool (just beginning to heat) and the recovery begins when the I-beams are hot.

This burn (Burn No. 24) was repeated and the ΔT from the bottom to the top of the I-beam was measured. The results are shown in Fig. 10. The ΔT rises quickly reaching a maximum value at about the same time as the temperature of the bottom of the I-beam reaches a maximum. The data plotted in Figs. 9 and 10, strengthen the contention that the deflection is caused not by the temperature of the I-beam but by the temperature gradient, ΔT .

Static measurements have been made periodically and as yet (for a total number of 32 burns of varying amounts of HE) these deflections appear to have been elastic. The I-beams will continue to be monitored through Phase IV.

Fig. 8. Maximum I-Beam Temperature (I-1) Versus Burn Time

Fig. 9. I-Beam Temperature Measured at the Bottom Flange Versus Time
(Burn No. 24)

-18-

Fig. 10. I-Beam Temperature Vs Time (Burn No. 25)

The I-beam temperatures, as yet, have not been severe and deflections appear to be elastic. However, "long burn" effects have not been evaluated with respect to I-beam temperatures nor is it known what long-term effects are produced by large, repeated, elastic deflections.

3. Wall Temperature

The temperature of the concrete wall was measured at 1/2 and 1 cm depths. The location of the thermocouples is shown in Figs. 4 and 11. The maximum temperatures measured at the respective depths are listed in Table III along with burn number, amount of HE, burn time and the time required to reach the maximum temperature. The analysis parallels that for the I-beams and for much the same reasons. The larger the amount of explosive and the slower the burn results in higher wall temperatures.

To investigate how much of the heat deposited in the walls is due to heat radiation, shields were used as shown in Fig. 12. Clearance between the shield and the wall was provided to allow for air circulation next to the wall. The results are also listed in Table III and plotted in Fig. 13. Ref. 16 discusses the case of calculating the heating (F) an infinite wall which is applicable to the case in the incinerator. The dashed lines indicate the prediction based on the calculation and show reasonably good agreement with the experimental measurements. In addition the theory assigns a value for the temperature on the surface of the concrete wall.

Surface temperatures within the incinerator are very high and a large part of the heat deposited is associated with radiant heat (700 K in the case of the wall). Radiant heating occurs almost instantaneously. As a result, the surfaces within the incinerator are thermally shocked during each burn. The surface of the concrete walls is deteriorating somewhat - there is a powdery texture on the surface.

4. Pressure Within the Incinerator

The time behavior of pressure is measured using two pressure transducers (0.1 and 0.5 psi full-scale, Model No. DP15TL, Validyne Engineering Corp.). The maximum pressure attained for each burn is listed in Table II.

Venting pressure was defined in Ref. 14 and by this definition Burn Nos. 12, 15, 16 and 19 (the pressure record was lost for Burn Nos. 13, 14, 27 and 28) should have vented. However, flames under the roof were observed only for Burn Nos. 19 and 27. The other burns mentioned above (Nos. 12, 15 and 16) probably vented but not enough explosive was present to cause flames in the roof area. All burns consuming more than 225 kg of explosive in less than 30 seconds will probably vent and hence pollution effluents will be increased.

Fig. 11. Location of the Thermocouples Imbedded in the Wall

Fig. 12. Shields Covering the Thermocouples in the Wall

Fig. 13. Concrete Wall Temperature Above Ambient Temperature (T_A) With and Without Shielding for Radiant Heating

Burning dry LX-04 machining waste will cause venting. However, the machining waste is not normally dried but rather is burned with some moisture content. Hence, the very high burn rates, causing venting in the FST facility, are not normally encountered in the HE waste disposal program of the plant. However, this disposal program should guard against burning explosives at rates faster than say 20 kg/s in order to maintain filter integrity. It is to be noted that the sand-gravel is self-repairing should venting occur.

B. PHASES III AND IV - DISCUSSION

Phase III will begin about October 15, 1975 and will continue until about April 1976. Gas sampling ports are presently being installed. Phase III will investigate pollution production parameters and filtration. A detailed outline will be forthcoming in the next quarterly report.

Phase IV is scheduled between April and September 1976 and will investigate burning procedures and safety requirements for the incinerator.

III. SUMMARY AND FUTURE WORK

The full-scale test (FST) facility, Fig. 1, has been in operation for 15 months in which 32 burns encompassing a variety of conditions have been made. Phase II, the study of temperature and pressure effects caused by large mass-flow rates, has been completed and the major portion of the design criteria for an individual incinerator has been submitted to the design engineers. The design criteria is contained in this report. The following is a summary of the conclusions resulting from Phase II. For more specific information the reader should consult the earlier portions of this report.

Air temperatures within the incinerator are appreciably below that of the fire ball temperature (~ 1923 K). This is mainly due to cooling by mixing with the outside air (via the blowers) and by heat radiation to the interior surfaces. Heat transmitted within the incinerator can be expected to be proportioned 1/3 by heat radiation and 2/3 by heat convection.

The gases within the incinerator contain approximately 15% water by weight and coupled with the burn products (specifically, NO and NO₂), should be considered acidic in their effect on the interior surfaces. However, no detrimental effects as yet have been observed.

Air flow through the sand filter raises the temperature of the sand a few hundred degrees and the air temperature a few centimeters above the sand is only a few degrees above ambient (if venting occurs then temperatures for short periods of time may exceed 573 K above the sand).

The temperature of the overhead I-beams are considerably below the maximum allowable value of 810 K. This is true for most of the burn conditions anticipated in the HE waste disposal program. However, if an extended burn time were to occur the temperature of the I-beams might well exceed 810 K.

The I-beams deflect (sag) elastically during HE burning. These deflections, in some cases, exceed 2 centimeters. The long-term effects of repeated deflections of this magnitude are not known. This should not be taken as a severe limitation to the closed-pit batch-type incinerator concept since there are several solutions to this problem and, as yet, it has not been demonstrated that a problem exists.

The surfaces of the I-beams are scaling possibly due to a combination of a higher rate of oxidation at the high temperatures and a moist and acidic environment.

Concrete wall temperatures are very high and show some signs of spall. Surface temperatures reach 922 K and a powdery texture is noted on the walls. The fire brick walls and liners show little effects from the heat.

The pressure excursions during a burn indicate no venting through the filter except for extreme burn rates (~ 20 kg/s). This is also verified by the 16 mm film records.

Finally, the forced air flow rate ($9.4 \text{ m}^3/\text{s}$ total) seems adequate. It would not be desirable to reduce this flow since air temperatures would rise with corresponding rises in I-beam and wall temperatures. However, these temperatures could be reduced by increasing the flow rate.

Phase III begins immediately. Pollution conditions will be studied and abatement requirements will be established. Installation of the sampling ports and analyzing equipment is nearing completion. Details of the instrumentation and details of the test plan for Phase III will be given in the next quarterly report.

IV. REFERENCES

1. F. I. Honea and Jane Wichmann, Disposal of Waste or Excess High Explosives, Mason & Hanger - Silas Mason Co., Inc., Report MHSMP-71-27, January - March 1971.
2. Jane Wichmann, F. I. Honea, W. A. Bullerdiel and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-71-55, April - August 1971.
3. Jane Wichmann and F. I. Honea, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-72-12, September - December 1971.
4. F. I. Honea, Jane Wichmann and W. A. Bullerdiel, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-72-30, January - March 1972.
5. F. I. Honea, Jane Wichmann and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-72-47, April - June 1972.
6. F. I. Honea and Jane Wichmann, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-72-73, July - September 1972.
7. Jane Wichmann, F. I. Honea, E. E. Leake and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-73-1, October - December 1972.
8. F. I. Honea, J. L. Barnard, W. A. Bullerdiel and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-73-11, January - March 1973.
9. F. I. Honea, W. A. Bullerdiel, Jane Wichmann and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-73-29, April - June 1973.
10. F. I. Honea and W. A. Bullerdiel, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-73-40, July - September 1973.
11. F. I. Honea and T. K. Mehrhoff, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-74-2, October - December 1973.
12. Disposal of Waste or Excess high Explosives, Mason & Hanger Burlington ERDA Plant Final Report MHSMP-75-14, April 1975.
13. R. D. Worley, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-74-39, July - September 1974.

14. R. D. Worley, Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-74-14, January - March 1974.
15. Disposal of Waste or Excess High Explosives, Mason & Hanger Report MHSMP-75-29, April - June 1975.
16. Operational Mathematics in Engineering, R. V. Churchill, McGraw Hill, p. 217.

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