**TIME- TO- EXPLOSION
THERMAL INITATION TEST FOR EXPLOSIVES (U)**

L.C. Myers

H.S. Schuldt

Mason & Hanger- Silas Mason Co., Inc.

Pantex Plant

April, 1964

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ABSTRACT

A controlled series of experiments have been performed in an attempt to evaluate the Henkin time-to-explosion test as a reactivity test and a quality assurance tool. This was done by comparing the Henkin results with those obtained with the presently used gas chromatograph chemical reactivity test. Two explosives, PBX 9404 and LX-04-1, were tested with four "inerts": sodium chloride, lead powder, Silastic Q-300030 and epoxy 633111. The experimental data from the two tests are given; a method for mathematically reducing the Henkin data is considered.

The data from the two tests are not in complete agreement. Both predict that the epoxy is reactive with and that NaCl is unreactive with both explosives. However, the Henkin data indicated reactivity of lead powder and Silastic with LX-04-1; the gas chromatograph did not. For PBX 9404, the Henkin test indicated that the lead was borderline reactive and the Silastic unreactive, while the gas chromatograph predicted the opposite. DTA thermograms are included to help interpret the comparison test results.

A section in the appendix is devoted to the experimental problems encountered in getting the Henkin test operational. All raw data generated during that time are included in the appendix. In addition, data obtained subsequently with a fairly wide variety of explosives (and propellants) are given; these indicate the present quality of data.

In the determination of the thermal sensitivity of explosives, the time-to-explosion investigation has proven to be of value. Henkin and McGill¹ investigated the time-temperature relationship at which decomposition becomes explosive in character within short time intervals. It was apparent to them that the time-temperature relation was not constant, but depended on several variables. This test had been used for many years, but was abandoned when it failed to give the correct activation energy of pure explosives. The theoretical work of Zinn², which introduced a chemical depletion term, explained the shortcomings in the previous treatments. Mader's³ experimental work with a scaled-up test verified the theoretical work. R. N. Rogers³ has recently modified the experimental arrangement; this has resulted in a lower energy input rate, operation at lower temperatures and expansion of the time range. In general, this reduces considerably the perturbation of thermal lags, simplifies the measurement of the time-to-explosion, allows one to work in a region where a lesser accuracy in time measurement is acceptable, and makes the test a better mock-up of some important practical situations (safety and chemical reactivity).

The test has been proposed as a means of detecting incompatibility; the purpose of the present work was to evaluate the test to that end and to determine the possibility of its use as a quality assurance tool. In short, the approach was to compare the results from the Henkin and gas chromatographic chemical reactivity tests in a controlled, statistical manner.

¹Henkin, H., McGill, R., I. & E.C. 44, 1391 (1952)

²Zinn, J., Mader, C.L., Journal of Applied Physics 31, 323 (1960)

³Rogers, R.N., I. & E.C. Production Research & Development, Vol. I, No. 3, (1962)

Additional modifications, generally in the methods of loading and timing, were adopted in the course of the work at Pantex. The various problems encountered along the way (appendix) and the test results are presented and discussed in this report.

Apparatus and Experimental Procedure Used in Comparison Test

In this section, the procedure and technique used in performing the Henkin and gas chromatographic comparison experiment will be described. The latter test was used as a "yard stick" because it is presently accepted and used as a means of measuring chemical reactivity. The problems encountered in the development of the procedure (and subsequent development) will constitute a separate section (the appendix of this report). It is believed that this separation will permit a minimum of confusion for the various readers.

The basic apparatus used for the Henkin portion of the test was similar to that described by Rogers. The reaction chamber was identical; the metal bath temperature was controlled via a Fenwal Electronics, Inc. probe thermistor (in series with a $42\ \Omega$ resistor) by a Fisher Temperature Controller Model 44. The reaction temperature was measured by a chromel-alumel thermocouple placed in the bath liquid and monitored with a Leeds and Northrup K-3 Potentiometer. Major modifications to Rogers' apparatus resulted from changes in the loading and sealing of the blasting cap sample containers. The technique settled upon after numerous other systems had failed was as follows. The blasting cap (#8 brass made by du Pont) was loaded with the desired sample and followed by two 6.5 mm diameter gas checks (obtained from Hornady) which were also brass and were resized to slide easily but snugly into the 0.260 inch I.D. blasting caps. The first gas check had the concave side turned toward the sample and the second had the concave side turned away from the sample. This was followed by a lead plug, 9/16 inch long and 1/4 inch in diameter. A punch and die was used to press the assembly at 350 pounds

(7000 psi). The cap was then crimped around the lead plug (about 1/4 inch from top of plug) with a Magneformer. Caps loaded in this way often blew the bottom out of the cap rather than forcing the gas check-plug assembly out the top. The timing system originally used had to be changed. A carbon-type earphone used in conjunction with a digital counter (Computer Measurements Co., Model 727B Universal Counter-Timer) proved to be satisfactory.

Four "inerts" with varying degrees of reactivity with the explosives PBX 9404 (Blend 1 of Lot 524-61) and LX-04-1 (Blend 2 of Lot 673-62) were chosen, ground, and sent to Pantex by LRL. These were sodium chloride (Baker & Adams Co.), lead powder (Fisher Scientific Co.), Silastic Q-30030, and epoxy 633111. The H.E. samples were ground with a Wiley Intermediate Model Mill; total (i.e., no sieving or other segregation) H.E. samples were used. The explosives, epoxy and Silastic were then dried in a vacuum oven at 60°C. for two hours. All of the samples were kept in a desiccator cabinet (calcium sulfate was the desiccant) with the exception of the sodium chloride which was kept in a sealed container. The pure H.E. sample size was 50 mg; the H.E.-inert mixtures were made by placing 50 mg of inert and 50 mg of explosives into the blasting cap and then rolling and shaking to achieve some degree of homogeneity.

The first step in the procedure was to experimentally obtain the time-temperature curves for the pure explosives. When these curves were determined, two temperatures, T_1 and T_2 , were chosen for each H.E. such that the time-to-explosion would be on the order of 50 and 200 seconds. Fifteen replicate runs (in subgroups of five) were then made for each combination of temperature, "inert" and explosive; these

subgroups of five were "randomly" sequenced within a given temperature and explosive. Pure explosive control runs were made each time a group of mixtures was tested. A typical day's run consisted of five pure H.E., five H.E. + NaCl, five H.E. + Pb, five H.E. + Silastic, and five H.E. + epoxy, all at T_1 .

The gas chromatograph reactivity experiment was performed in a two-column chromatograph designed by LRL and manufactured by the Royal Research Corporation, Hayward, California. The experimental conditions were those of USAEC Specification RM-251808 with the exception that modified sample tubes and Pyrex glass sample crucibles were used. The inert materials and H.E. samples were the same as those used in the Henkin portion of the test. The H.E. samples were given a different treatment however; they were ground and the fractions passing U.S. Sieve #100 (149μ) and retained on U.S. Sieve #270 (53μ) were used. All samples were dried for two hours in vacuo at 60°C . The sample weight taken was 250 mg or 250 mg of each material in the case of mixtures. After placing the sample crucibles in the sample holder, the holders were evacuated, purged, filled with helium (15 psig), and immersed in a $120 \pm 0.5^\circ\text{C}$. oil bath for 22 hours (experimentally, this varied from 22 to ~ 23 hours). The evolved fixed gases (N_2 , O_2 , NO, CO, N_2O , CO_2) were then analyzed in the chromatograph; the organics and other products were not analyzed. Instrument parameters were:

1. Column 1 Polypropylene glycol on firebrick, furnace 50°C ., Filament current 350 ma., 15 psig He.
2. Column 2 Silica gel, furnace 45°C ., Filament current 350 ma., 13 psig He.
3. Thermal Conductivity Cell Furnace 50°C .
4. He flow rate 100 cc/minute

Results

The Henkin raw data plotted as the time-to-explosion versus the reciprocal of the absolute temperature for the pure explosives are given in Figures 1 and 2. The solid lines were drawn for clarification and to indicate our choices of T_1 and T_2 . It should be noted that the lines are drawn along the locus of concentrated short time points in compliance with the principle that the worst conditions should be given the most weight in safety or compatibility considerations. During the course of checking out the loading technique, the PBX 9404 + lead powder Henkin curve was also generated; it is included here as Figure 3 because it introduces an interesting point to be discussed later.

The Henkin data for the comparison tests are given in Table I; the gas chromatograph reactivity data are reported in Table II.

DTA thermograms of the pure explosives and the mixtures are shown in Figures 4 through 13. These are included for comparison with chromatography and Henkin data.

The harmonic mean is offered as a possibility for the analysis of the Henkin data. The harmonic mean, M_h , is defined as

$$M_h = \frac{N}{\sum_{i=1}^N \frac{1}{X_i}}$$

where N is the number of trials in a subgroup; i.e., five for this experiment and X_i is the explosion times of the i th trial. For a reactivity coefficient

RC, the following relationship is used:

$$RC = \frac{\sum_{j=1}^S \left[\frac{M_h \text{ (H.E.)}}{M_h \text{ (mix)}} \right]_j}{S}$$

where M_h (H.E.) is the harmonic mean for the pure explosive, M_h (mix) is the harmonic mean for a mixture (of the explosive and the inert for a particular subgroup) and S is the number of subgroups; i.e., three for this test.

The numbers that result from this calculation are shown in Table III. It should be noted that those trials which did not produce an explosion (these were mixtures that were stopped after a reasonable length of time) were not used in the calculations; since the times would be large, their contribution to the mean reactivity coefficient would be very small.

Discussion

The Henkin curves of LX-04-1 and PBX 9404 in Figures 1 and 2 show that at a given temperature, the PBX 9404 explosion times are shorter than those for LX-04-1; this agrees with data from other thermal tests. The curves are of the general shape expected for explosives. They qualitatively agree with the Henkin data generated by Rogers of LASL; quantitatively, they would not be expected to agree since the cap loading techniques (ours being contained and sealed more tightly) are different. We feel the change in cap loading makes the data in this report considerably more representative and reproducible than was previously possible.

The data taken on September 16, 1963 (Table I) show that no explosions occurred with the PBX 9404 + NaCl; indeed, this happened a few other times. Since NaCl is hygroscopic, it is possible that the NaCl picked up some moisture and caused this difference in times. In the comparison test, certain mixtures consistently blew the plug and seal out the top; more recent data, using more refined cap loading techniques, have been generated in which these same mixtures blew the bottom out of the caps. There was no appreciable change in the explosion times so the comparison test data are considered as giving a true picture. It is felt that the most desirable loading system is one that ruptures the cap; experience has shown that this is more reproducible from day to day.

In analyzing the Henkin data the shortest explosion time at a given temperature represents the worst condition that exists. However, experience has shown that pressure blows can result from systems improperly sealed; these can give times that are anomalously short. Therefore, a method is needed that will

mathematically weigh the shorter times more heavily than the longer times but not overdo it. The harmonic mean does this rather well. It weighs the shorter times heavier than either the arithmetic or geometric mean. Also, the harmonic mean seems to be more promising for it can better handle data with a greater spread of values. Regardless of the choice, one must still make a reasonable selection of the critical value(s) of the reactivity coefficient, RC. On the basis of this one comparison test, the following ratio is considered a possibility. Samples having an RC value less than 1.5 are unreactive or indeterminant while those with RC greater than 1.5 but less than 3 are borderline reactive. Those with RC greater than 3 are reactive. The low critical ratios are dictated by safety criteria. The proper value would, of course, depend on the use to which the data are to be put.

No attempt was made here to subject the chromatograph data to a rigorous mathematical treatment. For our purposes, the reactivity coefficient, RC, taken as the ratio of the total volume of gas evolved by the mixture to the sum of the volumes from the individual components, was considered to be adequate (although very naive). Somewhat arbitrarily, critical values were assigned; namely, the system is considered unreactive or indeterminant for $RC < 2$, borderline reactive for $2 < RC < 3$ and reactive for $RC > 3$.

Using these ground rules, the comparison of the two tests is as follows:

1. Henkin test LX-04-1 + "inerts"

- a. LX-04-1 + epoxy 633111: Reactive; $RC \approx 23$
- b. LX-04-1 + lead powder: Reactive; $RC \approx 6.2$
- c. LX-04-1 + Silastic Q-30030: Reactive; $RC \approx 3.6$
- d. LX-04-1 + NaCl: Unreactive; $RC \approx 1.1$

2. Reactivity test LX-04-1 + "inerts"

- a. LX-04-1 + epoxy 633111: Reactive; $RR \approx 4.2$
- b. LX-04-1 + lead powder: Unreactive; $RR \approx 0.8$
- c. LX-04-1 + Silastic Q-30030: Unreactive; $RR \approx 0.5$
- d. LX-04-1 + NaCl: Unreactive; $RR \approx 0.4$

3. Henkin test PBX 9404 + "inerts"

- a. PBX 9404 + epoxy 633111: Reactive; $RC \approx 6.4$
- b. PBX 9404 + lead powder: Borderline reactive; $RC \approx 2.4$
- c. PBX 9404 + Silastic Q-30030: Unreactive; $RC \approx 0.6$
- d. PBX 9404 + NaCl: Unreactive; $RC \approx 0.7$

4. Reactivity test PBX 9404 + "inerts"

- a. PBX 9404 + epoxy 633111: Reactive; $RR \approx 3.9$
- b. PBX 9404 + lead powder: Unreactive; $RR \approx 1.0$
- c. PBX 9404 + Silastic Q-30030: Borderline reactive; $RR \approx 1.7$
- d. PBX 9404 + NaCl: Unreactive; $RR \approx 0.8$

The data for the two tests are not in complete agreement. They do agree that epoxy reacts strongly and NaCl is very unreactive with both explosives. However, the Henkin test reflects reactivity of lead and Silastic with LX-04-1, while the gas chromatograph does not. Also, the Henkin test indicates some reactivity of lead, but no reactivity of Silastic, with PBX 9404; the gas chromatograph predicts the opposite situation. The discrepancies are not as clear cut in the PBX 9404 cases as for the LX-04-1's. The reasons for the discrepancies have not generally been investigated (except to some extent for lead + PBX 9404) and, therefore, only a priori explanations can be offered. These probably involve one or more of confinement, reaction temperature, geometry, area of contact and thermal conductivity. For the record, we will say here that the DTA results align themselves more closely with those from the Henkin than the gas chromatograph test. The one case for which

some additional data are available is PBX 9404 + lead powder.⁴ It will be noted from Figures 2 and 3 that at low temperatures, the curves of PBX 9404 and PBX 9404 + lead cross. The explosion times for the latter are considerably shorter for all temperatures above about 215°C. At 210°C. ($\frac{1000}{T^{\circ}K} = 2.07$); however, PBX 9404 times were on the order of 700 seconds while the mixture did not explode after 2000 seconds. The latter caps were opened; the black residue was run in the DTA. The differential thermogram was essentially that of lead; i.e., the material never would have exploded. A possible explanation is that the lead powder can conduct away (both locally and on the whole) the heat generated by the slowly decomposing explosive, thus preventing it from reaching the explosion threshold temperature.

More important than any explanation of this activity is the lesson which can be learned and the warning sounded by these particular data. Great care must be exercised in choosing reaction temperatures in future Henkin work in order to minimize misinterpretation of hazardous or reactive mixtures. Obviously, choices of reaction temperatures corresponding to $\frac{1000}{T^{\circ}K}$ values of about 2.05 and 1.89 would present a much different picture than the temperatures chosen in this work. It would appear that considerable knowledge about a system is needed; i.e., fairly complete time-temperature curves, before one could "rely" on Henkin data; in critical situations, use of the two-temperature method alone would be

⁴The lead sample used for the generation of the PBX9404 + lead Henkin curve was supplied by Rogers, LASL, and was known to be reactive with PBX 9404. A different sample was used for the comparison test; the comparison test sample was bluish in color while the other was brown, indicating that some oxidation had probably taken place in the latter. The two samples gave essentially the same explosion times when mixed with PBX 9404.

unacceptable. It sort of boils down to the fact (and we are speaking from past experience) that new explosive systems will come equipped with their own eccentricities which may require variations in loading techniques, data interpretation, etc. For proposed routine testing programs or specification requirements, these problems could, of course, be worked out (and indeed must be for each specific system) in advance.

Building of workable Henkin equipment and mastering of loading techniques at other contractor installations could now surely be done with relative ease if the personnel are acquainted with basic thermal techniques and if the explosive systems are not too greatly different from those used in this work.

We feel the greatest problem with the Henkin test (and the gas chromatograph reactivity test for that matter) is in determining and quantitating what it is trying to tell. It would appear to be able to diagnose hazardous or unsafe situations, but not be directly or immediately relatable to long term surveillance problems. Therefore, it is thought that the test is not ready for use as a routine quality assurance tool. However, the Henkin test shows possibilities and should be allowed to take a place along side and be coupled with the DTA, pyrolysis, gas chromatograph, hot stage microscopy, etc., in diagnosing potentially hazardous materials and in investigating the thermal decomposition mechanisms, etc. of explosives and explosive systems.

TABLE I

HENKIN REACTIVITY TEST COMPARISON

Sample	9-12-63			9-24-63			9-11-63			9-13-63			9-18-63			9-20-63		
	Time			Time			Time			Time			Time			Time		
	Run (sec)@			Run (sec)@			Run (sec)@			Run (sec)@			Run (sec)@			Run (sec)@		
	No.	243°C		No.	242°C		No.	242.5°C		No.	264°C		No.	264°C		No.	@264°C	
LX-04-1	1	594.4		5	1014.7		1	767.9		8	243.4		5	75.0		1	56.9	
	10	539.8		10	1130.7		6	733.6		11	121.8		10	270.4		6	218.7	
	15	481.3		15	1093.8		11	704.1		13	69.7		15	71.4		11	85.2	
	20	709.5		23	702.2		20	724.8		18	53.4		20	117.2		16	78.5	
	28	735.9		25	616.7		25	737.0		20	88.2		25	62.5		25	62.5	
LX-04-1 + Pb	2	81.1†		4	92.7†		2	127.4†		2	22.3†		4	21.8†		2	9.4	
	9	55.2†		9	87.4†		7	106.3†		4	15.8†		9	18.3†		7	17.4†	
	11	81.2†		14	84.3†		12	149.9†		15	19.7†		14	21.0†		12	17.2†	
	21	100.6†		18	142.8†		17	149.4†		17	12.7†		19	25.8†		17	17.4†	
	25	59.1†		21	111.1†		22	126.8†		22	22.4†		24	14.8†		22	17.1†	
LX-04-1 + NaCl	3	536.7		3	849.6		3	497.0		5	112.9		3	58.1		3	37.2	
	8	576.4†		8	1008.5		8	477.1		10	196.3		8	42.5		8	103.3	
	16	538.1		13	848.8		13	483.3		12	374.3		13	144.1		13	125.8	
	24	495.4		22	447.7		19	586.2		19	288.2		18	204.4		18	273.8	
	26	402.3		24	767.1		24	609.2		23	98.6		23	42.8†		23	36.7	
LX-04-1+ Silastic	4	175.6†		2	195.6†		4	149.8†		1	44.1†		2	37.4†		5	32.6†	
	7	218.5†		7	196.2†		9	191.4†		6	17.3†		7	40.2†		9	21.2†	
	13	98.1†		12	228.3†		14	252.1†		14	22.2†		12	55.1†		14	25.6†	
	18	312.8†		17	159.9†		18	119.7†		16	38.8†		17	50.8†		19	24.8†	
	23	160.7†		20	110.7		23	151.0†		25	37.7†		22	36.8†		24	22.6†	
LX-04-1 + Epoxy	5	17.5†		1	19.6†		5	18.7†		3	10.0†		1	10.5†		4	8.6†	
	6	17.1†		6	17.9†		10	21.7†		7	10.9†		6	11.8†		10	9.0†	
	14	18.5†		11	18.9†		15	21.4†		9	8.5†		11	18.4†		15	8.4†	
	19	16.4†		16	18.4†		16	18.2†		21	9.9†		16	16.8†		20	10.2†	
	27	19.3†		19	19.4†		21	30.9†		24	11.2†		21	11.7†		25	9.0†	

† - Blew seal out of top.

TABLE I (Con't.)

Sample	9-23-63		9-25-63		9-16-63		9-17-63		9-10-63		9-19-63	
	Time		Time		Time		Time		Time		Time	
	Run (sec)@		Run (sec)@		Run (sec)@		Run (sec)@		Run (sec)@		Run (sec)@	
	No.	220°C	No.	219.5°C	No.	220°C	No.	242°C	No.	242.5°C	No.	242°C
9404	1	299.4	1	269.5	5	539.0	1	63.1	1	55.5	3	20.6†
	6	275.5	10	216.1	10	281.1	6	64.4	6	39.8	8	25.7
	11	299.2	15	143.4†	15	293.9	11	27.8	11	48.8	13	61.4
	16	700.0‡	20	184.8	20	241.8	16	62.0	16	39.2	18	51.4
	21	234.0	25	241.2	24	306.0	21	32.2†	21	52.1	23	25.2
9404 + Pb	2	586.7	2	111.8	4	169.8†	4	13.5	2	11.7	1	16.2†
	7	106.2†	9	148.4	9	209.3†	9	13.7	7	12.3	6	12.9
	12	112.2	14	270.5	14	143.4	14	13.9	12	14.6	11	14.6†
	17	114.9†	19	150.8	19	157.5	19	15.1	17	16.0	16	14.5†
	22	102.6†	24	111.6	23	143.5†	24	13.3	22	17.2	21	11.8†
9404 + NaCl	3	467.5	3	277.2†	3	1500.0‡	2	73.2	3	81.5	4	118.7
	8	226.2	8	261.0†	8	1000.0‡	7	69.0	8	85.5	9	74.0
	13	232.8	13	1000.0‡	13	1000.0‡	12	69.9	13	102.1	14	74.2
	18	421.8	18	296.2†	18	1000.0‡	17	76.0	18	60.0	19	71.4
	23	720.0‡	23	700.0‡	25	1800.0‡	22	63.5	23	68.8	24	76.5
9404 + Silastic	4	1000.0‡	4	397.8†	2	428.8†	5	103.0†	4	172.8†	2	70.5†
	9	403.7†	7	475.0†	7	418.0†	10	72.5	9	101.1†	7	81.2†
	14	338.0†	12	374.0†	12	1000.0‡	15	58.4†	14	95.2	12	82.2
	19	215.3	17	557.8†	17	664.4†	20	59.5†	19	61.2†	17	82.0†
	24	246.3†	22	272.2†	22	477.0†	25	76.4†	24	51.8†	22	94.3†
9404 + Epoxy	5	23.7	5	26.0†	1	328.9	3	16.4†	5	14.2†	5	15.1†
	10	22.8†	6	23.2†	6	22.0†	8	16.0†	10	14.6†	10	15.2†
	15	22.5†	11	25.8†	11	26.0†	13	14.8†	15	13.5†	15	14.4†
	20	21.9†	16	25.0†	16	24.8†	18	15.5†	20	17.6†	20	13.8†
	25	21.8†	21	25.1†	21	24.6†	23	16.2†	25	17.3†	25	15.8†

† Blew seal out of top.

‡ No explosion

Table II

Gas Chromatographic Reactivity Results^{1,2,3}
(Gas Evolved in μ liter @ STP)

Sample	Run No.	Date (1963)	Time (hrs.) @120°C. $\pm$ 0.5	N ₂ + O ₂	NO + CO	N ₂ O	CO ₂	TOTAL
NaCl	471	6-4	22:15	27.3	0	2.5	16.4	46.2
NaCl	472	6-4	22:00	19.5	0	0.6	16.1	36.2
Pb	473	6-4	22:00	21.1	0	1.0	17.9	40.0
Pb	474	6-4	21:45	20.1	0	0.8	5.0	25.9
Epoxy	475	6-4	22:00	16.7	0	1.5	16.1	34.4
Epoxy	476	6-4	22:00	17.3	0	2.5	17.4	37.2
Silastic	477	6-4	22:00	3.3	32.0	3.2	27.9	66.4
Silastic	478	6-4	22:15	6.3	15.2	1.8	30.5	53.9
9404	480	6-5	21:45	30.4	185.	31.0	114.	360.
9404	481	6-5	22:00	17.4	190.	25.5	114.	347.
NaCl + 9404	482	6-5	22:00	29.2	170.	18.9	99.3	317.
NaCl + 9404	483	6-5	21:45	32.7	154.	26.1	113.	326.
Epoxy + 9404	484	6-5	22:00	242.	272.	924.	327.	1760.
Epoxy + 9404	485	6-5	22:00	238.	322.	1050.	445.	2050.
Silastic + 9404	486	6-5	22:00	61.1	415.	194.	168.	839.
Silastic + 9404	487	6-5	22:15	69.4	445.	218.	204.	936.
9404	488	6-6	22:45	32.2	178.	23.4	115.	349.
9404	489	6-6	22:00	25.8	172.	25.0	115.	338.
Pb + 9404	490	6-6	22:00	36.4	172.	35.2	85.0	329.
Pb + 9404	491	6-6	22:15	39.5	174.	53.5	93.8	361.
NaCl + 9404	492	6-6	22:30	25.8	201.	28.8	124.	380.
NaCl + 9404	493	6-6	22:00	29.6	206.	29.6	138.	394.
Epoxy + 9404	494	6-6	22:15	240.	309.	1040.	391.	1980.
Epoxy + 9404	495	6-6	22:00	236.	326.	1020.	388.	1970.
Silastic + 9404	515	6-12	22:00	124.	195.	353.	204.	876.
Silastic + 9404	516	6-12	22:15	55.0	317.	125.	138.	635.
Epoxy + 9404	517	6-12	23:15	83.0	221.	228.	186.	718.
Epoxy + 9404	518	6-12	22:00	237.	289.	921.	374.	1821.
NaCl + 9404	519	6-12	22:30	26.3	206.	29.0	113.	374.
NaCl + 9404	520	6-12	22:45	34.3	226.	35.8	143.	439.
9404	521	6-12	23:15	30.2	211.	27.2	141.	409.
9404	522	6-12	23:00	32.6	206.	28.8	154.	421.
Pb + 9404	523	6-13	22:00	87.3	227.	145.	143.	602.
Pb + 9404	524	6-13	22:15	73.3	248.	93.6	133.	548.

¹Runs made from 6-4 to 6-19 were calculated using the calibration of 6-19.

²Volumes are not corrected to 22:00 hours.

³There is some uncertainty as to the reliability of the third significant figure.

Table II (Con't)

-17-

Gas Chromatographic Reactivity Results^{1,2,3}
(Gas Evolved in μ liter @ STP)

Sample	Run No.	Date (1963)	Time (hrs.) @120°C. $\pm$ 0.5	N ₂ + O ₂	NO + CO	N ₂ O	CO ₂	TOTAL
9404	525	6-13	22:15	430.	0	21.8	127.	579.
9404	526	6-13	22:15	32.8	224.	27.3	128.	412.
Pb + 9404	527	6-13	23:00	43.4	175.	44.3	88.8	352.
Pb + 9404	528	6-13	22:30	53.4	242.	54.1	99.5	449.
Silastic + 9404	529	6-13	22:30	61.6	376.	145.	132.	715.
Silastic + 9404	530	6-13	22:75	52.5	380.	115.	141.	728.
Pb	532	6-17	22:15	37.4	0	3.2	7.0	47.6
Pb	533	6-17	22:15	66.8	0	2.4	4.1	73.3
Silastic	534	6-17	22:00	6.2	28.4	20.8	13.4	68.8
Silastic	535	6-17	22:00	2.9	58.0	4.0	27.6	92.4
NaCl	536	6-17	23:00	24.7	0	5.3	4.4	34.4
NaCl	537	6-17	23:15	34.0	0	2.3	4.9	41.2
Epoxy	538	6-17	23:30	21.0	0	2.3	5.8	29.0
Epoxy	539	6-17	23:30	27.8	0	0.8	4.0	32.6
NaCl + LX-04-1	540	6-18	22:30	32.3	0	3.2	3.5	39.0
NaCl + LX-04-1	612	7-2	22:30	17.5	0	7.5	10.0	35.0
LX-04-1	544	6-18	22:00	133.	0	6.5	3.6	143.
LX-04-1	545	6-18	22:30	61.6	0	5.1	5.2	71.9
Pb + LX-04-1	546	6-18	22:45	31.2	0	20.4	3.6	55.2
Calibration Run 6-19-63								
Pb + LX-04-1	627	7-9	23:00	33.6	0	38.9	8.5	81.
Epoxy + LX-04-1	564	6-24	23:00	77.9	85.5	290.	34.7	488.
Epoxy + LX-04-1	565	6-24	22:30	62.8	58.0	256.	40.2	417.
Pb + LX-04-1	566	6-24	22:30	80.8	0	29.4	4.3	114.
Pb + LX-04-1	567	6-24	22:45	40.3	0	35.7	3.8	79.8
NaCl + LX-04-1	568	6-24	23:00	48.9	0	4.5	5.0	58.4
NaCl + LX-04-1	569	6-24	23:00	11.4	0	4.8	3.6	19.8
LX-04-1	570	6-24	23:15	37.9	0	8.7	3.3	49.9
LX-04-1	571	6-24	23:15	33.2	0	3.8	3.6	40.6
Pb + LX-04-1	572	6-25	22:15	97.0	0	25.0	4.9	127.
Pb + LX-04-1	609	7-2	23:00	30.0	0	37.4	7.4	74.8
NaCl + LX-04-1	574	6-25	22:30	41.7	0	3.4	4.4	49.5
NaCl + LX-04-1	575	6-25	22:30	13.9	0	5.5	4.2	23.6

¹Runs made from 6-4 to 6-19 were calculated using the calculation of 6-19.

²Volumes are not corrected to 22:00 hours.

³There is some uncertainty as to the reliability of the third significant figure.

Gas Chromatographic Reactivity Results^{1,2}
(Gas Evolved in μ liter @ STP)

Sample	Run No.	Date (1963)	Time (hrs.) @120°C. ± 0.5	N ₂ + O ₂	NO + CO	N ₂ O	CO ₂	TOTAL
Silastic + LX-04-1	576	6-25	23:30	37.2	0	16.6	5.9	59.7
Silastic + LX-04-1	577	6-25	23:30	38.4	0	14.2	7.4	60.0
LX-04-1	578	6-25	23:15	51.6	0	4.4	1.7	57.7
LX-04-1	579	6-25	23:15	28.6	0	3.6	2.7	34.9
Calibration Run 6-26-63								
LX-04-1	607	7-2	22:00	15.8	0	4.8	31.4	52.0
LX-04-1	608	7-2	22:00	17.7	0	20.4	17.6	55.7
Calibration Run 7-8-63								
Epoxy + LX-04-1	613	7-8	22:15	39.0	54.4	168.	97.0	358.
Epoxy + LX-04-1	614	7-8	22:30	36.0	60.4	181.	30.3	308.
LX-04-1	615	7-8	22:45	25.6	0	2.1	58.0	85.7
LX-04-1	616	7-8	22:30	19.0	0	3.0	27.6	49.6
Silastic + LX-04-1	618	7-8	22:15	29.8	0	6.5	9.7	46.0
Silastic + LX-04-1	622	7-9	22:30	35.6	0	12.4	18.9	66.9
Epoxy + LX-04-1	623	7-9	22:00	53.5	64.2	158.	162.	438.
Epoxy + LX-04-1	624	7-9	22:00	39.2	59.6	168.	60.5	327.
LX-04-1	626	7-9	22:30	17.8	0	5.0	16.9	39.7
Silastic + LX-04-1	621	7-9	22:15	35.5	0	9.8	58.5	104.
Silastic + LX-04-1	604	7-1	23:00	74.7	9.9	14.1	18.5	117.
Pb	628	7-10	22:45	22.0	0	0.9	29.2	52.1
Pb	629	7-10	23:00	21.4	0	3.2	15.6	40.2
Epoxy	630	7-10	22:45	18.0	0	2.0	12.2	32.2
Epoxy	644	7-12	22:45	31.0	0	1.8	5.1	37.9
NaCl	632	7-10	22:45	16.3	0	1.5	28.8	46.6
NaCl	643	7-12	21:45	31.1	0	0.2	2.9	34.2
Silastic	638	7-11	22:15	1.8	14.5	2.1	16.6	35.0
Silastic	637	7-11	22:15	1.7	18.4	1.4	18.5	40.0
LX-04-1	601	7-1	23:00	19.6	0	4.0	17.8	41.4
LX-04-1	602	7-1	23:00	44.4	0	2.0	8.9	55.3

¹Volumes are not corrected to 22:00 hours.

²There is some uncertainty as to the reliability of the third significant figure.

Table III

-19-

<u>Material</u>	<u>Date</u>	<u>Temp. (°C).</u>	<u>Harmonic Mean (sec.)</u>	<u>Ratio, RC</u>	<u>Average Ratio</u>
LX-04-1	9-12	243	596.6		
	9-24	242	857.7		
	9-11	243	733.0		
	9-13	264	88.1		
	9-18	264	90.0		
	9-20	264	79.8		
LX-04-1 + Pb	9-12	243	71.8	8.31	
	9-24	242	99.8	8.59	7.52
	9-11	242	129.8	5.65	
	9-13	264	17.7	4.98	
	9-18	264	19.6	4.59	4.98
	9-20	264	14.8	5.39	
LX-04-1 + NaCl	9-12	243	502.0	1.19	
	9-24	242	726.3	1.18	1.26
	9-11	242	525.0	1.40	
	9-13	264	165.4	0.53	
	9-18	264	65.8	1.37	1.03
	9-20	264	66.3	1.20	
LX-04-1 + Silastic	9-12	243	167.3	3.57	
	9-24	242	167.4	5.12	4.40
	9-11	242.5	162.1	4.52	
	9-13	264	28.1	3.14	
	9-18	264	42.9	2.10	2.82
	9-20	264	24.8	3.22	
LX-04-1 + Epoxy	9-12	243	17.7	33.7	
	9-24	242	18.8	45.6	37.86
	9-11	242	21.4	34.3	
	9-13	264	10.0	8.8	
	9-18	264	13.2	6.82	8.17
	9-20	264	9.0	8.87	

Table III (Con't)

<u>Material</u>	<u>Date</u>	<u>Temp. (°C)</u>	<u>Harmonic Mean (sec)</u>	<u>Ratio, RC</u>	<u>Average Ratio</u>
PBX 9404	9-16	220	308.3		
	9-23	220	274.3		
	9-25	219.5	201.1		
	9-10	242.5	46.2		
	9-17	242	43.7		
	9-19	242	30.7		
PBX 9404 + Pb	9-16	220	161.5	1.91	
	9-23	220	129.9	2.11	1.81
	9-25	219.5	143.0	1.41	
	9-10	242.5	14.0	3.30	
	9-17	242	13.9	3.14	2.89
	9-19	242	13.8	2.22	
PBX 9404 + NaCl	9-16	220			
	9-23	220	302.5	.907	.816
	9-25	219.5	277.4	.725	
	9-10	242.5	77.0	.600	
	9-17	242	70.1	.623	.536
	9-19	242	80.0	.384	
PBX 9404 + Silastic	9-16	220	480.4	.642	
	9-23	220	282.9	.970	.708
	9-25	219.5	391.9	.513	
	9-10	242.5	80.9	.571	
	9-17	242	70.9	.616	.522
	9-19	242	81.3	.378	
PBX 9404 + Epoxy	9-16	220	29.8	10.35	
	9-23	220	22.5	12.19	10.19
	9-25	219.5	25.0	8.04	
	9-10	242.5	15.3	3.02	
	9-17	242	15.8	2.77	2.62
	9-19	242	14.8	2.07	

Figure 1

LX-04-1

TIME-TO-EXPLOSION VERSUS THE RECIPROCAL OF
THE ABSOLUTE TEMPERATURE

-21-

Time-to-Explosion, seconds

Figure 2
PBX 9404

TIME-TO-EXPLOSION VERSUS THE RECIPROCAL OF
THE ABSOLUTE TEMPERATURE

Figure 3

PBX 9404 + LEAD
TIME-TO-EXPLOSION VERSUS THE RECIPROCAL OF
THE ABSOLUTE TEMPERATURE

-23-

Figure 4

Figure 5

Figure 8

Figure 9

FIGURE 10

FIGURE 11

Figure 12

Figure 13

A P P E N D I X

EXPERIMENTAL DIFFICULTIES ENCOUNTERED WITH HENKIN TEST

Pages 1 through 7

DATA SHEETS FROM HENKIN EXPERIMENT

Appendix Data Sheets 1 - 74

Experimental Difficulties Encountered with Henkin Test

This section contains information to be considered in assessing the usability of the Henkin test as a routine quality assurance tool; it may also serve as a guide for future builders of Henkin test equipment (at least it will indicate some avenues not to pursue).

The major difficulty in getting the Henkin test in operation was the sample cap loading technique. Many different methods were tried at Pantex. The following is a chronological account of the major features of the evolution; it extends in time beyond the actual comparison experiment. The data sheets of all the Henkin work to date are reproduced in the appendix.

The initial plan was to adopt the method as reported by Rogers. His loading technique consisted of a #8 brass blasting cap (du Pont, 0.265 inch in diameter) loaded with a 40 mg sample; this was followed by a gas check (6.5 mm resized to 0.259 inch) with the convex side toward the sample, then a #00 cork and another gas check turned the same as the first. A punch and die was used to press the assembly to 300 pounds (6000 psi). The cap was then ejected from the die and crimped just above the first gas check with a dulled tubing cutter. A second cork was used at the top of the cap to hold a timing wire in place.

A variation in this loading method resulted from our ordering #8 blasting caps from Hercules; these turned out to be aluminum and were 0.22 inch in diameter. Twenty-two caliber (0.22 inch in diameter) gas checks and #000 corks were obtained for the aluminum caps. It was necessary to resize the gas checks so they could be easily pushed into the blasting cap; in systems where the gas check had to be

forced into the blasting cap, a much larger percentage of the caps developed leaks and failed to explode. This technique was used with Grade II, 98% pure HMX. The data (see appendix data sheets 1 & 2.) show that while some caps failed to explode, those that did gave reproducible times even when the sample size and loading pressure were varied. The failure to explode seemed to be associated with the corks. Just what happens to the cork when pressed was not determined; however, the cork could turn slightly causing the gas checks to tilt and not seal properly. The same technique was tried with PBX 9404; the results were horrendous (see data sheet 3).

To reduce the number of failures, another loading system was tried which used one gas check (convex side toward sample) and a 1/8 inch lead plug (data sheets 4 - 11). With HMX and LX-04-1, this system gave few failures and reproducible times-to-explosions. It would not give satisfactory results with PBX 9404. At 225°C., for example, two groups of times-to-explosion were obtained, one at approximately 25 seconds and the other at approximately 2000 seconds; intermediate times could not be obtained for PBX 9404 samples in the range 225 - 235°C. (this was thought to be where the time-temperature curve broke sharply). The brass gas checks were than aluminum plated and used with PBX 9404, but this did not change the results.

The samples of PBX 9404 that exploded in 25 seconds at 225°C. had a residue left in the cap. This residue was run in the DTA and gave a thermogram that compared to HMX suggesting that the nitrocellulose had caused the explosions.

Twenty unreacted samples were subjected to the normal nitrocellulose analysis; no abnormal amount or intersample variation of NC was observed. Other lots of PBX 9404 and different sampling techniques (total sample, sieve cuts, etc.) were tried, but they gave the same results. The short time (25 seconds at 225°C.) explosions were not as noisy as the longer times; this strengthened the pressure blow theory. To eliminate the pressure blows, different loading techniques were again tried. The first used a gas check, cork, gas check, and lead plug in that order. It was thought that the pressure buildup would compress the cork slightly, thereby increasing the volume and reducing the pressure sufficiently to maintain a seal. Some intermediate times, approximately 200 seconds at 231°C., were obtained which had not been obtained before, but the times ranged from 19 to 700 seconds (data sheets 20, 21). The next method consisted of pressing the H.E. in the cap, placing washers next to the H.E. and then sealing with a gas check and lead plug. This was to provide an air space so the pressure buildup would not be as great. This system gave short times, but no long times (appendix data sheets 23, 24). Then we decided to try more than one 1/8 inch lead plug to provide a better seal as well as some additional inertia and side wall friction. This gave no "extra long" times at 225 - 235°C.; the times were in two groups of approximately 20 and 200 seconds (appendix data sheet 26).

In an attempt to further strengthen the seals, the following was done: two gas checks were used; the first had the convex side turned away from the sample, the second had the convex side toward the sample. This was followed by two 1/8 inch lead plugs (see appendix data sheets 29 - 35). The results for the first ten samples were quite reproducible times of about 350 seconds at 230°C.

The first five were shot on Friday and the second five on the following Monday; the latter group all blew the side out of the cap. After these ten shots, the succeeding ones gave a large scattering of times at 230°C. While this turn of events was heart rending, we were able to maintain some feeling of progress.

At this time the construction of a Magneformer was completed. It permits crimping by sharply increasing a magnetic field around the caps and pressing the walls into the lead. A 1/4 inch long lead plug was substituted for the dual 1/8 inch plug arrangement; a crimp was made such that it would be on the lead plug. The various methods using lead plugs were re-evaluated by including magneforming (appendix data sheets 37 - 42). The results were generally improved, but a large deviation in time still persisted. At this point other parameters were varied in an attempt to define the problem, i.e., sample size and loading pressure, with very little improving effect noted (appendix data sheets 34, 35, 37). A few samples were tried in which an epoxy L933A was poured over the gas check-plug assembly. The adhesive was dried overnight and shot the following day. All these blew the side out of the cap; there was less deviation in the times than in previous loadings (appendix data sheets 36, 37). The approach was discontinued because of undeterminable side effects (CTE problems, heat evolution and/or heat sink problems, "thermal strength", etc.); it did indicate, however, that if the sealing assembly could be held in place, the explosions could be made to rupture the caps and give more reproducible times.

Following a discussion with R. Rogers, in which we discovered that our reproducibility goals were unrealistic (i.e., all previous work had been plagued by

considerable scatter), it was decided that the experimental approach and philosophy should be changed as follows:

1. Accept the fact that scatter and odd times are inherent in the experiment.
2. Realize that just a few trials of any system are not sufficient to evaluate that system. This is especially true since loading is an art and the operator cannot duplicate seals except after considerable practice.
3. Choose one or two loading systems that appear to have the best chance of success and work with them extensively (with a minimum of modification). One desirable feature would be that the assembly be strong enough to cause explosions to rupture the cap rather than blow the seals out the top. It turns out that a shortage of aluminum caps occurred at this time; brass caps were amply available. We decided to load as follows:
 - a. Load caps with H.E.
 - b. Follow with two gas checks; the first with convex side away from H.E., the second with convex side toward H.E.
 - c. Use a 1/2 inch long lead plug.
 - d. Press at approximately 7000 psi.
 - e. Magneform crimp the caps on the lead plug.
 - f. Use both aluminum and brass caps.
4. Choose a known incompatible mixture of H.E. and "inert", compare its times with the pure H.E. (i.e., run the time-temperature curves) and use this to check out the loading techniques. The mixture chosen was PBX 9404 + lead powder; the latter was supplied by Rogers.

In generating these time-temperature curves, the brass cap assemblies quickly proved superior to the aluminum caps (appendix data sheets 38, 39). As a matter of fact, the brass system sealed in the manner described above was deemed sufficiently satisfactory (appendix data sheets 40 - 51) to be used in the comparison test. The

comparison test data, which are quite good (in precision), are found in appendix data sheets 52 and 53. During the experiment, it was noted that mixtures containing lead, Silastic and epoxy consistently blew the seal out the top of the caps. The pure explosives and mixtures with NaCl ruptured the caps. By including a second 1/2 inch lead plug or a single 1 inch lead plug, all these systems could be made to rupture the caps (appendix data sheets 54, 55). In addition, these systems functioned as well (both in terms of reproducibility and absolute times) when the magneform crimp step was eliminated (appendix data sheets 54, 55, etc.). This latter is very desirable and helpful since magneforming is quite time consuming; all subsequent experiments have been performed without crimping (and the last described loading assembly).

A considerable number of experiments involving a wide variety of explosive systems have now been performed with satisfactory results (appendix data sheets 57 - 74). One one occasion, vendor supplied lead plugs would not seal well; this turned out to be caused by a surface lubricant (on the plugs). Cleaning in acetone eliminated the problem (appendix data sheets 58 - 60). Aluminum cap assemblies were tried again (appendix data sheets 57); these again gave poor results, probably because of their relative lack of strength. Some concern has arisen about the use of brass because of possible chemical reaction with the reactants. Experiments to date with gold plated caps and check have neither verified or rejected this concern (data sheets 68, 69).

The presently used cap assembly is as follows:

1. Load #8 brass blasting caps, 0.260 inch diameter with the desired explosive.

2. Resize 6.5 mm diameter brass gas checks to .0.259 inch diameter.
3. Slide a gas check into the cap with its convex side turned toward the sample.
4. Insert a 1 inch long by 1/4 inch diameter into the cap.
5. Press the assembly in a Carver Laboratory Press to 350 pounds; i.e., 7000 psi.

	Leak rate SLU	Pressure PSI	HMX mg	Temp °C	Time sec	Cycle Time	Δ
1	125	230	20	278	10.65		
2	{	230	20	278	10.55	9.70	2.75
3		230	20	278	7.90		
4	125	230	60	278	9.90		
5	{	230	60	278	11.95	11.05	2.05
6		230	60	278	11.30		
7	125	230	40	278	10.65		
8	{	230	40	278	11.05	10.28	1.80
9		230	40	278	10.15		
10			40	278	9.25		
11	100	165	40	278	9.05		
12	{	165	40	278	10.60	9.52	1.70
13		165	40	278	8.90		
14	35	255	40	278	10.00	9.05	1.35
15	{	255	40	278	8.50	8.50	(Standard Error)
16		255	40	278	8.65	8.65	"
					5.94		

(12)

[illegible]

HMY - 98% pure.

④

temp (°C)	time (sec.)		temp (°C)	time (sec)	
266	35.9		269	19.35	
266	32.3	$\bar{x} = 32.3$	269	23.35	$\bar{y} = 22.0$
266	33.2	$\sigma = 2.80$	269	23.70	$\sigma = 2.17$
266	30.8	$\Delta = 6.3$	269	19.95	$\Delta = 4.35$
266	34.25		269	23.70	
266	29.75				
266	29.6		273	16.25	
			273	24.20	$\bar{x} = 18.52$
263	49.7	$\bar{x} = 43.73$	273	18.15	$\sigma = 3.37$
263	38.0	$\sigma = 4.75$	273	15.70	$\Delta = 8.5$
263	41.6	$\Delta = 11.7$	273	18.3	
263	47.5				
263	41.95		277	24.95	
			277	16.55	$\bar{x} = 19.95$
255	252.0		277	20.70	$\sigma = 4.37$
255	298.4	$\bar{x} = 262.1$	277	23.05	$\Delta = 10.45$
255	248.4	$\sigma = 20.98$			
255	262.0	$\Delta = 50.0$	277	14.50	
255	249.9				
260	51.4				
260	47.15	$\bar{x} = 51.2$			
260	56.7	$\sigma = 6.86$			
260	41.9	$\Delta = 16.75$			
260	58.65				

98% check & 1" lead plug

6-17-63

(6)

Urban Program

TC

Temp inside

200 220 22.5
212 229 23.5
225 238 24.5

4
10
0

26.7 12.0 9.2
25.55 9.8 13.05
1144.4
1700 (45) 15.25
NE.

1.944444

1.8" lead plug

777.8 10.2
9.65

965.15

19041

6-12-63

⑦

P.C.
T.C.

Inside

200	225
214	239
228	248

q₁⁰

22.1	11.65
19.5	13.9
30.8	12.0
24.2	14.3
11.5	16.5
21.0	15.2

1900 check
1/8" plug

Temp ~ 230

4082.4	1251.45
1797.9	
1181.2	
1251.2	
1232.85	

T₀⁰

1262.9

6-13-63

8

Pro.

T.C.

Swirl Temp

150	170	185	200
162	183	196	210
171	192	205	225

(17) 227715 2850 (E) 21004
 4000 (NE) 1500 (NE) 2000 (E)

4110 ft
 415645

~ (4252)

1 gas check
 1" lead plug

Data Sheet 9

1000

T.C.

Inside

200 205 202.5 202.5 202.5

213 219 215 214.5 216.0 216.5

222 229 224 223.5 224 224

23.5 20.3 33.25 1622.75 4300(NE) 30.1

24.26.0 22.55 2291.7 22.1+

22.9 22.9 29.1

12.2+

time fault

time fault

9404

1 gus check
1/2" lead plug

1000

[illegible]

1 good block
2 bad plug

94.6
84.6
174.85

296.4
339.0
297.5
150.7
223.25

296.4
205.1
89.55
143.7
234.8
128.8
481.8

Σ = 679.8

670.2
155.45
36.85
633.1
813.3

1 X-041

240
251
263

234
244
255

Progr. Bottom
Middle Camp

6-10-63

(12)

Temp.

Prog.

Bottom

Inside

230

239.5

250

9404

(B1-524-61)

(Mach. powder)

1542.2 (NE)

17.3 ?

11.0

10.2 ?

10.05

19 1/2 chudko
1 1/2 load

9404

Q23 Samples

(from line)

Chromatograph

sample

17.8

13.0

6-14-63

13

Temp

Flag

Bottom

Inside

205

217

227

210

222

232.5

1 good chucker

1 good plug

1/4

NE

NE

NE

~4100

13.7

25.0

NE

1700.0

9404

(Dried, Inside Powder)

2. 1-7.

17-2-79

5

10-1-16

2011.11.11

+ Grasslands, Crops

28

—

engd	in p.p	~0.02
------	--------	-------

32.2

18.	x
-----	---

16.7

15.5

Drass

Good

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

8	7	6	5	4	3	2	1
---	---	---	---	---	---	---	---

6-24-63

17

[illegible]

6-25-63

(18)

230°

NC

4.8

4.7

4.7

Mix + H₂O

239.4

NE

(1 drop)

220.3

NE

111.8

NE

NC + 2FF

6.0

(1 drop)

~ 6+

PEFT

7.5

5.8

PEFT

Mix + H₂O

5.1

(1 drop)

7.1

3.8

Mix (a acid)

19.2

940.4 + H₂O

692.4

NE

(1 drop)

6-26-63

(19)

	°C.					°C.	
9404 (ground)	232					232	
	15.2					2.5	PFFT
	21.4					2.5+	PFFT
	22.1					2.8+	PFFT
9404 + H ₂ O	203.8	NE				7.2	PFFT
(ad) (ground)	208.3	NE				5.4	PFFT
	203.5	NE				6.1	PFFT
9404 (ground)	19.5					12.1	
	17.1					17.5	
	18.5					16.5	
9404 + CEF	201.9	NE				115.0	NE
(50-50)	201.8	NE				106.8	NE
	213.0	NE				98.2	
9404 + H ₂ O	4.9	PFFT!					
(50-50)	4.4						
	4.9						
9404 + H ₂ O	203.1	NE					
(50-50 + 1 drop)	206.2	NE					
	202.4	NE					

Plugs placed
up

1-28-63

(20)

9404
left open
to room atm.

230.5

19.7

7400 NE

7900 NE

16.7

25.4

71000

13.5

Temp } 232

232

~23°C

23.1°C

537.9

681.9

106.25

19.3

71100 NE

7900

~30.1

22.7

numbers → 357.1

560.5

read with gravel
oak, gravel, & sand
flag.

237.8

lead with gravel
→ }
dark, gravel, & flag

3230

17.1

21.0

235.5

16.1

17.1

225

420.9

297.6

554.1

1194.7

2600 }
2900

Neuron

landing

just 150 lbs

1-2-63

(21)

8-
3.5

9.165 → 225.5

9.453 → 233.5

23.7⁰

797.5

22.5

322.4

288.4

21.8

19.8

7900^{NE}

71000

Need more cups

Sample was heated with 2 good
cups of bedding. 1st was spread
in room & 2nd was used
to load at 150 lbs

Sample was fluid over night
... at 150 lbs

233

162.6

431.8

7930^{NE}7900^{NE}

233

7900^{NE}

Sample was fluid over night
loaded at 120 lbs

236¹

15.9

fluid over night
loaded at 150 lbs

236

367.5

7400^{NE}

fluid over night
loaded at 120 lbs

25

7-10

1x041

1x041

10.372

10.770

134.0

703.9

440.8

318.8

245°

7-10-63
Heat Gauge
diagram

17.1
14.9
17.8
2.15 (190 260/300)

	245°				231.5°		(26)
9404	10.7	1st plug NE-260	NE	205.2			
	12.4	2nd plug 300		25.5			
	11.1	3rd plug 300	NE	220.3		avg matl two plugs	
2 plugs avg: 12.1	12.9			151.2		260/300	
1 plug avg: 16.05	16.5	one plug old sample		19.5			
	17.9		NE	351.6		ground matl	
	18.9	orig matl		19.0		260/300 3 plugs old matl	
	16.9	one plug 260		n 90		3 plugs old matl	
	13.4	orig matl	NE	238.7		2 plug old matl	
	13.3	two plugs		19.6		1 plug old matl	
	12.6	orig matl					
	11.4	2 plugs one old 260/300					
	124.5						
	106.0	2 plugs checked					
NE 209.3	209.3	old 16-125					
average	20.9	avg matl					
	22.1						

Data Sheet 27

8-2-03

29

	228.4	
9404	weak	321.6
		22.9
	weak	171.2
		16.9
		17.6
		390.1
		405.1
		261.7
		298.2
		273.1

out gas
check,
two plugs
260-300

conc. up-
side down
two gas
check,
two plugs
260-300

2.5
3.2
3.5

(32)

8-7-63

235	320.4	
	820.1	(leaf) NE
	290-2p	S Kingbird
	260-300	(nest with)
	44.1	
	21.5	
	536.9	
	15.5	190-200-2p
	14.3	260-300
	186.9	
	289-	290 (new)
	217.4	2p-260-300
	282.0	
	16.6	Amur-Admiral
	17.7	290-300
	41.6	290-3p
	16.3	

9/10/4

8-8-63 (all crimped)

(33)

234.5

9404

S

?

2gc-1p, 300

SN155

1gc-new 1p 200

SN390

2gc-1p 300

SN155

219

S

?

copper cap 300

SN67

" "

17.4

8-9-63

34

9404

233

N25

NE 700. 19cr-1ply 300 2 crimps

~~231-2 crimps~~

SN 62. 19cr-1p-300-

S 19.4

19.3

21.5 9c-cord-9c-p-300

19.3 19c-2p

18.8

Trace

SN 165 } 29cr-2p-269/300

238.6

S 235.8

Alarm

429.4 29c-1plog 260/arc 11,000v

207.5 29c-1plog 260 25mg no crimp

295.2

NE 400+

NE 400+

NE 400+

346

(35)

8-12-63

9404

238

local 2774

SN 142

S 212.0

SN 138

S 129.4

S 98.1

25mg

35mg

55mg

65mg

15mg

NE 325

29C-2P
200-300

③

[illegible]

318.8
440.8
703.9

134.0

10.70 265

10.872

14041

245

25

7-10

14041

7-10-63

245 R-6, C-9, F-8, F-9

Data Sheet 26

Data Sheet 26

Data Sheet 27

8-2-03

29

228+

9404

weak

321.6

one gas
checked,
two plugs
260-300

22.9

weak

171.2

16.9

17.6

(one up -
side down)
two gas
checked,
two plugs
260-300

390.1

405.1

261.7

298.2

273.1

0-6-63

(31)

235.5

236

23.0

178.0 } 290-2p

12.8 } 2 HC + 2 Plug

397.6 } 260-250

260-300

409.4

1st floor up 1 floor

S ~ 24.5

226.2

290-2p

213.4

39.7

260-300

23.5 } 1- RHC + 1 Plug 200 #

~ 42.

NE 609.2

NE 31.5 } 1- HC + 1 Plug 200 #

~ 170

S ~ 23.5 } 290-2p

411.7

260-250

S 460 ~ 2 HC-2p

26.5

290-2p

42.6 } 150-200

~ 230

260-250

T R 236.5

SC failed

NE 100.2

21.1 } Norm.

234.1

NE 337.2

290-2p

NE 150.2

25mg } 200-250

NE 100.1

18.7

S 251.3 } 75mg

19.8

8-7-63

32

POP 419

Data Sheet 32

8-8-63

(all crimped)

33

234.5

9404

S

?

2gc-1p, 300

S

SN155

1gc-w-1p 200

S

SN390

2gc-1p 300

S

SN155

27.9

S

?

copper cap 300

S

SN67

1gc-w-1p 300

17.4

8-9-63

34

233

N 25

NE 700.

192-1 plug 300 2 crimps

231 1 plug

S N 62.

192-1 p-300-

S 19.4

" "

19.3

" "

21.5

92-cable-gc-A-300

19.3

192-2 p

18.8

" "

S N 165 } 292-2 p-260/300

238.6

235.8

Alum.

429.4

292-1 plug

260/92 11,000V

207.5

292-1 plug

260 25 mg no crimp

295.2

" "

" "

NE 400+

" "

" "

NE 400+

" "

" "

NE 400+

" "

" "

346

" "

" "

8-12-63

35-

9404

238

WCA 277.4

SN 142.

S 212.0

SN 138.

S 129.4

S 98.1

25mg

35mg

29C-2P

260-300

55mg

65mg

NE 325

15mg

(36)

8-13-63

9404

239

SN 81
SN 68
SN 73
SN 51
SN 88
SN 82
SN 50
SN 55
SN 37
SN 43
SN 20
SN 15
SN 15.6

72.5 air

53.4 air

200-20
260-300
glue
200-10
260
glue
100-100
200
glue

NE 500
28.9
NE 100
15.9
NE 100
14.5
260-300
glue
200-20
260-300
glue
NE 100
200 air glue

2933A

[illegible]

(38)

8-15-6

8-14-63

237

252.5

26.8

S 16.6

NE 56.0

S 21.6

223.3

S 13

266.7

NE 49.5

S 22.2

S 13.5

S 12.3

S 14.4

279.7

S 11

NE 403

S 9.3

S 105

S 21.1

S 214

S 21.1

11.4

S 10.0

16.7

12.9

14.0

S 12.3

18.3

S 21.3

S 21.3

S 21.0

10.5

290-1P
260
all capesdick's edge
290-1P
260

all capes

290-1P
260
all capes

all capes

was not changed 2 GC 1P long

all capes

190-1P
260
all capes

8-16-63

39

9/10/4

225

652.7

sample on island
tail not crimped

NE 4000 Plug had moved

(290-1P)

260

(Alum)

lead

alum

290-1P
260

18.2

17.7

16.5

19.8

NE 1000 plugged

27.5

S 27.1

28.4

23.4

alum

S N/28

S 149.0

S N/35

NE 55

S N/33

S N/33

S 103.1

S N/27

S N/25

not crimped
brass

39.7

S N/56

54.9

44.1

tear crimped

lead

lead

lead

290-1P
350

18-19-63

40

[illegible]

8-20-6

(41)

9404

215

SN338

SN305

SN329

SN345

SN293

SN298 crimped

506.1

96.1

SN197

227.4

247.6

229.1

233.8

295.8

285.7

493.2

SN598. crimped

SN325

SN497

SN599

9404

9404

N. 5. 700

515

NE 700

NE 1150

NE 750

crimped

(cracked gas check)

9404 + Pb

crimped

crimped

crimped

crimped

crimped

9404 + Pb

(42)

8-21-03

9404

210

S~670 crimped

S~519

"

S~582

"

N.E. 1355

"

S~759

"

S~566 not crimped

S~659 crimped (30 sec dwell)

S~659 not crimped

N.E. 1300 crimped (30 sec dwell)

9404 + PH

N.E. 1135 crimped

N.E. 1300

"

N.E. 1300

"

N.E. 2000 not crimped

430.3

" (10 min of PH)

395

" (10 min of PH)

8-23-63

(43)

9404

(R-6
C-9
F-5.2)

218°C

R=6
C=10
F=2.0R-6
C-10
F-1.6

233

R-6
C-10
F-0.8

224

SN324

238°C

S 119

SN692

S 111

SN341

SN73

S 122

SN312

N.E. 320

S 121

SN286

S 71

S 128

SN375

32.7

S 81

S 80

NE 750

SN16

26.8

96.9

162.2

SN14

S 36

S 144

165.5

12.5

S 33

S 407

SN14

S 29

175.3

S 41

227.9

S 28

231.3

N.E. 2800

[illegible]

8-26-60

(45)

LX-04-1

(R6
C10
F3.5)

256°

345

316

338

114

257

358

338 av.

(R6
C10
F3)

249°

725

786

443

1061

676

738 av.

(R6
C10
F4.2)

263°

130

62

55

103

54

81 av.

8-28-63

(47)

LX-04-1

 $\left(\begin{smallmatrix} R_6 \\ C_{10} \\ F_{3.3} \end{smallmatrix} \right)$

252.5°

S 428

S 777

S 466

S 935

S 758

673 a.u.

 $\left(\begin{smallmatrix} R_6 \\ C_{10} \\ F_{4.1} \end{smallmatrix} \right)$

261.5°

S 253

S 197

S 262

S 164

S 192

214 a.u.

8-29-63

48

LX-04-1

(R60
210
F4.1) 262.584 av.
S 66
S 141
S 68
S 76
S 68

8-30-63

(49)

LX-04-1

26
C10
F2.7

2.46°

5	821	705 av.
Top	558	
5	656	
5	611	

5	965
---	-----

128

558

101

111
656

611

841.

R6
C10
F2.2

242°

518

0110

1551

7-2
1221.

201

972

552

941 av.

50

9-3-63

96 av.
141
91
83
86
81

235

1982

glue

162 av.
130
190
167
130
173

231.5

1982

92 av.
S 101
S 92
S 89
S 85
S 92

236 av.
S 402
S 123
S 225
S 247
S 183

260
261

(86
510
F3.8)

1-40-1

9404

9-6-63

(51)

9404

R6
C10
F2.7

245.5

246

36.2

18.5

14.7

11.9 not compared

19.9

14.0 "

13.8

13.5 "

14.4

15.2

9-6-63

242

15.3

not compared

14.3

"

22.0

compared

26.6

"

16.5

"

242.5

242

67.2

16.0

15.8

19.9

19

16.0

13.8

14.6

17.9

52

Date	Temp	7-12	9-13	9-18	9-20	9-24	9-11
LX-04-1	243°C	243.4	264°	264°	264	242	242.5
1	594.4	8	243.4	75.01	56.95	1014.71	767.91
10	539.8	11	131.810	270.46	218.710	1130.76	733.6
15	481.2	13	69.715	71.411	85.215	1093.811	704.1
20	709.5	18	53.420	117.216	78.523	702.220	724.8
28	735.9	20	88.225	54.221	62.525	616.725	737.0
LX-04-1 + Pb							
2	81.1	3	22.34	21.82	9.44	92.72	127.4
9	55.2	4	15.89	18.37	17.49	87.47	106.3
11	91.2	15	19.714	21.012	17.214	84.312	149.9
21	100.6	17	12.719	25.817	17.418	142.817	149.4
25	59.1	22	22.424	14.822	17.121	111.122	126.8
LX-04-1 + NaCl							
3	536.7	5	112.93	58.13	37.23	849.63	497.0
8	576.4	10	196.38	42.58	103.38	1003.58	477.1
16	538.1	12	374.313	144.113	125.813	848.813	483.3
24	495.4	19	288.218	204.418	273.822	447.719	586.2
26	402.3	23	98.623	42.823	36.724	767.124	609.2
LX-04-1 + Silica							
14	175.6	1	44.12	37.45	32.62	195.614	149.81
17	218.5	6	17.31	40.29	21.27	196.29	191.4
13	98.1	14	22.212	55.114	25.612	228.314	252.1
18	312.8	16	38.817	50.814	24.817	159.918	189.7
23	160.7	25	37.722	36.824	22.620	110.723	151.0
LX-04-1 + FePO4							
5	17.5	3	15.01	10.54	8.61	19.65	18.7
6	17.1	7	12.96	11.910	9.06	17.910	21.7
14	18.5	9	8.511	18.415	8.411	18.915	21.4
19	16.4	21	9.916	16.815	10.216	18.416	18.2
27	19.2	24	11.221	11.725	9.014	19.414	30.9

Time / Index

(53)

LRL	Date		9-10		9-16		9-17		9-19		9-23		9-25
	Temp.		242.5		220		242		242		220		219.5
9404	1		55.5	5	539.0	1	63.1	3	T 20.6	1	299.4	1	269.5
	6		39.8	10	281.1	6	64.4	8	25.7	6	275.5	10	216.1
	11		48.8	15	239.9	11	27.8	13	61.4	11	299.2	15	T 143.4
	16		39.2	20	241.8	16	62.0	18	51.4	16	NE 700	20	184.8
	21		52.1	24	306.0	21	T 32.2	23	25.2	21	234.0	25	241.2
9404 + PL	2		11.7	4	T 169.9	4	13.5	1	T 16.2	2	586.7	2	111.8
	7		12.3	9	T 209.3	9	13.7	6	12.9	7	T 106.2	9	142.5
	12		14.6	14	143.4	14	13.9	11	T 14.6	12	112.2	14	270.5
	17		16.0	19	157.6	19	15.1	16	T 14.5	17	T 114.9	19	150.8
	22		17.2	23	T 143.5	24	13.3	21	T 11.8	22	T 102.6	24	111.6
9404 + NaCl	3		81.5	3	NE 1500	2	73.2	4	118.7	3	467.5	3	T 277.2
	8		85.5	8	NE 1000	7	69.0	9	74.0	8	226.2	8	T 261.0
	13		102.1	13	NE 1000	12	69.9	14	74.2	13	232.8	13	NE 1000
	18		60.0	18	NE 1000	17	76.0	19	71.4	18	421.8	18	T 296.2
	23		68.8	25	NE 1800	22	63.5	24	76.5	23	NE 720.	23	NE 700
9404 + SILASTIC	4	T	172.8	2	T 428.8	5	T 103.0	2	T 70.5	4	NE 1000	4	T 397.8
30030	9	T	101.1	7	T 418.0	10	72.5	7	T 81.2	9	T 403.7	7	T 475.0
	14	T	95.2	12	NE 1000	15	T 58.4	12	82.2	14	T 338	12	T 374.0
	19	T	61.2	17	T 664.4	20	T 59.5	17	T 82.0	19	215.3	17	T 557.8
	24	T	51.8	22	T 477	25	T 76.4	22	T 94.3	24	T 246.3	22	T 272.2
9404 + EPOXY	5	T	14.2	1	329.9	3	T 16.3	5	T 15.1	5	23.7	5	T 26.0
633111	10	T	14.6	6	T 22.0	8	T 16.0	10	T 15.2	10	T 22.8	6	T 23.2
	15	T	13.5	11	T 26.0	13	T 14.8	15	T 14.4	15	T 22.5	11	T 25.8
	20	T	17.6	16	T 24.8	18	T 15.5	20	T 13.8	20	T 21.9	16	T 25.0
	25	T	17.3	21	T 24.6	23	T 16.2	25	T 15.8	25	T 21.8	21	T 25.1

Compression Test Data

(54)

220°

24.4

25.0

23.4

9404 + epoxy

124.8

98.3

112.2

9404 + lead

361.0

—

336.8

9404 + silastic

19.5 } Loaded with 2 bricks / 1 long beam
19.3 } beam and filled with sawdust cement.
24.4 } All out bottom

24 1/2

242°

15.8 } 2 ac, 2 ply, 300/350
15.2 } All out bottom
15.4 } 9404 + EPOXY (9-30)

245°

25.0 } 2 ac, 2 ply, 300/350
44.3 } All out bottom
34.0 } 9404 only (10-1)

242°

69.0 } 9404 + S17A5TIC (10-2)
87.1 } All out bottom
47.1 }

25.0 } 9404 + PL (10-2)
23.0 } All out bottom

56

Date	11-11	11-12	11-13	11-14	11-18														
Temp.	220-2	221-2	221	221	220+														
9404	1	210.2																	
	2	201.4																	
	3	190.1																	
	4	187.9																	
	5	186.4																	
	6	600 NE (LEAK)																	
	7	213.4																	
	8	211.1																	
	9	210.8																	
	10	186.2																	
	11	239.9																	
	12	207.1																	
	13	~200	(timer stopped)																
	14	600	NE (cap. failure)																
	15	221.5																	
	16	214.3																	
	17	~200	(timer stopped)																
	18	217.2																	
	19	213.6																	
	20	206.6																	
	21	175.0																	
	22	194.4																	
	23	196.2																	
	24	153.3																	
	25	178.2																	

temp not
accurate

(57)

11-19-63

9404 + epoxy

223°

29.0

28.4

32.2

30.9

31.5

28.4

28.7

30.6

30.5

33.0

aver. 30.4

2 qc, 1" @ 300 lb

aver. 30.2

1 qc, 1" @ 300 lb

6000 psi

Brass caps

Alum caps

9404 11-26-63

22.0 T

33.8

413.5

273.6

1000 NE

9404 11-19-63

~30

500.2

1000 NE

1 qc, 1"

~225 lbs

of caps 6000 psi

11-20-63

9404 + epoxy

30.6

27.2 T

28.0

9010

PROP. REFLECT

500 NE

(gray)

Hot. J. m.

12-6
210°

12-6
224.5°

12-6
220°

12-6
215°

12-9
202.5°

12-9
204°

(58)

PROP. REFLECT
(gray)

Hot. J. m.

26.0
23.0
24.2
26.4
24.0

35.8
32.8
35.2
36.2
35.7
29.6
30.4
31.8
31.0
37.5

Hot. J. m.

PROP. REFLECT
(gray)

118.6

650 NE

500 NE

113.0

115.1

600 NE IP
500 NE IP

IP

IP

IP

84.2

83.8

Rock
C
with
dip
0.0

* double wt.

9010

Habitat

12-10
204°

360 NE

96.2

101.0

12-10
208°

54.6

60.7

56.8

57.9

62.0

12-10
208°

420 NE

420 NE

420 NE

420 NE

420 NE

12-11
208.5°

43.8

45.1

48.8

12-11
205°

660

82.5

360

1P19

1P19

1P19

Production
(arbitr.)

1P 1380 NE

1P 500 NE

1P

1P

1P

1P

2G 1P

1020 NE

540 NE

420 NE

80 *

418 *

540 NE

420 NE

513 *

420 NE

525 *

300 NE

72.8

70.2

67.8

330

300

360

1P19

1P19

1P19

1P19

1P19

1P19

1P19

Production
(arbitr.)

9

plugs were

not cleared

with a stone

Discarded

9010

12-13

205°

NE 1200

Net 300

blue
out
TAP

T 534.2

458.1

464.1

NE 660

12-13

205°

W

397.8

!!!

303.0

143

472.2

84.8

89.2

104.7

97.8

102.7

225

2P20

22.12.2019

2F29

Z. X. Lu

1993

temperature
fluctuating
about 20°
Oct. 202-205

Holstene.

Disclosed

[illegible]

[illegible]

239.4

64

9404 (Doug. H.)

Control

240°

220°

17.8

171.2

13.4

169.2

15.1

186.6

14.2

160.4

37.0 ✓

178.6

13.8

161.1

14.2 ✓

10275C3101

35.0

152.6

38.6

140.4

23.2 ✓

152.6

36.6

171.2

37.7

167.5

38.9

131.4

These were solvent
pressed (9404)

10281C3101

12.9

148.9

10.6

125.6

10.9

135.4

13.0

174.6

14.0

143.2

16.2

165.5

POP 419

t and $\frac{1}{2}t$

159

Data Sheet 65

(67)

HMX

230°

T 174.6

245°

88.6

93.2

225°

T 256.1

91.7

88.3

100.6

HMX (8 schmid)

200 NE line

94.8 T

86.0

82.0 T

96.4

88.6

HMX (6 schmid)

90.3 T

200 NE

90.9

98.4

89.5 T

111.3

Braid case

[illegible]

[illegible]

HNX

Kroton

Alled Bridgewater

Unalled Bridgewater

255°

218°

240°

49.1

79.6

121.9

47.8

80.9

137.8

117.2

82.0

127.0

113.7

90.0

126.8

50.5

80.8

121.8

89.0

172.3

206.8

114.9

143.8

227.2

44.8

172.2

228.8

85.4

134.9

211.9

99.4

154.0

211.4

53.1

72.0

104.3

55.3

79.7

107.4

51.0

77.3

118.0

53.3

79.6

100.1

57.4

87.0

109.8

(72)

HPLX (LRL)	230°		245°		260°	
A-315	200.7 T		107.0		27.9	
B S _c C	245.2 T		110.1 T	N	38.0	
	229.8	6.8	110.9 T	9	33.0	
	273.8	101	111.1	8	38.7	
	233.6		105.5		13.5	
A-316	254.0		139.7		28.6	
B S _c F	270.6	8.7	95.6	0	27.5	
	256.2	9.1	121.6	9	29.7	
	216.2	11	114.0	8	31.5	
	208.2		113.2 T		35.6	
T - Plus blow out trap						
W - Available						
NE - 2nd edition						

HMX (BRIDGE WATER)	230°	230°	260°
Milled 62.4	510 T	88.7	62.2
	586.7	81.7	87.0
	530.7		96.0
125u	404.1	125u	85.8
	850 NE (plug moved)		88.2
	513.2		88.2
	441.4		
350u	357.3	350u	62.8
	301.8 T		69.0
	422.6 T		75.2
Milled 10.4	756.2 T	10u	120.2
	609.4 T		120.5
	639.3		122.6
11.4	723.4	11u	124.8
	695.8		124.8
	672.2		146.0
62u	613.6	30u	111.1
	626.6		128.2
	638.1		151.2

Data Sheet 74									
			240°				brass cups		240°
9404									
~25 mg			56.8						
~75 mg			14.2						
old. allug			23.2						
300#			14.4						
241 mg	T		43.5						
48 mg			42.6						
73 mg			12.6						
58 mg			12.0						
53 mg			17.8						
55 mg			13.2	T 38.7	13.8				
51 mg			17.5	29.6					
65 mg			15.6	13.2					
49 mg			39.6	33.6					
50 mg			22.3	25.1					
75 mg				14.1					
49 mg				21.6					
B3-569-61			14.9						
~60 mg			14.4						
			14.8						
B1-524-61			17.2						
~60 mg			14.6						
			17.0						

Data Sheet 72

8-5-63

(30)

	230- 231							243- 244					
9404													
374.7	{	S 433.7	2 gas checks					{	15.2				
		w 525.0	(one up-side down)						17.5				
		S 220.2	2 plugs						19.2				
		S 372.5	260-300						N205 S				
		S 323.3							715.7 NE				
		NE 810.5	2gc 1 plug 260										
		NE 940-	" " "						16.9	1 H.C. new. 1 Plug 200*			
		NE 1200-	2 gc 2 plug 260-300										
		NE 390-	1gc 1 plug 260										
		S 285.8	2 gc - 2 Plug 260-300										
		NE 601.8	2gc 1p. 200										
23.8	{	18.8							11.2				
		19.7	1gc 2 plugs						22.7				
		42.9	260-300						13.9				
		13.5							11.3				
		21.4							17.2				
		NE 613.7											
		NE 601.1	2gc 2p										
		NE 637.0	100-150.										
		NE 603.1											
			2gc 2p										
			150-200										
		~ 1112	2gc 2p										
Check did not stop		?	2gc 2p										
		~ 340	200-250										

8-13-63

36

9404

239

SN 81

SN 68

SN 73

SN 51

SN 88

72.5

72.5

72.5

72.5

72.5

SN 82

SN 50

SN 55

SN 37

SN 43

52.4

52.4

52.4

52.4

52.4

SN 15

SN 20

SN 15.6

15.6

15.6

15.6

28.9

NE 500

14.5

15.9

NE 100

NE 100

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

200-200

4933A

copy

100-100-P

100-100-P

100-100-P

200-200

200-200

200-200

200-200

200-200

200-200