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ROHM & HAAS COMPANY

REDSTONE ARSENAL RESEARCH DIVISION
HUNTSVILLE, ALABAMA

Report No. S-81

ABLATION OF EXTREME-TEMPERATURE-RESISTING MATERIALS IN ROCKET EXHAUSTS

by

Joe M. Viles

Approved by:



Louis Brown, Head
Ballistics Section

Contributing Staff:

J. L. Chaille
L. J. Wheeler



O. H. Loeffler
General Manager

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ABSTRACT

The ablation rate of contoured Micarta^{®1} specimens immersed in solid propellant exhaust gases has been measured under closely controlled conditions. The effect of particles in the exhaust stream was demonstrated by carrying out firings with propellants containing 0.5%, 8%, and 16% aluminum. Firings at chamber pressures of 400 psia and 550 psia showed the effect of pressure on ablation rate. The ablation rate increased directly with chamber pressure and aluminum content of the propellant.

Raw data for heating rate calculations were obtained for each propellant from instrumented copper calorimeters and heat flux transducers.

¹Trademark for a group of laminated plastics, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.

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1. INTRODUCTION

It is known that the presence of particles in the exhaust gases of solid propellant rocket motors has a great effect on the ablation rate of protective materials exposed to these gases. There are, however, little quantitative data available which would facilitate selection of the most suitable materials for blast deflectors, jet vanes, and other hot missile parts.

Under the direction of the Structures and Mechanics Laboratory of the U. S. Army Missile Command, the erosion rates of ablative specimens immersed in solid propellant gases were determined under carefully controlled conditions. In addition temperature versus time measurements from instrumented copper calorimeters were made at identical firing conditions to provide data for the calculation of heating rates. This report describes the propellant formulation work, the calorimeter and specimen tests, and summarizes the data.

This is the final technical report for Contract DA-01-021 AMC-11660(Z) under which this work was funded.

2. TEST PLAN

The test plan called for static testing of solid propellant motors with calorimeters and ablative specimens immersed in the exhaust stream. Ablative materials and instrumented calorimeters were to be provided by the Structures and Mechanics Laboratory.

Propellants were to be formulated with at least three variations in aluminum content and flame temperatures greater than 4000°R (2222°K). The motors were to have a nozzle exit diameter of three inches and mass flow rate at the nozzle exit of 0.5 lbm/in²-sec. The nozzle exit pressure was to be approximately equal to the ambient pressure.

The temperatures indicated by ten 30 gage chromel-alumel thermocouples in the calorimeters were to be recorded by a rapid-response oscillograph and suitable calibration factors provided. The thickness of material removed from the ablative specimens in the test, the motor chamber pressure, and the burning time were to be recorded and reported. The behavior of each specimen during firing was to be recorded in a high-speed color movie and before and after conditions documented with still photographs.

The original test plan specified a motor firing time of 5 seconds to provide reliable heating rate data from the calorimeters and measurable material loss from the composite specimens during exposure to the exhaust gases. In the course of motor development and propellant formulation work it was found that a copper calorimeter was quickly melted at these firing conditions and that marginal heating rate data would be obtained.

On the basis of other exploratory firings the test plan was modified. Ablation tests would be carried out with three low-flame-temperature propellants with 0.5%, 8.0%, and 16.0% aluminum contents. The three propellants were to have approximately the same flame temperature at 550 psia chamber pressures, and the motors were to be fired at 400 and 550 psia. Further, a heat flux transducer was to be used in place of one of the thermocouples during the calorimeter tests and during 3 of the ablation tests. The firing duration was to be about 2 seconds for the propellants containing 8.0% and 16.0% aluminum and about 3 seconds for the propellant with a 0.5% aluminum content.

3. DESCRIPTION OF ABLATIVE SPECIMENS AND CALORIMETERS

3.1 Ablative Specimen

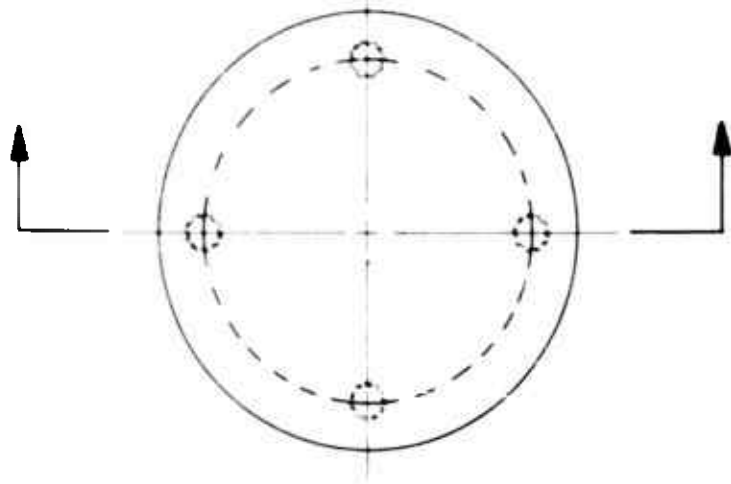
The ablative specimens had a "nose cone" appearance with a 1.25-inch spherical radius at the stagnation point and a 2.12-inch length (Fig. 1). The specimens were made from Micarta 259-2, a laminated glass-phenolic material, and the laminations were oriented parallel with the centerline of the specimen. The weight of each test specimen was about 0.6 lb.

3.2 Copper Calorimeter

The calorimeters were fabricated from electrolytic-tough-pitch copper and had the same size and shape as the ablative specimens (Fig. 2). Thirty gage chromel-alumel wire was mechanically joined to form a thermocouple in each 0.024-inch diameter hole by inserting the ends of the wire into the hole and peening the sides of the hole together. The thermocouples were numbered 1 thru 10 and the depth of the thermocouple was the distance along the side of the plug from the leading edge to the centerline of the hole. The depth of each thermocouple is given in Table A1 (Appendix A).

3.3 Specimen Holder

The calorimeters and ablative specimens were supported in the exhaust stream by a 1" diameter pipe and an adjustable fixture attached to the support block (Fig. 3). Four 1/4-inch cap screws held the specimens on a steel flange welded to the pipe. The thermocouple wires were threaded through the pipe to protect them against the motor exhaust.



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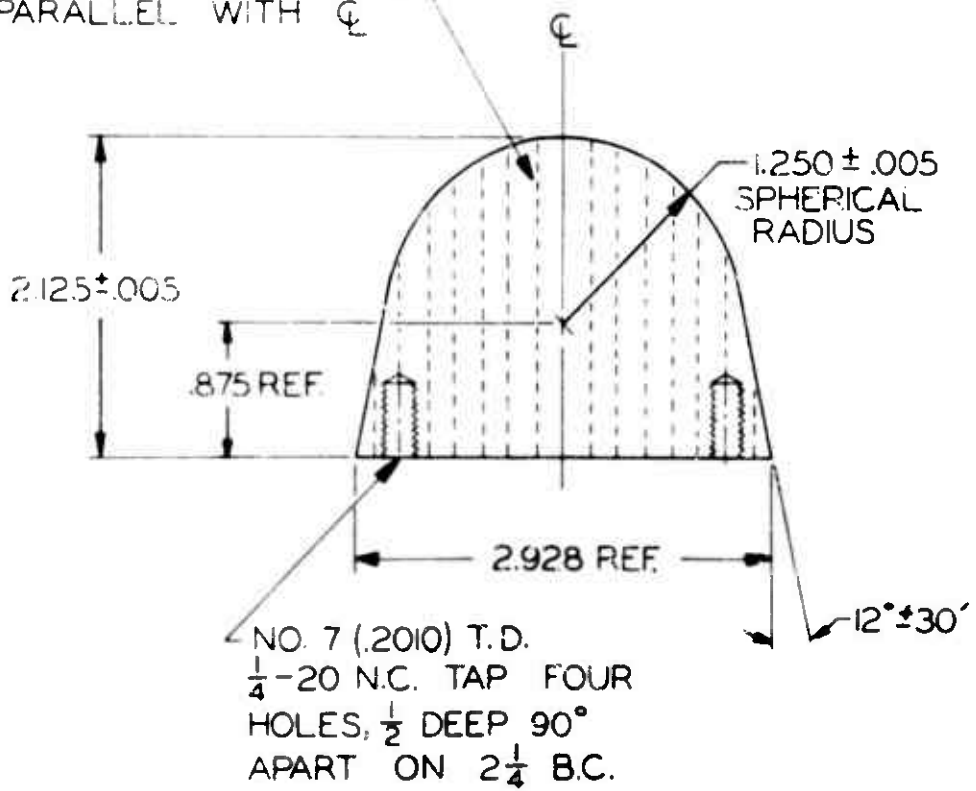


FIG. 1 CONTOUR OF ABLATIVE SPECIMENS

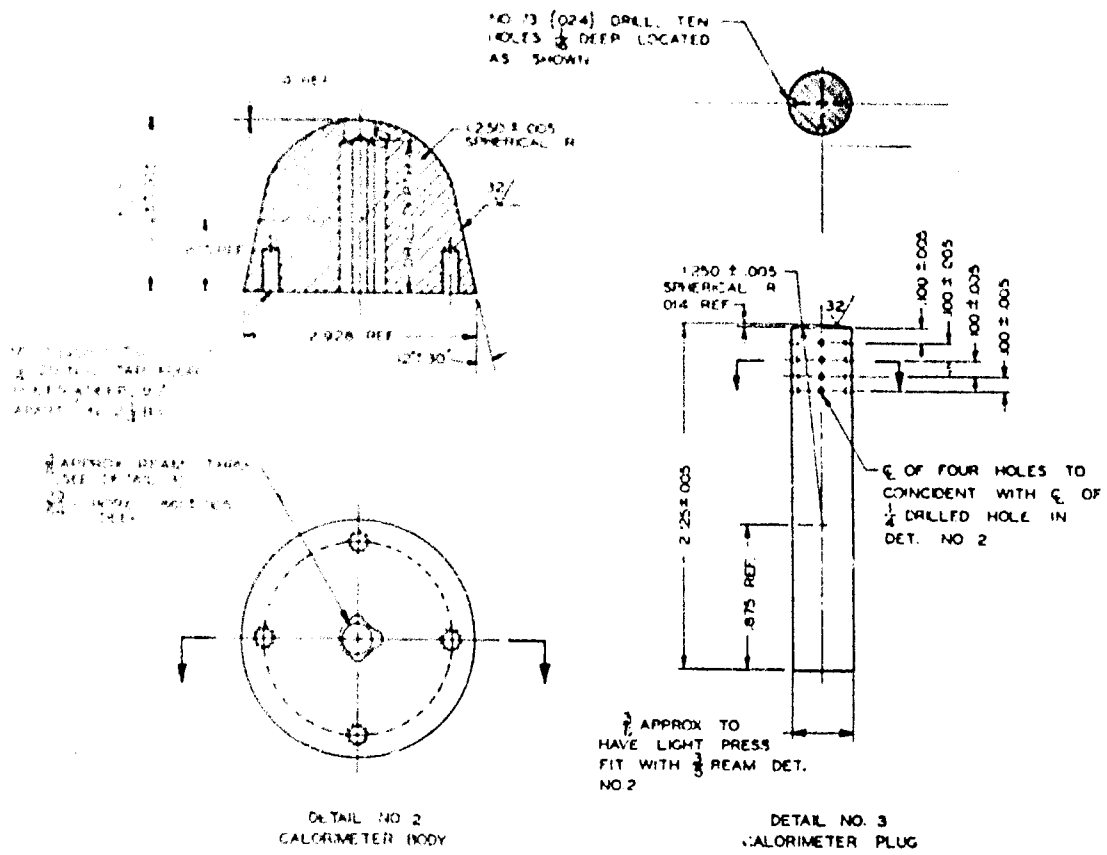


FIG. 2 DETAILS OF COPPER CALORIMETER

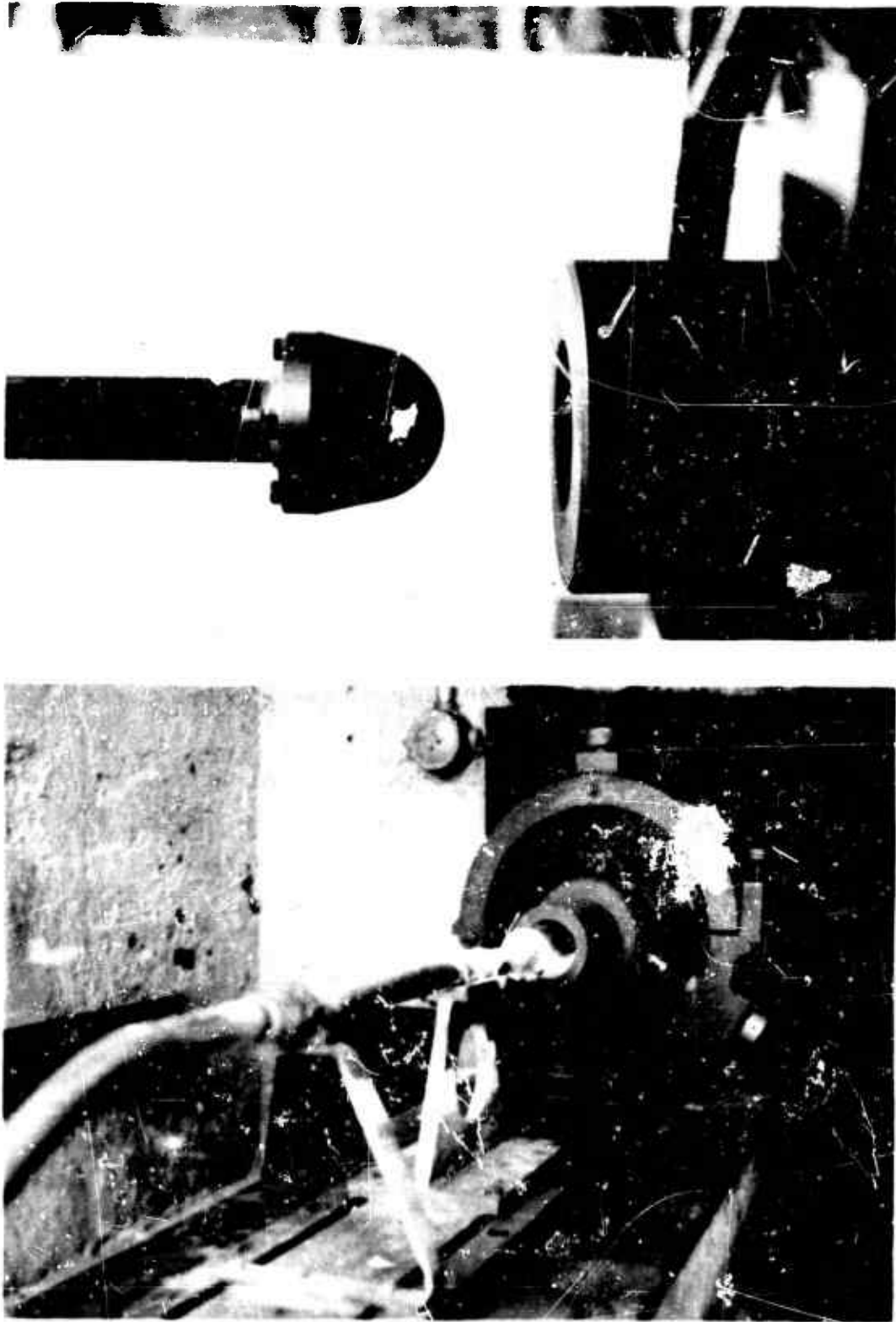


FIG. 3 SPECIMEN HOLDER AND SUPPORT FIXTURE

4. PRELIMINARY PROPELLANT DEVELOPMENT AND TESTING

A significant amount of propellant development and testing was carried out to achieve the originally specified firing conditions. This section summarizes the work and discusses the reasons that a change was found necessary.

4.1 Propellant Formulation for a Slotted-Tube Grain

The testing conditions were found to require propellant grains having a minimum mass of 18 lbm. Motor hardware and casting fixtures were available for a slotted-tube grain weighing about 30 lbs. A large number of these grains had been fired and the neutral pressure trace and uniform mass discharge rate were ideal for the purposes of this program. However, there were two drawbacks:

- a. This design has a 1.5-inch web so that the propellant burning rate would have to be about 0.3 in/sec to achieve the 5-second burning time. This would require some propellant development.
- b. The effect of the five 3-inch slots on the gas flow patterns was unknown. It is well-known that grains having slotted or star-shaped ports channel the flow and oxide particles such that non-uniform erosion and heat transfer occur on the nozzle's converging face and in the throat. This would be undesirable in this test.

Twenty 2C1.5-4¹ motors were fired to characterize three slow-burning-rate propellants for use in the slotted-tube motor. The firings, which were at relatively low pressures, had a considerable build-up of slag in the nozzle and motor case. In another program several slotted-tube motors containing a high-flame-temperature propellant with 18% aluminum were fired with the slots at the head of the motor; the pattern of the slots was visible in the slag deposited in the convergent portion of the nozzle but not in the throat. It was decided that a high-flame-temperature propellant should be used in an end-burning configuration to minimize oxide build-up and to insure uniform gas flow.

¹This nomenclature identifies a cylindrical port grain with a 2-inch O.D., 1.5-inch I.D., and 4-inch length.

4.2 Propellant Formulation for an End-Burning Charge

Plastisol nitrocellulose composite propellants have a high flame temperature and have excellent processing characteristics over a wide range of aluminum content. Compositions RH-P-399, RH-P-400, and RH-P-401 were formulated with 16.0%, 0.5%, and 8.0% aluminum, respectively. The properties of these propellants are given in Table I; the burning rates at 1000 psia chamber pressure were about 0.7 in/sec.

Table I
Theoretical Thermochemical Properties of Propellants

	<u>RH-P-399</u>	<u>RH-P-400</u>	<u>RH-P-401</u>
Aluminum Content, %	16	0.5	8
Chamber Pressure, psia	1000	1000	1000
Exhaust Pressure, psia	14.7	14.7	14.7
Chamber Temperature, °K	3413	2922	3166
Exhaust Temp. (frozen), °K	1700	1330	1510
Exhaust Temp. (equil.), °K	2033	1420	1695
Exhaust Enthalpy (frozen), Kcal/100 grams	-126	-129	-128
Exhaust Enthalpy (equil.), Kcal/100 grams	-130	-131	-131
Exhaust Specific Heat Ratio	1.20	1.24	1.22
Principle Components of Exhaust, moles/100 grams			
CO	1.230	0.621	0.968
CO ₂	0.124	0.733	0.386
N ₂	0.353	0.418	0.386
H ₂	1.076	0.497	0.725
H ₂ O	0.483	1.261	0.937
HCl	0.238	0.366	0.305
Al ₂ O ₃ (solid)	0.296	0.009	0.148

The end-burning charge configuration was selected as the best way of obtaining a neutral pressure trace and a uniform gas flow pattern in a compact motor case. A 14-inch diameter grain was designed to take advantage of the existing 14.5-inch diameter hardware. The mass discharge rate of about 0.77 lbm/in²-sec at the nozzle exit was a little higher than necessary, but acceptable.

Propellant shrinkage during the curing process can cause case bond failures and cracks in a solid propellant grain cast directly into the motor case. To avoid this problem it was decided to cast the propellant into a 14-inch diameter cup molded from liner material. During curing the flexible cup would permit the grain to shrink without building up any internal stresses. The plastic cup containing the propellant would be slipped into the motor case and held in place during firing with grease or a mastic compound. The liner material would restrict the sides of the grain so that burning would occur on the face only.

4.3 Results of Preliminary Testing

4.3.1 Exploratory Firings with High-Flame-Temperature Propellants

While design and fabrication of the cup molding and grain casting fixtures were being done, eighteen 2C1.5-4 motors were fired to obtain P-K-r data for the propellant (Fig. 4), and six nozzles were sized and made for the 14.5-inch motor. Also, one firing was made with a calorimeter to check out the computer program for reducing the thermocouple data in digital form. Two other firings were made to obtain an estimate of the ablation rate of the plastic specimens.

A copper calorimeter with four thermocouples was placed two inches from the nozzle exit of a 6C3-11.4 motor containing 16% aluminum propellant (RH-P-399). The motor operated at 706 psia with a mass flow rate at the nozzle exit of 0.50 lbm/in²-sec (Table II). The computer program performed satisfactorily even though the surface of the calorimeter began melting in less than 230 msec (Fig. 5).

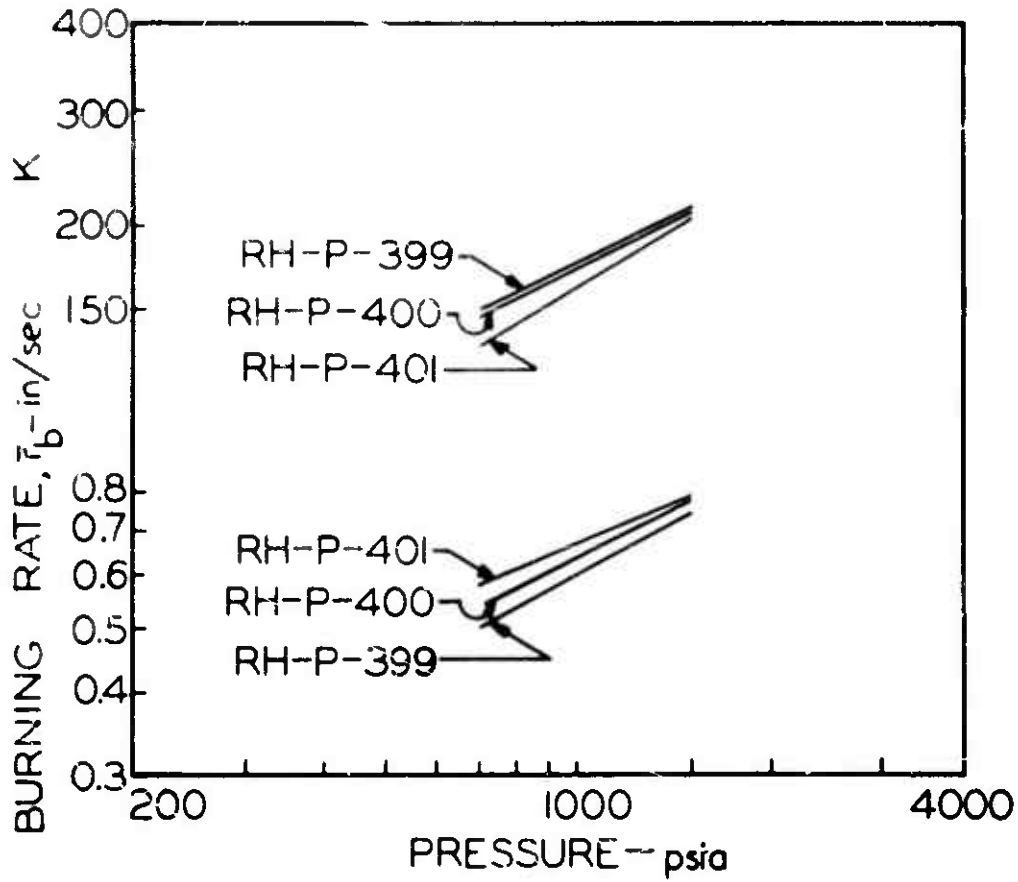


FIG. 4 PRESSURE-K-BURNING RATE RELATIONSHIPS FOR HIGH-FLAME-TEMPERATURE PROPELLANTS

Table II
Results of Ejector-Firing Tests With High-Flame-Temperature Propellants

Ordnance Number	Propellant	Aluminum Content (%)	Average Motor Pressure (psia)	Exit Plane Mass Flow Rate (lbm/l ² sec)	Action Time (sec)	Expansion Ratio	Theoretical Exit Mach Number	Test Specimen Material	Length Before Firing (in)	Length After Firing (in)	Ablation Rate (in/sec)
4000	RH-P-399	16	700	0.50	1.000	0.85	1.19	Copper	---	---	0.56
4000	RH-P-399	16	700	0.50	1.000	0.81	1.17	Alucarb 209-2	2.118	1.190	0.955
4000	RH-P-399	16	700	0.50	1.700	10.17	0.29	Alucarb 209-2	2.118	1.978	0.040

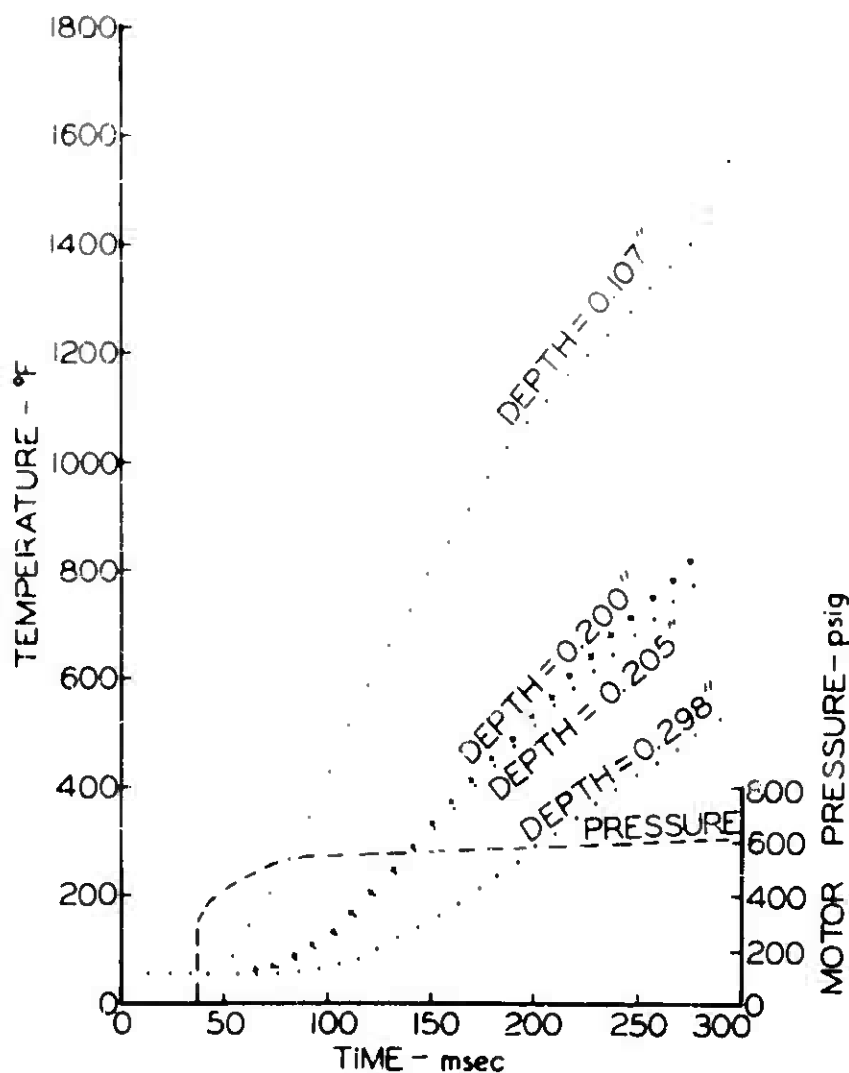


FIG. 5 MOTOR PRESSURE AND CALORIMETER RESPONSE FOR A FIRING WITH 16% ALUMINUM PROPELLANT (ROUND 4049)

A Micarta specimen ablated 1.016 inches at the stagnation point in 2.860 seconds when placed two inches from the nozzle exit of a 6C3-11.4 motor containing 16% aluminum propellant (Table II). The motor was fired at 727 psia with a mass flow rate of .50 lbm/in²-sec at the nozzle exit. A second specimen ablated 0.136 inches in 2.748 seconds when placed two inches from the nozzle exit of 6C3-11.4 motor containing 0.5% aluminum propellant (RH-P-400)(Table II).

The heating and ablation rates on the calorimeter and test specimens were much more severe than expected, and it was obvious that the specified test duration of 5 seconds and a chamber pressure of 700 psia were unreasonable for these propellant formulations. To

obtain the desired ablation rate and calorimeter data the test motors would have to be fired at less severe conditions.

4.3.2 Formulation and Testing of Low-Flame-Temperature Propellants

With the approval of personnel of the Structures and Mechanics Laboratory propellant formulation work and further exploratory firings were carried out. The purpose was to redefine the test conditions such that measurable ablation rates would be obtained on the Micarta specimens with the low aluminum composition and at least 500 milliseconds of usable thermocouple data would be obtained with the highest aluminum composition.

Six firings were carried out in 6C5-11.4 motors with RH-P-390 and RH-P-391, relatively low-flame-temperature propellants containing 15.0% and 0.5% aluminum respectively, and with RH-P-401, a propellant containing 8.0% aluminum.

For the tests with the high aluminum compositions a two-dimensional copper specimen was made from 3-inch bar stock to substitute for the more expensive copper calorimeters (Fig. 6). A single Micarta specimen was used for three tests with low aluminum compositions. High-speed color movies were made of each firing.

A shock wave obscured the front of the copper specimens so that it was not possible to determine from the movies the time at which the surface started to melt. However, at low pressures the overall ablation rates (using the action time of the motors) were 0.066 in/sec and 0.205 in/sec for the cool 15% aluminum and the 8% aluminum compositions respectively (Table III). In comparison the ablation rate of the copper calorimeter with a high-flame-temperature, 16% aluminum composition was approximately 0.56 in/sec at 700 psia. It was estimated that the cool 15% aluminum composition would provide at least 500 milliseconds of usable thermocouple data.

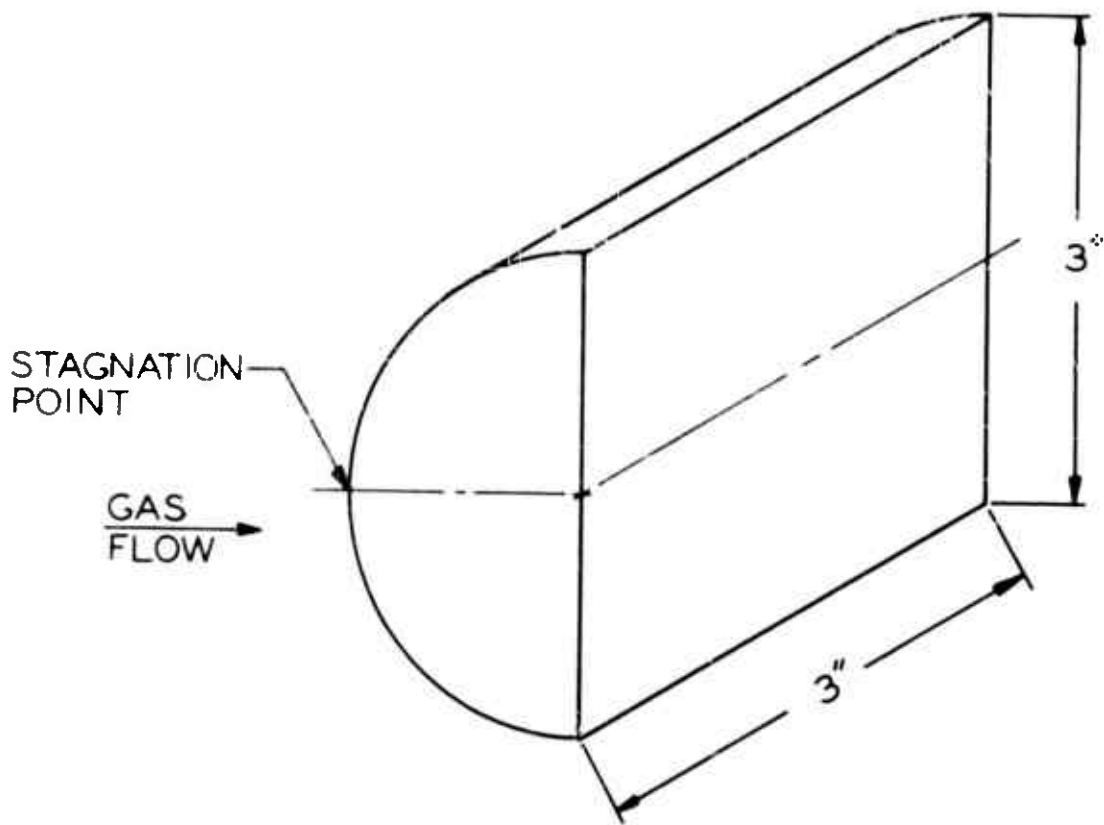


FIG. 6 TWO-DIMENSIONAL COPPER SPECIMEN

Table III
Performance of Cartridges and Ablative Specimens with
Low Flame Temperature Propellants

Round Number	Propellant	Cartridge Weight (%)	Motor Pressure (psi)	Exit Mach Flow Rate (lbm/in ² sec)	Action Time (sec)	Expansion Ratio	Exit Mach Number	Type Specimen	Distance From Nose (in)	Specimen Length Before (in)	Specimen Length After (in)	Ablation Rate (in/sec)
0200	020 P-111	1	17	0.29	2.700	7.00	5.13	3-D Copper	2.0	1.474	1.120	0.340
0204	020 P-110	1	500	0.50	1.070	10.00	3.51	3-D Copper	2.0	1.403	1.104	0.351
0421	020 P-111	0.1	107	0.50	2.105	7.76	5.13	Miscote 259-2	2.0	1.770	1.405	0.365
0422	020 P-111	0.1	107	0.50	1.732	6.71	5.00	Miscote 259-2	2.0	1.605	1.515	0.070
0590	020 P-021	1	800	0.43	0.810	7.82	3.13	Miscote 259-2	2.0	2.130	1.770	0.220
0604	020 P-021	0	107	0.15	0.107	3.00	2.03	3-D Copper	3.0	1.672	1.276	0.206

The effect of pressure on the ablation rate was marked. Increasing the pressure from 420 to 800 psia increased the copper ablation rate from 0.066 to 0.357 in/sec while increasing the pressure from 645 to 990 psia increased the Micarta ablation rate from 0.036 to 0.070 in/sec (Fig. 7). While there were not enough data points to provide valid extrapolation, it was evident that a measurable ablation rate could be obtained at pressures as low as 400 psia with the low aluminum compositions.

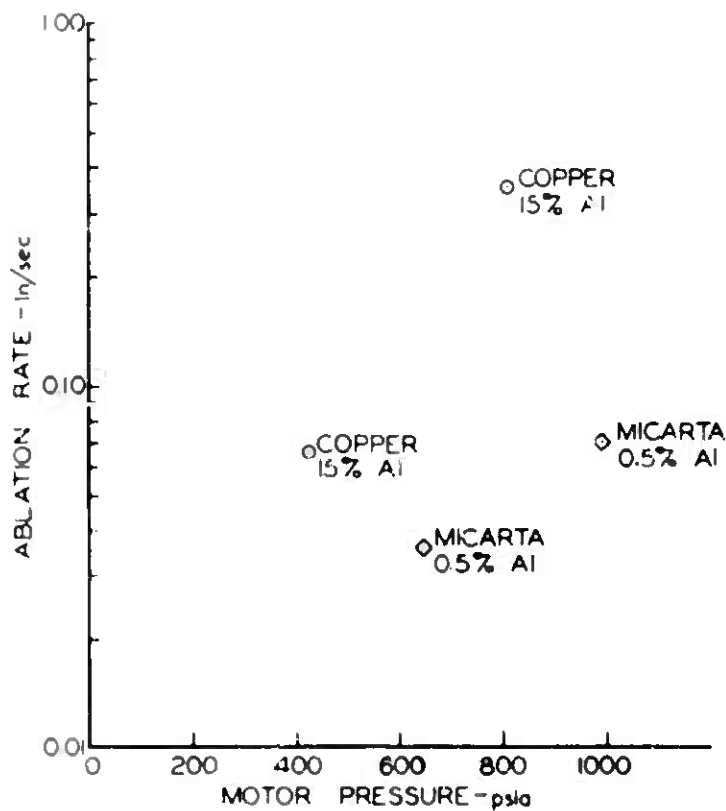


FIG. 7 ABLATION RATES WITH LOW-FLAME-TEMPERATURE PROPELLANTS

There were not enough firings to define the effect of aluminum content on the ablation rates, but the ablation rate with 8% aluminum propellant was about the same order of magnitude as with 16% aluminum propellant.

Some build-up of slag was observed in the nozzle after the firings with the cool 15% aluminum composition. The throat diameter before and after slag removal was 1.056 and 1.072 inches respectively for the 422 psia shot (Round 4394) and 0.832 and 0.844 inches for the 806 psia shot (Round 4395). For the hot 16% aluminum composition fired earlier there was no appreciable buildup. There was also no build-up during the firings with 8% aluminum propellant.

These exploratory firings indicated that the desired exposure conditions could be achieved either with high-flame-temperature propellants operating in the 400-500 psia range with aluminum contents of 0.5%, 6.0%, and 12.0%, or with cooler propellants operating at 500 psia with the original 0.5%, 8.0% and 16.0% aluminum content. The latter approach was taken.

5. DEVELOPMENT OF FINAL TEST PROPELLANTS AND HARDWARE

5.1 Characteristics of Test Propellants

The low-flame-temperature propellant RH-P-390 was modified by substituting 1% aluminum for 1% ammonium perchlorate to form a 16% aluminum composition, RH-P-407. Theoretical flame temperatures were calculated at chamber pressures of 550 psia for RH-P-407 and for several 0.5% and 8.0% aluminum compositions with varying amounts of di-n-propyl adipate, which served as a coolant. From these data the 0.5% and 8.0% aluminum compositions, RH-P-405 and RH-P-406, were formulated and additional computer runs were made to determine the flame temperatures. The maximum difference for the six cases was less than one per cent of the total temperature (Table IV).

Twelve 2C1.5-4 motors were fired to obtain P-K-r data (Fig. 8). These propellants, before curing, have a very high viscosity for a plastisol propellant, and to make the motor casting operations less difficult unground ammonium perchlorate was used. The larger particles of perchlorate and the di-n-propyl adipate made the motors hard to ignite. Surface roughening and a larger igniter were necessary to get good ignition.

It was not necessary to use end-burning charges with these propellants. The shorter firing times permitted use of 6C5-11.4 motors for the 8% and 16% aluminum compositions, and 6C4-11.4 motors for the 0.5% aluminum composition. The flow patterns from these symmetrical charges are uniform.

Table IV
Theoretical Thermochemical Properties of Test Propellants

	RH-P-405		RH-P-406		RH-P-407	
	400	550	400	550	400	550
Chamber Pressure, psia	400	550	400	550	400	550
Exhaust Pressure, psia	14.7	14.7	14.7	14.7	14.7	14.7
Chamber Temperature, °K	2960	2979	2952	2964	2958	2970
Exhaust Temperature (frozen), °K	1625	1542	1632	1545	1655	1570
Exhaust Temperature (equil), °K	1793	1692	1727	1631	1747	1651
Exhaust Enthalpy (frozen), K cal/100 grams	-118	-122	-116	-120	-114	-118
Exhaust Enthalpy (equil), K cal/100 grams	-120	-124	-118	-122	-116	-120
Exhaust Specific Heat Ratio	1.22	1.23	1.22	1.23	1.22	1.22
Principle Components of Exhaust, moles/100 grams						
CO	0.55	0.53	1.11	1.21	1.51	1.51
CO ₂	0.71	0.73	0.32	0.21	0.05	0.05
N ₂	0.42	0.42	0.36	0.36	0.30	0.30
H ₂	0.29	0.31	0.87	0.77	1.55	1.55
N ₂ O	1.38	1.36	0.84	0.93	0.17	0.17
HCl	0.40	0.40	0.34	0.32	0.27	0.27
Al ₂ O ₃ (liquid)	0.01	0.01	0.15	0.15	0.30	0.30

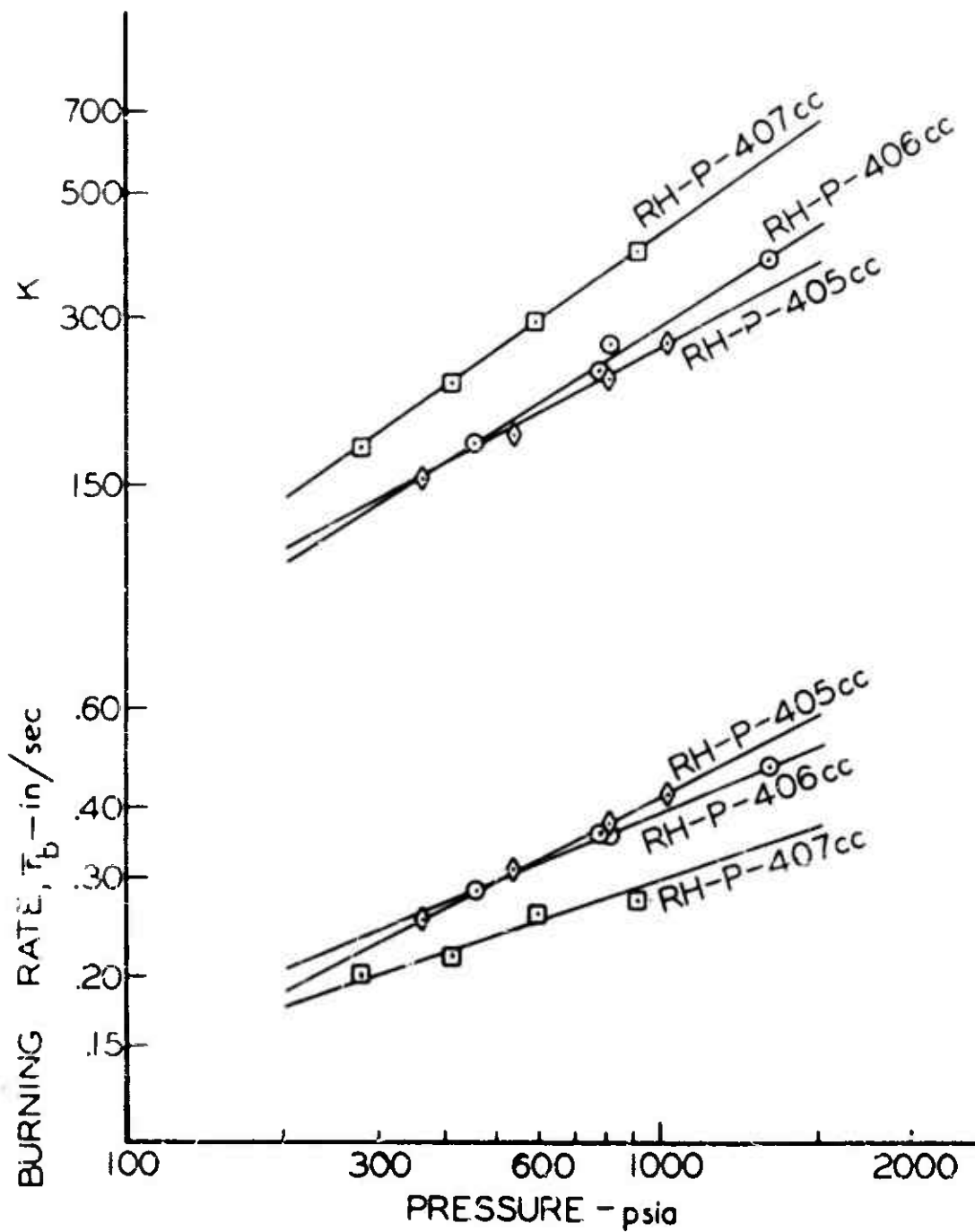


FIG. 8 PRESSURE-K-BURNING RATE RELATIONSHIPS FOR TEST PROPELLANTS

6. DESCRIPTION AND RESULTS OF TEST FIRINGS

6.1 Calorimeter Tests

Six firings were made with copper calorimeters immersed in the exhaust stream of 6-inch motors. The tip of the calorimeters was positioned two inches from the nozzle exit. There was one test at 400 and 550 psia for each of the three aluminum contents. During these tests the response of eight thermocouples in each calorimeter was recorded in analog and digital form.

Also recorded was the output of a heat flux transducer. During the first firing (Round 4955) the sensing face of the heat flux transducer was positioned perpendicular to and four inches away from the centerline of the exhaust stream at a point one inch downstream from the nozzle. After the firing the window of the gauge was clouded (possibly by the blast from the igniter). In all other firings the transducer face was located five inches from the centerline of the exhaust stream and was shielded from the igniter blast by a 3 X 5-inch paper card. The card was removed immediately after ignition and this quick-fix remedy seemed to prevent clouding for the low aluminum firings. However, some pits and spots were observed on the window after the 16% aluminum firings.

The chamber pressure of each firing was measured at the head-end of the motor case with a calibrated strain-gage-type transducer and recorded on an analog trace and in digital form. In five of the six tests the average pressures, \bar{P}_b , were close to the nominal values of 400 and 550 psia (Table V). The burning times were about 3 seconds for the motors with 0.5% aluminum propellant, 1.5 seconds for motors with 8% aluminum propellant, and 2 seconds for motors with 16% aluminum propellant. Calorimeter No. 1 was not damaged in the test with 0.5% aluminum and was subsequently reused. The others each sustained some degree of melting at the stagnation point. The mass flux at the nozzle exit (based on the action time t_a) exceeded the required value of 0.5 lbm/in²-sec (Table V).

Table V
Firing Conditions for Calorimeter Tests

Propellant Aluminum Content	Round	Calorimeter Number	t_b (sec)	t_a (sec)	\bar{P}_b (psia)	\bar{P}_a (psia)	\dot{m}/A_a (lbm/in ² -sec)	Expansion Ratio	Theoretical Exit Mach Number
0.5	4954 ^a	1	3.443	3.543	394	389	0.59	4.31	2.68
0.5	4957 ^a	2	2.878	3.071	561	545	0.67	5.50	2.92
8.0	4956 ^b	3	1.626	1.907	399	372	0.63	4.57	2.74
8.0	4955 ^b	4	1.525	1.666	560	538	0.66	5.77	2.89
16.0	4959 ^b	5	2.346	2.476	388	381	0.58	4.58	2.72
16.0	4958 ^b	1	2.148	2.279	518	506	0.63	5.67	2.87

^a Calorimeter located two inches from nozzle of a 6C4-11.4 motor.
^b Calorimeter located two inches from nozzle of a 6C5-11.4 motor.

Appendix A describes the thermocouple locations in detail and presents the temperature-time measurements in tabular form. The thermocouple data, heat flux measurements, and motor pressure are also plotted as a function of time in Figs. 9 through 14. The 1 second delay was to allow the movie camera to get up to speed before the firing occurred. Comparing the data in these figures shows that the heating rate increased at the higher pressures and aluminum contents. A composite plot of the response of the thermocouples located 0.1 inch from the calorimeter surface more clearly shows this effect (Fig. 15). The heat flux measurements also confirm this trend, although the data were not as consistent (Fig. 16).

These results were not analyzed further since the primary purpose of the project was to provide raw data for the Structures and Mechanics Laboratory.

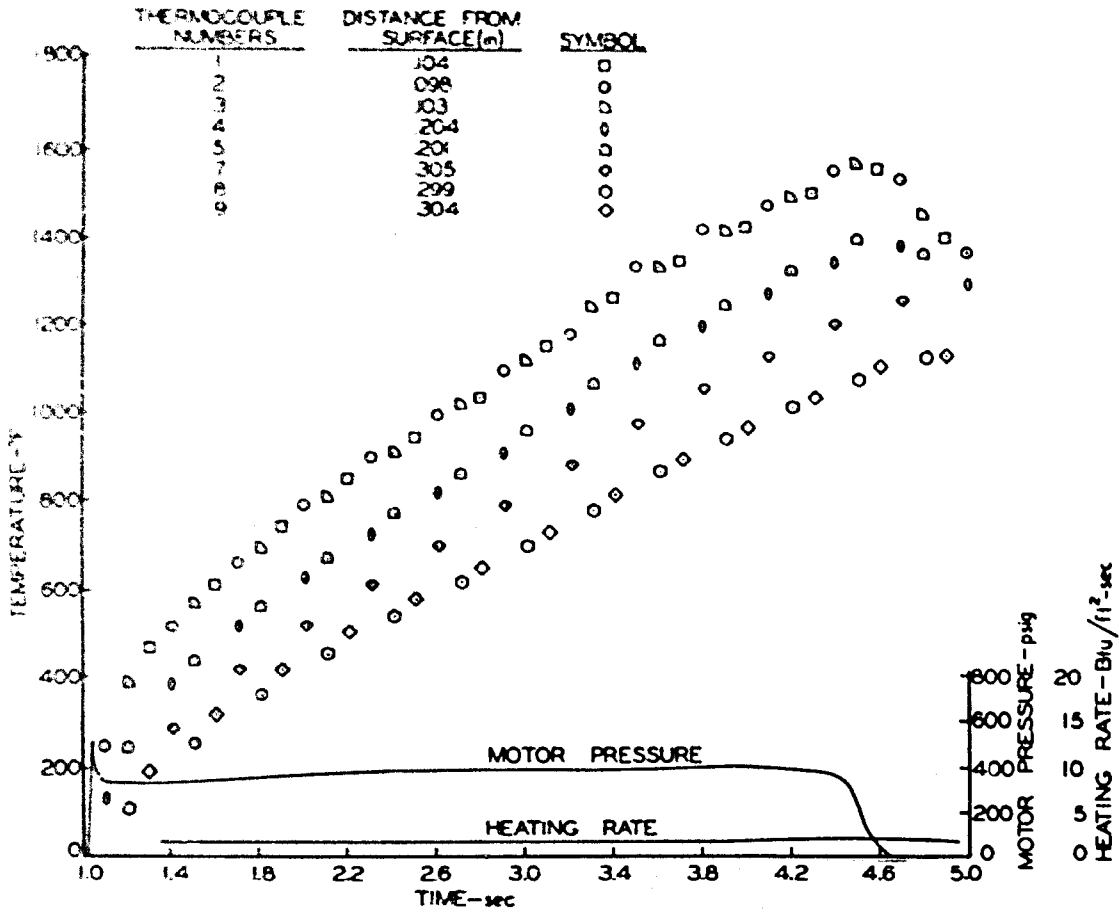


FIG. 9 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 0.5% ALUMINUM PROPELLANT (ROUND 4954)

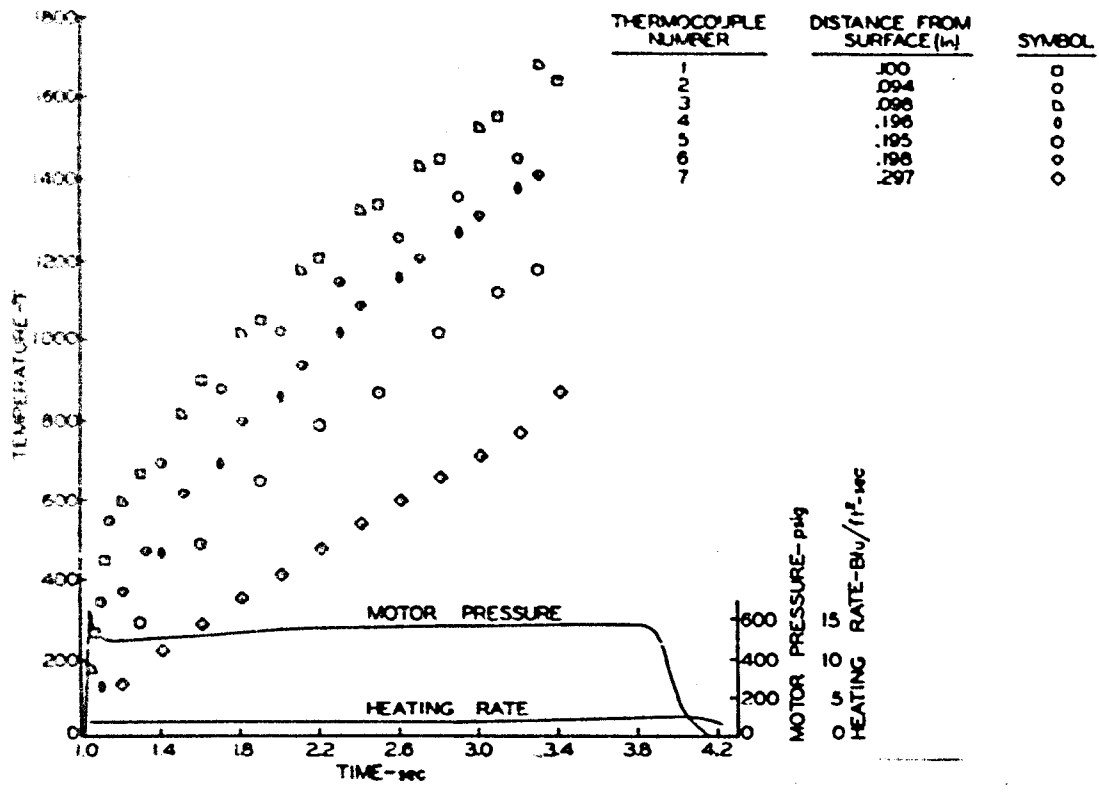


FIG. 10 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 0.5% ALUMINUM PROPELLANT (ROUND 4957)

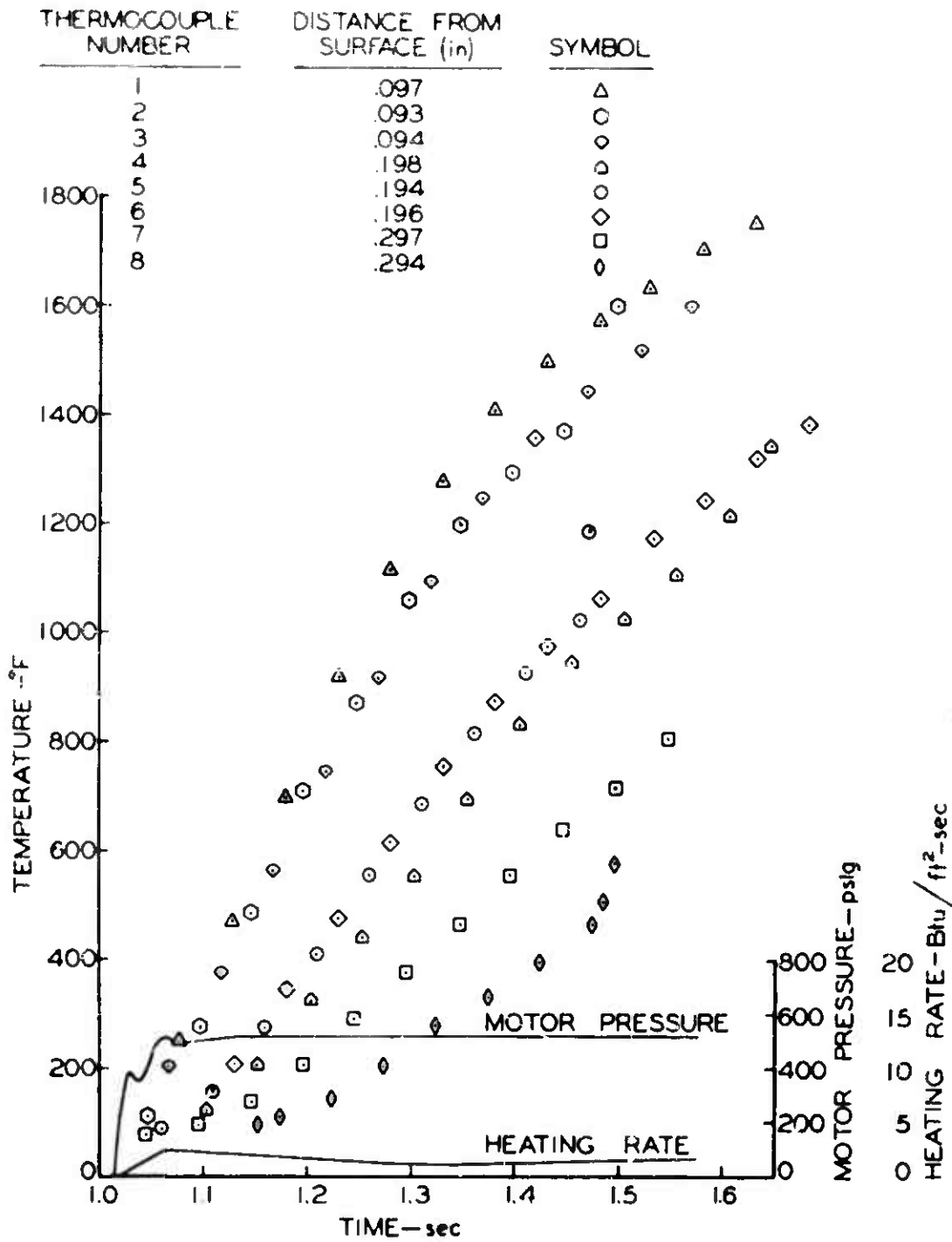


FIG. 11 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 8% ALUMINUM PROPELLANT (ROUND 4955)

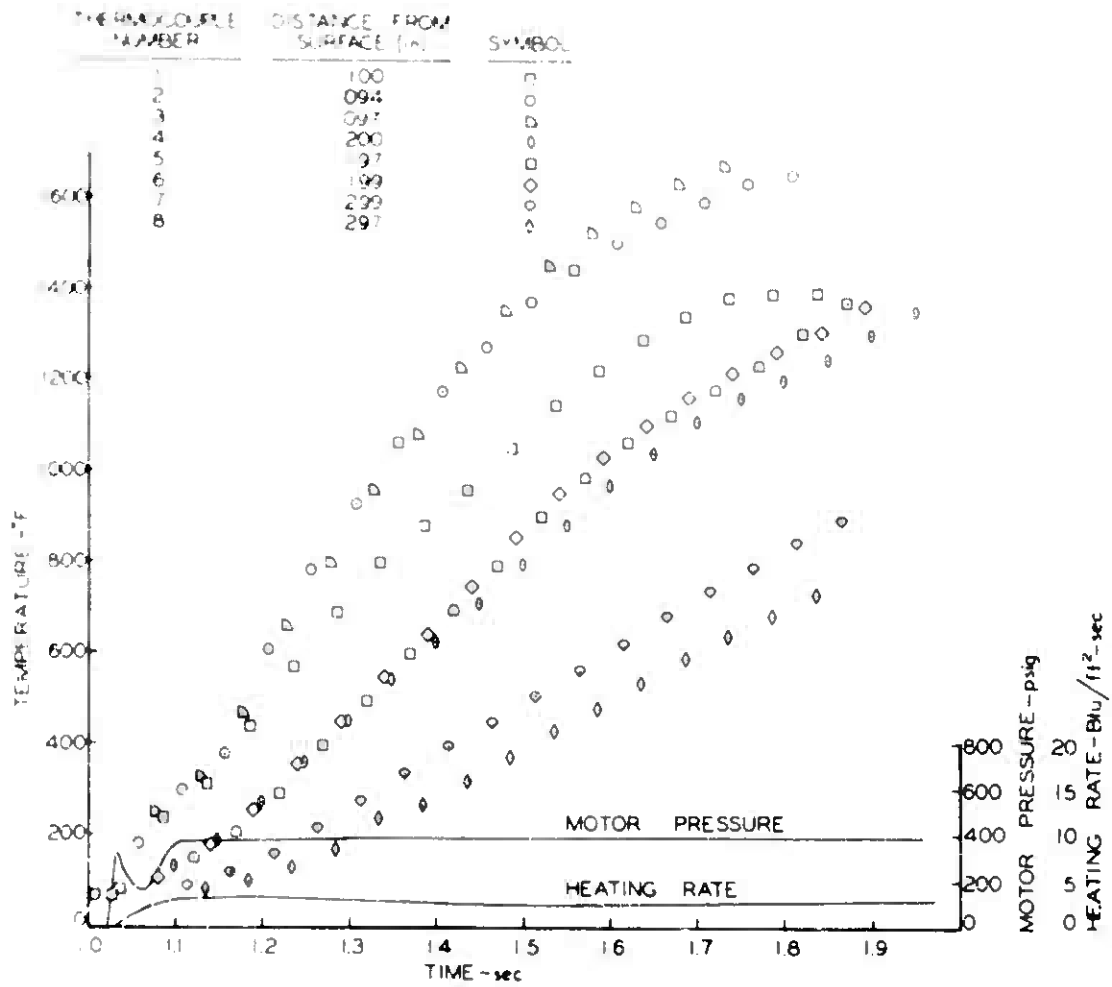


FIG. 12 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 8% ALUMINUM PROPELLANT (ROUND 4956)

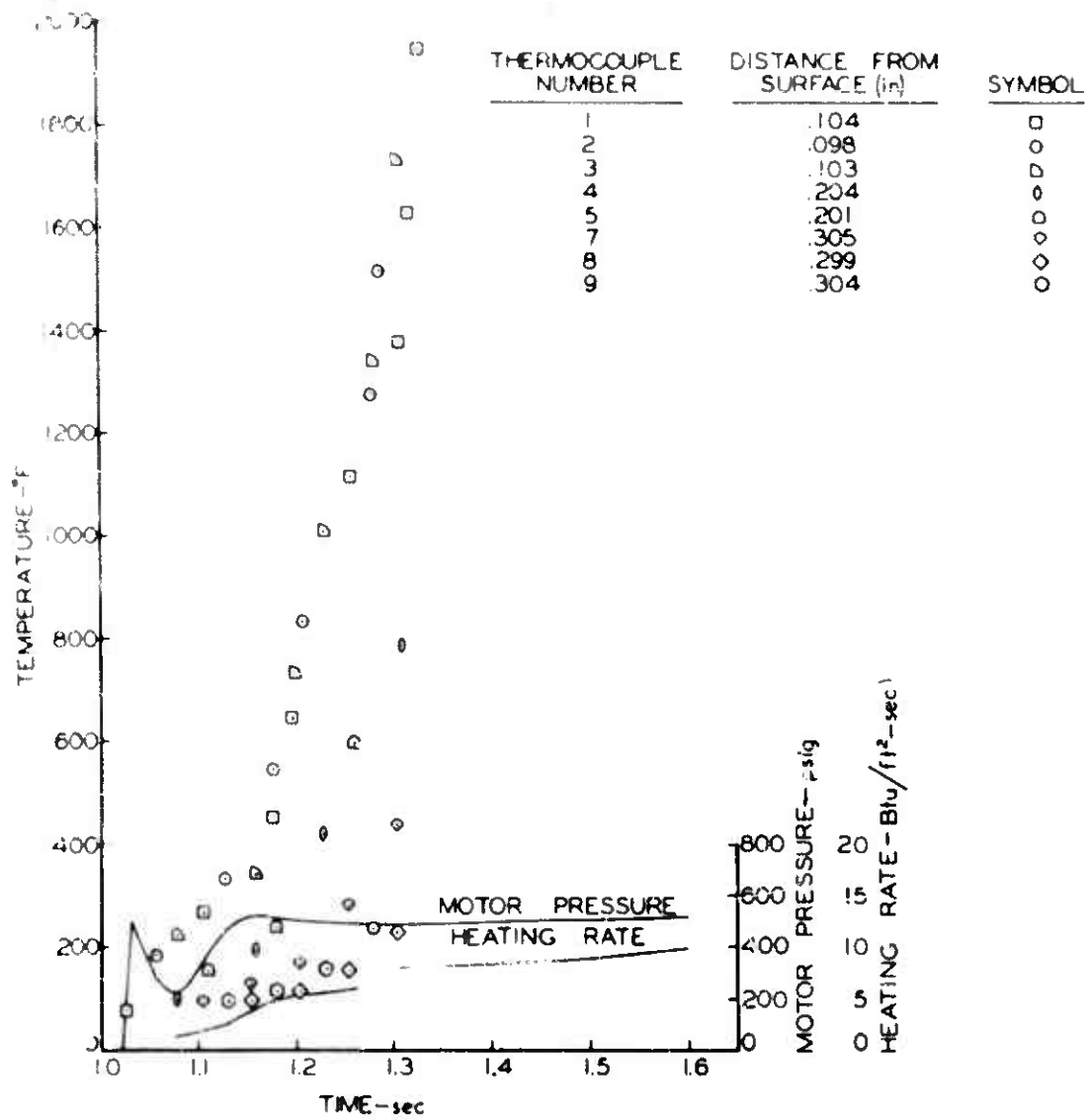


FIG. 13 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 16% ALUMINUM PROPELLANT (ROUND 4958)

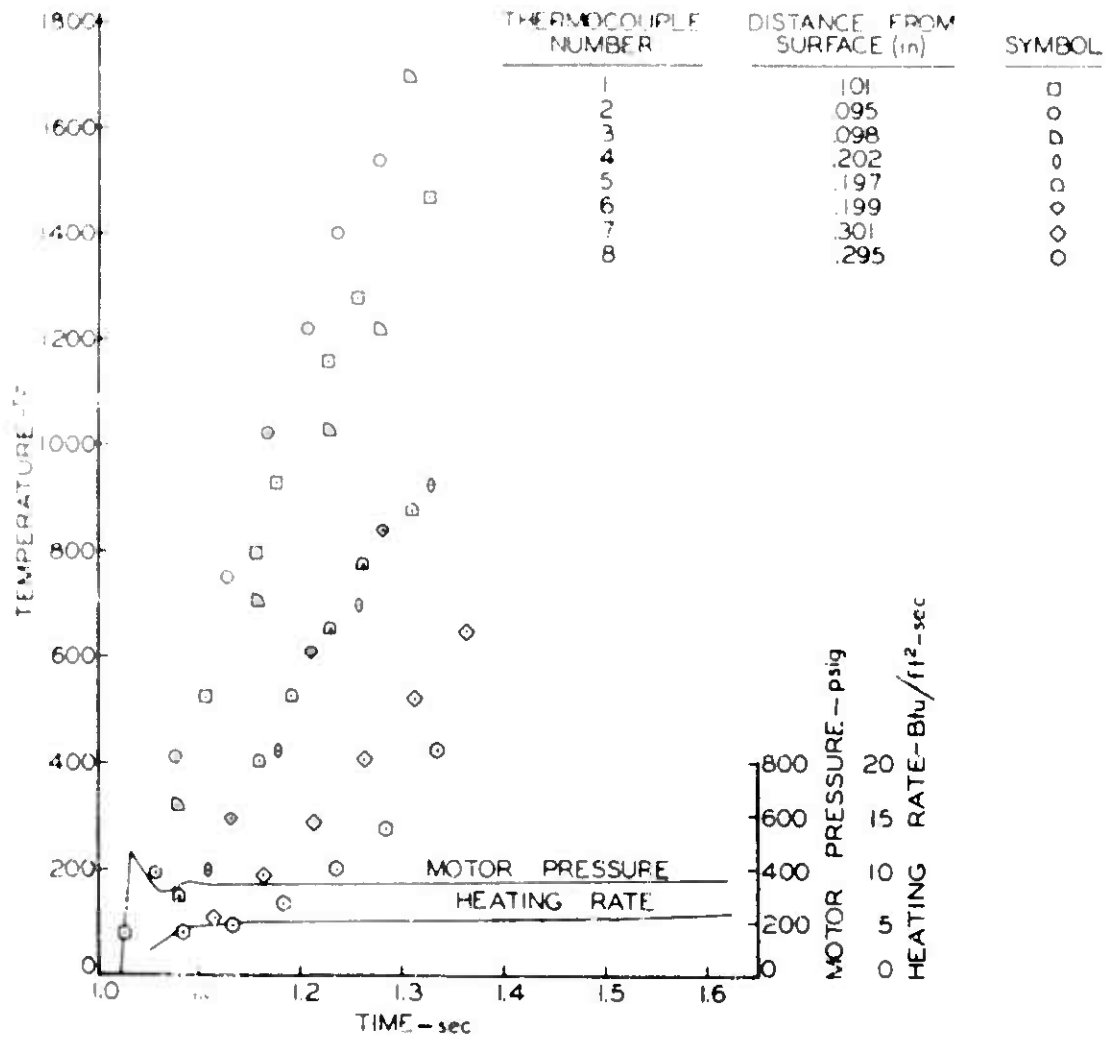


FIG. 14 TEMPERATURE, MOTOR PRESSURE, AND HEATING RATE MEASUREMENTS FROM A FIRING WITH 16% ALUMINUM PROPELLANT (ROUND 4959)

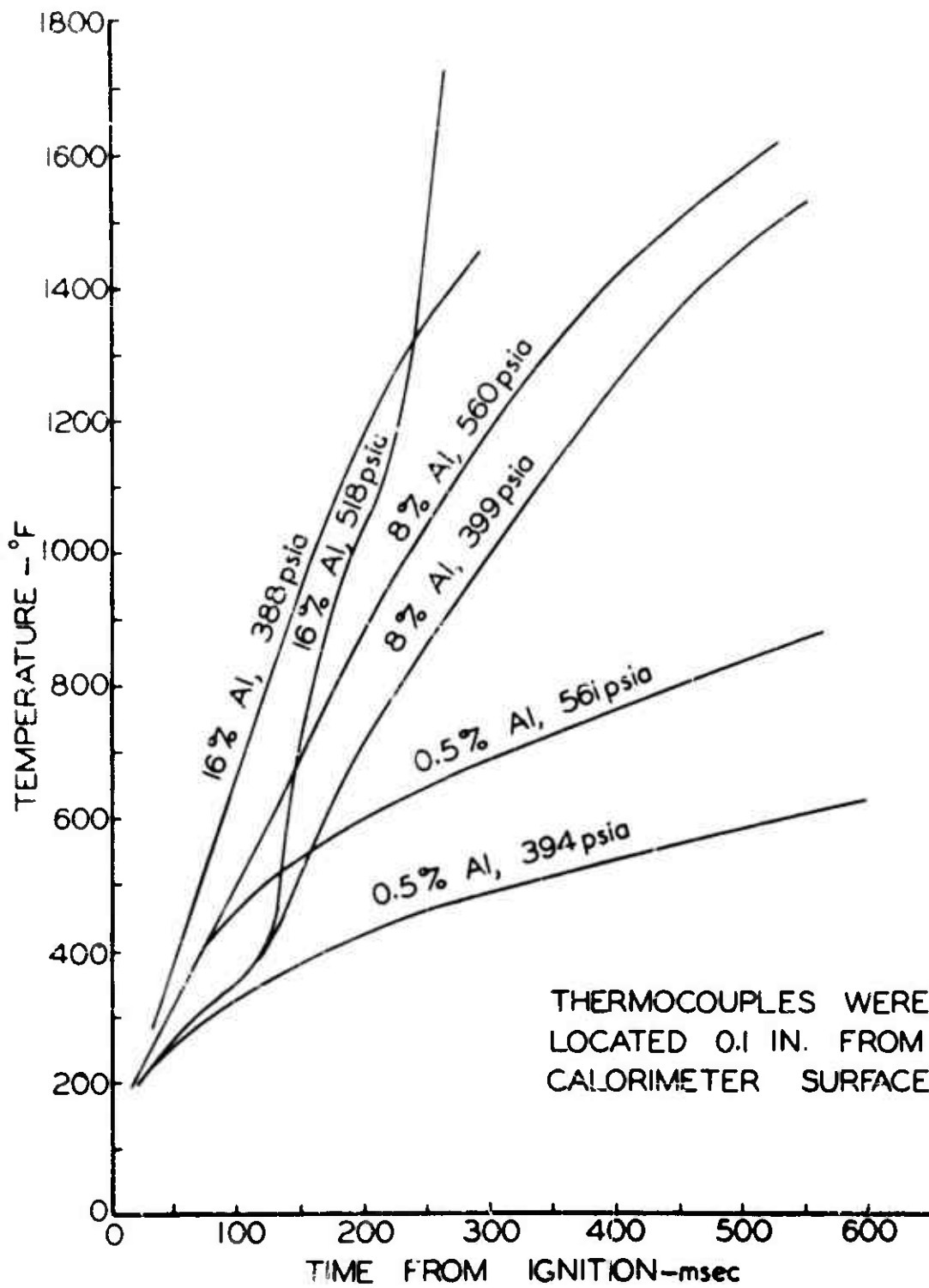


FIG. 15 THERMOCOUPLE RESPONSE AS A FUNCTION OF ALUMINUM IN PROPELLANT AND MOTOR PRESSURE

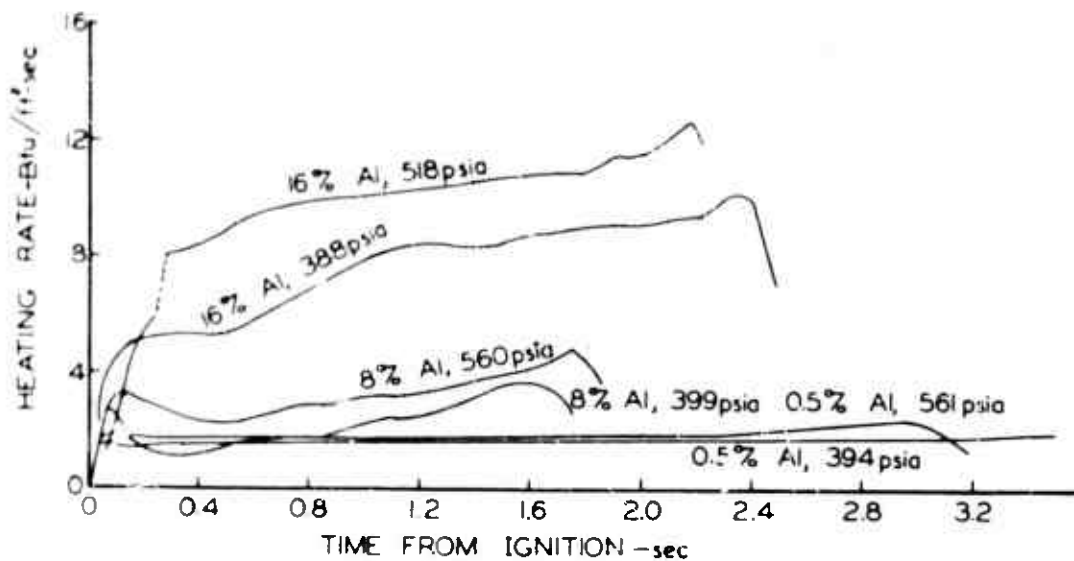


FIG. 16 RADIATION HEAT FLUX WITH CALORIMETERS IMMERSED IN THE EXHAUST STREAM

6.2 Tests on Ablative Specimens

Thirteen firings were carried out with ablative specimens immersed in the exhaust gases of 6-inch motors. The stagnation point of the specimen was positioned two inches from the nozzle exit. There were firings at 400 and 550 psia chamber pressures for each of the three aluminum contents.

Heat flux measurements were made during four of these ablative firings (Rounds 4969, 4960, 4971, and 4984) with a more sensitive transducer. Its position was the same with respect to the nozzle and specimen as described in Section 6.1. The heating rates were higher with an ablative specimen in the exhaust stream than with a calorimeter in the exhausts (Fig. 17).

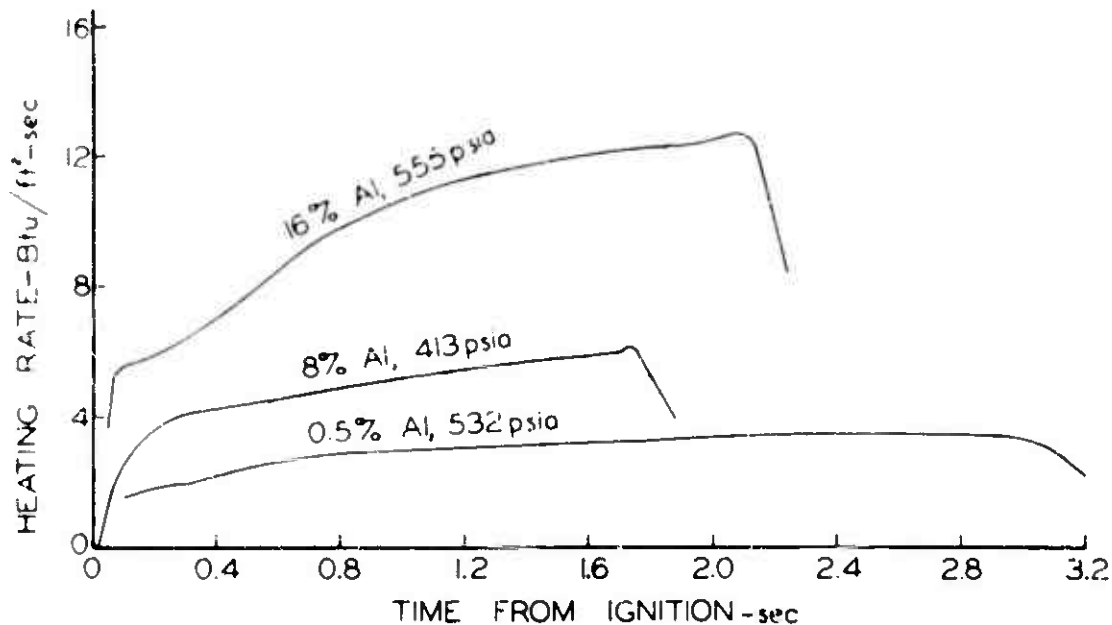


FIG. 17 RADIATION HEAT FLUX WITH ABLATIVE SPECIMENS IMMERSSED IN THE EXHAUST STREAM

The motor chamber pressure was measured at the head-end of the case with a calibrated transducer and recorded on an analog trace and in digital form. There were duplicate firings at each condition for the 0.5% and 16% aluminum compositions. In general the average pressures, \bar{P}_b , were close to the nominal values of 400 and 550 psia (Table VI).

Thrust measurements were made during nine of the firings. The ratio of measured to calculated specific impulse at test conditions, η , was lower than expected for the composition containing 16% aluminum (Table VI). This correlates with the greater amount of slag build-up in the nozzles of rounds containing that propellant.

The mass flux at the nozzle exit (based on t_a) exceeded the required value of 0.5 lbm/in²-sec in each case.

Table VI
Firing Conditions and Results for Ablative Specimen Tests*

Specimen No.	Pressure (psia)	P_0 (psia)	P_1 (psia)	P_2 (psia)	P_3 (psia)	P_4 (psia)	Propellant Ratio	Temperature Rate Meas. (°C/sec)	Specimen Wt. Before Firing (grams)	Specimen Wt. After Firing (grams)	Specimen Length Before Firing (mm)	Specimen Length After Firing (mm)	Char Layer Thickness (mm)	Ablation Rate (mm/sec)	$\frac{dL}{dt}$
1.1	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.9	2.110	1.910	0.010	0.097	0.000
1.2	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.59.0	2.110	1.910	0.010	0.092	0.001
1.3	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.58.0	2.110	1.822	0.010	0.100	0.017
1.4	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.891	0.010	0.076	0
1.5	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.741	0.010	0.200	0.060
1.6	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.620	0.010	0.222	0
1.7	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.520	0.010	0.200	0.020
1.8	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.410	0.010	0.200	0.010
1.9	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.300	0.010	0.200	0.000
1.10	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.190	0.010	0.200	0
1.11	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	1.080	0.010	0.200	0
1.12	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	0.970	0.010	0.200	0
1.13	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	0.860	0.010	0.200	0
1.14	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	0.750	0.010	0.200	0
1.15	400	1.82	1.90	1.91	1.91	1.91	0.5%	0.11	1.64	1.57.0	2.110	0.640	0.010	0.200	0

* Ablation Specimens from various firing tests.
 † Values are values.
 ‡ Support Surface loss as that specimen was slightly off center and at an angle with the exhaust stream.

Measurable changes in specimen weight and length occurred during each firing (Table VI, Fig. 18). The ablation rates, which were calculated at the stagnation point using the action time t_a , were a direct function of pressure and aluminum content of the propellant. The values ranged from 0.057 in/sec at 400 psia and 0.5% aluminum content to 0.378 in/sec at 550 psia and 16% aluminum content (Table VI).

The 1500 frame/second movies taken of each ablative specimen during the firing were spectacular. The specimen was clearly visible through the exhaust gases of the 0.5% and 8% compositions. Droplets of melted glass could be seen flowing back over the surface and the change in shape and length was obvious. The original films were transmitted to the Structures and Mechanics Laboratory for analysis but a good print is available on loan from the author.

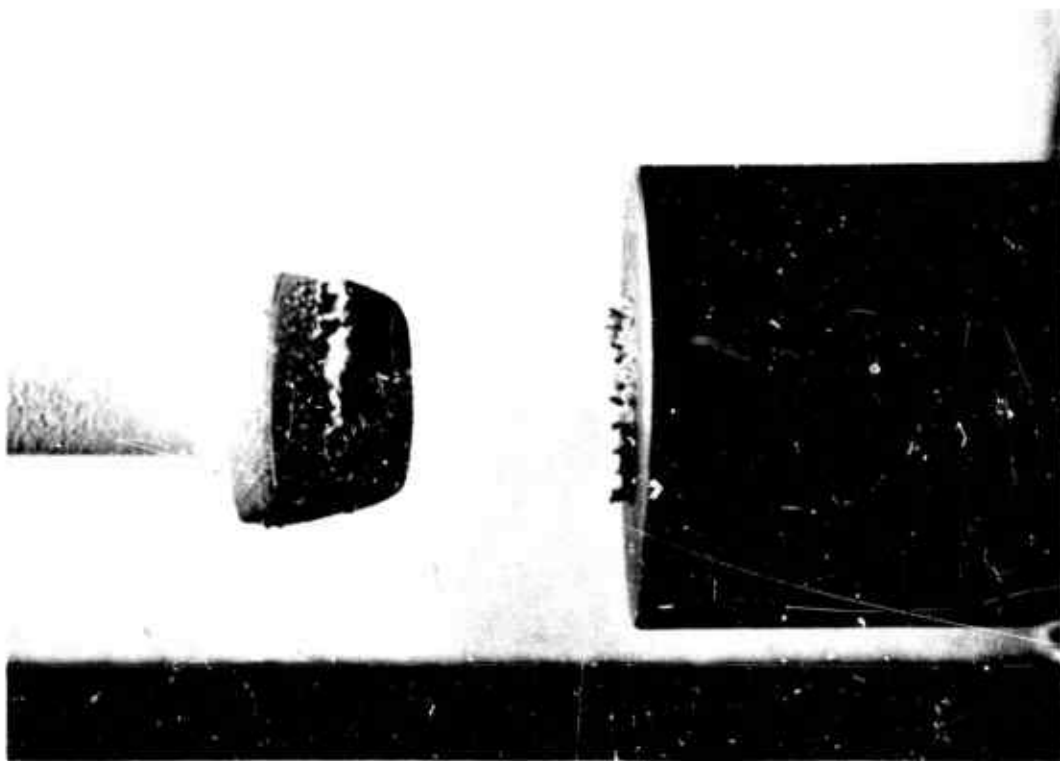
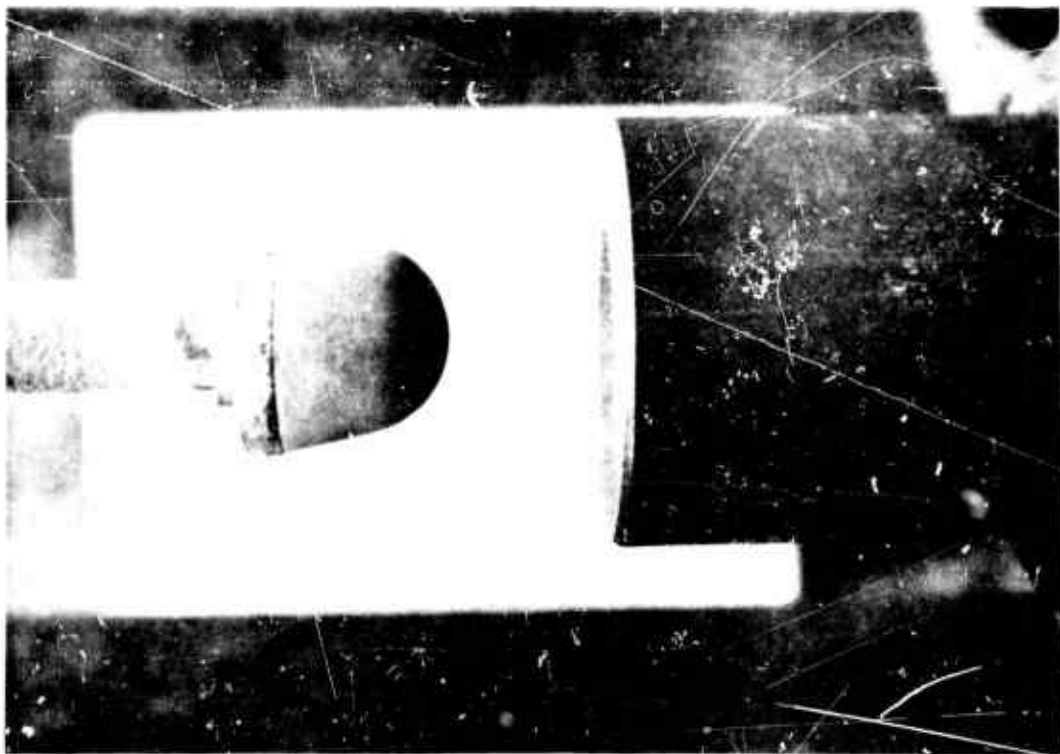


FIG. 18 CHANGE IN ABLATIVE SPECIMEN SHAPE DURING A 2.37-SECOND FIRING WITH A 16% ALUMINUM PROPELLANT

7. SUMMARY

A test program for determining the effect of solid particles on heating and erosion rate of ablative-type protective materials has been successfully carried out. Extensive formulation work was necessary to develop propellants which would provide suitable test conditions on both copper calorimeters and ablative specimens. Testing was carried out at nominal chamber pressures of 400 and 550 psia and with propellants having aluminum contents of 0.5%, 8%, and 16%. The flame temperatures of these propellants were within 1% of 2965°K.

Raw data for calculating heating rates on the specimens were obtained from copper calorimeters instrumented with thermocouples. The temperature readings were recorded in digital form and printed out in convenient tabular form. Ablation rates were obtained on 13 specimens and reproducibility of data on identical firings was excellent.

Close-up color movies taken at 1500 frames/second showed the details of specimen melting and ablation.

APPENDIX A

DESCRIPTION OF COPPER CALORIMETERS, DATA
ACQUISITION SET-UP, AND DATA PRINT-OUT

The ten 30-gage chromel-alumel thermocouples were located at different depths from the calorimeter surface in a $\frac{3}{8}$ -inch diameter copper plug. The distance from the leading edge along the side of the $\frac{3}{8}$ -inch plug to the centerline of the 0.024-inch diameter hole is given in Table A-I.

The reference junction of the thermocouples was maintained at $150^{\circ}\text{F} \pm 1^{\circ}$. The response of the thermocouples was recorded on paper by a rapid-response oscillograph; the signal was also fed into a TRW 230 computer in digital form. The computer determined the temperature from a third degree polynomial equation representing the temperature vs millivolt relationship for chromel-alumel thermocouples and printed out the results in degrees Fahrenheit. Above 200°F the maximum difference between the polynomial and the temperature-millivolt plot was 1.7°F .

The computer print-out of the thermocouple readings for each firing is given in Tables A-II through A-VII. The computer received data from ten multiplexer channels during these tests, and a channel was sampled every millisecond beginning with the Number 1 Multiplexer channel and taking each channel in order. Zero time was the beginning of the firing sequence. The time at which the Number 1 multiplexer channel was sampled is given in the first column of the print-out sheet. The multiplexer channel number is listed in the heading of each print-out. The numbers go from 1 thru 6, skip 7 and 8, and then pick-up at 9 and 10 on the print-out; the times at which the readings shown in the first line were recorded are 735.1, 736.1, 737.1, 738.1, 739.1, 740.1, 743.1, and 744.1 msec.

Ignition of the motors occurred at times varying from 1018 to 1026 msec after the start of the timing sequence. These approximate times are marked in the margin of the print-out sheets.

Table AI

Calorimeter	Distance from Leading Edge to Centerline of Thermocouple Holes (in)									
	1	2	3	4	5	6	7	8	9	10
1	0.104	0.098	0.103	0.204	0.201	0.203	0.305	0.299	0.304	0.401
2	0.100	0.094	0.098	0.196	0.195	0.198	0.297	0.288	0.298	0.394
3	0.100	0.094	0.097	0.200	0.197	0.199	0.299	0.297	0.300	0.398
4	0.097	0.093	0.094	0.198	0.194	0.196	0.297	0.294	0.296	0.395
5	0.101	0.095	0.098	0.202	0.197	0.199	0.301	0.295	0.299	0.395

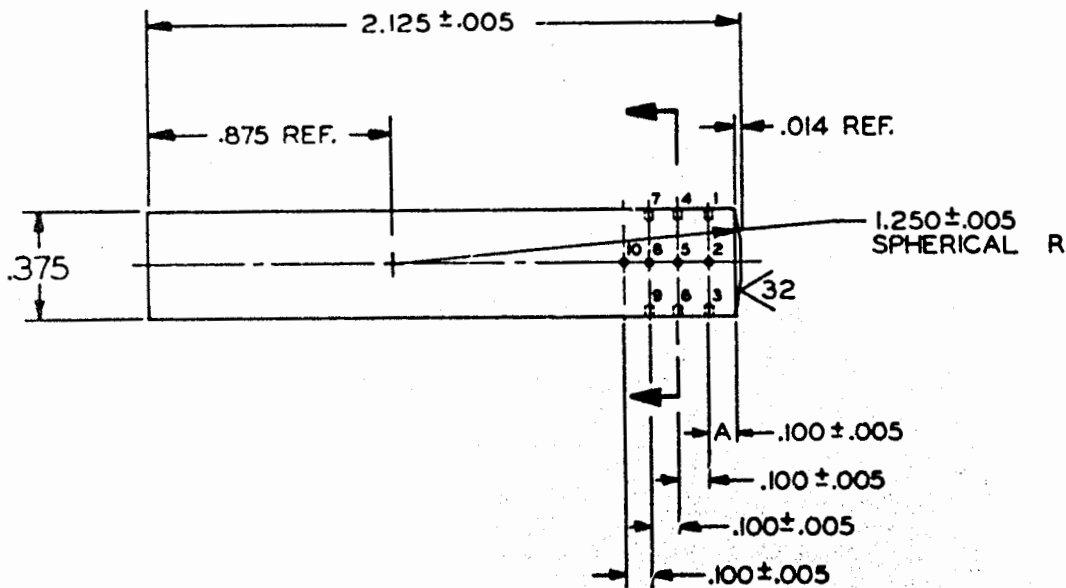


FIG. A-1 CALORIMETER PLUG

Table A-II

Temperature Data Print-Out for Round 4954

Thermocoupl. No.	1	2	3	4	5	6	7	8
Multiplex Channel	01	02	03	04	05	06	09	10
Time (msec)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)
735.1	70.835	71.333	71.294	71.238	71.825	70.975	71.277	70.948
745.1	70.991	71.113	71.294	71.339	71.321	71.882	71.277	71.815
755.1	71.818	71.278	71.294	71.297	71.134	71.885	71.223	70.960
765.1	70.991	71.113	71.274	71.285	71.880	70.975	71.387	71.878
775.1	70.991	71.223	71.239	71.285	71.188	71.196	71.113	70.795
785.1	70.888	71.113	71.294	71.172	70.971	70.928	71.277	70.960
795.1	70.935	71.278	71.294	71.339	71.324	71.838	71.332	70.960
805.1	70.935	71.278	71.239	71.283	71.188	71.882	71.277	70.850
815.1	70.991	71.113	71.129	71.238	71.188	70.975	71.387	71.878
825.1	71.846	71.278	71.184	71.886	71.243	71.188	71.829	70.850
835.1	70.835	71.168	71.129	71.121	71.848	71.818	71.277	70.960
845.1	71.181	71.223	71.294	71.172	71.297	71.221	71.113	70.960
855.1	70.975	71.333	71.294	71.121	71.825	71.885	71.223	70.985
865.1	71.846	71.223	71.184	71.121	71.188	71.838	71.332	71.878
875.1	71.181	71.223	71.239	71.121	71.243	71.361	71.859	70.850
885.1	70.888	71.113	71.184	71.239	71.188	70.975	71.332	70.960
895.1	70.888	71.148	71.184	71.285	71.278	71.148	71.223	70.985
905.1	70.935	71.278	71.294	71.172	71.297	71.148	71.223	70.850
915.1	70.991	71.113	71.184	71.172	71.188	70.975	71.277	71.878
925.1	71.181	71.278	71.484	71.339	71.243	71.251	71.168	70.795
935.1	70.888	71.188	71.184	71.172	71.188	70.975	71.332	71.815
945.1	71.181	71.223	71.184	71.285	71.243	71.148	71.168	70.985
955.1	71.181	71.223	71.239	71.121	71.188	71.838	71.332	70.985
965.1	70.935	71.223	71.129	71.285	71.888	70.928	71.332	71.122
975.1	71.846	71.333	71.294	71.238	71.297	71.196	71.859	70.741
985.1	70.935	71.168	71.184	71.121	70.971	70.869	71.277	71.878
995.1	71.181	71.113	71.349	71.172	71.391	71.199	71.223	71.815
1005.1	70.991	71.168	71.239	71.121	71.888	71.148	71.113	70.985
Ignition	70.888	71.838	71.874	71.886	71.888	70.928	71.223	70.960
1025.1	71.846	71.333	71.238	71.172	71.215	71.196	71.884	70.795
1035.1	72.283	79.158	72.778	70.957	70.818	70.424	70.848	70.831
1045.1	89.154	102.138	92.659	70.464	70.888	69.653	70.184	70.391
1055.1	120.977	136.392	129.218	74.565	76.129	78.788	71.859	70.521
1065.1	156.188	168.196	166.357	62.212	85.212	71.981	72.426	71.878
1075.1	189.447	192.384	198.849	71.118	95.523	72.737	74.448	71.289
1085.1	218.341	213.632	225.139	105.292	107.164	74.664	78.491	71.649
1095.1	242.856	231.883	247.524	117.981	129.287	77.698	83.821	72.714
1105.1	263.240	245.592	266.732	130.738	132.144	81.188	88.911	74.387
1115.1	280.931	283.484	284.227	144.138	144.726	84.782	95.956	76.849
1125.1	296.796	288.383	308.282	156.868	156.877	89.229	102.138	70.529
1135.1	318.923	295.178	313.889	189.714	188.478	93.783	109.745	81.817
1145.1	325.819	307.424	325.919	181.892	179.632	98.687	116.419	89.848
1155.1	337.484	320.387	337.778	191.911	191.218	103.885	123.484	88.898
1165.1	349.698	332.378	348.293	203.618	202.388	109.227	131.689	92.761
1175.1	368.912	343.778	358.557	214.342	212.895	114.584	139.839	98.477
1185.1	378.275	354.292	367.881	226.988	222.443	120.699	148.947	100.988
1195.1	388.388	365.398	378.251	239.147	233.312	126.971	158.782	109.319
1205.1	389.119	375.142	382.882	244.291	242.884	133.617	161.889	102.271

1715	1	787.877	384.878	383.834	263.847	251.330	134.711	169.306	114.526
1720	1	405.274	395.545	401.147	262.567	259.741	140.451	176.730	118.936
1725	1	414.878	403.667	409.184	271.409	268.351	152.259	184.110	124.429
1730	1	421.492	411.280	416.372	279.228	276.335	158.042	192.248	129.100
1735	1	428.945	419.015	424.400	286.474	284.495	163.480	197.380	133.876
1740	1	432.133	427.459	431.292	294.712	292.181	169.149	204.037	138.863
1745	1	441.212	434.915	438.723	301.596	300.632	174.840	210.726	143.579
1750	1	449.919	441.910	441.207	309.156	307.710	179.804	217.220	148.084
1755	1	454.192	448.937	452.863	315.869	314.935	185.366	223.829	153.967
1760	1	462.293	455.822	459.467	322.627	321.574	190.814	229.997	158.722
1765	1	469.076	462.105	466.441	328.655	328.228	195.931	236.371	163.635
1770	1	474.822	467.114	473.199	335.271	335.292	201.240	242.738	168.220
1775	1	480.518	471.447	479.118	342.178	341.722	206.266	248.940	173.266
1780	1	486.827	475.774	484.822	347.450	346.344	209.074	254.288	178.294
1785	1	492.254	480.148	491.113	352.748	351.739	212.074	259.579	182.921
1790	1	497.572	484.252	496.914	358.028	357.999	217.750	265.235	187.920
1795	1	503.996	489.994	502.758	364.379	363.992	222.756	270.938	192.109
1800	1	508.104	494.252	507.928	369.288	368.827	227.236	276.328	197.288
1805	1	513.183	498.875	513.662	375.633	374.450	232.321	281.591	201.712
1810	1	518.046	503.458	519.077	380.824	382.636	236.867	286.858	206.320
1815	1	523.145	507.403	523.982	385.934	389.218	241.416	292.278	210.924
1820	1	528.136	511.504	529.293	391.179	393.622	245.744	298.000	215.697
1825	1	532.712	515.441	534.090	396.505	398.970	250.112	301.949	219.855
1830	1	537.595	519.676	539.343	401.319	404.159	254.378	307.093	224.235
1835	1	542.166	524.057	544.032	406.154	408.857	258.428	311.657	228.719
1840	1	547.043	527.852	548.714	410.237	414.117	262.315	316.217	233.196
1845	1	551.712	532.059	554.064	415.170	419.090	266.626	320.408	236.979
1850	1	556.441	535.278	558.999	420.074	423.906	269.817	325.642	241.403
1855	1	561.194	538.720	563.779	424.614	429.180	273.910	329.304	245.448
1860	1	565.988	542.254	568.597	429.392	433.477	277.861	333.217	249.752
1865	1	570.208	547.046	573.330	433.787	438.565	281.769	338.291	254.060
1870	1	574.069	551.019	577.848	438.077	443.117	285.641	342.885	257.917
1875	1	579.313	555.242	582.212	442.845	447.487	289.511	346.745	261.971
1880	1	584.229	559.719	586.624	447.472	452.429	293.485	351.333	265.949
1885	1	588.911	564.155	591.541	451.840	456.968	297.350	355.240	269.818
1890	1	592.992	568.904	595.945	456.565	461.759	301.425	359.770	274.214
1895	1	597.495	573.922	599.999	460.261	466.037	305.021	363.360	277.179
1900	1	602.035	579.044	604.280	464.313	470.161	307.717	367.676	281.676
1905	1	606.369	583.242	608.349	468.235	474.994	311.203	371.386	285.687
1910	1	610.853	587.691	612.649	472.770	479.290	314.583	375.289	288.853
1915	1	615.338	592.354	616.387	476.842	483.534	318.086	379.102	292.455
1920	1	619.460	597.052	620.783	480.962	487.698	321.494	383.201	295.832
1925	1	623.887	601.452	624.823	485.259	491.768	325.131	387.141	299.895
1930	1	628.058	605.898	629.366	489.810	496.528	328.925	391.494	303.373
1935	1	632.481	610.442	633.504	493.438	500.255	332.408	394.705	306.983
1940	1	636.750	614.279	637.534	497.626	504.586	335.399	398.949	310.641
1945	1	641.271	618.670	641.471	501.174	508.741	339.187	402.158	313.508
1950	1	645.283	623.654	646.107	505.842	512.462	342.341	406.138	317.030
1955	1	649.587	628.391	649.935	509.514	516.839	345.651	409.962	320.435
1960	1	653.706	633.372	653.717	513.234	520.682	349.012	413.287	324.313
1965	1	658.067	637.704	657.235	516.953	524.272	351.637	417.242	327.726
1970	1	662.224	642.152	661.159	520.671	528.516	355.205	420.389	330.889
1975	1	666.379	646.352	664.352	524.895	532.202	358.142	424.515	334.442
1980	1	670.633	650.135	668.954	528.558	536.745	361.444	427.942	337.370
1985	1	674.884	654.108	672.871	532.448	539.974	364.787	431.471	340.941
1990	1	679.732	658.341	676.140	536.336	544.260	367.887	435.201	344.136
1995	1	682.830	662.852	680.208	540.222	548.091	371.132	438.676	347.329
2000	1	686.825	667.972	683.622	544.085	551.928	374.210	442.536	350.887
2005	1	691.672	673.738	687.434	547.859	555.787	377.722	445.569	353.816
2010	1	694.912	678.205	691.299	551.439	559.623	380.458	449.423	357.180
2015	1	698.761	682.818	695.261	555.394	563.321	384.253	452.918	360.481
2020	1	702.741	687.733	699.921	559.817	567.218	387.647	456.510	363.580
2025	1	707.031	692.844	702.780	562.382	570.335	390.284	459.588	366.778
2030	1	711.472	697.674	706.488	565.987	574.950	393.856	463.029	370.057
2035	1	715.184	702.213	710.598	569.704	578.227	396.932	466.488	373.977
2040	1	719.380	706.269	714.300	572.246	582.238	399.590	469.842	376.289

1875.1	723.422	738.274	719.384	676.920	589.801	432.973	473.171	379.657
1899.1	727.153	714.203	721.967	568.788	509.664	405.912	476.960	392.719
1899.1	731.131	738.854	726.104	564.261	593.174	498.440	480.194	355.526
1905.1	734.959	742.732	729.959	566.157	597.106	411.609	493.560	396.703
1915.1	739.714	748.632	735.867	591.641	658.868	414.561	486.632	391.879
1925.1	742.759	758.984	737.984	599.654	624.746	418.116	490.605	394.422
1939.1	746.734	755.924	741.950	599.609	628.750	420.558	493.424	399.162
1945.1	750.707	759.823	746.945	602.489	612.120	423.883	490.743	400.914
1959.1	754.177	764.292	750.889	609.869	615.754	426.842	500.244	403.621
1965.1	754.249	768.759	751.232	609.325	619.304	429.292	503.320	400.988
1975.1	762.217	772.651	757.274	612.221	623.252	432.964	506.997	406.691
1995.1	765.931	777.348	760.893	616.194	626.449	435.557	509.699	412.742
1995.1	768.488	781.379	764.555	619.970	630.145	438.148	513.368	416.006
2005.1	772.864	788.818	768.114	623.492	631.440	441.237	510.878	418.952
2015.1	776.426	796.301	771.513	627.166	636.963	444.313	520.090	422.272
2025.1	779.991	798.810	775.519	630.584	640.625	447.470	523.448	425.015
2035.1	783.557	798.848	778.706	633.900	643.866	450.109	526.450	427.757
2045.1	787.115	803.200	782.292	636.966	647.805	451.886	529.933	431.273
2055.1	791.225	807.833	785.820	640.382	651.293	456.205	532.957	433.960
2065.1	794.964	910.764	789.360	643.647	654.929	458.434	536.006	436.750
2075.1	798.543	814.645	792.594	647.316	658.440	461.534	539.459	439.746
2085.1	802.080	818.625	795.920	650.773	661.691	464.220	542.697	442.791
2095.1	805.696	822.454	799.459	654.093	665.134	467.421	545.906	445.784
2105.1	809.312	827.034	802.741	657.541	668.567	470.466	549.205	448.679
2115.1	812.717	829.868	806.221	660.351	671.998	473.146	551.942	451.457
2125.1	816.421	833.190	809.451	663.706	675.280	476.397	555.135	453.992
2135.1	819.824	836.516	812.880	667.115	679.957	479.766	558.379	457.092
2145.1	823.476	839.946	816.308	670.721	682.336	481.757	561.722	460.215
2155.1	826.978	843.820	819.487	673.675	685.514	484.383	564.507	462.995
2165.1	830.279	847.147	822.913	677.076	688.660	486.855	567.645	466.391
2175.1	833.878	851.016	826.389	680.038	692.792	490.407	571.066	468.660
2185.1	836.926	854.245	830.062	684.032	696.067	492.825	574.171	471.894
2195.1	840.326	857.669	833.239	688.682	699.609	495.054	577.184	474.772
2205.1	843.984	860.293	836.364	689.681	702.663	498.584	580.440	477.290
2215.1	847.172	863.364	839.635	693.338	705.895	500.846	583.320	480.474
2225.1	850.716	867.341	843.407	696.302	709.400	503.929	586.250	483.938
2235.1	853.769	871.834	846.829	699.823	712.546	506.189	589.279	485.913
2045.1	857.509	874.184	850.082	702.719	715.963	509.004	592.297	489.147
2255.1	860.935	877.703	853.571	706.189	719.281	511.425	595.789	491.814
2265.1	863.766	880.925	856.445	709.150	722.449	514.847	596.463	494.874
2275.1	867.743	884.591	860.813	711.952	725.863	517.273	591.196	496.688
2065.1	870.137	867.465	863.183	715.742	728.930	516.640	604.014	500.371
2285.1	873.379	888.734	866.453	718.754	732.194	522.787	607.587	502.983
2085.1	879.621	894.053	869.969	721.625	735.606	529.116	610.586	505.748
2315.1	879.814	898.876	872.890	724.715	738.478	527.729	613.178	508.558
0325.1	883.154	900.666	876.455	727.560	741.837	530.596	616.140	510.619
2335.1	885.897	903.809	879.672	731.892	744.653	533.104	619.188	514.059
2345.1	889.465	906.579	883.007	734.889	748.062	535.458	620.337	516.536
2355.1	892.877	910.893	886.284	737.415	751.173	538.118	625.284	519.554
0365.1	895.316	916.880	906.975	740.351	754.165	540.680	628.026	520.881
2375.1	898.784	918.829	892.537	743.207	757.492	543.641	630.639	524.019
0365.1	901.345	919.544	895.554	746.546	760.452	546.145	633.099	527.682
2395.1	904.931	922.759	898.918	749.784	763.799	549.211	636.763	530.884
0405.1	902.670	906.001	891.962	750.339	766.764	551.487	639.375	533.660
2415.1	918.898	928.941	904.999	759.370	769.362	553.709	642.237	535.887
2405.1	914.443	930.109	906.656	756.884	772.436	556.070	645.046	560.309
2425.1	917.828	935.616	911.967	761.484	775.181	559.854	648.189	541.398
0445.1	920.467	936.536	915.486	764.668	778.600	562.874	651.110	544.143
2455.1	924.493	942.191	918.391	767.893	781.729	566.922	653.876	548.489
2465.1	926.489	945.156	921.405	770.593	784.657	567.120	656.564	644.287
2475.1	929.972	948.888	924.813	773.811	787.959	569.168	659.198	591.831
0486.1	932.690	951.650	927.727	776.160	790.266	571.466	660.197	594.509
2495.1	936.348	955.336	930.987	780.892	793.891	574.518	665.182	597.638
2505.1	938.126	958.843	934.089	783.830	796.881	576.494	667.656	599.510
2515.1	942.359	961.939	936.813	788.489	800.167	578.634	670.716	562.562
2525.1	945.291	964.919	940.181	789.886	801.116	581.725	673.413	292.358

2535	1	848.474	847.833	842.757	761.216	808.365	593.673	676.465	987.646
2532	1	721.727	721.141	745.945	799.927	809.414	586.267	679.267	270.792
2533	1	954.889	974.696	946.709	797.505	812.315	588.581	681.667	573.330
2531	1	737.622	778.824	728.821	809.973	812.844	591.647	684.567	576.274
2534	1	941.893	941.411	954.607	809.900	816.243	593.438	687.217	578.557
2535	1	981.826	984.274	958.824	806.422	821.815	595.824	689.185	581.245
2536	1	967.265	967.927	963.955	809.244	823.914	596.263	693.013	583.426
2537	1	778.258	778.819	788.591	812.648	826.812	600.548	696.035	586.721
2538	1	972.930	993.457	473.421	615.432	829.955	502.630	698.056	589.458
2539	1	778.189	777.483	778.752	818.151	832.410	602.726	701.472	591.879
2540	1	978.891	1068.664	963.826	821.024	835.307	607.401	704.147	594.473
2541	1	781.722	1004.884	989.889	823.794	838.480	609.279	706.967	597.025
2542	1	985.101	1006.926	993.143	826.888	841.099	611.713	709.785	599.384
2543	1	787.733	1018.278	977.922	829.982	844.187	613.844	712.528	602.012
2544	1	990.882	1013.734	1002.853	832.644	847.453	616.277	715.371	604.494
2545	1	991.792	1018.940	1007.169	835.810	850.176	618.254	718.461	607.276
2546	1	998.871	1020.689	1011.968	838.726	853.707	621.295	720.953	608.684
2547	1	1000.297	1023.892	1015.781	841.691	856.424	623.220	724.092	612.433
2548	1	1003.524	1027.643	1020.047	844.655	859.762	625.499	726.682	615.010
2549	1	1006.593	1031.142	1024.182	847.619	863.022	628.335	729.521	617.538
2550	1	1009.620	1034.745	1028.027	850.638	866.110	630.563	732.459	620.263
2551	1	1013.006	1038.140	1031.672	854.049	869.538	633.144	735.445	622.788
2552	1	1016.232	1041.695	1036.004	857.200	872.845	635.826	738.382	625.161
2553	1	1019.812	1045.443	1039.305	860.310	876.105	638.384	741.367	628.340
2554	1	1022.460	1048.947	1042.999	863.124	879.190	640.753	744.363	630.711
2555	1	1022.692	1052.299	1046.101	866.430	882.178	643.097	746.997	633.284
2556	1	1026.739	1055.553	1050.040	869.341	885.605	646.192	750.219	636.410
2557	1	1032.914	1059.252	1053.290	872.693	888.444	648.314	752.853	639.939
2558	1	1034.643	1061.967	1056.146	875.653	891.724	650.730	756.133	641.651
2559	1	1038.018	1065.462	1059.543	878.516	894.685	653.020	759.766	644.171
2560	1	1041.045	1068.322	1062.300	881.622	897.645	655.688	761.647	646.840
2561	1	1044.972	1071.674	1065.645	884.123	901.266	658.617	764.826	649.408
2562	1	1047.286	1075.826	1068.750	887.883	903.859	661.291	767.957	652.277
2563	1	1050.174	1077.836	1071.655	891.156	907.202	663.713	770.485	655.056
2564	1	1053.280	1081.188	1074.855	893.689	910.217	666.185	773.314	657.289
2565	1	1056.326	1084.491	1077.809	897.197	913.297	668.858	776.341	660.475
2566	1	1059.293	1088.174	1080.672	900.184	916.540	671.438	779.536	663.894
2567	1	1061.931	1094.547	1083.864	902.512	919.287	673.848	781.956	665.256
2568	1	1065.285	1099.476	1088.818	906.113	922.879	676.822	785.128	668.322
2569	1	1069.626	1104.553	1090.105	909.216	926.276	679.593	787.787	670.883
2570	1	1072.374	1108.889	1093.021	911.973	929.477	681.308	790.523	673.547
2571	1	1072.475	1113.821	1096.319	915.321	933.288	683.774	793.447	676.058
2572	1	1079.295	1117.962	1099.568	918.324	936.876	686.899	796.468	678.820
2573	1	1093.013	1122.276	1102.574	921.425	940.762	689.351	799.352	681.651
2574	1	1087.328	1128.294	1105.771	924.575	944.230	691.828	802.515	684.850
2575	1	1091.296	1138.632	1108.577	927.872	947.575	694.295	805.236	687.880
2576	1	1095.661	1134.231	1112.073	931.266	951.262	696.908	808.108	689.658
2577	1	1099.679	1138.127	1115.513	934.651	954.875	699.272	811.272	692.667
2578	1	1105.895	1142.822	1118.375	938.655	958.170	702.158	814.346	695.874
2579	1	1108.797	1146.266	1121.429	941.590	961.895	704.802	817.463	697.680
2580	1	1114.312	1149.815	1124.573	945.162	965.223	707.114	820.380	700.588
2581	1	1120.413	1154.054	1128.271	948.136	968.932	709.627	823.397	703.882
2582	1	1125.849	1157.753	1131.422	952.168	972.152	712.539	826.581	706.847
2583	1	1131.178	1162.255	1134.573	955.683	975.763	714.648	829.526	709.181
2584	1	1136.848	1164.929	1137.725	959.541	979.276	717.611	832.494	711.454
2585	1	1140.387	1168.752	1140.827	963.920	982.374	720.121	835.825	714.157
2586	1	1145.318	1172.463	1144.176	967.583	986.088	722.588	839.893	717.059
2587	1	1149.669	1176.941	1148.664	971.280	989.125	725.050	842.873	719.711
2588	1	1153.156	1180.319	1148.851	974.922	992.456	727.688	845.836	722.361
2589	1	1157.620	1187.809	1152.655	978.655	996.386	730.456	848.658	725.112
2590	1	1160.850	1192.472	1155.552	982.143	1000.102	732.311	852.185	727.663
2591	1	1164.225	1198.259	1159.985	985.974	1004.693	735.669	855.169	730.660
2592	1	1167.798	1204.782	1164.183	989.314	1007.878	737.925	858.421	733.758
2593	1	1170.675	1206.703	1168.592	992.899	1011.552	740.283	861.778	736.256
2594	1	1174.949	1211.821	1173.876	996.591	1015.184	743.337	864.812	738.883
2595	1	1178.786	1219.391	1178.093	1000.116	1018.999	747.071	868.328	742.624

1109.1	1181.940	1228.633	1184.664	1003.499	1023.013	748.696	871.596	744.595
1209.1	1199.102	1024.470	1199.933	1007.204	1030.474	751.200	874.001	747.599
1219.1	1188.897	1228.776	1198.486	1018.476	1030.285	753.953	878.855	750.434
1229.1	1193.416	1332.272	1202.163	1014.131	1034.417	757.106	890.964	752.779
1239.1	1197.939	1237.423	1207.546	1017.022	1038.364	759.507	884.424	756.171
1349.1	1207.753	1042.019	1212.372	1031.763	1042.307	762.559	887.716	758.603
1259.1	1207.774	1244.917	1217.981	1029.806	1046.298	765.280	891.219	761.855
1269.1	1211.298	1050.621	1221.743	1039.000	1050.440	768.340	894.569	765.095
1279.1	1219.028	1254.972	1229.905	1033.884	1054.345	770.810	898.456	767.636
1099.1	1319.646	1256.661	1229.605	1037.769	1050.007	773.909	901.657	771.024
1289.1	1223.373	1243.231	1233.701	1041.605	1062.262	777.047	894.957	774.513
1309.1	1207.022	1247.330	1237.363	1045.029	1045.091	779.209	900.649	776.882
1319.1	1238.488	1271.384	1241.036	1049.192	1049.594	783.453	911.652	779.930
1329.1	1231.912	1279.749	1244.639	1052.675	1073.637	785.548	919.491	783.776
1339.1	1237.492	1279.758	1248.391	1056.844	1077.315	788.345	918.740	786.108
1349.1	1240.774	1003.570	1251.799	1059.700	1080.944	791.739	921.913	788.047
1359.1	1243.788	1287.931	1259.902	1063.834	1084.646	794.484	925.383	791.783
1369.1	1247.140	1291.045	1259.613	1066.403	1089.399	797.320	928.161	794.706
1379.1	1250.724	1294.414	1262.248	1070.615	1091.708	800.371	931.478	797.789
1389.1	1253.359	1090.000	1265.202	1073.933	1095.316	803.615	934.700	800.931
1399.1	1256.842	1308.984	1268.345	1078.612	1098.723	806.508	938.219	803.764
1409.1	1259.430	1304.472	1271.310	1080.143	1101.962	808.999	941.022	806.796
1419.1	1263.013	1307.247	1274.324	1088.841	1105.348	811.848	944.218	809.827
1429.1	1265.000	1310.321	1277.141	1086.333	1108.700	815.205	947.366	812.757
1439.1	1268.817	1313.146	1279.858	1089.315	1111.432	817.771	950.411	815.489
1449.1	1272.523	1316.070	1282.026	1090.356	1114.444	820.060	953.459	818.510
1459.1	1274.742	1319.843	1285.595	1095.740	1118.032	823.799	956.487	821.393
1469.1	1277.099	1320.120	1300.661	1090.634	1121.131	826.239	959.050	824.336
1479.1	1280.937	1325.495	1291.357	1101.593	1124.308	828.978	962.304	826.510
1489.1	1283.179	1220.532	1304.046	1104.423	1137.220	831.967	965.154	829.035
1499.1	1288.487	1331.350	1297.911	1107.561	1130.338	834.504	968.445	832.663
1509.1	1280.050	1334.000	1300.465	1110.300	1133.261	837.142	971.147	835.242
1519.1	1291.549	1337.868	1303.691	1113.226	1136.333	839.829	974.045	838.317
1529.1	1294.440	1339.039	1306.423	1115.997	1139.254	842.913	976.942	840.540
1539.1	1297.538	1342.868	1309.284	1119.000	1141.983	845.100	979.742	843.930
1549.1	1300.521	1345.301	1312.413	1131.909	1145.093	848.305	982.402	846.101
1559.1	1303.752	1348.033	1315.837	1124.581	1147.761	850.870	985.487	848.778
1569.1	1306.505	1351.614	1318.355	1137.770	1150.002	853.600	988.305	851.001
1579.1	1309.597	1355.697	1321.079	1130.125	1153.434	856.291	990.819	854.080
1589.1	1313.091	1056.430	1323.655	1138.313	1156.017	858.627	993.337	856.706
1599.1	1314.885	1359.918	1328.876	1135.844	1159.233	861.510	994.337	859.381
1609.1	1317.770	1062.970	1330.740	1136.960	1161.719	864.344	999.194	861.987
1619.1	1320.623	1365.454	1332.277	1141.854	1164.936	868.429	1001.883	864.532
1629.1	1303.009	1309.910	1335.797	1144.370	1167.510	869.410	1004.334	867.255
1639.1	1326.210	1371.397	1338.177	1147.099	1170.598	871.695	1007.389	870.126
1649.1	1330.710	1074.930	1341.251	1150.141	1173.925	874.437	1009.003	873.304
1659.1	1330.957	1377.816	1344.878	1152.595	1176.074	877.089	1012.631	874.977
1669.1	1333.953	1301.002	1347.004	1155.195	1178.975	878.641	1015.408	877.600
1679.1	1338.750	1304.138	1350.279	1158.483	1182.646	882.123	1018.829	880.074
1689.1	1330.390	1000.429	1352.059	1160.709	1184.500	884.506	1020.075	880.042
1699.1	1342.598	1398.114	1355.956	1163.587	1187.774	887.484	1023.279	885.269
1709.1	1345.104	1392.555	1350.065	1166.521	1190.360	889.060	1006.104	887.701
1719.1	1347.843	1395.295	1361.645	1169.182	1193.213	892.095	1028.675	890.680
1729.1	1350.790	1290.694	1364.306	1171.507	1195.200	895.106	1021.177	890.005
1739.1	1353.192	1401.475	1367.207	1174.284	1198.519	897.118	1023.879	895.250
1749.1	1356.342	1404.417	1360.900	1170.910	1201.363	898.000	1006.406	890.076
1759.1	1359.218	1407.459	1373.116	1180.120	1204.334	902.319	1039.410	900.844
1769.1	1361.444	1400.753	1375.603	1182.900	1207.115	904.997	1041.001	900.110
1779.1	1364.398	1412.397	1378.207	1185.111	1209.871	907.828	1043.980	905.836
1789.1	1267.749	1415.141	1381.000	1188.007	1210.400	916.104	1247.200	900.027
1799.1	1370.792	1417.588	1383.895	1190.631	1213.207	918.444	1049.767	910.629
1809.1	1373.906	1400.007	1006.242	1193.679	1017.074	914.913	1002.200	930.097
1819.1	1376.918	1422.978	1388.728	1196.019	1220.495	917.351	1059.819	919.718
1829.1	1379.013	1405.076	1391.763	1199.904	1003.071	910.060	1057.910	910.130
1839.1	1382.778	1427.971	1394.251	1201.848	1225.894	921.761	1059.078	924.460
1849.1	1382.327	1430.819	1397.137	1204.738	1228.762	924.076	1063.088	923.324

1888.1	1387.738	1433.847	1508.774	1267.614	1231.175	924.852	1042.184	922.544
1849.1	1389.737	1417.815	1481.969	1299.544	1233.989	929.195	1097.471	929.889
1879.1	1387.849	1441.845	1484.821	1212.467	1236.643	931.167	1076.512	930.982
1889.1	1395.749	1449.815	1487.842	1244.899	1239.231	934.335	1072.914	933.347
1885.1	1388.488	1448.917	1418.531	1217.700	1242.794	936.613	1075.592	935.568
1883.1	1408.805	1421.886	1413.421	1220.883	1245.043	939.141	1077.888	937.857
1919.1	1403.121	1454.722	1418.812	1222.595	1248.072	941.719	1080.393	940.583
1922.1	1408.811	1427.272	1416.784	1224.897	1250.979	943.944	1082.819	942.872
1939.1	1418.441	1459.729	1421.949	1227.971	1253.250	946.222	1085.442	945.438
1812.1	1418.838	1402.534	1425.288	1238.828	1258.138	949.893	1088.489	948.281
1959.1	1413.189	1494.738	1424.532	1231.884	1258.821	951.271	1090.713	950.273
1962.1	1412.589	1488.917	1429.228	1235.448	1261.382	953.488	1093.214	952.838
1879.1	1417.938	1449.599	1431.928	1238.888	1263.688	956.328	1095.764	955.354
1882.1	1428.441	1472.252	1435.812	1248.385	1268.544	958.291	1098.889	957.721
1999.1	1423.154	1474.711	1437.989	1243.418	1298.964	960.873	1100.422	968.335
1882.1	1422.182	1477.476	1448.288	1248.828	1271.312	961.128	1102.217	962.828
1819.1	1428.828	1498.229	1442.783	1247.889	1274.122	965.924	1105.473	965.119
1822.1	1438.581	1482.887	1445.258	1259.218	1276.616	968.248	1107.824	967.482
1839.1	1433.189	1484.945	1448.898	1252.952	1278.915	970.922	1110.821	969.852
1849.1	1439.518	1497.758	1458.888	1255.363	1282.046	973.888	1112.928	972.189
1859.1	1434.134	1498.241	1433.145	1257.921	1284.891	975.567	1115.182	974.468
1842.1	1448.198	1492.224	1452.494	1268.488	1288.292	977.642	1117.928	977.148
1879.1	1442.913	1495.841	1457.624	1292.948	1289.292	980.217	1120.837	979.368
1882.1	1445.228	1498.782	1468.592	1285.482	1291.782	982.294	1122.218	981.838
1889.1	1448.198	1501.971	1483.746	1287.785	1294.181	984.915	1125.888	983.958
1882.1	1448.484	1504.718	1487.848	1278.228	1297.117	987.141	1127.638	986.582
1819.1	1453.384	1507.158	1478.151	1272.589	1299.712	989.811	1129.948	988.881
1822.1	1452.222	1518.478	1473.382	1275.199	1301.984	992.132	1131.923	990.947
1839.1	1458.472	1513.835	1478.188	1277.488	1304.795	994.112	1134.651	993.839
1842.1	1461.442	1515.899	1479.589	1288.888	1307.449	997.072	1137.281	995.924
1859.1	1493.984	1517.718	1481.921	1282.882	1309.782	999.353	1139.555	998.898
1882.1	1498.834	1528.482	1488.378	1285.148	1312.494	1001.528	1141.929	1000.588
1879.1	1498.855	1523.883	1487.883	1287.217	1314.993	1004.247	1143.981	1002.723
1882.1	1471.427	1522.421	1489.289	1298.272	1317.149	1008.221	1146.373	1007.184
1899.1	1473.889	1528.394	1491.997	1292.785	1320.138	1008.948	1149.218	1007.581
1889.1	1478.119	1538.488	1494.629	1295.827	1322.548	1011.384	1151.273	1009.981
1819.1	1478.887	1532.988	1488.913	1297.615	1324.844	1013.788	1153.587	1012.377
1822.1	1488.578	1535.552	1499.572	1299.178	1327.487	1016.358	1156.478	1014.387
1839.1	1462.943	1538.124	1502.182	1302.449	1330.819	1018.388	1158.833	1017.283
1849.1	1487.884	1548.344	1504.894	1305.898	1332.917	1021.858	1161.139	1019.184
1859.1	1488.347	1543.824	1508.993	1307.598	1334.593	1023.323	1163.494	1021.192
1869.1	1492.177	1545.898	1509.313	1309.892	1337.692	1025.389	1165.947	1023.784
1879.1	1494.956	1548.722	1511.725	1312.334	1339.882	1028.168	1168.288	1026.818
1889.1	1497.332	1551.854	1513.835	1315.178	1342.883	1028.944	1170.558	1028.185
1899.1	1499.818	1551.177	1516.344	1317.361	1345.892	1032.659	1173.813	1030.894
1889.1	1502.237	1554.953	1519.94	1319.987	1347.318	1035.888	1175.487	1033.188
1819.1	1584.645	1558.332	1521.276	1322.227	1349.568	1037.888	1177.381	1035.825
1822.1	1507.844	1582.467	1524.892	1324.373	1352.178	1039.928	1179.883	1038.969
1839.1	1508.371	1584.945	1526.789	1326.792	1354.625	1042.848	1182.681	1039.884
1849.1	1512.884	1597.778	1528.973	1329.458	1357.277	1044.819	1184.846	1042.819
1859.1	1514.434	1578.287	1531.288	1331.698	1359.635	1047.238	1187.899	1044.838
1869.1	1519.814	1572.588	1533.858	1333.853	1362.238	1049.288	1189.891	1046.362
1879.1	1518.448	1575.878	1536.578	1336.619	1364.382	1051.779	1191.844	1048.188
1889.1	1522.832	1578.189	1538.948	1338.578	1366.798	1054.882	1193.971	1051.128
1899.1	1524.878	1580.434	1541.889	1341.889	1369.482	1056.571	1196.484	1053.899
1889.1	1527.485	1582.919	1543.579	1343.598	1371.871	1058.991	1198.783	1055.883
1819.1	1528.888	1585.352	1545.345	1346.179	1374.388	1061.362	1201.189	1058.887
1829.1	1532.828	1587.735	1548.298	1348.582	1377.788	1063.831	1203.291	1060.888
1839.1	1534.887	1589.814	1550.588	1350.578	1378.982	1065.955	1205.959	1062.894
1849.1	1537.246	1592.681	1553.888	1353.898	1381.182	1068.223	1207.788	1064.882
1859.1	1538.274	1594.789	1555.583	1355.588	1383.772	1070.894	1210.224	1066.888
1869.1	1541.387	1599.993	1558.398	1357.998	1386.835	1072.828	1212.789	1069.852
1879.1	1543.884	1598.848	1561.885	1368.344	1388.398	1075.831	1214.948	1071.356
1889.1	1549.378	1888.877	1563.498	1892.898	1398.589	1077.888	1217.883	1073.571
1899.1	1549.844	1882.274	1564.189	1384.623	1383.123	1888.328	1218.588	1379.887
1889.1	1548.728	1884.939	1598.783	1398.877	1394.949	1882.897	1821.878	1877.883

4519	1	1557.307	1509.170	1571.766	1369.728	1577.013	1084.916	1223.038	1080.660
4525	1	1557.110	1413.990	1576.245	1371.056	1589.721	1087.956	1226.092	1082.626
4535	1	1561.688	1417.781	1579.685	1373.383	1482.134	1080.561	1226.451	1084.544
4545	1	1565.955	1419.533	1583.524	1374.453	1438.214	1092.327	1230.899	1087.007
4554	1	1568.191	1419.889	1584.744	1379.078	1405.752	1094.302	1232.977	1089.221
4545	1	1568.935	1416.261	1584.999	1381.603	1412.167	1096.722	1235.479	1091.405
4575	1	1567.603	1415.187	1582.975	1384.278	1412.040	1099.784	1237.691	1093.158
4595	1	1569.897	1418.562	1578.218	1384.061	1413.327	1101.562	1239.952	1096.613
4584	1	1567.844	1409.499	1574.121	1387.897	1414.653	1104.000	1242.312	1098.000
4605	1	1557.610	1399.912	1569.521	1388.489	1414.826	1106.402	1244.377	1100.147
4619	1	1553.093	1393.973	1568.827	1388.787	1415.073	1108.673	1246.196	1102.509
4629	1	1548.214	1388.140	1560.277	1389.035	1414.837	1110.797	1247.671	1104.429
4639	1	1543.744	1382.311	1555.631	1384.011	1413.371	1112.624	1249.147	1106.693
4645	1	1539.124	1376.057	1551.244	1386.445	1412.237	1115.390	1250.474	1108.300
4655	1	1534.383	1370.389	1546.854	1387.647	1410.487	1117.168	1251.685	1110.182
4645	1	1529.735	1364.883	1539.296	1384.507	1408.867	1118.650	1252.245	1112.254
4675	1	1524.566	1357.437	1531.782	1385.219	1406.742	1120.576	1252.888	1113.484
4665	1	1518.843	1350.440	1524.787	1383.405	1404.007	1121.761	1253.229	1115.100
4695	1	1517.472	1343.321	1517.807	1381.883	1401.642	1123.638	1253.229	1116.241
4704	1	1504.993	1336.250	1511.072	1379.622	1398.538	1124.626	1253.229	1117.520
4719	1	1501.125	1328.096	1504.291	1377.542	1395.437	1125.663	1252.933	1118.940
4725	1	1495.050	1321.996	1497.666	1374.967	1392.335	1126.700	1252.540	1118.784
4735	1	1488.943	1314.896	1491.345	1372.442	1388.688	1127.441	1252.245	1118.670
4745	1	1483.135	1307.904	1485.328	1369.918	1385.445	1128.379	1251.450	1121.310
4759	1	1477.129	1301.117	1479.315	1364.791	1381.608	1129.120	1250.573	1121.764
4765	1	1471.327	1294.434	1473.195	1363.960	1378.263	1129.565	1249.343	1122.249
4775	1	1465.830	1288.157	1467.640	1360.847	1374.673	1130.207	1248.183	1122.491
4765	1	1460.135	1281.633	1461.645	1357.797	1370.886	1130.405	1247.130	1122.767
4795	1	1455.846	1275.564	1456.504	1354.838	1367.666	1130.845	1245.950	1122.984
4805	1	1449.957	1269.598	1450.846	1351.764	1363.565	1130.750	1244.672	1123.033
4819	1	1444.722	1263.880	1445.650	1348.681	1360.175	1130.948	1243.492	1123.131
4825	1	1439.148	1258.026	1440.695	1345.704	1356.467	1131.155	1241.673	1122.830
4835	1	1433.980	1252.220	1435.314	1342.374	1352.807	1130.849	1240.247	1122.885
4845	1	1429.234	1246.916	1430.623	1339.558	1349.494	1130.940	1238.576	1122.590
4855	1	1424.289	1241.565	1425.533	1336.347	1345.788	1130.602	1236.904	1122.245
4865	1	1419.286	1236.966	1420.698	1333.285	1342.304	1130.298	1235.331	1122.046
4875	1	1414.489	1232.069	1416.112	1330.224	1338.820	1129.968	1233.267	1121.433
4885	1	1409.545	1227.774	1411.129	1326.965	1335.092	1129.219	1231.743	1121.212
4895	1	1405.078	1223.831	1406.845	1324.053	1332.062	1129.170	1230.672	1120.923
4905	1	1400.113	1219.740	1402.015	1320.694	1328.619	1128.379	1228.303	1118.001
4919	1	1395.499	1215.801	1397.485	1317.884	1325.840	1127.938	1226.387	1119.486
4925	1	1391.038	1211.913	1392.957	1314.924	1321.796	1127.589	1224.323	1118.200
4935	1	1386.727	1208.777	1388.530	1311.589	1318.227	1126.801	1222.853	1117.819
4945	1	1382.618	1205.993	1384.203	1308.635	1315.091	1126.157	1220.700	1118.979
4955	1	1377.318	1201.280	1379.530	1305.828	1311.417	1125.418	1218.579	1118.191
4965	1	1372.804	1196.254	1375.255	1302.347	1308.233	1124.673	1218.512	1115.691
4975	1	1368.499	1191.047	1370.783	1299.582	1305.074	1124.181	1214.547	1114.370
4985	1	1364.746	1187.119	1366.780	1296.407	1301.401	1123.292	1212.928	1113.077
4995	1	1359.894	1182.382	1362.489	1293.426	1298.537	1122.799	1210.716	1112.795
5005	1	1355.042	1178.164	1358.269	1290.567	1294.760	1121.564	1208.500	1111.000
5015	1	1351.042	1173.390	1354.000	1287.788	1291.685	1120.576	1206.839	1110.974
5025	1	1346.844	1169.114	1350.179	1284.212	1288.455	1119.884	1204.977	1120.480
5035	1	1342.548	1164.942	1346.819	1281.355	1285.030	1118.748	1202.310	1120.809
5045	1	1338.399	1160.318	1342.844	1276.176	1282.192	1118.100	1200.305	1120.576
5055	1	1334.203	1155.947	1338.828	1275.445	1278.573	1117.168	1198.430	1120.693
5065	1	1330.058	1151.775	1334.812	1272.392	1275.712	1116.081	1196.479	1120.700
5075	1	1326.164	1147.809	1330.245	1269.340	1272.337	1115.439	1193.971	1120.478
5085	1	1321.921	1143.286	1326.331	1266.337	1269.135	1113.900	1192.188	1120.543
5095	1	1318.128	1139.217	1322.387	1263.230	1266.775	1112.871	1190.893	1120.820
5105	1	1313.837	1135.074	1318.652	1260.486	1262.731	1111.800	1187.662	1120.688
5115	1	1310.044	1130.882	1314.845	1257.577	1259.898	1110.698	1185.890	1120.688
5125	1	1306.806	1127.014	1311.876	1254.526	1256.720	1109.957	1183.515	1200.375
5135	1	1302.142	1123.887	1307.116	1251.771	1253.617	1108.873	1181.658	1200.343
5145	1	1298.178	1120.932	1303.701	1248.910	1250.486	1107.933	1179.560	1200.884
5155	1	1294.490	1118.687	1299.791	1246.018	1247.330	1106.896	1177.282	1200.389
5165	1	1290.583	1116.954	1296.276	1243.213	1244.522	1105.210	1175.221	1200.150

8175	1	1278.855	1277.347	1282.864	1248.115	1241.527	1134.138	1177.515	1091.765
8185	1	1283.829	1281.444	1288.007	1237.312	1236.255	1102.846	1170.629	1090.645
8195	1	1277.787	1288.887	1285.484	1234.485	1237.764	1101.858	1168.805	1089.517
8205	1	1275.558	1288.144	1282.032	1231.511	1237.346	1100.722	1166.761	1088.237
8215	1	1275.152	1282.372	1274.723	1229.854	1229.681	1099.436	1164.622	1086.761
8225	1	1282.211	1279.243	1275.283	1228.278	1228.932	1098.492	1162.169	1085.198
8235	1	1249.151	1275.155	1272.551	1223.254	1223.511	1096.870	1160.354	1084.103
8245	1	1251.287	1271.833	1268.541	1220.640	1221.076	1095.432	1158.744	1082.676
8255	1	1250.205	1268.079	1245.430	1217.774	1217.947	1094.549	1155.988	1081.445
8265	1	1252.280	1219.725	1262.021	1215.376	1212.110	1093.364	1153.780	1080.264
8275	1	1251.577	1261.382	1248.612	1212.442	1212.453	1092.179	1151.720	1078.394
8285	1	1258.124	1257.848	1252.742	1209.042	1209.432	1090.747	1149.905	1077.311
8295	1	1245.250	1254.475	1252.539	1207.086	1206.822	1089.512	1147.550	1075.667
8305	1	1241.119	1251.253	1249.527	1204.435	1203.944	1088.277	1145.539	1074.467
8315	1	1234.884	1244.149	1246.269	1201.734	1201.261	1087.067	1143.479	1073.076
8325	1	1237.484	1244.040	1243.358	1199.130	1198.229	1086.055	1141.321	1071.367
8335	1	1235.371	1241.574	1240.394	1196.626	1195.647	1084.475	1139.310	1070.076
8345	1	1232.438	1239.512	1237.232	1194.023	1193.359	1082.438	1137.152	1068.521
8355	1	1234.287	1235.397	1234.324	1191.371	1190.531	1081.610	1135.288	1067.271
8365	1	1228.373	1232.452	1231.363	1188.088	1188.288	1082.472	1133.278	1066.340
8375	1	1228.242	1229.196	1228.551	1186.285	1185.313	1079.487	1130.997	1064.465
8385	1	1217.281	1225.158	1225.440	1183.761	1182.729	1078.153	1129.226	1063.038
8395	1	1214.427	1223.244	1222.677	1181.527	1180.584	1076.968	1127.196	1061.414
8405	1	1211.127	1220.211	1220.016	1178.950	1177.561	1075.684	1125.186	1060.036
8415	1	1204.315	1217.266	1217.304	1176.299	1175.245	1074.104	1122.930	1058.805
8425	1	1205.982	1214.582	1214.492	1174.054	1174.881	1072.849	1120.968	1057.279
8435	1	1202.952	1211.341	1211.534	1171.587	1170.151	1071.367	1119.301	1056.147
8445	1	1200.443	1204.734	1209.167	1169.329	1167.909	1070.540	1117.438	1054.324
8455	1	1187.435	1205.713	1206.258	1168.924	1165.423	1069.116	1115.182	1052.898
8465	1	1184.207	1202.649	1203.545	1166.614	1165.035	1068.029	1113.318	1051.818
8475	1	1187.178	1200.678	1201.135	1162.114	1160.646	1066.844	1111.368	1050.240
8485	1	1180.245	1197.272	1198.271	1159.783	1158.210	1064.918	1109.494	1048.961
8495	1	1186.110	1194.903	1195.606	1157.332	1156.167	1064.078	1107.434	1047.385
8505	1	1184.180	1192.346	1193.243	1155.293	1153.288	1062.744	1105.222	1045.659
8515	1	1181.488	1189.405	1190.483	1152.987	1151.290	1061.559	1103.808	1044.579
8525	1	1175.688	1186.988	1188.088	1150.677	1149.146	1060.522	1101.893	1043.132
8535	1	1174.386	1184.244	1185.604	1148.715	1146.587	1058.744	1099.883	1042.419
8545	1	1174.003	1181.530	1183.190	1146.216	1144.468	1057.707	1098.689	1041.522
8555	1	1171.173	1179.013	1180.361	1144.057	1142.178	1056.225	1096.194	1038.319
8565	1	1169.791	1176.497	1178.191	1141.849	1139.888	1055.039	1094.440	1037.219
8575	1	1166.359	1173.932	1176.045	1139.642	1137.949	1054.200	1092.332	1035.161
8585	1	1163.678	1171.416	1173.266	1137.532	1135.259	1052.570	1090.684	1033.078
8595	1	1161.448	1168.047	1171.167	1135.570	1133.359	1051.831	1088.899	1033.661
8605	1	1159.262	1166.332	1168.652	1133.440	1130.728	1050.026	1087.232	1032.625
8615	1	1156.631	1164.770	1166.241	1131.057	1128.528	1048.717	1085.320	1030.894
8625	1	1154.349	1161.649	1164.073	1129.070	1127.382	1047.630	1083.182	1029.169
8635	1	1152.066	1158.887	1161.709	1126.985	1126.638	1046.099	1081.691	1028.088
8645	1	1149.833	1156.693	1159.443	1125.121	1124.397	1045.259	1079.975	1026.809
8655	1	1147.352	1154.375	1156.882	1122.693	1120.234	1043.874	1078.259	1025.427
8665	1	1145.119	1151.933	1154.813	1120.706	1118.378	1042.245	1076.248	1023.999
8675	1	1143.135	1149.517	1152.444	1118.881	1116.684	1041.367	1074.585	1022.423
8685	1	1140.455	1147.347	1149.987	1116.762	1115.994	1039.778	1073.110	1021.359
8695	1	1136.372	1144.931	1148.017	1114.526	1112.240	1038.887	1071.345	1019.613
8705	1	1134.818	1142.568	1145.949	1112.490	1110.924	1037.882	1069.334	1018.582
8715	1	1133.807	1140.345	1143.634	1110.700	1107.905	1036.410	1067.589	1017.499
8725	1	1131.624	1138.222	1141.320	1108.738	1106.005	1035.181	1065.652	1015.726
8735	1	1129.442	1135.661	1139.153	1106.482	1103.740	1033.689	1064.476	1014.544
8745	1	1127.457	1133.443	1137.282	1104.667	1102.084	1032.711	1062.881	1013.116
8755	1	1124.077	1131.478	1134.826	1102.883	1099.849	1031.377	1061.783	1011.934
8765	1	1122.794	1129.173	1132.653	1100.890	1097.895	1030.290	1059.134	1010.653
8775	1	1120.868	1126.885	1130.888	1098.732	1096.141	1028.253	1057.516	1009.323
8785	1	1118.578	1124.642	1128.659	1096.820	1094.193	1027.620	1056.045	1008.043
8795	1	1116.783	1122.405	1126.448	1095.258	1092.661	1026.486	1054.377	1006.468
8805	1	1114.411	1120.674	1124.381	1093.435	1090.128	1025.201	1052.415	1005.286
8815	1	1112.574	1118.289	1122.510	1091.179	1088.421	1024.114	1050.695	1004.182
8825	1	1110.443	1116.385	1120.442	1089.413	1086.594	1023.076	1049.375	1002.772

Table A-III
Temperature Data Print Out for Round 4955

Thermocouple No. Multiplexer Channel	1	2	3	4	5	6	4	8
	01	02	03	04	05	06	09	10
Time (hr:mn:sc)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)
735.1	79.538	79.638	79.847	79.898	79.613	79.781	79.692	79.516
745.1	79.428	79.555	79.736	79.678	79.529	79.528	79.628	79.689
755.1	79.538	79.610	79.847	79.841	79.667	79.811	79.583	79.516
765.1	79.372	79.665	79.681	79.678	79.491	79.481	79.692	79.516
775.1	79.538	79.444	79.847	79.787	79.464	79.756	79.583	79.571
785.1	79.528	79.773	79.847	79.789	79.667	79.791	79.583	79.571
795.1	79.483	79.728	79.681	79.787	79.559	79.556	79.747	79.789
805.1	79.483	79.665	79.792	79.787	79.776	79.811	79.628	79.406
815.1	79.428	79.555	79.626	79.732	79.451	79.591	79.628	79.571
825.1	79.483	79.610	79.626	79.732	79.667	79.701	79.528	79.571
835.1	79.483	79.655	79.736	79.841	79.559	79.756	79.692	79.551
845.1	79.428	79.501	79.792	79.678	79.613	79.591	79.628	79.625
855.1	79.538	79.565	79.847	79.732	79.559	79.921	79.528	79.551
865.1	79.483	79.555	79.681	79.623	79.585	79.591	79.528	79.689
875.1	79.648	79.665	79.736	79.732	79.721	79.644	79.383	79.516
885.1	79.593	79.773	79.736	79.705	79.613	79.811	79.747	79.481
895.1	79.483	79.555	79.736	79.732	79.613	79.426	79.747	79.625
905.1	79.538	79.665	79.736	79.787	79.721	79.811	79.628	79.242
915.1	79.372	79.665	79.736	79.623	79.589	79.481	79.692	79.689
925.1	79.483	79.555	79.736	79.787	79.776	79.756	79.528	79.571
935.1	79.593	79.830	79.681	79.678	79.613	79.701	79.692	79.516
945.1	79.428	79.336	79.792	79.678	79.532	79.481	79.881	79.689
955.1	79.538	79.773	79.792	79.732	79.694	79.756	79.583	79.297
965.1	79.428	79.728	79.681	79.732	79.559	79.591	79.692	79.571
975.1	79.483	79.501	79.736	79.623	79.667	79.644	79.583	79.571
985.1	79.428	79.555	79.716	79.841	79.613	79.796	79.583	79.571
995.1	79.538	79.555	79.732	79.732	79.559	79.591	79.628	79.689
1005.1	79.593	79.610	79.776	79.678	79.667	79.866	79.528	79.551
1015.1	79.372	79.610	79.571	79.678	79.396	79.426	79.583	79.461
1025.1	79.593	79.401	79.792	79.787	79.667	79.591	79.583	79.516
1035.1	79.593	86.136	89.467	92.577	79.884	79.756	79.528	79.461
1045.1	79.538	115.542	128.083	136.428	82.877	81.799	88.916	79.799
1055.1	88.281	149.411	178.685	188.868	89.461	89.888	84.928	79.023
1065.1	81.250	189.394	202.335	218.779	101.232	101.156	92.125	79.625
1075.1	84.396	222.797	228.984	259.946	114.595	115.813	109.779	88.447
1085.1	88.148	246.988	254.551	278.347	127.864	131.829	118.838	88.447
1095.1	93.899	277.119	287.788	312.834	148.899	145.661	121.784	82.288
1105.1	99.661	317.948	331.766	359.888	157.955	163.666	134.175	83.624
1115.1	108.885	368.991	375.111	413.771	177.435	184.418	149.073	86.698
1125.1	115.211	408.217	416.146	468.387	199.816	207.999	166.188	89.261
1135.1	124.798	442.478	494.813	518.173	224.486	233.482	189.286	92.652
1145.1	135.694	485.521	491.333	585.244	240.316	259.456	206.722	96.914
1155.1	147.926	529.958	528.184	618.498	273.911	286.823	228.958	101.661
1165.1	161.763	574.815	564.829	684.729	298.982	313.876	255.825	107.664
1175.1	178.183	619.114	681.289	696.168	325.351	348.671	288.533	114.419
1185.1	191.328	663.606	638.729	743.227	352.494	367.688	304.513	121.681
1195.1	208.744	719.989	671.843	784.861	381.176	384.781	337.313	129.814
1205.1	222.377	757.139	707.897	822.689	410.847	421.762	349.714	137.828

1715	1	238	398	891	970	744	447	888	865	447	346	448	847	371	834	147	420
1725	1	254	405	873	867	781	423	720	176	471	231	475	667	394	132	157	263
1735	1	271	447	873	316	815	841	360	846	801	794	582	742	417	136	167	626
1745	1	288	415	868	848	850	484	206	776	529	362	550	241	440	664	179	262
1755	1	304	394	807	740	881	314	734	077	457	075	558	657	261	948	100	120
1765	1	321	486	948	342	817	160	200	975	281	726	580	115	484	936	292	409
1775	1	340	830	887	873	881	741	111	437	610	697	614	300	807	955	214	401
1785	1	358	749	1024	742	980	752	1151	591	636	693	642	399	230	027	220	471
1795	1	374	115	1057	874	1028	772	1166	634	562	073	670	771	553	764	239	165
1805	1	391	830	1090	389	1081	099	1216	166	687	657	699	570	576	567	201	934
1815	1	411	370	1170	387	1084	791	1247	564	712	846	726	896	608	566	264	940
1825	1	429	220	1147	777	1127	415	1278	077	738	295	753	547	633	495	276	024
1835	1	447	078	1170	887	1160	306	1308	064	763	642	778	930	660	991	290	869
1845	1	465	404	1195	582	1191	384	1338	910	788	540	804	104	693	707	304	426
1855	1	483	120	1218	417	1221	101	1363	132	814	661	829	770	726	676	316	846
1865	1	501	150	1237	319	1247	514	1397	267	837	551	851	310	727	322	330	611
1875	1	519	400	1256	434	1271	074	1400	457	863	894	873	845	783	036	343	768
1885	1	537	001	1275	409	1295	519	1429	720	885	639	895	264	806	324	356	696
1895	1	554	067	1293	417	1317	284	1449	293	904	476	915	694	830	614	370	421
1905	1	572	332	1310	265	1336	295	1467	426	924	936	936	255	853	960	383	759
1915	1	589	203	1329	687	1357	382	1482	992	945	655	955	514	878	104	396	947
1925	1	606	042	1341	225	1376	390	1499	529	965	292	974	465	901	558	418	408
1935	1	622	494	1355	810	1394	621	1514	640	985	659	993	158	925	234	423	255
1945	1	638	480	1370	1201	1411	725	1530	424	1004	335	1011	447	946	184	436	336
1955	1	654	400	1392	357	1427	847	1545	203	1021	417	1029	483	964	220	446	981
1965	1	669	707	1455	116	1442	969	1559	074	1103	181	1046	671	980	134	464	022
1975	1	684	997	1530	976	1457	495	1572	185	1157	904	1064	603	994	815	506	179
1985	1	700	980	1603	624	1471	386	1584	078	1182	152	1082	579	1009	834	577	626
1995	1	715	951	1601	663	1486	612	1595	179	1196	977	1101	146	1025	584	1512	888
2005	1	732	312	1621	201	1502	987	1606	699	1207	481	1118	332	1029	183	1602	452
2015	1	750	680	1559	720	1520	146	1619	195	1264	404	1133	692	1073	453	2233	018
2025	1	769	395	1557	409	1537	334	1633	460	1207	182	1153	600	1084	629	2233	818
2035	1	787	813	1554	501	1644	917	1648	917	12207	162	1174	807	1098	688	2233	018
2045	1	805	986	1572	862	1667	309	1667	309	12207	182	1193	137	1110	425	2233	818
2055	1	823	877	1586	688	1677	573	1677	573	12207	182	1212	374	1122	538	2233	018
2065	1	841	178	1599	870	1690	995	1690	995	12207	182	1228	592	1138	525	2119	315
2075	1	857	841	1612	382	1703	622	1703	622	12207	182	1245	979	1155	694	1743	690
2085	1	874	483	1623	730	1716	475	1716	475	12207	182	1262	336	1162	927	2181	824
2095	1	891	416	1641	376	1726	116	1726	116	12207	182	1278	088	1216	021	1888	255
2105	1	908	726	1659	083	1735	641	1735	641	12203	141	1293	217	1234	791	2080	058
2115	1	924	888	1626	043	1746	157	1746	157	12212	025	1307	710	1246	745	2080	692
2125	1	940	003	1581	720	1757	645	1757	645	12779	415	1321	848	1262	2	2331	359
2135	1	954	788	1532	866	1912	149	2194	842	1335	785	1343	587	1343	587	2835	907
2145	1	1041	263	1433	501	2209	869	2207	182	1348	478	1438	475	1438	475	2225	483
2155	1	1261	632	1332	687	1443	199	2207	182	1361	165	1738	669	1738	669	2233	018
2165	1	1663	722	1257	692	1293	179	2207	182	1372	774	2828	137	2233	018	2233	018
2175	1	1519	024	1381	066	1213	818	2226	166	1384	848	2120	017	2233	818	2233	818
2185	1	1631	696	1262	656	2226	166	2207	182	1487	916	2226	584	2233	818	2233	818
2195	1	2045	598	1372	512	2226	166	2207	182	1461	578	2226	584	2233	818	2233	818
2205	1	2252	384	1458	265	2226	166	2237	182	1888	879	2226	584	2233	818	2233	818
2215	1	2252	384	2237	327	2226	166	2207	182	2241	237	2226	584	2233	818	2233	818
2225	1	2252	384	2237	327	2226	166	1396	182	2241	237	2226	584	2227	762	2227	762
2235	1	2257	384	2237	327	2207	078	2158	318	2241	237	2226	584	2233	818	2233	818
2245	1	1894	632	2237	327	2151	243	1922	402	2207	182	2241	237	2226	584	2189	434
2255	1	2252	384	2170	996	1625	512	1868	847	1963	187	1892	272	2226	584	2111	771
2265	1	2252	384	2878	739	1688	092	2853	817	2142	882	1978	825	2226	584	1742	988
2275	1	2252	384	2180	486	1037	815	2186	785	2282	509	2241	237	2226	584	1516	159
2285	1	2252	384	2226	584	1663	754	2226	166	2207	182	2241	237	2226	584	1439	877
2295	1	2252	384	2226	765	2148	867	2226	166	2207	182	2241	237	2226	584	1113	334
2305	1	2195	426	2237	327	1535	031	2224	656	2196	631	2883	843	2226	584	992	882
2315	1	2307	530	2237	327	1186	721	2885	489	2207	182	1473	412	2226	584	912	636
2325	1	2184	583	2237	327	1457	155	1884	381	2207	182	1745	724	2226	584	1183	774
2335	1	2242	281	2237	327	1798	621	1912	373	2207	182	2241	237	2226	584	984	429
2345	1	2181	684	2237	327	1574	981	2188	712	2207	182	1665	182	2226	584	1321	783
2355	1	2242	384	2237	327	1374	231	2226	166	2207	182	2241	237	1881	184	1582	342
2365	1	2243	680	2237	327	1166	611	2226	166	2207	182	2241	237	2016	614	1598	874

Table A-IV
Temperature Data Print-Out for Round 4956

Temperature Channel	1	2	3	4	5	6	7	8
Temperature Channel	01	02	03	04	05	06	09	10
Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)
735.1	67.684	67.855	67.835	67.804	68.029	67.784	68.023	67.834
745.1	67.629	67.937	68.022	67.914	67.893	67.839	67.829	67.670
755.1	67.740	67.827	67.835	67.859	67.812	67.563	68.078	67.999
765.1	67.795	67.892	67.945	67.914	67.975	67.894	67.913	67.834
775.1	67.740	67.842	67.890	67.859	67.703	67.618	67.913	67.834
785.1	67.584	67.892	67.835	67.941	67.975	67.728	67.913	67.944
795.1	67.740	67.947	68.055	67.859	67.757	67.894	67.859	67.615
805.1	67.829	67.927	67.947	67.968	67.893	67.618	68.132	67.889
815.1	67.684	67.992	68.000	67.941	67.920	67.894	67.859	67.670
825.1	67.684	67.774	67.990	67.914	67.757	67.673	67.968	67.779
835.1	67.750	67.827	67.890	68.133	67.866	67.839	67.913	67.834
845.1	67.740	67.827	68.000	67.914	67.812	67.949	67.859	67.670
855.1	67.740	67.827	67.835	68.023	67.757	67.784	68.023	68.054
865.1	67.740	67.827	68.000	67.914	67.757	67.949	67.913	67.670
875.1	67.629	67.827	67.835	67.832	67.784	67.728	67.968	67.779
885.1	67.629	67.772	67.945	67.914	67.947	67.839	67.859	67.889
895.1	67.745	68.047	68.055	67.914	67.866	67.839	67.804	67.725
905.1	67.684	67.772	67.780	67.941	67.893	67.618	67.968	68.054
915.1	67.795	67.937	67.945	67.914	68.029	67.839	67.913	67.670
925.1	67.684	67.937	67.890	67.968	67.757	67.728	67.968	67.834
935.1	67.795	67.662	67.835	67.996	67.866	67.784	67.859	67.944
945.1	67.629	68.047	65.000	68.023	67.920	67.839	67.859	67.779
955.1	67.740	67.827	67.890	68.023	67.812	67.618	68.078	67.944
965.1	67.650	67.992	68.000	67.968	67.920	67.894	67.913	67.779
975.1	67.629	68.047	67.835	67.859	67.703	67.784	67.913	67.779
985.1	67.629	67.717	67.890	67.914	67.757	67.784	67.968	67.889
995.1	67.795	67.992	68.000	67.968	67.703	67.839	67.859	67.779
1005.1	67.684	67.807	67.781	67.914	67.703	67.673	67.859	67.834
1015.1	67.740	67.827	67.835	67.914	67.975	67.894	67.913	67.779
1025.1	67.629	67.937	67.945	67.894	67.757	67.563	67.968	67.615
1035.1	79.176	80.345	81.307	67.859	70.094	67.894	68.023	67.605
1045.1	128.099	128.245	136.245	70.512	72.104	70.428	67.913	67.834
1055.1	171.023	179.854	184.545	78.792	77.235	78.188	68.515	68.109
1065.1	199.095	221.049	219.047	98.749	86.580	89.835	49.719	68.109
1075.1	240.741	246.362	244.784	184.291	97.302	102.442	72.344	68.548
1085.1	234.711	260.634	260.227	117.519	109.428	115.513	76.333	49.726
1095.1	245.626	284.659	283.739	130.268	121.980	128.606	80.782	71.073
1105.1	263.081	296.191	298.512	142.452	134.479	141.233	86.849	73.652
1115.1	278.625	308.962	312.305	153.857	146.548	153.615	91.771	74.120
1125.1	290.638	316.504	326.958	165.211	157.066	165.156	97.786	79.190
1135.1	309.686	328.291	346.286	176.223	167.351	176.783	154.286	82.860
1145.1	333.439	350.018	373.063	188.655	177.857	189.832	110.478	86.309
1155.1	360.446	378.200	403.416	202.771	189.888	202.707	117.422	98.248
1165.1	389.246	411.895	434.217	217.771	203.745	218.128	124.274	94.239
1175.1	411.318	449.518	467.328	234.115	217.731	234.080	132.257	98.937
1185.1	436.589	493.338	501.944	250.585	234.110	251.225	140.847	103.503
1195.1	462.338	546.801	539.747	267.544	251.444	269.224	149.855	109.028
1205.1	484.439	603.497	579.296	284.971	270.939	288.348	159.495	115.974

1719	1	516.285	542.185	519.186	587.858	780.487	500.188	149.788	120.841
1725	1	543.714	479.114	459.772	321.312	509.716	330.262	180.110	127.471
1731	1	580.171	716.738	607.681	348.763	338.632	341.892	191.283	134.419
1737	1	591.493	751.515	714.787	150.426	351.461	373.630	202.740	141.683
1743	1	618.181	778.747	738.218	378.244	373.832	393.520	214.697	149.897
1749	1	636.644	802.564	744.140	394.164	395.237	412.643	226.916	157.699
1755	1	681.974	838.714	782.258	414.253	414.682	430.562	239.184	164.763
1761	1	485.774	842.049	821.899	431.845	433.554	448.096	251.243	172.600
1767	1	718.838	848.765	858.241	449.766	453.118	467.352	263.887	184.505
1773	1	735.314	422.176	608.898	488.601	472.686	469.758	276.787	194.780
1779	1	757.457	455.650	922.464	487.130	492.195	504.629	288.725	204.174
1785	1	777.293	484.828	922.688	504.746	511.912	523.819	300.661	213.596
1791	1	763.444	1819.695	478.456	922.123	437.186	943.160	313.098	223.696
1797	1	089.375	2834.868	1001.899	510.749	232.811	562.511	325.892	233.894
1803	1	425.689	1056.726	1623.944	555.012	572.483	581.462	336.907	244.484
1809	1	842.187	1001.545	1048.348	370.885	592.762	608.877	347.970	253.948
1815	1	458.128	1184.172	1674.415	587.269	612.245	619.396	359.274	264.584
1821	1	873.646	1126.651	1181.608	603.014	631.737	638.482	370.568	275.095
1827	1	889.747	1149.263	1136.428	619.585	650.990	656.136	381.359	285.475
1833	1	938.744	1189.722	1168.828	638.781	670.524	677.989	392.191	294.332
1839	1	420.180	1140.376	1192.577	653.671	689.535	696.138	402.285	306.368
1845	1	934.988	1210.071	1222.770	670.456	708.682	718.887	412.982	318.946
1851	1	655.158	1228.493	1251.117	686.943	726.391	740.161	423.251	327.481
1857	1	873.437	1247.766	1278.686	703.777	744.817	761.928	434.620	337.630
1863	1	901.718	1268.083	1304.894	720.586	767.515	783.819	444.669	348.052
1869	1	1009.847	1291.555	1327.993	737.794	787.821	805.975	455.611	358.875
1875	1	1025.972	1313.299	1347.111	755.326	806.442	827.700	466.690	369.419
1881	1	1654.288	1233.349	1387.441	773.206	830.214	848.948	477.957	380.466
1887	1	1661.883	1356.878	1389.834	798.344	851.768	868.928	489.259	390.667
1893	1	1882.627	1347.158	1411.818	867.981	872.375	888.094	501.058	401.732
1899	1	1181.864	1383.584	1425.843	825.622	891.938	907.142	512.176	411.796
1905	1	1122.688	1398.448	1445.980	843.046	910.238	925.878	524.833	422.931
1911	1	1148.617	1413.658	1461.185	848.552	928.238	944.184	535.827	433.759
1917	1	1157.248	1426.436	1477.679	878.114	945.231	961.725	547.402	444.531
1923	1	1174.512	1447.628	1491.898	895.316	962.467	978.496	559.417	455.416
1929	1	1189.754	1449.631	1505.263	912.747	978.865	999.168	570.858	466.169
1935	1	1198.786	1481.945	1518.283	929.877	994.268	1010.631	582.848	477.171
1941	1	1215.238	1472.769	1531.097	946.304	1009.640	1026.048	594.553	487.848
1947	1	1228.884	1483.954	1543.475	962.328	1024.289	1040.771	605.898	498.385
1953	1	1246.457	1494.886	1554.962	977.214	1038.837	1055.095	617.984	509.004
1959	1	1257.898	1504.699	1565.865	993.182	1052.918	1069.122	629.452	519.535
1965	1	1266.750	1514.185	1575.958	1007.952	1065.952	1082.803	641.187	530.104
1971	1	1283.134	1522.512	1585.487	1022.945	1079.715	1096.233	652.998	541.816
1977	1	1294.795	1531.632	1595.932	1037.199	1092.368	1109.122	664.325	551.848
1983	1	1318.388	1540.861	1608.884	1051.376	1104.731	1121.419	675.789	561.627
1989	1	1323.581	1550.099	1615.447	1064.880	1116.934	1133.667	687.341	571.330
1995	1	1331.469	1559.588	1625.842	1075.831	1128.749	1145.275	698.681	581.782
2001	1	1334.665	1568.424	1632.768	1089.485	1140.370	1156.889	708.818	591.880
2007	1	1347.856	1574.589	1640.754	1101.181	1152.846	1168.151	720.928	601.289
2013	1	1357.958	1584.249	1648.138	1112.829	1162.983	1178.978	732.139	611.804
2019	1	1370.114	1592.568	1655.884	1123.766	1174.198	1189.305	742.884	621.150
2025	1	1376.226	1600.839	1663.364	1134.410	1184.679	1199.488	754.170	631.364
2031	1	1377.473	1608.868	1670.225	1144.614	1195.35	1209.979	764.751	640.721
2037	1	1384.085	1616.493	1677.994	1154.426	1205.818	1219.374	775.869	648.863
2043	1	1385.737	1623.728	1684.856	1162.767	1215.298	1228.728	786.533	659.247
2049	1	1386.647	1631.288	1688.275	1171.454	1225.418	1238.832	797.257	668.488
2055	1	1387.893	1638.575	1696.328	1180.141	1234.694	1248.846	807.919	677.589
2061	1	1384.035	1646.757	1703.191	1188.364	1250.839	1258.662	818.326	686.623
2067	1	1388.879	1645.217	1711.147	1197.398	1272.199	1264.931	828.613	695.349
2073	1	1381.488	1643.244	1718.154	1225.165	1285.626	1273.264	838.239	705.119
2079	1	1378.624	1650.647	1725.885	1214.782	1296.785	1282.629	848.552	713.939
2085	1	1379.078	1645.226	1731.974	1223.262	1306.579	1291.978	858.188	722.684
2091	1	1383.834	1659.598	1739.788	1232.232	1316.491	1308.588	869.885	732.881
2097	1	1388.645	1643.732	1746.716	1248.811	1326.377	1328.871	878.474	748.773
2103	1	1391.592	1787.183	1754.461	1248.182	1338.516	1319.168	887.889	769.587
2109	1	1481.933	292.874	1761.616	1258.378	1349.288	1338.837	898.524	788.831

1475.1	1476.513	1575.177	1772.772	1260.459	1627.277	1342.226	915.647	776.273
1445.1	1439.404	1371.740	1701.271	1209.005	1554.136	1353.074	932.803	603.059
1895.1	1474.874	1544.152	1589.449	1296.631	1777.824	1363.461	965.076	-673.344
1915.1	1424.423	982.474	1798.717	1395.157	1996.095	1573.748	1019.062	-152.319
1915.1	1413.724	2872.730	1406.769	1314.529	1941.376	1364.865	1228.127	-2015.183
1922.1	1411.714	2178.122	1823.497	1324.768	1028.777	1317.827	1127.684	1238.714
1915.1	1417.591	1514.676	1819.127	1335.704	1831.016	1303.618	1096.191	-693.174
1945.1	1418.344	1156.970	1824.432	1346.153	2125.546	1307.635	1048.514	-1231.061
1885.1	1418.134	1169.130	1435.324	1362.927	2269.812	1316.675	991.056	1446.411
1945.1	1458.898	1236.123	1829.792	1439.530	2209.812	1326.910	974.167	2232.056
1975.1	1483.861	1048.253	1846.090	1760.836	2209.012	1336.953	966.247	1557.752
1982.1	1428.271	1849.382	1852.534	1823.076	2439.812	1348.109	990.807	1910.530
1995.1	1449.080	1778.257	1658.649	2036.108	2209.680	1359.347	992.776	2232.056
2002.1	1432.792	1845.164	1864.443	2147.688	2140.241	1370.157	907.819	2232.056
2015.1	1458.787	1719.999	1870.905	2225.427	2179.686	1380.476	979.324	2232.056
2022.1	1472.888	1812.277	1877.743	2188.789	2209.012	1391.391	972.301	2232.056
2035.1	1478.352	-1119.397	1891.290	2225.427	2209.012	1410.285	973.922	2232.056
2042.1	1482.946	-2826.723	2182.594	2225.427	2209.012	1635.905	961.661	2232.056
2055.1	1488.946	-2867.910	2232.392	2225.427	2209.012	1685.971	995.182	2232.056
2045.1	1497.601	-2867.910	1721.757	2225.427	2209.012	2017.865	1026.030	2232.056
2075.1	1564.607	-1377.296	-431.963	2225.427	2209.012	2103.999	1041.582	2232.056
2085.1	1733.187	2236.511	692.434	2225.427	2209.012	1893.231	976.618	2232.056
2095.1	2258.985	2236.511	657.965	2225.427	2209.012	2226.386	1026.566	2232.056
2102.1	2258.985	2236.511	2232.392	2225.427	2209.012	2231.354	729.565	2232.056
2115.1	2250.985	2236.511	3147.919	2225.427	2209.012	2161.232	-1131.047	2232.056
2125.1	2250.985	2236.511	2223.014	2225.427	2209.012	2213.569	37.333	2232.056
2135.1	2250.985	2236.511	2232.392	2225.427	2209.012	2233.790	449.786	1906.448
2145.1	2250.985	2236.511	2125.725	2225.427	2209.012	2188.830	631.029	1176.248
2155.1	2250.985	2236.511	2232.392	2225.427	2209.012	2233.565	610.795	2232.056
2165.1	2250.985	2236.511	2232.392	2225.427	2209.012	2079.488	982.988	2232.056
2175.1	2250.985	2236.511	2232.392	2225.427	2209.012	1886.828	1119.680	2232.056
2185.1	2250.985	2236.511	2185.581	2225.427	2209.012	1793.597	1278.765	2232.056
2195.1	2250.985	2236.511	2175.671	2164.446	2209.012	1086.125	1365.927	2232.056
2205.1	2250.985	2236.511	2232.392	1703.911	2209.012	1892.457	1494.454	2232.056
2215.1	2250.985	2236.511	2232.392	2169.465	2209.012	1546.819	1382.712	2232.056
2225.1	2250.985	2236.511	2232.392	2186.153	2209.012	1500.451	1216.867	2232.056
2235.1	2250.985	2232.392	2232.392	2142.958	2209.012	1548.218	1380.048	2232.056
2245.1	2250.985	1719.399	2232.392	2194.290	2209.012	1697.723	1331.919	2232.056
2255.1	429.695	2174.912	2232.392	2225.427	2209.012	1953.693	1734.349	2232.056
2262.1	398.488	2092.482	2232.392	2225.427	2209.012	2240.249	2122.788	2232.056
2275.1	2639.218	2236.511	2232.392	2225.427	2209.012	2186.152	1065.904	2232.056
2285.1	825.262	2236.511	2232.392	2225.427	2157.445	1988.254	1026.808	2232.056
2295.1	47.913	2236.511	2232.392	2225.427	2209.012	2012.598	1218.218	2232.056
2305.1	1584.863	2187.746	2232.392	2225.427	2209.012	2112.972	2173.589	2232.056
2315.1	2250.985	2183.842	2232.392	2225.427	2125.869	2240.246	1970.592	2232.056
2325.1	2250.985	2236.511	2232.392	2225.427	2209.012	2228.580	1802.581	2232.056
2335.1	2250.985	2236.511	2232.392	2225.427	2256.812	2218.369	1913.734	2232.056
2345.1	2250.985	2236.511	2232.392	2225.427	2209.012	2175.029	1129.916	2232.056
2355.1	2250.985	2236.511	2232.392	2225.427	2209.012	2240.249	2191.473	2232.056
2365.1	2250.985	2236.511	2232.392	2225.427	2209.012	2240.249	2225.800	2232.056
2375.1	2250.985	2236.511	2232.392	2225.427	2209.012	2240.249	2225.606	2232.056
2385.1	2250.985	2236.511	2232.392	2225.427	2209.012	2240.249	2225.606	2232.056
2395.1	1943.482	2236.511	2232.392	2225.427	2209.012	2140.249	2225.886	2232.056
2405.1	1610.858	2236.511	2232.392	2034.693	2209.012	2240.249	2225.886	2232.056
2415.1	1829.189	2236.511	2232.392	1890.842	2209.012	2240.249	2084.980	2232.056
2425.1	2087.732	2236.511	2232.392	1938.326	2209.012	2240.249	938.552	2232.056
2435.1	2250.985	2236.511	2232.392	1388.874	2187.284	2240.249	671.321	2232.056
2445.1	2250.985	2236.511	2232.392	1576.560	2128.994	2240.249	866.539	2232.056
2455.1	2250.985	2236.511	2232.392	1478.648	2118.921	2240.249	1312.119	2232.056
2465.1	2250.985	2236.511	2232.392	2225.427	2098.661	2240.249	1536.697	2232.056
2475.1	2250.985	2236.511	2232.392	2225.427	2064.232	2240.249	1894.829	2232.056
2485.1	2250.985	2236.511	2232.392	2225.427	2038.509	2208.734	2045.282	2232.056
2495.1	2250.985	2236.511	2232.392	2225.427	1989.492	2191.949	1973.881	2232.056
2505.1	2250.985	2236.511	2232.392	2225.427	1890.223	2146.246	2065.184	2232.056
2515.1	2250.985	2236.511	2232.392	2225.427	1844.864	2240.249	2027.284	2232.056
2525.1	2250.985	2236.511	2232.392	2225.427	1798.669	2240.246	2008.847	2232.056

Atmospheric Data - Part 1 of 2 - Round 452

Time	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)
735.1	75.110	75.272	75.190	75.334	77.832	75.022	74.967	75.199
745.1	75.088	75.327	75.255	75.334	77.770	75.077	75.022	75.199
755.1	75.110	75.272	75.465	75.334	77.778	75.187	74.898	75.034
765.1	75.095	75.382	75.245	75.444	77.724	75.077	75.131	75.308
775.1	75.110	75.417	75.465	75.225	77.941	75.242	74.913	75.144
785.1	75.945	75.327	75.410	75.280	77.669	75.022	74.913	75.144
795.1	75.095	75.217	75.300	75.280	77.832	75.132	75.322	75.199
805.1	75.110	75.382	75.465	75.389	77.832	75.132	74.828	75.089
815.1	75.144	75.300	75.300	75.334	77.778	75.022	75.022	75.253
825.1	75.095	75.352	75.320	75.334	77.632	75.187	74.940	75.089
835.1	75.088	75.217	75.300	75.170	77.615	75.242	74.858	75.089
845.1	75.095	75.217	75.307	75.389	77.778	75.242	74.882	75.308
855.1	75.110	75.492	75.465	75.334	77.724	75.297	74.749	75.034
865.1	75.088	75.327	75.410	75.334	77.669	75.187	74.313	75.383
875.1	75.110	75.217	75.410	75.225	77.832	75.352	74.913	75.199
885.1	75.088	75.272	75.410	75.280	77.669	75.077	74.858	75.199
895.1	75.095	75.162	75.245	75.280	77.886	75.187	75.077	75.253
905.1	75.110	75.382	75.465	75.352	77.632	75.187	74.803	74.979
915.1	75.088	75.272	75.355	75.334	77.832	75.022	75.131	75.308
925.1	75.088	75.272	75.355	75.307	77.886	75.242	74.967	75.089
935.1	74.945	75.327	75.355	75.334	77.791	75.187	74.967	75.199
945.1	74.945	75.272	75.355	75.334	77.778	75.132	75.077	75.199
955.1	75.095	75.437	75.520	75.280	77.778	75.187	74.803	75.144
965.1	75.095	75.272	75.300	75.334	77.778	75.077	75.131	75.383
975.1	75.144	75.217	75.355	75.292	77.886	75.187	74.913	75.144
985.1	75.095	75.382	75.520	75.334	77.615	75.187	74.858	75.089
995.1	75.088	75.217	75.190	75.225	77.778	75.297	74.967	75.199
1005.1	75.095	75.327	75.520	75.225	77.724	75.242	74.749	74.979
1015.1	74.645	75.272	75.245	75.116	77.778	75.022	75.131	75.199
1025.1	76.326	75.767	76.671	75.334	26.804	75.187	74.913	75.034
1035.1	107.201	93.129	105.134	75.498	81.944	75.482	75.077	74.286
1045.1	151.716	126.066	174.951	78.640	83.282	80.522	75.459	75.089
1055.1	194.286	166.559	240.587	84.944	49.703	93.973	75.623	78.131
1065.1	232.944	208.275	285.328	92.089	95.985	111.022	77.644	78.378
1075.1	266.980	237.701	324.961	101.395	88.240	131.828	80.328	81.063
1085.1	304.038	280.937	364.920	109.166	103.053	151.252	85.178	86.430
1095.1	343.588	327.745	403.214	119.645	119.671	173.627	89.810	93.774
1105.1	328.562	342.819	440.732	128.663	127.703	188.331	96.128	100.140
1115.1	420.572	387.273	467.230	141.160	109.273	218.658	103.688	109.257
1125.1	447.603	388.511	489.376	158.095	92.679	241.648	112.812	120.837
1135.1	468.886	408.179	508.544	172.479	95.488	261.860	122.353	129.927
1145.1	486.386	427.863	521.683	186.608	91.259	279.727	133.238	140.361
1155.1	502.864	445.174	535.160	197.888	119.538	297.375	141.873	151.188
1165.1	518.175	460.353	547.597	210.688	127.709	313.824	137.379	162.838
1175.1	537.818	473.338	558.693	224.827	115.357	328.854	199.497	173.568
1185.1	545.110	466.815	569.978	237.904	91.613	341.367	134.389	185.468
1195.1	557.736	496.342	581.349	250.286	84.496	355.873	132.988	198.849
1205.1	569.077	502.216	591.946	262.906	93.549	367.127	137.824	208.976

1273	582 758	818 883	401 421	274 817	124 871	378 793	144 395	217 355
1275	590 763	829 887	411 429	285 795	127 776	390 856	148 778	227 077
1278	401 703	538 805	428 732	296 061	124 414	401 752	153 735	237 262
1245	610 930	949 347	628 575	309 516	128 210	411 122	158 957	247 215
1255	421 822	956 999	634 931	321 937	125 779	421 971	163 959	256 569
1249	631 541	966 975	645 603	334 186	96 112	432 263	169 957	265 961
1275	630 773	978 898	653 983	342 692	100 455	441 334	173 190	273 750
1205	444 404	994 133	661 612	358 331	116 045	449 926	177 276	282 335
1285	654 673	995 440	669 607	362 444	131 296	459 700	181 512	291 306
1305	665 249	695 440	674 943	372 843	121 923	466 221	185 316	289 118
1315	673 443	614 562	684 676	382 863	115 625	476 422	189 613	307 758
1325	401 546	679 666	692 152	390 899	98 546	482 439	193 077	312 705
1335	688 441	633 579	699 723	401 306	97 005	493 467	197 300	322 854
1345	697 662	643 821	706 089	410 636	100 192	501 334	201 147	329 576
1355	709 086	650 006	714 300	420 164	122 932	509 654	204 244	336 469
1365	713 212	663 069	721 926	428 823	119 327	517 299	207 980	343 416
1375	726 373	672 072	728 006	438 226	116 595	524 865	211 446	350 586
1385	726 572	678 813	735 106	446 333	126 271	532 310	214 820	357 226
1395	734 560	686 253	741 451	455 729	111 153	539 627	218 373	365 008
1405	742 332	692 131	748 741	464 195	114 088	547 346	221 461	371 308
1415	748 672	696 433	754 979	472 242	115 464	553 526	225 398	377 523
1425	755 508	705 032	761 613	480 588	122 754	561 130	228 217	383 772
1435	762 544	711 953	767 645	488 566	112 015	568 864	231 406	389 391
1445	768 772	718 018	774 173	496 945	122 992	574 892	235 017	395 992
1455	775 599	724 631	780 449	504 703	117 992	581 612	238 176	402 649
1465	782 273	730 439	787 510	513 599	119 338	587 767	241 598	409 178
1475	788 292	736 695	794 535	520 424	121 388	595 138	244 515	414 102
1485	793 606	742 848	800 851	527 624	126 546	600 675	247 960	420 111
1495	798 720	747 498	807 563	534 895	134 865	607 629	250 674	425 907
1505	803 101	753 122	814 072	542 100	140 181	614 970	253 680	431 244
1515	813 493	759 630	820 530	549 213	146 175	620 003	257 437	437 383
1525	823 751	767 978	827 431	556 070	141 410	626 339	260 081	443 475
1535	834 103	776 160	835 024	564 419	144 154	632 714	263 253	448 995
1545	843 350	784 238	844 300	572 239	151 218	639 442	266 793	454 253
1555	852 797	792 283	854 817	580 294	160 442	646 366	270 434	459 958
1565	861 376	799 634	863 728	588 237	164 623	653 088	272 917	465 941
1575	869 862	806 554	872 791	596 300	163 258	660 913	275 668	471 495
1585	877 494	813 073	880 509	604 434	177 493	668 328	279 035	477 862
1595	887 086	818 992	888 431	612 798	192 204	676 092	282 724	484 680
1605	895 092	826 003	895 554	620 501	192 352	683 144	285 779	489 724
1615	897 817	830 775	903 878	628 323	181 358	690 343	289 411	496 681
1625	906 592	835 992	909 496	635 310	201 826	696 732	292 620	501 203
1635	914 637	841 804	916 116	642 468	193 747	703 428	295 565	507 756
1645	920 193	847 813	921 940	649 790	204 291	709 952	299 031	513 847
1655	926 265	852 702	928 369	657 068	204 594	716 531	302 763	519 975
1665	931 639	857 193	933 653	664 135	207 823	722 705	306 595	526 208
1675	938 713	860 836	939 625	670 396	189 334	728 876	309 323	531 878
1685	946 643	868 850	944 810	677 293	200 835	734 391	312 365	538 786
1695	945 367	873 810	950 288	683 857	205 244	740 206	315 563	542 627
1705	949 445	878 783	955 963	690 206	206 043	746 117	318 801	548 178
1715	954 488	882 879	961 735	696 501	209 459	751 675	321 795	554 337
1725	959 487	887 339	968 098	703 392	192 652	757 731	325 355	559 877
1735	964 532	894 917	974 213	709 938	202 785	762 634	328 127	565 318
1745	969 170	899 845	979 834	715 441	191 621	768 735	331 284	570 900
1755	973 680	902 839	985 652	721 299	208 958	773 534	334 357	575 627
1765	978 212	909 126	991 074	727 838	206 120	777 781	338 446	581 106
1775	983 639	912 294	996 840	733 504	208 349	783 676	339 884	589 973
1785	988 404	917 514	1002 686	739 826	230 657	787 820	343 485	598 948
1795	984 815	923 772	1008 026	745 548	210 631	792 814	348 486	595 781
1805	998 534	926 740	1014 185	751 187	180 447	797 084	349 691	608 763
1815	1003 152	931 843	1019 555	757 082	207 540	801 584	352 489	606 129
1825	1008 100	936 805	1025 170	761 978	214 080	806 269	354 757	611 938
1835	1012 931	942 463	1030 884	768 086	195 010	811 716	358 688	617 788
1845	1018 844	947 109	1036 644	773 373	180 388	816 608	361 485	626 932
1855	1023 158	951 813	1041 866	779 179	181 233	822 038	364 322	625 577
1865	1028 288	955 509	1047 322	784 883	182 230	826 411	367 398	638 724

1875	1633.428	848.282	1055.409	720.048	827.354	836.344	376.352	635.414
1885	1638.341	864.994	1057.989	725.041	144.573	834.728	373.314	640.192
1895	1643.253	869.637	1063.114	801.249	175.673	839.256	376.274	645.241
1905	1648.314	875.221	1068.750	806.193	197.399	843.684	379.921	649.672
1915	1653.175	880.125	1073.855	812.307	200.288	847.863	382.656	654.355
1925	1657.842	885.229	1079.298	911.133	222.309	851.561	385.249	659.284
1935	1662.601	889.849	1083.718	422.575	207.825	857.360	387.945	664.263
1945	1667.318	895.140	1088.129	827.719	292.707	860.938	391.107	668.739
1955	1671.774	895.812	1091.611	832.763	187.956	864.216	393.950	673.356
1965	1676.292	1002.957	1098.304	837.780	210.742	867.199	396.294	678.290
1975	1681.499	1007.447	1103.881	843.642	207.209	871.670	400.061	681.944
1985	1686.203	1012.002	1109.673	848.279	216.488	875.395	402.596	686.662
1995	1691.718	1015.637	1114.847	853.385	194.259	879.864	405.750	691.627
2005	1696.430	1020.422	1119.123	858.401	212.123	883.091	408.499	695.738
2015	1701.837	1024.072	1124.574	863.781	184.188	887.410	411.899	700.950
2025	1706.949	1026.412	1129.999	868.719	192.779	891.269	414.429	704.356
2035	1711.797	1032.654	1134.967	873.550	210.508	897.681	418.042	708.214
2045	1717.012	1037.191	1139.942	878.777	179.973	902.492	420.873	712.718
2055	1722.610	1040.643	1144.520	884.250	175.273	906.757	424.025	717.872
2065	1728.722	1045.673	1150.282	889.130	190.467	911.319	426.654	722.124
2075	1735.767	1050.940	1157.079	894.797	198.680	916.524	429.333	726.674
2085	1742.465	1056.224	1163.679	900.019	178.335	920.885	432.704	730.672
2095	1749.660	1061.204	1170.272	905.930	213.506	926.286	435.719	735.269
2105	1756.219	1066.185	1177.523	911.593	187.127	932.033	438.961	739.265
2115	1763.413	1070.965	1184.421	917.697	208.449	938.293	442.459	744.607
2125	1768.871	1075.205	1190.533	923.185	194.506	941.889	445.235	749.340
2135	1773.432	1080.214	1198.856	929.262	195.169	945.454	448.473	753.938
2145	1778.694	1084.810	1201.180	934.376	192.069	950.950	451.914	758.477
2155	1783.689	1089.156	1208.701	940.723	199.609	955.058	455.201	762.862
2165	1789.574	1092.854	1211.682	945.714	202.796	959.968	458.742	768.498
2175	1793.093	1097.241	1217.004	951.098	214.175	964.411	461.512	772.631
2185	1797.593	1100.692	1222.187	956.505	201.082	969.062	465.460	777.710
2195	1798.884	1105.573	1228.072	961.420	207.253	975.295	468.433	782.041
2205	1206.783	1108.727	1231.407	966.285	205.127	981.379	471.917	786.272
2215	1211.472	1113.361	1236.717	972.034	200.782	985.385	474.887	791.197
2225	1215.705	1117.207	1241.283	976.943	175.129	991.863	477.858	795.872
2235	1219.820	1120.886	1245.524	987.153	173.088	995.868	481.898	800.898
2245	1224.343	1124.143	1249.672	966.770	183.707	1002.442	484.762	804.970
2255	1228.816	1128.300	1254.415	991.926	200.138	1008.522	488.084	808.847
2265	1233.440	1131.652	1259.156	996.664	191.529	1011.685	491.508	813.863
2275	1237.815	1136.435	1263.697	1001.286	221.477	1017.962	493.969	817.339
2285	1242.191	1140.232	1268.637	1006.753	199.741	1023.346	497.463	822.105
2295	1246.787	1144.762	1273.781	1011.465	197.923	1028.684	500.392	826.020
2305	1250.896	1147.875	1278.155	1016.520	209.661	1033.477	503.657	830.244
2315	1256.670	1151.270	1282.530	1021.261	224.658	1037.973	506.672	834.610
2325	1260.499	1155.943	1286.634	1026.090	234.473	1043.654	509.826	839.528
2335	1265.028	1159.909	1290.986	1031.193	257.776	1052.594	512.833	842.594
2345	1269.589	1163.707	1295.388	1036.394	242.543	1061.090	518.144	848.857
2355	1274.488	1167.456	1299.404	1041.390	231.157	1063.708	518.588	850.822
2365	1278.721	1170.904	1303.849	1046.500	234.676	1067.412	522.987	855.430
2375	1282.805	1174.955	1307.957	1051.553	222.052	1073.388	525.203	858.997
2385	1287.012	1179.020	1312.462	1056.238	264.866	1079.277	528.222	863.089
2395	1291.425	1182.356	1316.671	1060.624	225.617	1085.219	531.559	867.089
2405	1296.389	1186.501	1321.773	1066.367	270.647	1087.611	534.907	871.630
2415	1300.347	1190.381	1325.954	1071.875	309.440	1091.611	537.483	875.583
2425	1304.695	1193.904	1330.196	1075.538	291.232	1097.093	540.399	879.295
2435	1308.674	1197.803	1334.662	1080.639	276.687	1102.278	543.544	883.495
2445	1312.964	1201.555	1337.393	1095.397	296.771	1108.303	548.540	887.689
2455	1317.655	1205.163	1340.654	1089.860	337.580	1112.896	551.848	891.344
2465	1321.766	1209.467	1344.127	1094.715	356.482	1117.242	552.728	899.884
2475	1326.786	1212.719	1347.848	1099.816	345.739	1121.292	559.668	899.728
2485	1330.732	1215.577	1351.960	1104.230	398.333	1125.441	568.799	903.822
2495	1335.077	1219.160	1355.092	1108.423	454.856	1129.491	561.798	907.479
2505	1336.273	1222.665	1359.262	1113.598	431.120	1132.850	564.927	911.284
2515	1345.328	1226.444	1362.333	1117.840	534.141	1136.782	568.733	915.730
2525	1347.049	1229.952	1366.909	1122.525	516.498	1141.420	578.999	918.042

2535	1352 267	1234 883	1376 486	1126 893	592 717	1144 754	573 893	922 842
2545	1359 667	1237 164	1374 137	1131 427	612 418	1148 706	577 879	926 894
2554	1360 868	1241 128	1378 013	1135 728	628 458	1158 613	580 112	938 387
2562	1363 272	1244 312	1381 987	1140 331	712 878	1153 499	581 191	934 443
2573	1347 223	1246 690	1385 048	1144 501	767 938	1157 698	586 275	938 443
2585	1379 324	1251 798	1388 578	1148 769	740 691	1160 762	588 951	941 759
2595	1374 131	1255 489	1391 882	1152 744	799 985	1164 171	591 776	945 748
2605	1377 215	1259 265	1395 298	1157 658	818 192	1168 079	594 832	949 397
2615	1380 892	1262 134	1398 381	1160 791	848 696	1171 831	597 984	953 344
2625	1384 248	1265 844	1401 617	1165 562	854 917	1176 832	600 505	956 608
2635	1387 498	1269 208	1405 197	1169 477	872 841	1180 135	603 513	960 693
2645	1391 414	1272 474	1408 439	1173 109	876 653	1183 792	606 705	964 099
2655	1395 274	1275 938	1412 824	1177 338	926 077	1188 242	609 274	967 843
2665	1399 335	1278 958	1415 145	1180 983	945 786	1191 258	612 724	971 688
2675	1402 395	1282 522	1418 854	1184 792	980 888	1196 153	615 247	974 548
2685	1405 554	1286 141	1422 184	1189 014	980 801	1200 818	618 488	978 738
2695	1408 148	1288 489	1425 836	1192 427	1004 920	1201 471	621 258	982 139
2705	1412 964	1292 624	1428 376	1196 429	1022 418	1206 785	624 123	985 638
2715	1415 599	1296 141	1431 521	1200 260	1036 868	1209 951	628 889	989 135
2725	1419 813	1299 486	1434 884	1204 236	1060 973	1213 760	629 754	992 438
2735	1423 936	1302 731	1437 989	1207 775	1079 301	1217 371	632 719	996 133
2745	1428 947	1305 982	1441 180	1211 568	1091 675	1220 884	635 382	999 582
2755	1433 817	1309 372	1444 888	1215 045	1105 364	1224 348	638 545	1003 080
2765	1438 684	1312 991	1448 646	1219 326	1126 028	1227 961	641 599	1006 626
2775	1443 686	1315 817	1452 896	1222 539	1112 965	1231 525	644 521	1009 828
2785	1448 722	1319 339	1454 544	1226 718	1138 486	1235 039	647 888	1013 473
2795	1444 107	1322 612	1457 284	1230 280	1145 317	1238 604	649 990	1016 920
2805	1447 770	1325 888	1459 995	1233 967	1081 655	1242 367	653 099	1020 268
2815	1451 842	1329 812	1462 996	1237 506	1081 195	1245 239	655 757	1023 667
2825	1454 588	1331 925	1465 797	1240 273	1084 282	1248 881	658 714	1026 917
2835	1457 691	1335 365	1468 890	1244 907	922 194	1252 222	661 675	1030 560
2845	1461 288	1338 324	1472 283	1248 672	959 816	1255 442	664 275	1034 887
2855	1464 897	1341 922	1475 188	1252 310	621 547	1258 960	667 888	1037 158
2865	1468 074	1344 382	1478 514	1255 855	641 248	1262 188	670 435	1040 890
2875	1471 755	1347 258	1481 428	1259 542	589 875	1266 145	672 887	1043 804
2885	1474 782	1350 711	1484 677	1263 164	588 193	1268 970	675 840	1047 299
2895	1478 163	1353 444	1487 935	1267 121	582 929	1272 539	678 992	1051 640
2905	1481 648	1356 575	1490 994	1270 911	583 866	1275 861	681 742	1054 181
2915	1484 877	1359 888	1494 484	1274 235	582 484	1279 133	684 842	1057 585
2925	1488 463	1362 541	1497 565	1277 657	588 680	1282 903	687 492	1060 245
2935	1491 949	1366 671	1501 828	1281 498	595 344	1286 077	690 448	1064 884
2945	1495 588	1369 384	1504 492	1285 143	591 781	1289 698	692 988	1067 234
2955	1498 773	1372 563	1507 957	1288 232	588 324	1292 923	695 935	1070 532
2965	1502 184	1375 374	1510 971	1292 898	592 184	1296 498	698 981	1074 875
2975	1505 854	1378 709	1514 690	1295 983	593 791	1300 368	701 727	1076 782
2985	1509 346	1381 496	1517 555	1299 976	591 233	1303 396	704 821	1080 621
2995	1512 637	1384 683	1520 773	1303 476	588 389	1307 268	707 416	1083 771
3005	1516 637	1387 671	1523 891	1307 223	583 056	1310 246	710 389	1086 822
3015	1520 132	1391 267	1527 715	1311 070	584 336	1314 023	713 182	1090 888
3025	1523 527	1394 246	1530 433	1314 278	585 717	1317 458	716 193	1093 122
3035	1527 388	1397 438	1534 058	1318 223	585 663	1320 688	719 383	1097 385
3045	1531 234	1400 725	1537 180	1321 824	591 083	1324 208	721 925	1100 812
3055	1534 684	1403 964	1540 686	1325 624	587 824	1327 588	724 715	1103 211
3065	1537 992	1407 127	1543 882	1329 328	589 679	1331 918	727 783	1106 951
3075	1541 383	1410 188	1546 884	1332 735	591 259	1334 697	730 293	1109 688
3085	1544 436	1413 193	1549 932	1336 389	591 284	1337 938	733 479	1113 281
3095	1547 325	1415 938	1552 959	1340 391	593 966	1341 312	735 267	1116 488
3105	1550 882	1419 182	1556 087	1344 647	594 248	1344 895	738 994	1119 688
3115	1554 135	1422 402	1559 217	1347 398	593 639	1347 938	742 287	1122 648
3125	1557 186	1425 523	1562 844	1350 921	593 315	1351 314	744 688	1125 457
3135	1560 441	1428 178	1565 278	1354 624	594 344	1354 688	747 957	1128 952
3145	1563 892	1431 288	1568 188	1357 764	596 095	1357 938	750 343	1131 888
3155	1567 311	1434 216	1570 938	1361 696	593 441	1360 924	753 325	1134 888
3165	1570 621	1436 715	1573 767	1364 912	595 344	1364 862	756 884	1138 858
3175	1573 877	1440 114	1576 883	1368 227	600 894	1367 588	759 089	1141 159
3185	1577 197	1442 798	1579 887	1371 988	599 147	1370 889	761 921	1144 587

1195.1	1985.957	1445.816	1503.177	1375.404	600.355	1373.630	765.349	1147.559
1205.1	1994.925	1449.117	1509.214	1379.117	598.477	1376.970	797.581	1150.070
1215.1	1987.134	1452.320	1509.297	1382.434	602.633	1380.061	771.205	1153.703
1222.1	1992.888	1452.774	1502.771	1383.979	602.158	1381.652	773.468	1152.919
1232.1	1991.446	1456.976	1499.146	1389.699	603.635	1386.599	776.267	1159.916
1242.1	1990.228	1462.219	1488.828	1392.888	604.812	1389.818	778.922	1162.724
1255.1	1999.649	1465.390	1603.944	1396.584	605.136	1393.432	782.169	1165.975
1265.1	1461.617	1449.040	1607.291	1399.632	900.239	1398.779	799.047	1169.028
1275.1	1489.573	1471.554	1411.987	1403.403	609.114	1400.421	787.022	1171.983
1282.1	1499.188	1474.414	1419.292	1408.827	609.718	1403.117	790.792	1172.628
1285.1	1911.914	1477.722	1618.372	1409.903	605.313	1406.914	793.125	1178.169
1292.1	1418.822	1508.758	1422.842	1413.873	607.890	1412.552	796.244	1182.503
1315.1	1620.770	1592.582	1429.741	1417.382	609.906	1413.711	790.714	1275.493
1322.1	1624.354	1675.283	1451.086	1421.893	622.495	1417.135	603.874	1384.191
1335.1	1431.013	1769.670	1636.533	1448.623	950.993	1421.391	809.172	1549.270
1342.1	1448.282	1759.132	1443.288	1449.927	1024.670	1424.712	615.902	1731.317
1355.1	1447.832	1879.469	1458.988	1442.947	1038.950	1420.412	626.339	1939.929
1362.1	1417.863	1223.672	1655.226	1448.712	1218.829	1404.421	639.183	1922.097
1375.1	1925.276	2119.317	1648.320	1460.473	1038.632	1565.111	646.229	1339.137
1382.1	1623.893	2106.290	1672.184	1462.271	1265.611	1648.794	628.375	1738.822
1395.1	1933.839	2151.425	1976.399	1498.997	1133.924	1696.051	663.185	920.073
1402.1	1645.808	2222.348	1683.679	1474.432	1324.244	1714.928	669.086	1368.838
1415.1	1640.556	2602.376	1693.081	1488.598	2019.894	1704.337	673.790	1190.563
1422.1	1689.814	1888.388	1781.111	1483.184	2019.974	1683.228	679.214	1982.786
1435.1	1975.380	1711.239	1711.939	1498.475	-913.340	1585.338	684.636	2155.859
1442.1	1679.162	1824.348	1731.482	1492.558	1418.878	1599.791	690.482	1878.644
1455.1	1693.332	1441.270	1917.613	1498.656	1021.707	1694.307	696.788	1939.214
1465.1	1995.750	1485.563	1931.324	1506.507	1888.409	1845.978	903.791	1633.258
1475.1	1685.184	2115.857	1917.770	1509.559	1903.141	1864.406	909.166	2216.042
1485.1	1691.748	1638.061	1948.479	1540.768	2167.424	1499.771	914.778	1922.830
1495.1	1993.107	1774.509	2199.724	1607.534	2209.427	1701.422	927.897	2054.944
1505.1	1760.019	1801.534	2220.931	1528.511	2177.487	1748.388	958.348	2201.189
1515.1	1721.151	1814.766	2226.911	1451.188	1983.361	1569.511	955.572	2043.548
1522.1	1669.574	1983.678	1794.794	1623.736	2035.321	1455.647	960.419	2232.799
1535.1	1920.945	2105.890	2235.256	1647.950	2110.415	1373.171	1344.523	2162.685
1542.1	2078.111	1849.977	2074.218	1624.826	2155.457	1263.973	1898.389	2156.118
1555.1	2197.804	1937.579	2087.096	1638.925	2209.427	1153.502	1997.396	2130.531
1565.1	1639.119	1986.299	2229.383	1667.580	2209.427	1133.245	2027.476	2203.747
1575.1	1731.248	1743.536	2233.517	2098.509	2209.427	1140.218	2031.892	2232.799
1585.1	1996.710	1847.081	2033.469	2088.957	1318.625	1150.438	2034.373	2189.388
1595.1	2226.813	1863.688	2126.883	2096.791	1128.984	1167.853	1887.483	2213.638
1605.1	2250.950	1970.825	2119.781	2038.891	1267.475	1175.390	1893.288	2031.685
1615.1	2258.858	2237.845	2212.218	2028.844	1587.002	1190.478	1394.698	2229.715
1625.1	2250.950	1957.262	1999.965	2039.285	1823.283	1203.852	1346.389	2117.027
1635.1	2250.950	2225.742	1638.928	2134.189	1978.131	1162.697	1119.235	1945.178
1642.1	1728.238	2184.871	2287.318	2149.276	1878.283	1294.577	1138.857	1824.758
1655.1	1524.834	2237.045	2239.294	2178.805	1918.343	1502.538	1192.497	1848.676
1665.1	1889.386	2237.045	2235.256	2157.242	574.848	1582.976	1031.289	1743.441
1675.1	1911.802	2237.045	2235.256	2157.682	-235.829	1456.732	983.157	1733.393
1682.1	1948.798	2237.045	2232.259	2197.118	539.864	1484.424	1059.918	1694.378
1695.1	1980.022	2237.045	2239.299	2026.028	1906.491	1418.016	1338.988	1989.177
1702.1	1826.426	2237.045	2237.256	2226.026	1681.329	1298.248	1372.367	1657.537
1715.1	2227.682	2237.045	2235.256	2026.026	1474.944	1248.599	1376.823	1679.090
1725.1	2197.427	2231.771	2235.256	2226.029	1915.123	1246.576	1354.218	1683.749
1735.1	2058.876	2185.735	2223.262	2224.626	1465.286	1250.785	1328.527	1692.981
1745.1	2051.265	1795.159	2197.959	2226.825	1369.331	1237.278	1392.982	1699.125
1755.1	2083.878	1735.836	2181.771	2226.826	1335.326	1172.364	1341.488	1724.928
1765.1	2143.994	1698.885	2038.845	2226.826	1199.880	1296.940	1367.328	1744.928
1775.1	2178.844	1647.786	1984.647	2226.826	1228.723	1328.845	1374.456	1756.881
1785.1	2165.843	1937.789	1905.783	2226.826	1290.928	1305.226	1507.888	1727.688
1795.1	2197.398	1815.785	1887.174	2226.826	1375.792	1387.943	1647.183	1748.288
1805.1	2185.557	1928.227	1729.979	2026.826	1369.580	1389.839	1689.741	1898.589
1815.1	2184.343	1579.891	1687.361	2226.826	1488.498	1343.818	1693.424	1488.484
1825.1	2288.781	1542.877	1887.871	2226.826	1389.497	1392.147	1793.681	1689.841
1835.1	2208.821	1988.492	1668.264	2226.826	1811.092	1482.918	1813.384	1489.431
1845.1	2225.589	1516.936	1643.513	2226.826	1881.549	1402.269	1818.529	1691.930

1885	1	2245	468	1613	344	1622	444	2224	524	1377	183	1423	617	1838	784	1868	713
1886	1	2244	422	1654	531	1660	745	2224	076	1325	145	1401	520	1859	685	1961	340
1887	1	2243	822	1687	880	1681	103	2224	026	1326	495	1408	364	1878	922	1670	340
1888	1	2247	324	2012	324	1743	712	1412	770	1324	415	1417	911	1883	886	1856	469
1889	1	2235	635	2887	641	1549	378	1726	824	1354	552	1419	611	1898	389	1849	939
1890	1	2241	944	2237	845	1436	226	1667	539	1431	367	1426	919	1894	151	1839	813
1891	1	2237	877	2237	845	1518	571	1603	549	1360	070	1435	127	1907	801	1833	670
1892	1	2224	187	2237	845	1445	732	1562	903	1371	346	1439	429	1910	105	1826	986
1893	1	2287	842	2237	845	1456	747	1521	233	1372	110	1442	234	1926	005	1822	073
1894	1	2105	414	2237	845	1428	194	1479	837	1373	833	1445	781	1926	495	1805	673
1895	1	2102	386	2237	845	1396	442	1432	860	1441	422	1448	307	1931	616	1561	177
1896	1	2143	841	2002	172	1343	199	1422	786	1461	990	1452	900	1946	953	1565	508
1897	1	2132	827	2227	507	1357	060	1400	201	1496	335	1453	218	1936	253	1573	360
1898	1	2131	866	2237	845	1329	483	1399	193	1486	419	1454	714	1929	194	1563	767
1899	1	2138	839	2237	845	1303	801	1347	211	1511	013	1457	431	1922	626	1549	442
1900	1	2131	864	2092	303	1278	032	1315	315	1511	705	1458	927	1903	787	1529	449
1901	1	2089	723	2087	458	1253	125	1287	125	1519	792	1456	676	1892	257	1595	874
1902	1	2092	147	1815	952	1221	990	1251	619	1517	254	1459	276	1883	426	1461	655
1903	1	2083	825	1865	950	1194	783	1232	761	1522	978	1459	128	1874	821	1458	638
1904	1	2040	834	1616	616	1170	921	1196	037	1522	061	1459	120	1866	645	1434	464
1905	1	2014	828	1813	855	1148	817	1169	036	1516	634	1458	275	1858	478	1411	234
1906	1	1960	109	1815	947	1128	517	1142	343	1512	764	1457	073	1848	952	1389	238
1907	1	1898	339	1818	835	1112	221	1116	590	1448	620	1457	073	1840	822	1367	523
1908	1	1830	090	1819	189	1097	690	1093	244	1431	033	1456	921	1832	481	1347	656
1909	1	1517	758	1818	342	1085	784	1079	630	1418	992	1456	670	1823	838	1328	293
1910	1	1694	779	1819	446	1075	399	1049	272	1411	717	1456	620	1814	946	1310	121
1911	1	1873	897	1817	826	1066	535	1029	034	1382	133	1455	707	1800	170	1293	183
1912	1	1857	364	1815	161	1058	952	1009	256	1350	788	1455	216	1797	226	1276	519
1913	1	1835	151	1819	213	1052	059	951	287	1331	601	1453	902	1788	187	1261	330
1914	1	1869	541	1814	429	1046	249	975	129	1244	200	1452	989	1762	887	1246	828
1915	1	1848	184	1812	847	1041	127	958	372	1212	647	1451	505	1753	762	1231	373
1916	1	1829	763	1818	505	1036	449	941	706	1205	238	1449	801	1764	317	1217	712
1917	1	1854	237	1887	955	1032	213	924	435	1183	028	1448	848	1759	341	1204	580
1918	1	1862	888	1885	346	1028	717	909	229	1184	752	1445	041	1751	651	1191	963
1919	1	1853	546	1881	644	1025	466	884	288	1179	437	1443	536	1742	669	1179	667
1920	1	1839	884	1882	510	1022	510	860	682	1205	044	1441	232	1733	282	1167	359
1921	1	1828	128	1792	286	1019	850	866	892	1212	142	1438	427	1723	898	1155	929
1922	1	1817	226	1784	645	1017	289	852	972	1202	189	1435	973	1714	177	1144	162
1923	1	1886	888	1779	366	1015	318	842	448	1201	725	1433	328	1705	233	1133	677
1924	1	1795	912	1773	703	1013	692	830	760	1210	605	1430	116	1696	448	1122	897
1925	1	1781	878	1788	279	1012	214	848	828	1285	921	1427	464	1688	851	1112	798
1926	1	1766	345	1741	978	1010	986	827	887	1203	847	1424	212	1679	892	1103	814
1927	1	1688	931	1755	581	1009	110	820	883	1214	855	1421	811	1669	885	1093	318
1928	1	1822	184	1745	134	1007	977	815	549	1228	873	1417	660	1660	706	1084	411
1929	1	1865	428	1742	410	1007	140	808	874	1218	958	1414	461	1651	768	1079	484
1930	1	1593	465	1736	304	1006	253	800	348	1220	046	1411	212	1642	870	1066	939
1931	1	1584	892	1738	884	1005	513	793	113	1217	583	1407	514	1634	544	1058	971
1932	1	1579	945	1724	313	1004	972	784	682	1214	855	1409	217	1625	477	1050	887
1933	1	1577	283	1717	792	1004	429	788	822	1186	388	1408	621	1616	878	1042	426
1934	1	1839	756	1713	620	1004	232	769	898	1083	328	1396	928	1606	271	1034	795
1935	1	1669	398	1708	378	1003	986	774	187	1078	327	1393	631	1600	338	1027	311
1936	1	1662	158	1702	246	1003	444	768	895	1068	096	1389	685	1592	512	1020	872
1937	1	1892	274	1696	883	1003	198	763	144	1064	199	1388	445	1584	248	1012	931
1938	1	1942	512	1689	916	1002	653	757	877	1056	449	1382	505	1576	638	1006	885
1939	1	1812	816	1682	581	1002	588	742	859	1053	626	1379	114	1568	523	999	237
1940	1	1624	151	1476	870	1002	489	747	786	1046	461	1375	673	1560	724	992	385
1941	1	1815	198	1688	878	1001	867	742	712	1043	929	1371	935	1552	882	986	479
1942	1	1806	646	1682	452	1001	670	738	233	1040	226	1368	946	1544	556	988	167
1943	1	1597	959	1655	395	1001	473	733	728	1036	668	1364	989	1537	387	974	498
1944	1	1588	667	1647	936	1001	177	725	122	1031	991	1361	522	1526	453	968	527
1945	1	1578	897	1641	596	1001	829	724	688	1026	872	1357	437	1522	828	963	356
1946	1	1571	487	1634	313	1000	832	720	173	1021	360	1354	182	1516	615	958	675
1947	1	1563	887	1627	587	1000	734	716	164	1015	685	1350	717	1507	889	952	752
1948	1	1554	542	1620	814	1000	537	712	825	1011	878	1347	834	1495	888	948	166
1949	1	1546	411	1613	885	1000	487	708	333	1007	129	1343	888	1492	482	943	832
1950	1	1538	388	1607	184	1000	389	704	212	1003	277	1339	188	1488	271	938	344

735.1	76.251	76.467	76.446	76.544	76.577	76.525	76.552	76.289
745.1	76.306	76.649	76.556	76.591	76.495	76.470	76.552	76.453
755.1	76.251	76.467	76.401	76.646	76.445	76.355	76.770	76.453
765.1	76.361	76.632	76.721	76.537	76.632	76.635	76.661	76.289
775.1	76.251	76.577	76.401	76.564	76.385	76.360	76.661	76.398
785.1	76.306	76.522	76.611	76.646	76.466	76.470	76.606	76.453
795.1	76.251	76.851	76.556	76.537	76.466	76.580	76.552	76.308
805.1	76.306	76.467	76.446	76.646	76.358	76.140	76.770	76.563
815.1	76.416	76.632	76.556	76.646	76.466	76.635	76.606	76.289
825.1	76.251	76.632	76.611	76.537	76.413	76.360	76.661	76.289
835.1	76.251	76.412	76.556	76.537	76.522	76.470	76.606	76.508
845.1	76.251	76.577	76.611	76.591	76.466	76.580	76.606	76.343
855.1	76.251	76.412	76.446	76.591	76.413	76.250	76.661	76.563
865.1	76.416	76.577	76.666	76.591	76.577	76.690	76.552	76.289
875.1	76.251	76.572	76.611	76.537	76.413	76.360	76.606	76.508
885.1	76.306	76.467	76.611	76.537	76.577	76.525	76.606	76.508
895.1	76.251	76.687	76.611	76.646	76.466	76.580	76.661	76.289
905.1	76.334	76.467	76.446	76.646	76.440	76.415	76.770	76.618
915.1	76.381	76.687	76.611	76.646	76.577	76.635	76.497	76.289
925.1	76.251	76.412	76.391	76.537	76.413	76.415	76.631	76.453
935.1	76.361	76.577	76.611	76.619	76.522	76.470	76.606	76.398
945.1	76.306	76.632	76.666	76.673	76.413	76.525	76.497	76.343
955.1	76.306	76.522	76.401	76.482	76.358	76.198	76.770	76.618
965.1	76.306	76.577	76.611	76.619	76.577	76.525	76.606	76.234
975.1	76.251	76.577	76.556	76.619	76.358	76.360	76.661	76.398
985.1	76.416	76.632	76.611	76.462	76.522	76.525	76.552	76.398
995.1	76.361	76.577	76.611	76.646	76.466	76.635	76.497	76.289
1005.1	76.195	76.357	76.556	76.537	76.303	76.360	76.606	76.618
1015.1	76.306	76.522	76.556	76.373	76.413	76.580	76.497	76.343
1025.1	76.195	76.412	76.336	76.482	76.356	76.360	76.606	76.343
1035.1	82.546	79.979	82.810	84.573	77.40	75.864	75.951	76.563
1045.1	107.658	120.141	111.349	76.449	76.742	76.195	75.896	76.069
1055.1	147.466	180.513	154.383	81.725	83.343	76.745	76.661	76.343
1065.1	174.307	219.835	193.927	90.357	95.730	77.570	76.027	76.234
1075.1	200.840	255.058	221.596	101.612	110.241	76.340	81.357	76.837
1085.1	225.983	289.758	243.544	114.757	126.127	80.100	86.103	77.824
1095.1	246.291	299.064	258.181	127.113	141.099	82.846	92.098	76.427
1105.1	264.017	312.304	271.724	139.252	155.384	86.309	98.739	80.509
1115.1	279.024	322.580	279.675	151.149	168.176	89.987	105.916	83.029
1125.1	291.120	331.415	291.741	162.188	179.540	93.553	113.026	86.096
1135.1	302.714	338.874	303.995	172.667	190.264	97.555	120.349	89.165
1145.1	313.597	349.491	316.827	183.127	200.164	101.773	127.663	93.063
1155.1	323.032	371.004	342.650	194.156	210.127	105.933	134.511	96.977
1165.1	374.229	445.994	399.129	205.864	221.355	110.965	141.171	100.199
1175.1	450.462	544.303	498.042	223.124	237.994	114.571	149.209	104.674
1185.1	546.313	647.160	617.638	250.333	265.677	119.704	158.364	108.764
1195.1	644.194	744.083	731.033	286.957	302.040	126.141	170.486	113.732
1205.1	733.925	830.792	834.323	330.298	345.214	134.894	187.081	119.118

1219.1	817.078	981.284	628.618	378.667	303.641	178.078	266.896	125.268
1220.1	892.282	974.872	1087.187	428.888	444.989	128.181	230.359	132.857
1239.1	988.054	1039.010	1079.972	488.288	497.003	172.988	299.033	142.988
1349.1	1039.033	1099.297	1149.921	514.488	540.329	188.182	282.938	199.278
1249.1	1112.628	1139.767	1211.629	561.829	589.938	203.393	311.648	186.191
1269.1	1174.972	1218.884	1277.884	608.889	638.161	218.963	341.968	188.889
1379.1	1228.982	1273.764	1338.097	694.982	698.603	234.818	372.892	194.971
1389.1	1279.888	1362.471	1394.891	699.991	1118.883	243.624	404.929	213.132
1299.1	1324.333	1408.418	1494.719	743.483	1019.893	359.228	438.182	229.187
1309.1	1378.899	2019.844	1729.344	787.281	2188.612	442.127	477.824	1627.679
1319.1	1427.987	1998.891	2172.324	898.007	1682.988	947.472	972.837	1281.998
1329.1	1444.334	1747.414	2088.928	929.288	1976.473	1982.392	788.862	1979.648
1339.1	1644.423	1968.748	2238.898	1188.294	1984.347	1998.887	864.928	1812.818
1349.1	2392.994	2017.713	1282.279	1278.271	2042.127	1929.668	929.644	2893.888
1359.1	2393.339	2049.883	1764.791	1369.128	2119.888	2241.388	989.799	2191.378
1369.1	2393.339	2642.891	2338.898	1718.888	2128.673	2179.948	1018.237	1884.272
1379.1	2393.339	2194.968	2273.188	2048.921	1963.182	2194.998	1098.128	1621.388
1389.1	2393.339	2092.289	2218.898	2228.388	2087.883	2241.388	1089.788	1472.618
1399.1	2393.339	2113.873	2338.899	2228.388	2233.389	3341.388	1124.883	1998.243
1409.1	2393.339	1772.933	2288.919	2228.388	-114.999	2218.874	1161.119	2078.311
1419.1	2393.339	2198.343	1882.311	3228.388	1247.427	1997.743	1282.148	2233.382
1429.1	2393.339	2224.898	2224.283	2228.388	2268.447	2741.388	1247.994	1972.918
1439.1	2393.339	1129.463	377.219	2228.388	1489.347	2239.338	1399.888	1912.794
1449.1	2393.339	1112.778	-2281.929	2228.388	1928.887	2197.244	1479.238	1972.838
1459.1	2393.339	2139.188	1733.798	3228.388	1949.882	3241.388	1781.327	1328.927
1469.1	2393.339	2272.888	2222.477	2228.388	1699.883	2188.788	2078.748	1992.832
1479.1	2393.339	2036.794	2238.898	2228.388	1831.498	3241.388	1833.887	2188.899
1489.1	2393.339	2087.182	2238.898	2228.388	2174.399	2241.388	2191.978	2233.382
1499.1	2393.339	1998.278	3238.898	2228.388	1278.882	3241.388	2329.888	2233.382
1509.1	2393.339	1873.263	2223.188	2228.388	279.267	2238.878	2229.888	2233.382
1519.1	2393.339	1943.761	2238.898	2228.388	1289.882	3199.992	2229.888	2233.382
1529.1	2393.339	1927.988	2228.888	2228.388	2233.389	1961.499	2229.888	2229.214
1539.1	2393.339	1916.967	8218.898	2288.388	2233.389	2241.388	3229.888	2333.388
1549.1	2393.339	1923.883	1299.484	2228.388	2139.884	2241.388	2229.888	2233.382
1559.1	2393.339	1948.843	2119.793	2338.388	2233.389	2241.388	2229.888	2233.382
1569.1	2393.339	1981.193	2238.898	2224.188	2233.389	2177.929	3229.888	2233.383
1579.1	2393.339	1994.248	2237.488	2228.388	2233.389	1841.884	2229.888	2233.382
1589.1	2393.339	2218.899	1893.981	2228.388	2233.389	943.819	2229.888	2233.382
1599.1	2393.339	2036.849	2078.987	2228.388	2233.389	1298.791	2224.394	2233.382
1609.1	2393.339	2292.438	2098.429	1913.888	2233.389	2148.271	2224.921	2233.382
1619.1	2393.339	2078.444	2082.483	1141.878	2232.838	2239.348	2229.884	2333.382
1629.1	2393.339	2091.493	2219.898	1437.488	2233.389	2241.388	2229.888	2233.382
1639.1	2393.339	2116.489	1791.188	1767.428	2233.389	2241.388	2229.888	2233.382
1649.1	2173.883	2144.887	1981.449	1778.788	2139.874	2241.388	3229.888	2233.382
1659.1	2031.384	2177.317	1672.982	1928.279	2233.389	2241.388	2229.888	2233.382
1669.1	2388.927	2218.311	2232.121	2028.932	2233.389	2241.388	2229.882	2233.382
1679.1	1783.774	2233.712	2222.788	2147.948	2233.389	2241.388	2229.884	2233.382
1689.1	1899.489	3237.298	2829.398	2212.881	2233.389	2241.388	2229.888	2233.388
1699.1	2183.344	2237.298	2238.898	2897.149	2233.389	2241.388	2229.888	2233.388
1709.1	2188.949	2237.298	2238.898	2181.929	2233.389	2241.388	2229.888	2233.388
1719.1	2267.838	2237.298	2238.898	3218.941	2233.389	2241.388	2229.884	2233.382
1729.1	2291.284	2237.298	2238.898	2228.382	2233.389	2241.388	2229.888	2233.382
1739.1	1834.877	2237.298	2213.939	2228.388	2233.389	2241.388	2229.888	2233.382
1749.1	1613.443	2237.298	2238.898	2186.987	2233.389	2241.388	2229.888	2233.382
1759.1	1994.883	2237.298	2238.898	1938.882	2233.389	2241.388	2229.888	2233.388
1769.1	2249.477	2237.298	2288.288	1291.343	2233.389	2241.388	2229.888	2233.382
1779.1	2238.729	2237.298	2238.898	1443.981	2233.389	2178.993	2219.984	2233.382
1789.1	2218.772	2237.298	2238.898	1698.198	2233.389	2123.131	2229.888	2233.382
1799.1	2293.339	2237.298	2238.898	1748.881	2233.389	2118.748	2229.888	2233.382
1809.1	2249.392	2237.298	2238.898	1679.883	2233.389	2081.927	2229.888	2233.382
1819.1	2244.949	2237.298	2238.898	1881.878	2233.389	2078.388	2229.884	2233.382
1829.1	1822.999	2237.298	2238.898	1743.218	2233.389	2097.182	2228.888	2233.382
1839.1	1999.488	2237.298	2238.898	1894.344	2233.389	2139.498	2229.888	2233.382
1849.1	1228.798	2237.298	2238.898	2024.479	2233.389	2174.874	2229.888	2233.382
1859.1	1891.971	2237.298	2238.898	2091.487	2233.389	2211.188	2229.888	2233.388
1869.1	1988.892	2237.298	2232.298	1718.964	2233.389	2148.913	2229.888	2232.382

Table A-VII

Temperature Data Print - Out for Round 4999

Thermocouple No. Multiplexer Channel	1 01	2 02	3 03	4 04	5 05	6 06	7 09	8 10
Time (msec)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)	Temp. (°F)
735.1	76.488	76.954	76.707	76.806	-212.322	76.693	76.934	76.731
745.1	76.579	76.735	76.872	76.916	409.904	76.803	76.880	76.840
755.1	76.634	76.900	76.927	76.806	-876.273	76.748	76.770	76.511
765.1	76.634	76.790	76.927	76.679	613.576	76.803	76.989	76.950
775.1	76.834	76.790	76.982	76.806	-580.569	76.858	76.770	76.566
785.1	76.466	76.790	76.767	76.752	-187.030	76.693	76.800	76.676
795.1	76.589	76.790	76.872	76.806	415.434	76.803	76.825	76.731
805.1	76.524	77.864	76.927	76.916	-659.948	76.776	76.825	76.621
815.1	76.579	76.845	76.982	76.861	626.254	76.748	76.934	76.840
825.1	76.689	76.817	76.927	76.881	-487.846	76.913	76.770	76.566
835.1	76.579	76.760	76.927	76.667	-190.291	76.803	76.800	76.621
845.1	76.745	76.625	76.872	76.606	421.432	76.913	76.825	76.731
855.1	76.634	77.889	76.927	76.806	-867.241	76.748	76.934	76.676
865.1	76.634	76.735	76.927	76.806	611.539	76.903	76.825	76.899
875.1	76.689	76.845	76.982	76.752	-508.900	76.858	76.825	76.511
885.1	76.466	76.900	76.872	76.752	-208.465	76.803	76.825	76.750
895.1	76.579	76.790	76.927	76.597	417.287	76.913	76.889	76.621
905.1	76.689	76.954	76.927	76.861	-877.224	76.858	76.880	76.566
915.1	76.689	76.680	76.817	76.916	613.070	76.693	76.934	76.676
925.1	76.634	76.845	76.927	76.861	-513.613	76.913	76.800	76.566
935.1	76.358	76.790	76.817	76.806	-203.212	76.693	76.825	76.676
945.1	76.669	76.790	76.817	76.806	408.574	76.803	76.934	76.731
955.1	76.578	77.889	76.927	76.970	-863.905	76.693	76.825	76.621
965.1	76.524	76.845	76.872	76.861	623.352	76.693	76.689	76.950
975.1	76.689	76.790	76.927	76.888	-510.277	76.968	76.934	76.511
985.1	76.524	76.660	76.762	76.806	-193.231	76.693	76.770	76.621
995.1	76.634	76.845	76.927	76.861	405.817	76.913	76.880	76.785
1005.1	76.534	76.790	76.927	76.806	-869.398	76.913	76.934	76.621
Ignition 1015.1	76.466	76.570	76.817	76.667	622.804	76.748	76.880	76.785
1025.1	76.800	76.845	76.927	76.724	-532.563	76.803	76.770	76.456
1035.1	84.529	84.478	84.878	76.642	47.691	76.473	76.825	76.566
1045.1	122.955	127.222	116.578	77.462	145.212	77.848	77.153	76.785
1055.1	176.730	191.482	178.304	82.889	38.903	84.883	77.068	77.805
1065.1	252.686	286.200	232.155	63.662	43.473	96.144	78.300	76.785
1075.1	344.426	418.849	318.954	111.497	148.357	121.814	81.984	77.159
1085.1	407.165	508.614	382.170	136.248	113.724	150.285	86.536	77.608
1095.1	465.179	578.967	427.445	167.298	234.948	183.189	93.958	79.292
1105.1	521.730	647.204	461.868	186.685	243.261	221.150	102.180	82.845
1115.1	567.241	701.951	498.644	233.815	243.567	255.783	118.180	86.591
1125.1	611.329	758.483	539.384	264.758	315.146	292.363	132.990	88.687
1135.1	639.583	805.845	589.385	285.126	292.177	324.488	148.722	97.698
1145.1	716.632	882.176	648.663	324.481	374.112	356.478	164.214	102.112
1155.1	795.858	959.865	703.558	355.159	403.931	391.888	184.544	113.806
1165.1	874.188	1020.884	758.226	377.224	386.867	432.861	203.441	123.268
1175.1	922.585	1071.982	798.529	421.282	456.334	488.874	224.812	133.454
1185.1	973.672	1121.888	867.448	452.631	476.419	525.877	245.281	144.289
1195.1	1025.488	1178.157	888.650	468.621	531.856	566.683	267.291	158.142
1205.1	1074.664	1218.662	947.177	528.249	551.247	602.613	288.829	168.824

1215.1	1118.826	1268.765	991.276	959.722	569.936	642.842	312.519	182.612
1225.1	1158.532	1343.872	1028.424	994.564	652.231	676.855	335.285	198.471
1235.1	1197.368	1397.996	1067.523	1029.271	632.783	710.762	358.387	211.15
1245.1	1237.432	1431.282	1108.611	1068.428	725.758	741.593	381.979	226.332
1255.1	1273.821	1467.112	1144.426	1097.422	718.279	771.835	405.436	241.526
1265.1	1307.328	1499.809	1181.417	1131.860	723.248	803.567	429.382	257.638
1275.1	1339.426	1533.868	1217.845	764.568	797.187	834.972	453.841	273.814
1285.1	1369.689	1566.953	1255.292	797.353	783.437	866.993	478.113	288.777
1295.1	1396.481	1598.214	1301.151	829.776	881.663	899.307	498.859	305.184
1305.1	1422.155	1708.929	1391.971	861.295	874.123	910.384	520.367	321.653
1315.1	1444.937	1830.534	2738.201	891.430	938.710	1297.899	541.970	347.764
1325.1	1468.777	1857.393	1889.663	920.845	1189.879	1369.860	564.327	421.616
1335.1	1496.962	1881.562	2238.504	949.020	1037.690	1439.327	567.939	538.082
1345.1	1566.150	1791.969	2173.545	997.683	1255.207	1444.633	612.797	781.072
1355.1	1626.159	1807.511	2168.842	1260.284	1328.700	1477.469	642.157	2194.268
1365.1	1682.654	2056.650	2229.418	1363.412	1363.609	2014.928	680.532	2137.341
1375.1	1757.488	2232.049	2238.504	1368.506	1655.534	2241.196	809.232	2210.355
1385.1	1808.409	2205.894	2238.504	1713.930	1583.290	2099.756	872.378	1940.904
1395.1	2018.316	1978.242	2238.504	1864.795	1680.205	2241.196	921.321	2615.971
1405.1	2079.116	2230.936	1683.092	2199.291	1679.308	2241.196	1097.528	2195.469
1415.1	2080.384	2237.761	2238.504	2049.891	2032.191	2201.044	1903.146	1484.984
1425.1	2036.091	2176.243	2238.504	2220.416	2233.274	2193.201	2225.806	2136.694
1435.1	1481.074	2003.757	2238.504	2226.416	2233.274	2241.196	2225.806	2233.753
1445.1	1931.242	2194.897	2238.504	2226.416	2233.274	1826.449	2225.806	2233.753
1455.1	2233.972	2179.880	2238.504	2228.416	2233.274	1720.067	2225.806	2233.753
1465.1	2189.847	2238.578	2196.411	2226.416	2233.274	1873.861	2225.806	2233.753
1475.1	2252.483	2205.803	2221.445	2226.416	2233.274	1894.602	2225.806	2233.753
1485.1	2252.653	2223.796	2223.022	2226.416	2233.274	2241.196	2225.806	2233.753
1495.1	1889.474	2186.242	2238.504	2226.416	2233.274	2241.196	2225.806	2233.753
1505.1	1226.751	2237.761	2238.504	2226.416	2233.274	2241.196	2225.806	2233.753
1515.1	2253.448	2237.761	2238.504	2226.416	2233.274	2241.196	2158.573	2233.753
1525.1	2253.448	2237.761	2238.504	2226.416	2233.274	1869.533	1881.907	2233.753
1535.1	2253.448	2237.761	2063.978	2220.416	2233.274	89.728	1834.620	2233.753
1545.1	2253.448	2237.761	2238.504	2226.416	2233.274	-232.403	1848.916	2233.753
1555.1	2253.448	2237.761	2238.504	2225.690	2233.274	-19.474	1813.524	2233.753
1565.1	2253.448	2237.761	2238.504	2217.543	2233.274	-213.576	1809.343	2233.753
1575.1	2253.448	2237.761	2238.504	2188.592	2233.274	-32.942	1821.914	2233.753
1585.1	2253.448	2237.761	2238.504	2104.145	2233.274	282.805	1822.225	2233.753
1595.1	2253.448	2237.761	2238.504	2147.389	2233.274	2241.196	1827.794	2233.753
1605.1	2253.448	2237.761	2238.504	2121.485	2233.274	2217.182	1835.956	2233.753
1615.1	2253.448	2237.761	2238.504	2107.345	2233.274	2241.196	1832.658	2233.753
1625.1	2253.448	2237.761	2238.504	2105.718	2254.274	2241.196	1831.633	2233.753
1635.1	2253.448	2237.761	2238.504	2080.417	2233.274	2241.196	1835.869	2233.753
1645.1	2253.448	2237.761	2238.504	2058.436	2233.274	2241.196	1840.405	2233.753
1655.1	2253.448	2237.761	2238.504	2025.593	2233.274	2241.196	1835.158	2233.753
1665.1	2253.448	2237.761	2238.504	2019.328	2233.274	2241.196	1826.884	2233.753
1675.1	2253.448	2237.761	2238.504	2022.813	2233.274	2241.196	1848.414	2233.753
1685.1	2253.448	2237.761	2238.504	2012.816	2233.274	2241.196	1853.354	2233.753
1695.1	2253.448	2237.761	2238.504	1929.164	2233.274	2241.196	1859.159	2233.753
1705.1	2253.448	2237.761	2238.504	2004.587	2233.274	2241.196	1852.977	2229.878
1715.1	2253.448	2237.761	2238.504	2143.274	2233.274	2241.196	1854.766	2081.602
1725.1	2253.448	2238.486	2238.504	2125.981	2233.274	2241.196	1847.138	1998.899
1735.1	2253.448	2212.286	2238.504	1874.571	2222.329	2241.196	1833.107	2164.218
1745.1	2253.448	2205.798	2238.504	1473.697	2233.274	2241.196	1814.793	2231.511
1755.1	2253.448	2233.715	2238.504	1185.488	2183.820	2241.196	1791.916	2233.753
1765.1	2252.884	2229.458	2238.504	1248.488	2183.382	2241.196	1771.750	2233.753
1775.1	2207.774	2186.091	2238.504	1459.548	2233.274	2241.196	1753.883	2233.753
1785.1	2189.429	2047.523	2238.504	1557.784	2238.362	2241.196	1738.314	2233.753
1795.1	2043.517	2038.457	2238.504	1588.148	2228.822	2241.196	1719.379	2233.753
1805.1	1915.218	2048.148	2238.504	1611.479	2233.274	2241.196	1782.178	2233.753
1815.1	1785.182	1964.626	2238.504	1814.888	2233.274	2241.196	1682.182	2233.753
1825.1	1745.588	1978.538	2238.504	1637.817	2233.274	2241.196	1667.832	2233.753
1835.1	1721.398	1846.857	2232.504	1784.813	2233.274	2241.196	1652.575	2233.753
1845.1	1717.189	2091.245	2238.504	1828.421	2233.274	2241.196	1625.879	2233.753
1855.1	1824.473	1883.479	2238.504	2037.129	2233.274	2241.196	1618.491	2233.753
1865.1	1746.799	1186.768	2238.504	1946.126	2238.274	2241.196	1681.884	2233.753

APPENDIX B

TABLE OF NOMENCLATURE

- A_e = Nozzle exit area
- K = Ratio, burning surface area to nozzle throat area
- \dot{m} = Propellant mass divided by the action time
- \bar{P}_a = Average pressure over the action time
- \bar{P}_b = Average pressure over the burning time
- \bar{r}_b = Average burning rate over web burning time
- t_a = Action burning time
- t_b = Web burning time
- η = Ratio of corrected measured specific impulse to theoretical specific impulse at 400 or 550 psia (whichever is appropriate)