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THE EFFECTIVENESS OF ULLAGE NITROGEN-INERTING SYSTEMS AGAINST 30-mm HIGH-EXPLOSIVE INCENDIARY PROJECTILES

Final Report

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FOREWORD

This report presents the results of tests conducted at the Naval Weapons Center (NWC), China Lake, Calif., to determine the effectiveness of the use of nitrogen to produce an inert atmosphere in the fuel-tank ullage of combat aircraft and to protect the ullage from damage induced by the impact of a 30-mm high-explosive incendiary projectile. Funding for the publication of this report was provided by the Joint Technical Coordinating Group on Aircraft Survivability under AIRTASK A93-5164/008C/7W0591000.

This document was revised for technical accuracy by J. Duzan and Dr. R. L. Hoffmann. This report has been prepared for timely presentation of information, and, although care has been taken in the preparation of the technical data presented, the conclusions drawn are not necessarily final and may be subject to revision.

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13. ABSTRACT *(Maximum 200 words)*

This report presents the data and results of tests conducted at the Naval Weapons Center to evaluate the use of nitrogen in aircraft fuel tanks to produce an inert atmosphere in the ullage. The objective of these tests was to define the limits of nitrogen effectiveness against explosive reactions in a large ullage space.

Tests were conducted at simulated low, high, and ambient altitudes. Testing included the evaluation of inert atmospheres containing 9, 12, 15, and 21% oxygen and the effects of these atmospheric conditions on reactions produced by a low-energy J-57 engine igniter and a comparatively high-energy 30-mm HEI projectile. All tests were conducted in a 30-cubic-foot steel simulator. A total of 65 tests were performed, including both control and inert tests.

14. SUBJECT TERMS
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INTRODUCTION

The need to protect the fuel-tank ullage of combat aircraft from the hazards of explosion has been recognized for many years. During World War II, the French passed incoming vent air through gasoline-saturated material in an attempt to force an over-rich fuel-to-air mixture into the ullage of some of their aircraft. Engineers in the Unites States installed a system to spray fuel into the ullage of their P-40 aircraft fuel tanks for the same reason (Reference 1). Although these particular survivability enhancements performed marginally, the more modern inerting systems, including nitrogen-inerting systems, put into service since the War have performed quite well.

The current trend in aircraft survivability has been to try to decrease the vulnerability of United States aircraft by protecting them against larger, more lethal threats. Although nitrogen-inerting systems have been used to enhance aircraft survivability for many years, improvements to these systems are needed to counter the changes in threat systems.

OBJECTIVE

The tests described in this report were conducted to define the effects of the use of a nitrogen-inerting system and simulated aircraft altitude (including fuel-tank pressurization) on the pressure, or overpressure, that is generated in large-volume aircraft fuel tanks as a result of fuel-vapor combustion. The tests also provided data used to determine the maximum percentage of oxygen allowable during suppression (by nitrogen inerting) of an explosion initiated by a 30-mm high-explosive incendiary (HEI) projectile in fuel tanks with varying initial pressures. Before these tests were done, no data had existed on the 30-mm HEI's performance in generating an ullage explosion in large-volume fuel tanks.

APPROACH

Sixty-five tests were conducted during the period of June through August 1989. To limit the scope of this project, testing was conducted at three different simulated pressure-altitude conditions (low, high, and ambient) and four different percentages of oxygen (9, 12, 15, and 21%). Table 1 is a matrix of tests and indicates which threats were used for each condition.

To save wear and tear on the large-volume fuel-tank simulator from repeated firings of the 30-mm HEI projectile, which was used as an ignition source, an alternate, less severe ignition source was used for initial testing. The first tests began with ignition generated by a spark from a J-57 engine igniter; in later tests ignition was generated by the 30-mm HEI. The fuel-tank simulator was designed to minimize venting of the overpressure, to withstand repeated vapor explosions and HEI blasts, and to contain blast fragmentation.

TABLE 1. Test Conditions and Threats Used.

Test altitude, psia	J-57 engine igniter	30-mm HEI
	Oxygen, %	
Low, 15.7	21 15 12	21 15 12 9
Ambient [a], 13.8	21 15 12	21 12
High, 8.4	21 15 12	21 12 9

[a] The ambient altitude, or condition, existing at NWC's Weapons Survivability Laboratory at the time of the test.

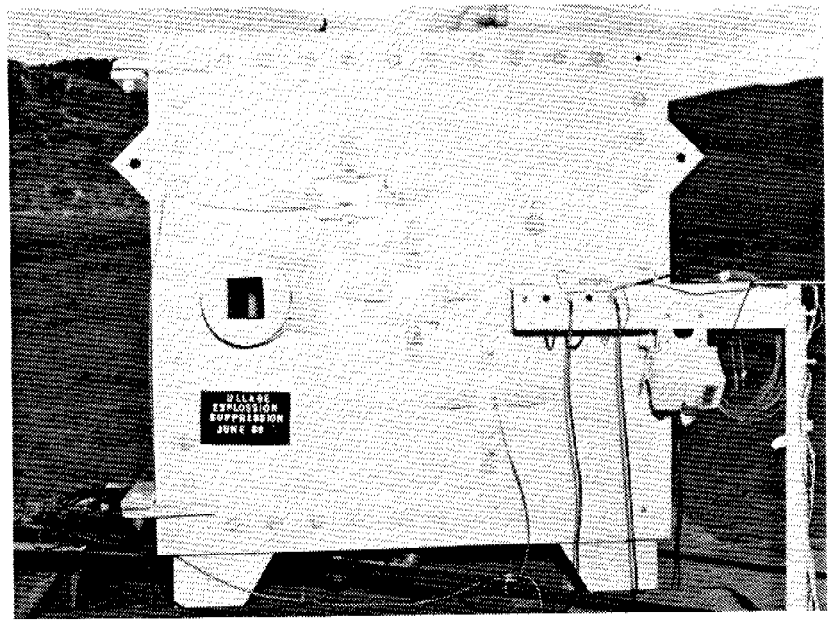
Test Equipment

Simulator. The fuel-tank simulator used during testing was constructed of 2-inch-thick steel plate to ensure the integrity of the structure during repetitive explosion testing. The simulator was rectangular in shape; its internal dimensions were approximately 40 by 40 by 32 inches. The total ullage volume was approximately 30 cubic feet. The projectile impact point was a 4- by 4-inch access port in the center of the simulator's front face (Figure 1a); this port was covered by a 1/8-inch-thick aluminum panel. The two other access ports on the front face of the simulator accommodated 5- by 5-inch Panaflo fans (Figure 1b) to ensure a homogeneous fuel-to-air mixture in the simulator.

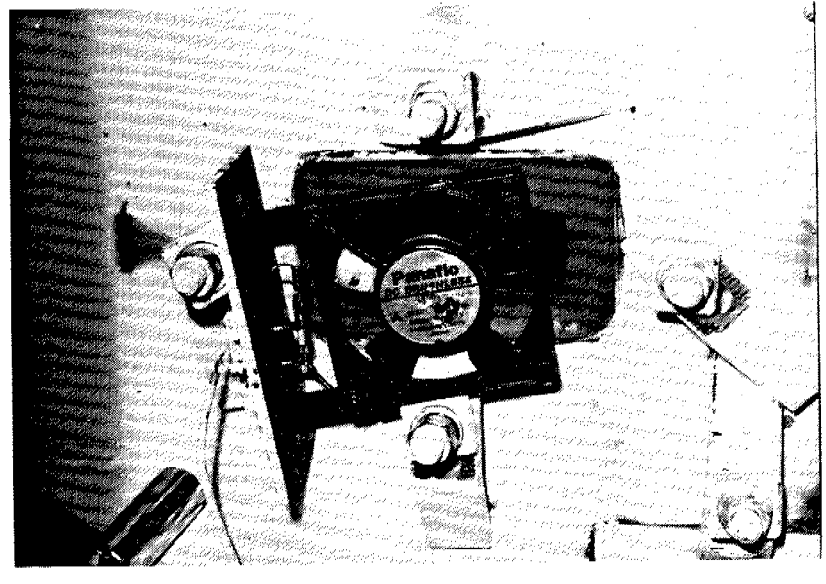
Ignition Sources. The two different ignition sources used during the tests were the 30 X 155B Fragmentation-High Explosive Incendiary (Frag-HEI) Soviet projectile (30-mm HEI) and a J-57 engine igniter. The J-57 engine igniter produces a spark from a capacitance discharge of 19 joules of energy.

Explosive Mixture. A guaranteed explosive mixture was a necessity for testing. The explosive mixture was generated using a simulated JP-4 fuel vapor, designated JP-4S (Reference 2). The JP-4S was produced by Monsanto Co., St. Louis, Mo.

A number of JP-4 samples were obtained from various fuel lots across the United States. The vapor emitted from each sample of JP-4 at 70°F was collected and analyzed using gas chromatography. From this analysis, the 15 most prevalent hydrocarbons



(a) Front face of simulator.



(b) Panaflo fans.

FIGURE 1. Fuel-Tank Simulator.

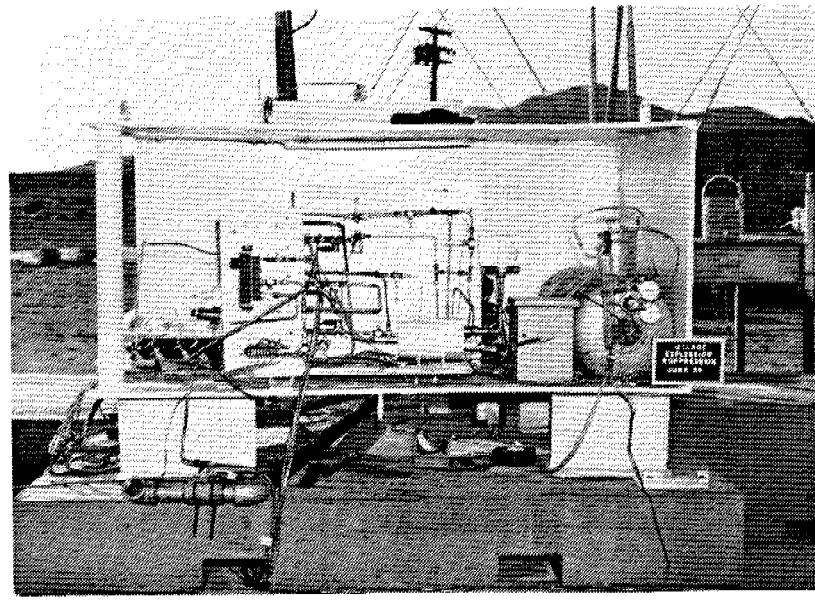
were selected and averaged to obtain a "standard" mixture.

This standard mixture was introduced into the ullage of the simulator to produce a fuel-to-air ratio that was 3% by volume. This percentage is slightly rich; a stoichiometric mix is 2.39% by volume but generates the highest overpressure.

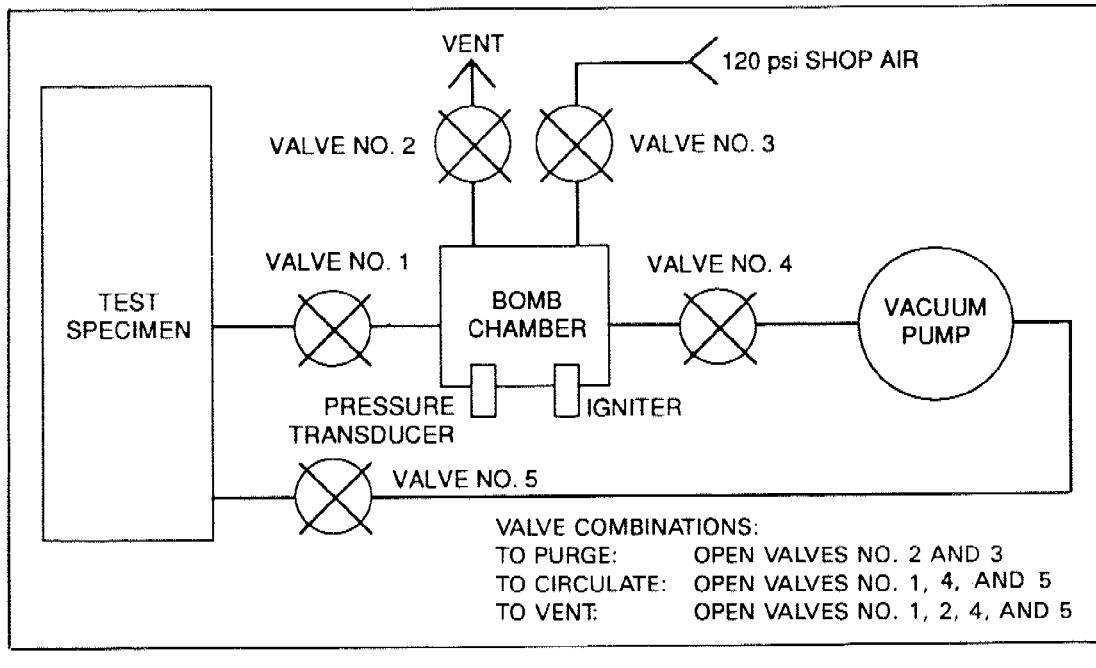
Bomb-Sampling System. A bomb-sampling system (Figure 2) was used before each test to confirm that an explosive mixture was present in the ullage. The bomb-sampling system consists of a cylindrical bomb chamber, a vacuum pump that circulates the ullage vapors between the bomb chamber and the ullage, the ignition source, and various valves for isolating the bomb chamber during ignition. Shop air was used to purge the bomb chamber after a successful explosion so that the products of combustion were not pumped into the simulator.

Nitrogen and Air. Bottled nitrogen was used when required to produce an inert atmosphere in the fuel-tank simulator. Clean (filtered) and dried shop air was used for the air source. The amount of nitrogen or air required for a given set of test conditions was determined by application of the ideal gas law. For each type of gas, the pressure of the ullage was adjusted to obtain the correct fuel-to-air mixture. For tests simulating high-altitude operation, an air-driven venturi vacuum pump was used to reduce the ullage pressure.

Instrumentation. The instrumentation used to record data during testing consisted of five Model 218 pressure transducers from Viatran Corp., Grand Island, N.Y., and five type K thermocouples. A BioMarine Model 225R oxygen meter was used to measure the oxygen content of the ullage gases. Table 2 lists the types and locations of the instrumentation used during testing. Figure 3 shows the locations of the test instrumentation on the fuel-tank simulator.



(a) Bomb-sampling system and JP-4S test setup.



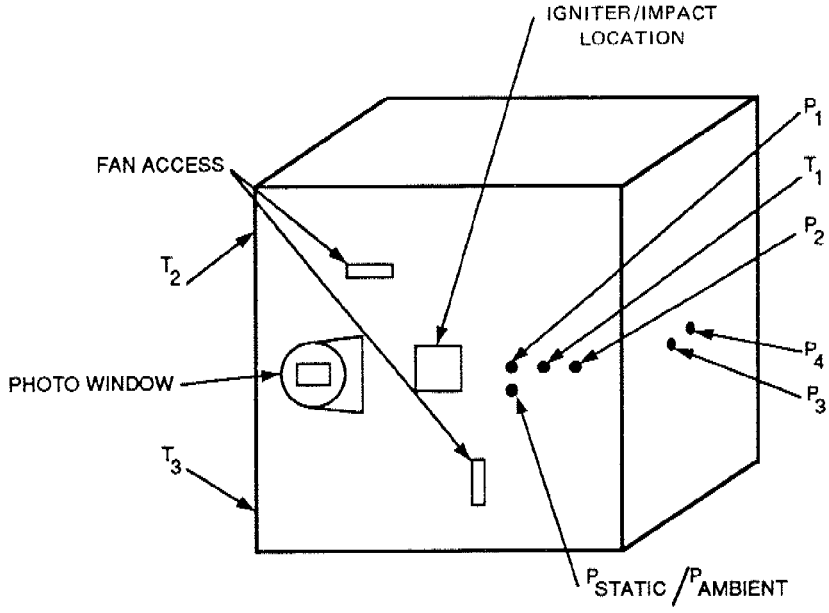
(b) System diagram.

FIGURE 2. Bomb-Sampling System.

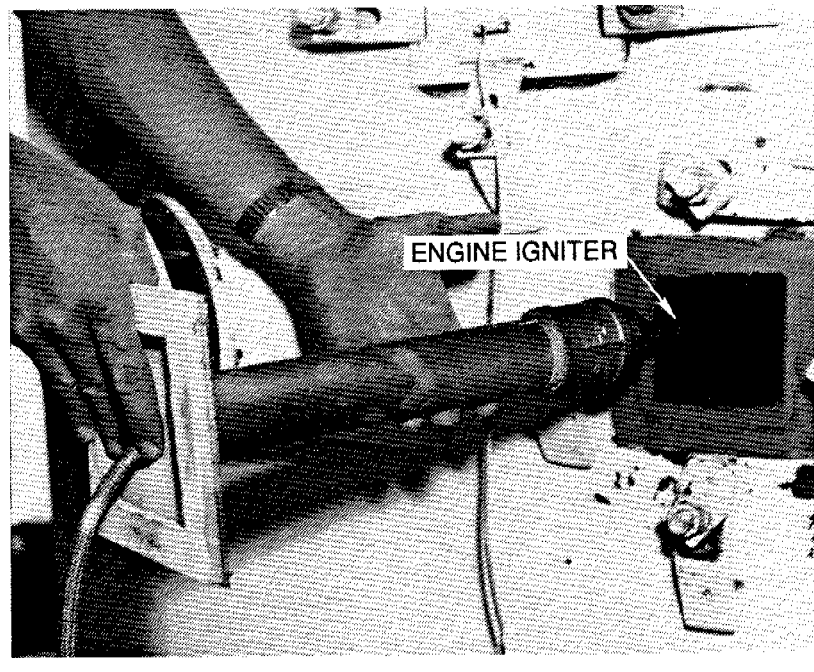
TABLE 2. Types and Locations of Test Instrumentation.

Temperature transducer, designation	Description	Location
T_1	Type K	Front face of simulator
T_2	Type K	Left side (top) of simulator
T_3	Type K	Left side (bottom) of simulator
T_4	Type K	Bomb-sampling system
T_5	Type K	Test area [a]
Pressure transducer, designation		
P_1	Viatran (psig)	Front face (left) of simulator
P_2	Viatran (psig)	Front face (left) of simulator
P_3	Viatran (psig)	Right side (front) of simulator
P_4	Viatran (psig)	Right side (back) of simulator
P_{STATIC}	Viatran (psia)	Front face (far right) of simulator
$P_{AMBIENT}$	Same as P_{STATIC}	The same transducer as P_{STATIC}; in the ambient mode, the transducer was vented to the atmosphere

[a] T_5 was used to measure the ambient temperature.



(a) Fuel-tank simulator.



(b) Engine igniter.

FIGURE 3. Test Instrumentation.

TEST PROCEDURES

Variations of two test procedures were used in this series of tests. The two basic test procedures were "baseline" tests (tests conducted at 21% oxygen with simulated fuel vapors present) and "inert" tests (tests conducted at less than 21% oxygen with simulated fuel vapors present). Additionally, seven "quasi-static" tests (tests conducted at 21% oxygen with no simulated fuel vapors present) were conducted. The quasi-static tests measured the overpressure contribution of the ignition source alone; only the 30-mm HEI threat was tested in this manner.

For each of the two basic test procedures, tests were performed at three different simulated pressure-altitude conditions (low, high, and ambient). The low-altitude tests were conducted at 15.7 pounds per square inch absolute pressure (psia), and the high-altitude tests were conducted at 8.4 psia. The ambient-condition tests were conducted at the ambient pressure at the time of the test, which was about 13.8 psia.

The J-57 engine igniter was first used as the ignition source beginning at 21% oxygen. The oxygen content was then lowered in increments from 21, to 15, to 12, and then to 9% until no reaction/overpressure was measured. These steps were repeated at all three pressure-altitude conditions. Testing was then continued, using the 30-mm HEI as the ignition source, from the no-reaction or -overpressure points measured using the J-57 engine igniter to determine if the HEI would generate any reaction/overpressure. If a reaction was generated, the ullage nitrogen content was increased until no reaction occurred using the 30-mm HEI.

BASELINE TESTS

The first step of each baseline test was to generate an explosive mixture using the JP-4S, regardless of test altitude. Using a form of the ideal gas law, the amount of JP-4S was calculated to be 3% by volume for the given amount of air. The ullage was then sampled and tested using the bomb-sampling system to confirm an explosive mixture. The proper initial pressure was then set, and the firing of the J-57 engine igniter or 30-mm HEI was initiated.

Once the proper fuel-to-air mixture was achieved, a reduction in the total pressure in the fuel-tank simulator did not change the ratios of the mixture. Thus, when high-altitude tests were being conducted, the vacuum pump was used to reduce the pressure in the simulator before the J-57 engine igniter or 30-mm HEI firing was initiated.

INERT TESTS

The first step of each inert test was to add nitrogen to raise the pressure in the simulator to a level calculated to achieve an inert atmosphere of 15, 12, or 9% oxygen. The oxygen percentage was then confirmed by venting the simulator slowly and measuring the oxygen concentration using an oxygen sensor at the venting point. Next, the JP-4S was added to create an explosive fuel-to-air mixture, taking into account the

reduced amount of oxygen. Finally, prior to initiating the J-57 engine igniter or firing the 30-mm HEI, the simulator pressure was adjusted to replicate the desired altitude condition.

TEST RESULTS

Table 3 lists the tests in the order in which they were conducted and lists the conditions for each test.

The data sheets from each test were filled out by the test engineer and are presented in Appendix A. The comments at the bottom of each data sheet are preliminary thoughts written by the test engineer before a review of the data; these comments should not be considered as final conclusions or recommendations.

The pressure traces from each of the four pressure transducers used during each test where overpressures were recorded are included in Appendix B.

DISCUSSION

Explosions produced from hydrocarbon vapors combined with oxygen, or air, are typically two-stage, free-radical, branched-chain reactions. During the first stage of the two-stage explosion, a bluish flame propagates throughout the gas mixture and produces many different, highly reactive free radicals. This first stage of the reaction then terminates in an explosion (the second stage), which is quite violent. During the second stage, the free radicals react with one another, producing the stable molecules that are the products of combustion. The increase in pressure associated with the first stage of combustion is on the order of 1 pound per square inch, and the increase associated with the second stage of combustion is on the order of many tens of pounds per square inch (References 3, 4, and 5).

The exact reaction a hydrocarbon gas will undergo is somewhat dependent on the ignition source, all other variables (i.e., fuel-to-air ratio, initial pressure, and initial temperature) being constant. If an ignition source such as the spark produced by the J-57 engine igniter is used, the spark produces a seed of free radicals, which in turn produces a blue flame front that propagates throughout the gas mixture. In the wake of the first stage, the mixture transitions to the second stage of combustion and accelerates rapidly to explosion. If an ignition source such as the 30-mm HEI is used, the ignition source is so large and so intense that it tends not to initiate a two-stage reaction. Instead, the mixture reacts violently and directly produces the products of combustion (References 3, 4, and 5).

In tests 17 through 22, too much JP-4S was injected into the simulator, resulting in a mixture that was too rich. This overly rich fuel-to-air mixture, which was much greater than 3% by volume, had two effects on the test results. Either no combustion reaction took place, as in tests 20 and 21, or a slow, rich burning occurred, as can be seen from the pressure traces of tests 17, 18, 19, and 22. The data from test 18 exhibit the most pronounced slow-burning reaction. Figure 4 is a photograph taken from the

TABLE 3. Quasi-Static, Baseline, and Inert Tests and Conditions.

Test no.	Ignition source	Type of test	Condition [a]	Oxygen, %
1	30-mm HEI	Quasi-static	Low altitude	21
2	30-mm HEI	Quasi-static	Low altitude	21
3	30-mm HEI	Quasi-static	Low altitude	21
4	30-mm HEI	Quasi-static	Ambient	21
5	30-mm HEI	Quasi-static	Ambient	21
6	30-mm HEI	Quasi-static	High altitude	21
7	30-mm HEI	Quasi-static	High altitude	21
8	30-mm HEI	Baseline	Ambient	21
9	30-mm HEI	Baseline	Low altitude	21
10	30-mm HEI	Baseline	High altitude	21
11	30-mm HEI	Baseline	Ambient	21
12	30-mm HEI	Baseline	Low altitude	21
13	30-mm HEI	Baseline	High altitude	21
14	Spark [b]	Baseline	Ambient	21
15	Spark	Baseline	Ambient	21
16	Spark	Baseline	Ambient	21
17	Spark	Inert (too rich)	Ambient	15
18	Spark	Inert (too rich)	Ambient	15
19	Spark	Inert (too rich)	Ambient	15
20	Spark	Inert (too rich)	Ambient	12
21	Spark	Inert (too rich)	Ambient	12
22	Spark	Inert (too rich)	Ambient	15
23	Spark	Baseline	High altitude	21
24	Spark	Inert	Ambient	12
25	Spark	Baseline	High altitude	21
26	Spark	Baseline	High altitude	21
27	Spark	Inert	High altitude	15
28	Spark	Inert	High altitude	15
29	Spark	Inert	High altitude	15
30	Spark	Inert	High altitude	12

[a] Other test conditions (fuel-tank pressure, temperature, and oxygen percentage, for example) are listed on the test data sheets in Appendix A.

[b] A spark from the J-57 engine igniter was used as the ignition source.

TABLE 3. (Contd.)

Test no.	Ignition source	Type of test	Condition [a]	Oxygen, %
31	Spark	Inert	High altitude	12
32	Spark	Inert	High altitude	12
33	Spark	Inert	High altitude	9
34	Spark	Baseline	Low altitude	21
35	Spark	Baseline	Low altitude	21
36	Spark	Baseline	Low altitude	21
37	Spark	Inert	Low altitude	15
38	Spark	Inert	Low altitude	15
39	Spark	Inert	Low altitude	15
40	Spark	Inert	Low altitude	12
41	Spark	Inert	Low altitude	12
42	Spark	Baseline	High altitude	21
43	Spark	Inert	High altitude	15
44	Spark	Inert	High altitude	12
45	Spark	Baseline	High altitude	21
46	Spark	Inert	High altitude	15
47	Spark	Inert	High altitude	12
48	30-mm HEI	Inert	High altitude	9
49	30-mm HEI	Inert	High altitude	9
50	30-mm HEI	Inert	High altitude	9
51	30-mm HEI	Inert	Ambient	12
52	30-mm HEI	Inert	Ambient	12
53	30-mm HEI	Inert	Ambient	12
54	30-mm HEI	Inert	Low altitude	12
55	30-mm HEI	Inert	Low altitude	12
56	30-mm HEI	Inert	Low altitude	12
57	30-mm HEI	Inert	High altitude	12
58	30-mm HEI	Inert	Low altitude	15
59	30-mm HEI	Inert	Low altitude	9
60	30-mm HEI	Inert	Low altitude	9
61	30-mm HEI	Inert	Low altitude	9
62	30-mm HEI	Inert	Low altitude	15
63	30-mm HEI	Inert	High altitude	12
64	30-mm HEI	Inert	High altitude	12
65	30-mm HEI	Inert	Low altitude	15

high-speed film used to record the test reactions. Figure 5 is the pressure trace from test 18, which was conducted at ambient pressure with 15% oxygen. A spark from the J-57 engine was used as the ignition source, and the initial pressure in the simulator was 13.9 psia.

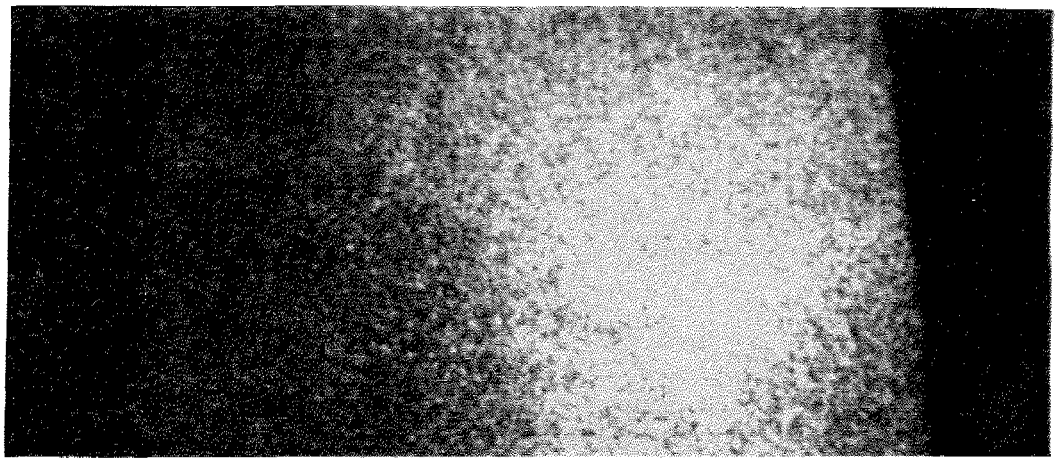


FIGURE 4. The Slow, Rich Burning Reaction of Test 18. This photo was taken seconds after the initiation of combustion.

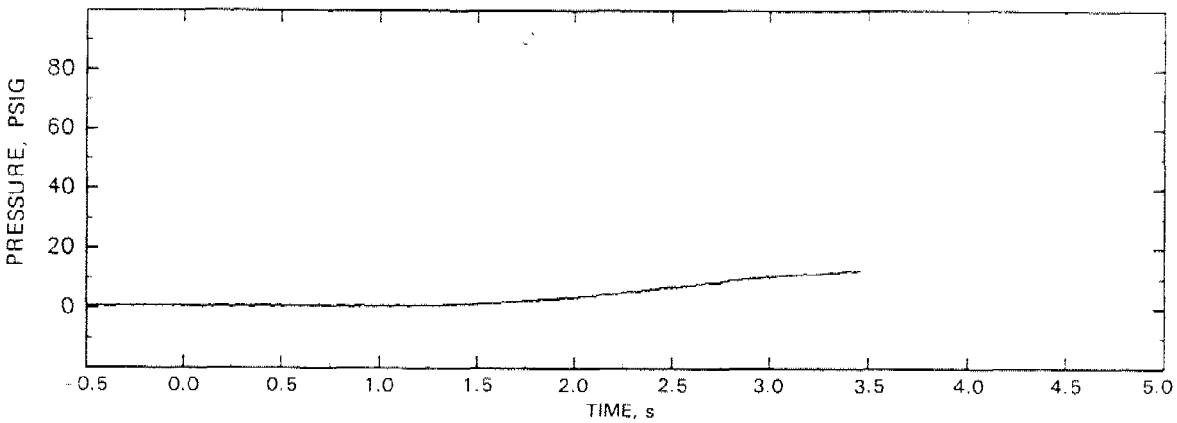
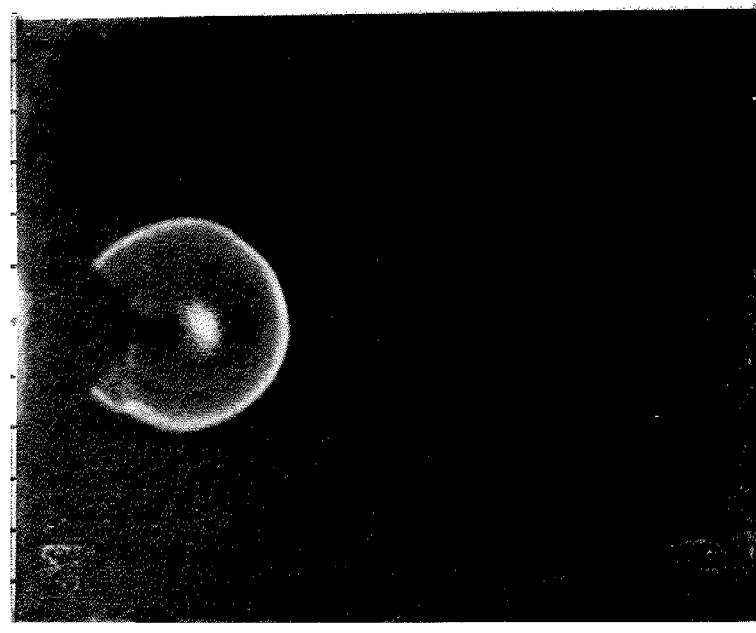
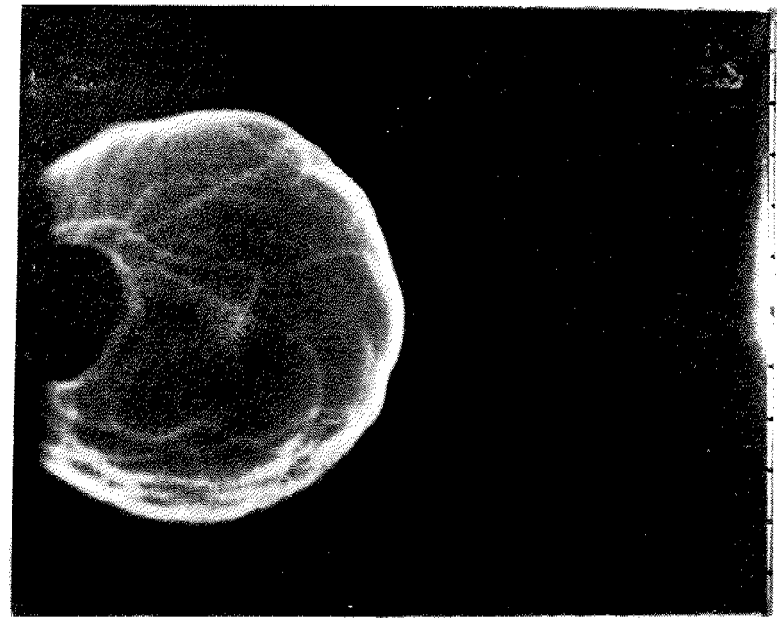


FIGURE 5. Pressure Versus Time As Recorded by Pressure Transducer P_2 During Test 18.

Test 45 provided the best photo record of the spark-ignited, two-stage, free-radical, branched-chain reaction. Figure 6 presents selected frames from the high-speed film record. Test 45 was conducted at a simulated high altitude, with a pressure of 8.4 psia and 21% oxygen. The flame velocity of the first stage of burning was measured from film to be 11 ft/s. Figure 7 is the pressure trace from Test 45.



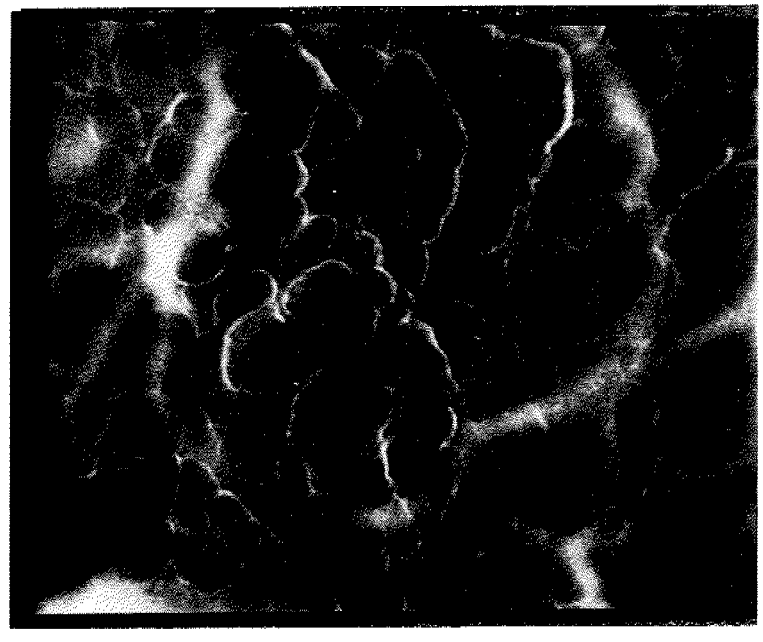
(a) 0.015 s after ignition.



(b) 0.0305 s after ignition.

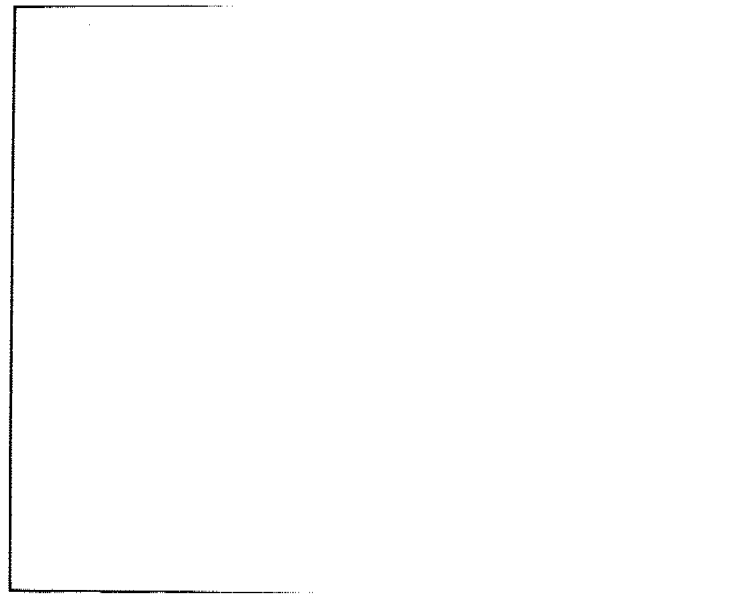
FIGURE 6. Selected Frames From the Combustion Reaction of Test 45.

(c) 0.0725 s after ignition.

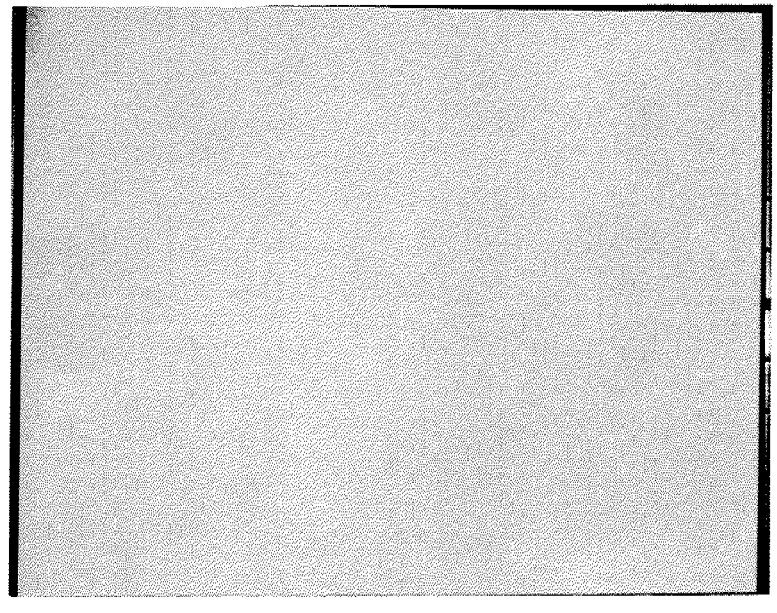


(d) 0.1175 s after ignition.

FIGURE 6. (Contd.)



(e) 0.2075 s after ignition.



(f) 0.375 s after ignition.

FIGURE 6. (Contd.)

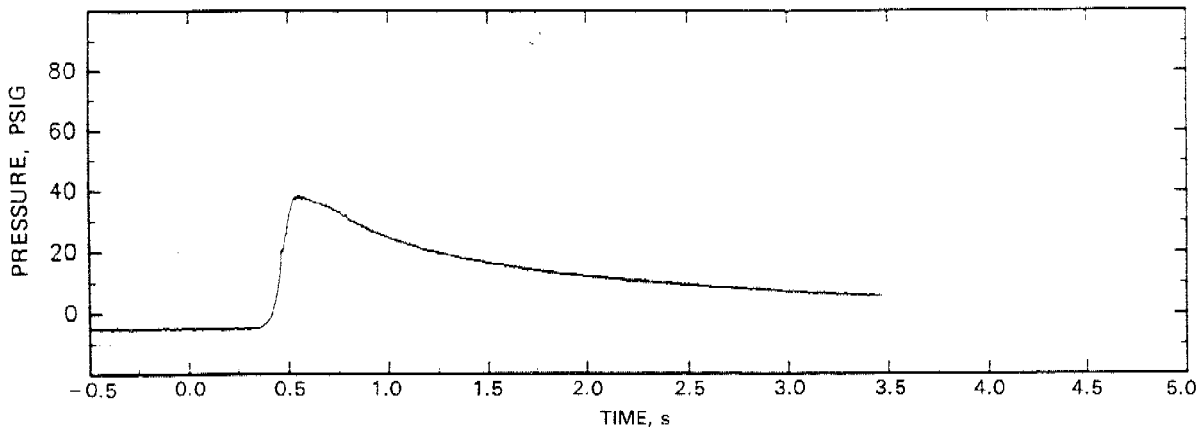


FIGURE 7. Pressure Versus Time History as Recorded by Pressure Transducer P_2 During Test 45.

In the high-speed photo record of Test 58, the 30-mm HEI projectile is seen to detonate and then the explosive reaction dies out, followed by the development of a violent explosion. The cause for the delay in the ignition of the gases is unknown but the pressure record shown in Figure 8 agrees with the visual observation. Test 58 was conducted at a simulated low altitude, with a pressure of 15.7 psia and 15% oxygen.

Figure 9 presents the pressures generated during quasi-static testing (tests 2 through 7). The 30-mm HEI projectile was used as the ignition source, and the simulator contained 21% oxygen. There was no explosive mixture to contribute to the pressure. Each pressure trace was generated by averaging all of the data from the pressure transducers for all the tests at the given condition. All of the following pressure traces (Figures 9 through 17) were generated using this averaging method.

Figure 10 presents the pressures generated during baseline testing (tests 8 through 13). The 30-mm HEI projectile was used as an ignition source for the fuel vapors, and the simulator contained 21% oxygen. A comparison of Figures 9 and 10 demonstrates that the severity of the combustion reaction is significantly increased when fuel vapor is present. The contribution of the fuel vapor to the combustion reaction resulted in peak pressure increases from 38 to 96%, depending on the initial fuel-tank pressure. This peak-pressure trend with relation to initial pressure is noticeable in all of the pressure traces. (The ratio of peak pressure to initial pressure is a function of initial pressure, available oxygen, energy released by the reaction, and the amount of venting of the simulator.)

Figure 11 presents the pressures generated during baseline testing in which a spark from the J-57 engine igniter was used as the ignition source for the fuel vapors (tests 14, 15, 16, 23, 25, 34, 35, 36, 42, and 45). The mixture in the simulator contained 21% oxygen.

Two features are evident in the pressure traces of these baseline tests. The first feature is a delay in the initiation of the pressure rise as compared to the tests in which a 30-mm HEI projectile was used. The two contributors to this delay are the spark, which is generated by a capacitance discharge (approximately two-tenths to one quarter of a

second must pass before the capacitors are sufficiently charged to make the first discharge), and the dwell time (length of time that the first-stage reaction persisted) of the first stage of combustion. For this test setup and initial conditions, the dwell time was measured from film records to be anywhere from 150 to 688 milliseconds (ms). Even though a pressure rise is associated with the first stage of combustion, the instrumentation used in this test was not scaled to enable the measuring of the first stage's dwell time and pressure.

The second feature evident in the pressure traces is the change in the slope of the curves where the peak pressure increases above 60 psig. This slope change is a direct result of the inability of the simulator to contain the pressure at those levels and was evident during testing when "smoke" was observed and "hissing" was heard from the simulator; this leakage naturally resulted in the measurement of a lower peak pressure.

Peak pressures were found to be greater in the J-57 engine igniter baseline tests than in the 30-mm HEI baseline tests. This difference in the peak pressures can be attributed to the lack of an entrance hole from a projectile in the J-57 engine igniter tests. The hole made by a projectile allows a significant amount of venting to occur. (The difference in peak pressures is noticable when figures 10 and 11, 12 and 13, and 14 and 15 are compared.)

Figure 12 shows the pressures generated during baseline and inert testing at low altitude using the 30-mm HEI projectile as the ignition source (tests 9, 12, 54, 55, 56, 58, 59, 60, 61, 62, and 65). Note that in the low-altitude condition, the reduction of oxygen to 12% and below greatly affects the pressure generated by the explosion. The reduction in pressure at these conditions is greater than 79% of the pressure generated in the baseline condition. Notice also that the peak pressure at 9 and 12% oxygen (inert condition) is less than the pressure at 21% oxygen (quasi-static condition). These results indicate that the use of nitrogen to produce an inert atmosphere in the ullage not only reduces the force of the fuel-air explosion, but also reduces the damaging high pressure generated by the projectile's high explosive.

For the low-altitude tests (tests 34 through 39) in which the J-57 engine igniter was used as the ignition source (Figure 13), the peak pressures were quite high because of the lack of projectile damage that would allow venting. No reaction was measured at 12% oxygen and below. Note the trend of reduced peak pressure as a result of reduced oxygen for the inert condition.

Reductions in peak pressure also occurred during baseline and inert high-altitude tests (tests 10, 13, 48, 49, 50, 57, 63, and 64) in which the 30-mm HEI projectile was used as the ignition source (Figure 14). At 12% oxygen, the reduction in peak pressure is 41% of the pressure generated at 21% oxygen; at 9% oxygen, the reduction in peak pressure is 71%. While these percentages do not reflect as dramatic a reduction in peak pressure as shown in Figure 12, the reduction is still quite significant. Note that the effect of air rushing into the hole made by the 30-mm HEI projectile, which occurred because the pressure inside the simulator was below ambient pressure, was not compensated for during these tests and thus contributes to the pressure rise. Figure 15 presents the results of inert tests at high altitude using a spark from the J-57 engine igniter as the ignition source (tests 23, 25, 27, 28, 29, 30, 31, 32, 42, 43, 44, 45, 46, and 47). No reaction was measured at 9% oxygen for the high-altitude

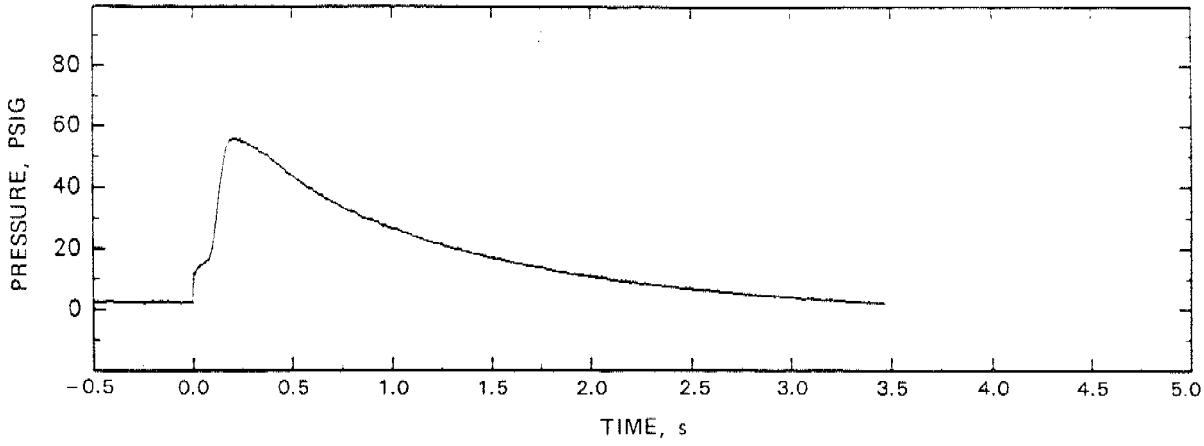


FIGURE 8. Pressure Versus Time as Recorded by Pressure Transducer P_2 During Test 58.

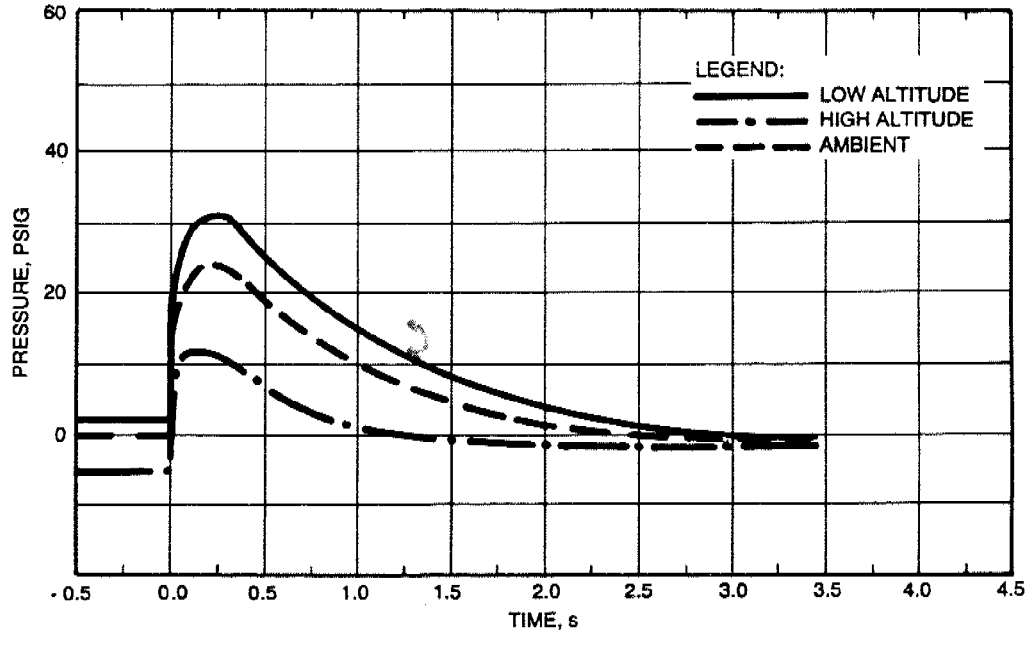


FIGURE 9. Pressures Generated During Quasi-Static Testing Using the 30-mm HEI Projectile as the Ignition Source. The mixture in the simulator contained 21% oxygen and no fuel vapors.

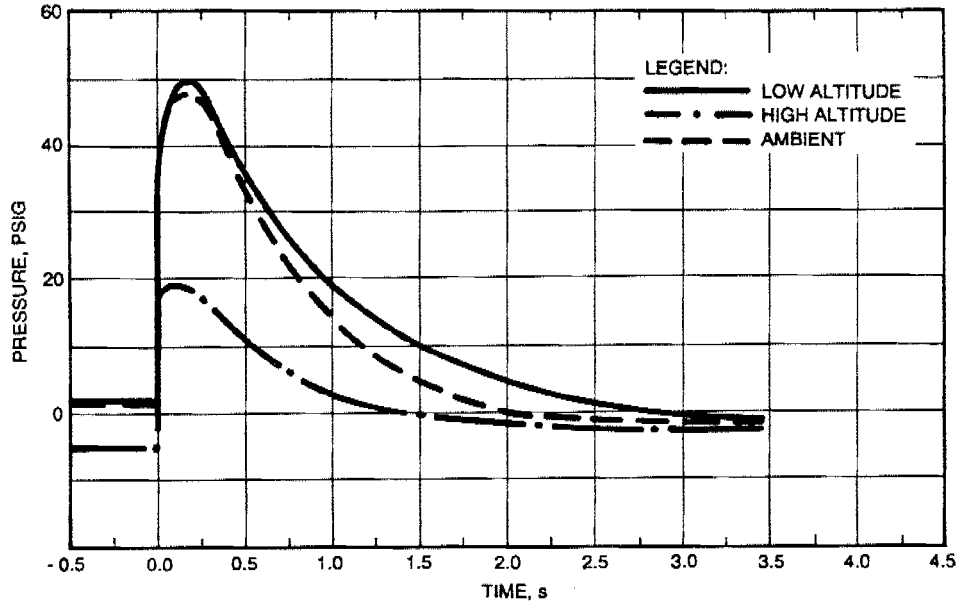


FIGURE 10. Pressures Generated During Baseline Testing Using the 30-mm HEI Projectile as the Ignition Source. The mixture in the ullage simulator contained 21% oxygen in addition to fuel vapors.

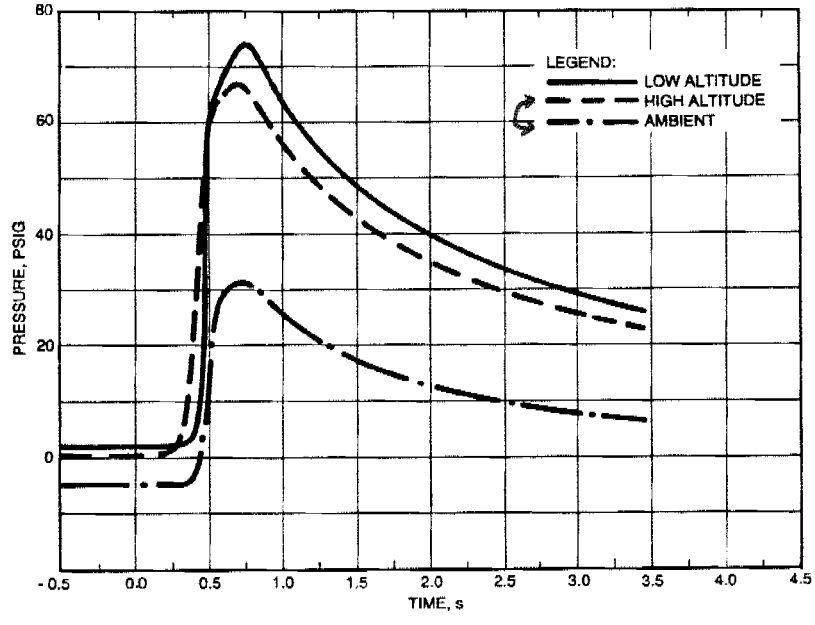


FIGURE 11. Pressures Generated During Baseline Testing Using the J-57 Engine Igniter as the Ignition Source. The mixture in the ullage simulator contained 21% oxygen in addition to fuel vapors.

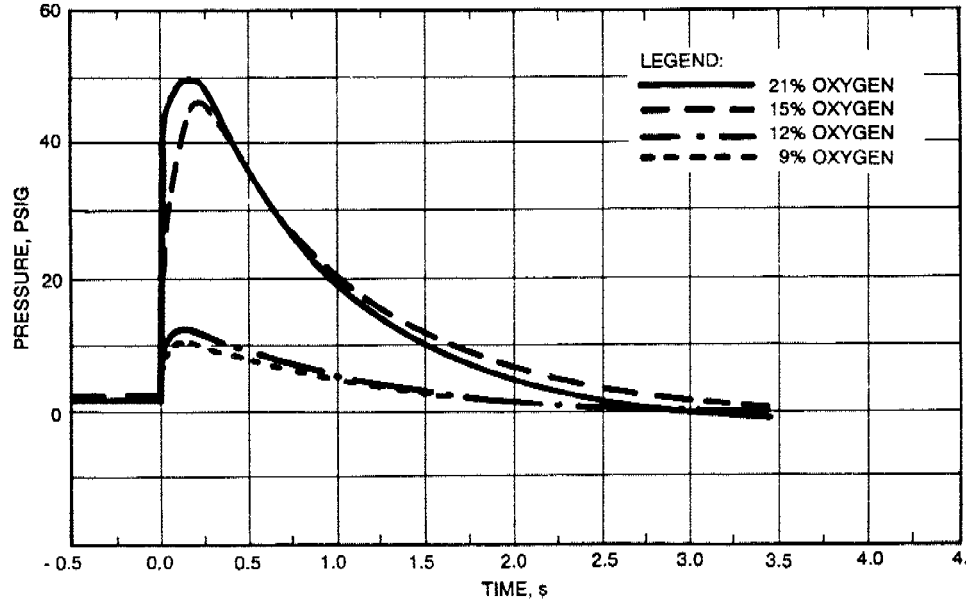


Figure 12. Pressures Generated During Baseline and Inert at a Simulated Low Altitude Using the 30-mm HEI Projectile as the Ignition Source. Oxygen percentages of 9, 12, and 15% indicate the inert condition, and an oxygen percentage of 21% indicates the baseline condition.

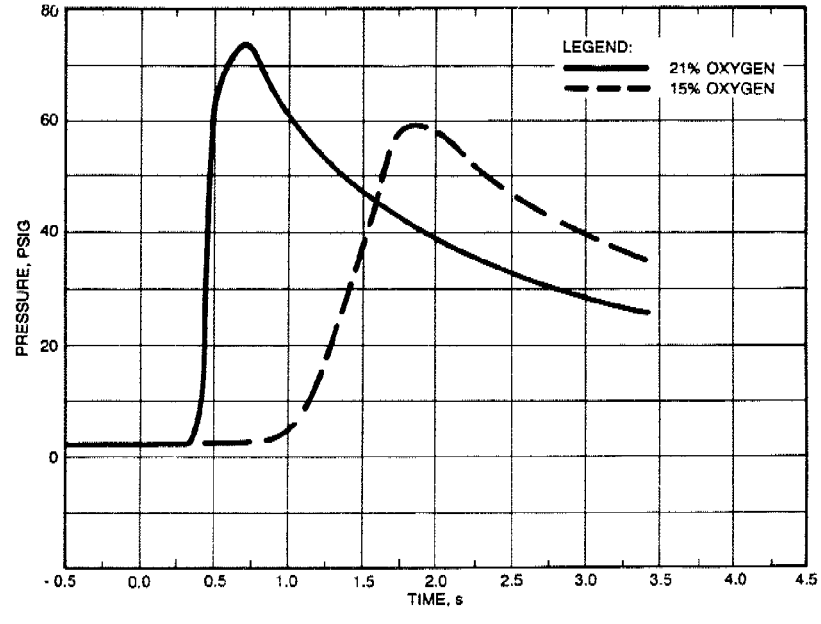


FIGURE 13. Pressures Generated During Baseline and Inert Testing at Low Altitude Using the J-57 Engine Igniter as the Ignition Source.

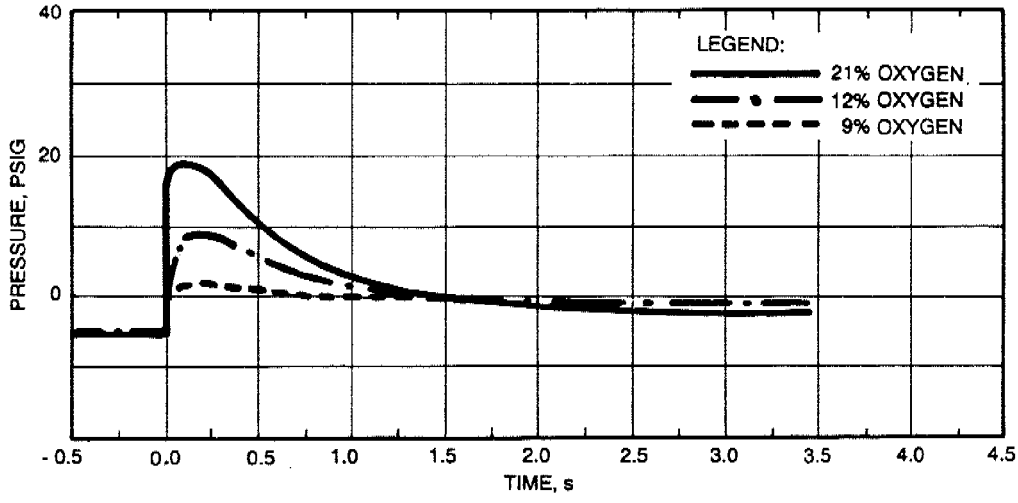


FIGURE 14. Pressures Generated During Baseline and Inert Testing at a Simulated High Altitude Using the 30-mm HEI Projectile as the Ignition Source.

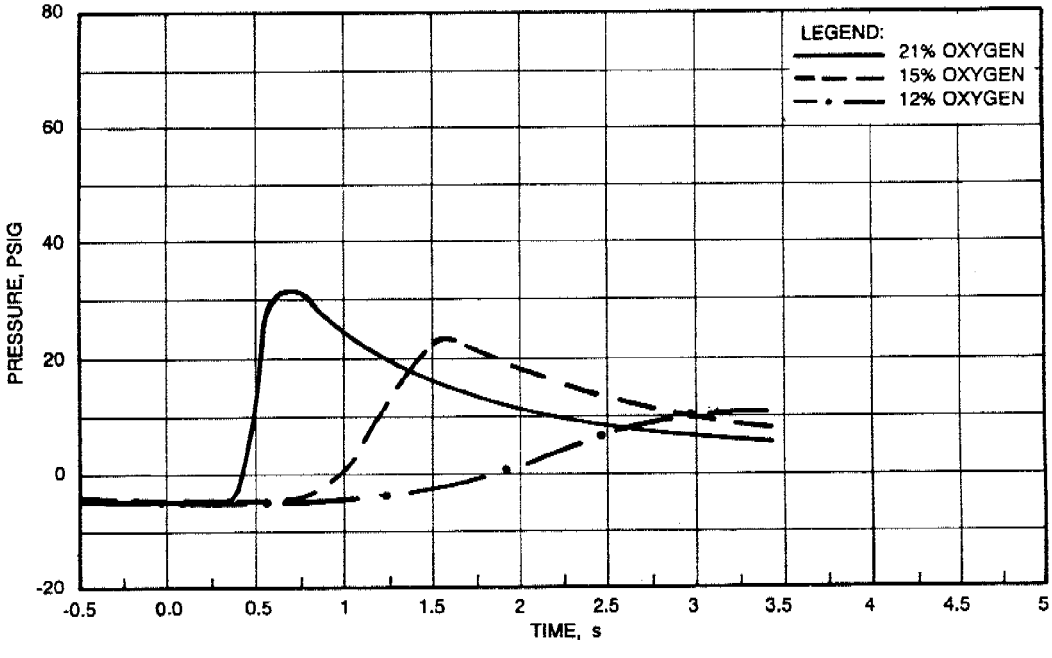


FIGURE 15. Pressures Generated During Baseline and Inert Testing at a Simulated High Altitude Using the J-57 Engine Igniter as the Ignition Source.

condition. Figure 15 shows that, as the inert atmosphere increases, the relative violence of the reaction decreases. This fact is evident in the pressure traces, where the rates at which the pressures rise become longer. A decrease in the rate of pressure rise tends to reduce the damage inflicted (Reference 6).

Notice that, while a reaction occurred at high altitude and 12% oxygen, no reaction occurred at low altitude and 12% oxygen (Figure 13). These results are contrary to the data presented in Figure 3-6 of Reference 7. Unfortunately, at the time of this writing the authors have no explanation for this discrepancy.

The results of inert tests at ambient conditions (tests 8, 11, 51, 52, and 53) using the 30-mm HEI projectile as the ignition source for the fuel vapors (Figure 16) are very similar to the results of the low-altitude test. The reduction in peak pressure at 12% oxygen is 80%. As in Figure 12, note that at 12% oxygen the peak pressure was reduced below that of the quasi-static tests at the ambient condition.

The results of the J-57 engine igniter tests (tests 14, 15, 16, 17, 18, 19, and 22) at ambient conditions (Figure 17) are also similar to the low-altitude J-57 engine igniter tests. Tests at ambient conditions with 12% oxygen were conducted but are not presented in this figure because they were conducted in a fuel-rich condition (i.e., the fuel-to-air mixture was much greater than 3% by volume).

Final results of the tests are presented in Figures 18 and 19. These figures show the average of the measured peak pressures versus the oxygen percent. It is important to

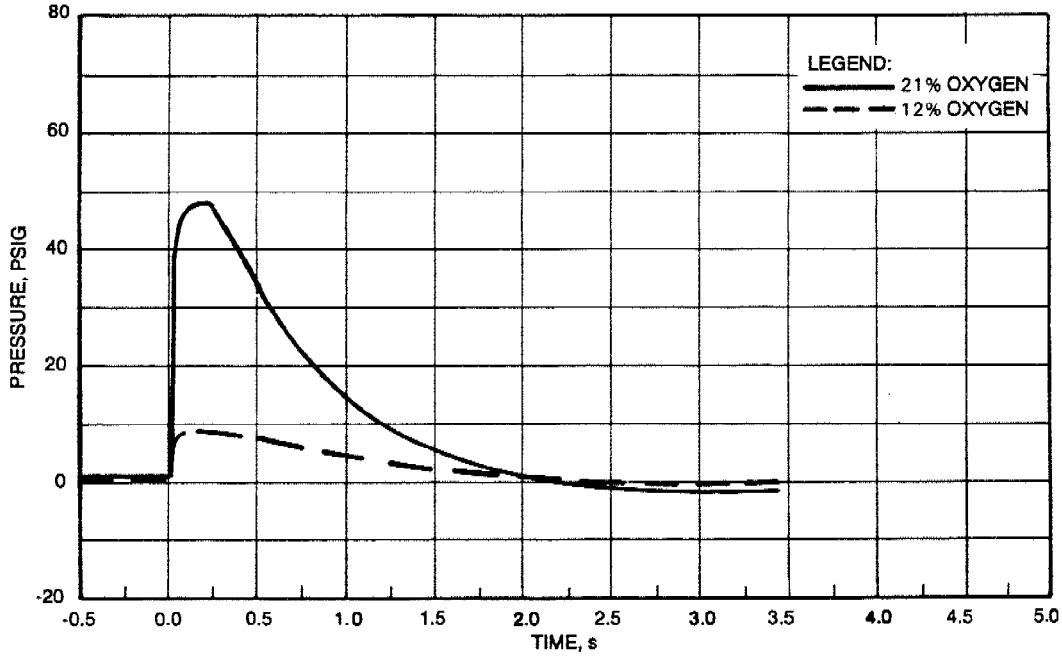


FIGURE 16. Pressures Generated During Baseline and Inert Testing at Ambient Conditions Using the 30-mm HEI Projectile as the Ignition Source.

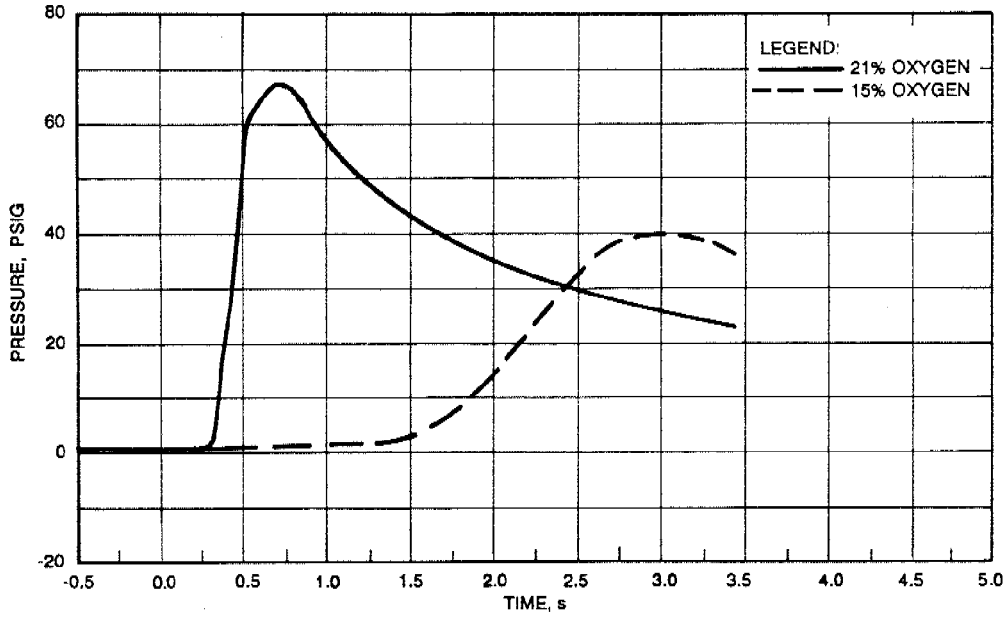


FIGURE 17. Pressures Generated During Baseline and Inert Testing at Ambient Conditions Using the J-57 Engine Igniter as the Ignition Source.

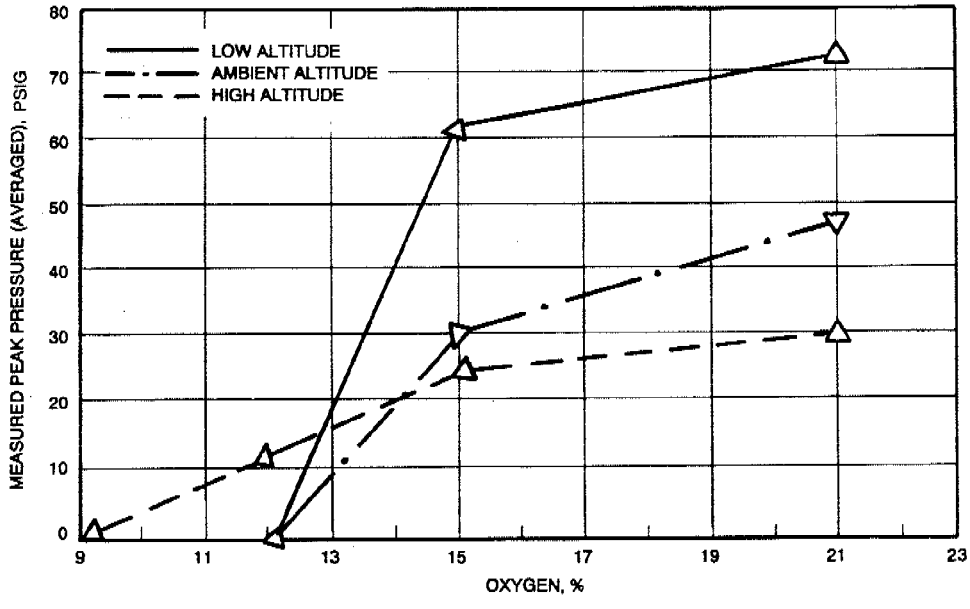


FIGURE 18. The Effect of an Inert Atmosphere on the Peak Pressure Resulting From Fuel Vapors Ignited by the J-57 Engine Igniter.

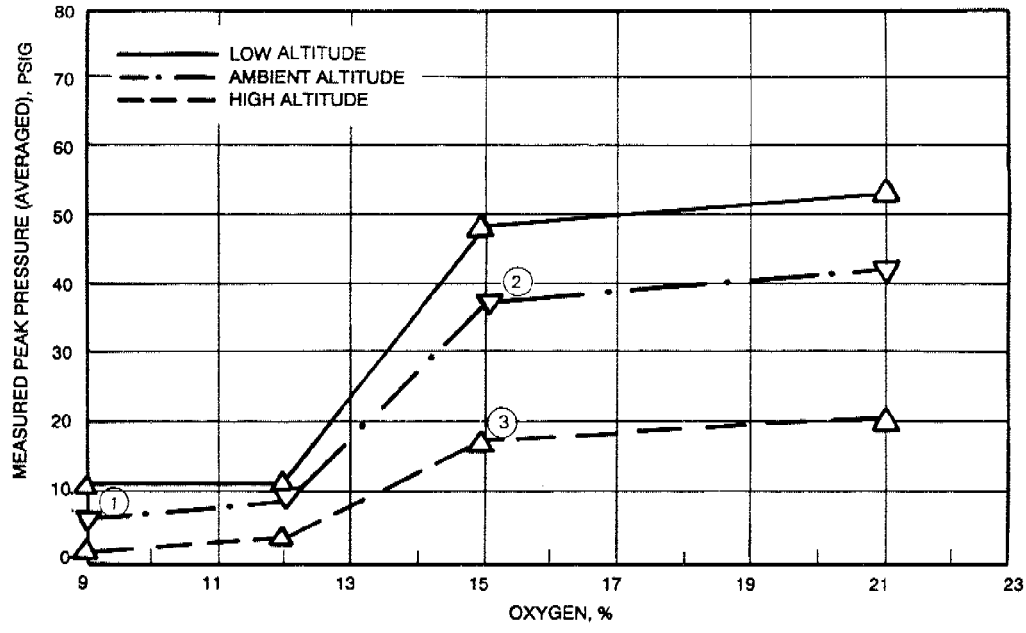


FIGURE 19. The Effect of an Inert Atmosphere on the Peak Pressure Resulting From Fuel Vapors Ignited by the 30-mm HEI Projectile.

note that a dramatic reduction in peak pressure occurs in the inert environment at somewhere between 12 and 15% oxygen for tests in which either the J-57 engine igniter or the 30-mm HEI was used as the ignition source. Using engineering judgement, points 1, 2, and 3 were added to fill in the data gaps in Figure 19 in order to generate the family of curves.

Reference 8 indicates that the dramatic reduction in peak pressure when a 23-mm HEI projectile is used as the ignition source occurs at 14% oxygen by volume when nitrogen is used to create an inert atmosphere. The data in Figures 18 and 19 are in agreement with the data presented in Reference 8.

CONCLUSIONS

The maximum percentage of oxygen allowable during suppression of spark-ignited jet-fuel vapor combustion reactions at sea-level conditions is generally accepted to be 9%. As altitude increases, absolute pressure decreases and the amount of allowable oxygen increases. The peak pressure achieved in an ullage explosion is a function of the available oxygen. As a result, ullage explosions occurring at higher altitudes and/or in a nitrogen-enriched atmosphere generate lower overpressures, which in turn result in less damage to the aircraft structure.

During the testing using the 30-mm HEI as the ignition source, the use of nitrogen to produce an inert atmosphere in the ullage was found not only to reduce the force of the fuel-air explosion, but also to reduce the damaging high pressure generated by the projectile's high explosive.

The data collected demonstrate that at oxygen concentrations of 15%, the reduction in fuel-tank overpressure resulting from fuel-vapor explosions generated by the 30-mm HEI was very slight. However, at oxygen concentrations of 12%, a large reduction in the overpressure resulting from a fuel-vapor explosion initiated by the 30-mm HEI was achieved. Oxygen concentrations of 9% were found to provide very little improvement to the protection afforded to the fuel tank from the 30-mm HEI when compared to oxygen concentrations of 12%.

The information presented in this report, along with existing information, should enable the refinement of the design of the on-board inert gas-generating system (OBIGGS). Such a refinement may provide benefits in the form of reduced OBIGGS weight.

The results of the tests conducted at NWC add important data to the information existing on the performance of nitrogen-inerting systems in effectively reducing the vulnerability of combat aircraft to the 30-mm HEI threat.

RECOMMENDATIONS

Meeting the goal of complete ullage protection 100% of the time appears possible. Understanding the environment of the ullage and the reactions that take place within it is a means of achieving this goal. It is recommended that the altitude and the level of nitrogen-inerting dependence for other threats, such as missile fragments and armor-piercing incendiary (API) projectiles, on overpressures associated with fuel-vapor explosions be investigated.

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8. Air Force Flight Dynamics Laboratory. *Test and Evaluation of Halon 1301 and Nitrogen Inerting Against 23-mm HEI Projectiles,* by Charles L. Anderson. May 1978 (AFFDL-TR-78-66, publication UNCLASSIFIED.)

Appendix A

TEST DATA SHEETS

This Appendix contains facsimiles of the actual data sheets used by the engineer to record data during testing. The comments found on each data sheet are preliminary thoughts written by the test engineer before a review of the data and should not be considered final conclusions or recommendations.

For further discussion or interpretation of these test data sheets or the test results detailed in this report, please contact the authors.

TEST # 1		TEST PRESSURE	15.7
DATE	6/12/89	TEST OXYGEN CONC.	21 %
TIME	1325	THREAT	30mm HEI
TEST PROCEDURE	1	PHOTOGRAPHY	NO

A-30 Fuze ≈ 2000 fps

AMBIENT TEMP	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 1	96.0 (F)	555.7 (R)	35.6 (C)	
THERMOCOUPLE 2	95.0 (F)	554.7 (R)	35.0 (C)	
THERMOCOUPLE 3	90.0 (F)	549.7 (R)	32.2 (C)	
AVG TANK TEMP	93.7 (F)	553.3 (R)	34.3 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		18.0 (psia)		124105.2 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.7
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.016348005
Required moles oxygen	0.077847641
Required N2 pres (psia)	15.7
Required JP-4S Vol. (ml)	126

RESULTS

PEAK BOMB PRESSURE	(psig)	(Pa)
XDUCER 1 PEAK PRES	20.0 (psig)	137894.7 (Pa)
XDUCER 2 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 3 PEAK PRES	18.0 (psig)	124105.2 (Pa)
XDUCER 4 PEAK PRES	18.0 (psig)	124105.2 (Pa)
AVG PEAK PRES	14.0 (psig)	96526.3 (Pa)

COMMENTS

QUASI STATIC TEST OF 30MM HEI AT INITIAL TANK PRESSURE OF 15.7 PSIA
T3 DAMAGED
P2 - NO DATA RECORDED - XDUCER SWAPPED OUT FOR TEST 2
PRESSURE XDUCERS WERE REPLACED WITH VIATRAN XDUCERS- NEW XDUCERS WERE NOT ABLE TO PERFORM IN THE REQUIRED LOWER FREQUENCY RANGE

P_{BOMB} - 98psig

20 psi/vol 1+

TEST # 2		TEST PRESSURE	15.7
DATE	6/14/89	TEST OXYGEN CONC.	21 %
TIME	1100	THREAT	30mm HEI Powder
TEST PROCEDURE	1	PHOTOGRAPHY	NO

HC 25F5 ~4 grams

AMBIENT TEMP		99.0 (F)	558.7 (R)	37.2 (C)	
THERMOCOUPLE 1	97	97.0 (F)	556.7 (R)	36.1 (C)	
THERMOCOUPLE 2	98	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 3	97	97.0 (F)	556.7 (R)	36.1 (C)	
AVG TANK TEMP		97.3 (F)	557.0 (R)	36.3 (C)	
AMBIENT PRESSURE		28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0 (Pa)
STATIC TANK PRES.			13.7 (psia)		94457.8 (Pa)
ELEVATED TANK PRES			18.0 (psia)		124105.2 (Pa)
REDUCED TANK PRES			15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES			15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.4
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.016240388
Required moles oxygen	0.077335182
Required N2 pres (psia)	15.7
Required JP-4S Vol. (ml)	126

RESULTS

PEAK BOMB PRESSURE		(psig)		(Pa)
XDUCER 1 PEAK PRES	33.8	(psig)	233042.0	(Pa)
XDUCER 2 PEAK PRES	37.0	(psig)	255105.1	(Pa)
XDUCER 3 PEAK PRES	29.7	(psig)	204773.6	(Pa)
XDUCER 4 PEAK PRES	30.0	(psig)	206842.0	(Pa)
AVG PEAK PRES	32.6	(psig)	224940.7	(Pa)

COMMENTS

RETEST OF SHOT 1

TEST # 3		TEST PRESSURE	15.7
DATE 6/14/89		TEST OXYGEN CONC.	21 %
TIME 1230		THREAT	30mm HEI
TEST PROCEDURE 1		PHOTOGRAPHY	NO

AMBIENT TEMP	100.0 (F)	559.7 (R)	37.8 (C)		
THERMOCOUPLE 1 101	101.0 (F)	560.7 (R)	38.3 (C)		
THERMOCOUPLE 2 102	102.0 (F)	561.7 (R)	38.9 (C)		
THERMOCOUPLE 3 107	101.0 (F)	560.7 (R)	38.3 (C)		
AVG TANK TEMP	101.3 (F)	561.0 (R)	38.5 (C)		
AMBIENT PRESSURE	28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0	(Pa)
STATIC TANK PRES.		15.7 (psia)		108247.3	(Pa)
ELEVATED TANK PRES		18.0 (psia)		124105.2	(Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3	(Pa)
FINAL TANK PRES		15.7 (psia)		108247.3	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.7	Moles Oxygen in air	0.016124593
Sample 2	Required moles oxygen	0.076783776
Sample 3	Required N2 pres (psia)	15.7
Sample 4	Required JP-4S Vol. (ml)	125

RESULTS

PEAK BOMB PRESSURE	(psig)		(Pa)	
XDUCER 1 PEAK PRES	31.7 (psig)	229	218563.0	(Pa)
XDUCER 2 PEAK PRES	34.2 (psig)	112	235799.9	(Pa)
XDUCER 3 PEAK PRES	29.5 (psig)	343	203394.6	(Pa)
XDUCER 4 PEAK PRES	29.6 (psig)	320	204084.1	(Pa)
AVG PEAK PRES	31.3 (psig)		215460.4	(Pa)

COMMENTS

LOW ALTITUDE - QUASI STATIC THREAT CHARACTERIZATION

TEST # 4		TEST PRESSURE	13.6
DATE	6/14/89	TEST OXYGEN CONC.	21 %
TIME	1405	THREAT	30mm HEI
TEST PROCEDURE	2	PHOTOGRAPHY	ND

AMBIENT TEMP		106.0 (F)	565.7 (R)	41.1 (C)	
THERMOCOUPLE 1	104	104.0 (F)	563.7 (R)	40.0 (C)	
THERMOCOUPLE 2	103	103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 3	103	104.0 (F)	563.7 (R)	40.0 (C)	
AVG TANK TEMP		103.7 (F)	563.3 (R)	39.8 (C)	
AMBIENT PRESSURE		27.8 (In Hg)	13.6 (psia)	1959.0 (psf)	94158.6 (Pa)
STATIC TANK PRES.			13.6 (psia)		93768.4 (Pa)
ELEVATED TANK PRES			0.0 (psia)		0.0 (Pa)
REDUCED TANK PRES			0.0 (psia)		0.0 (Pa)
FINAL TANK PRES			13.6 (psia)		93768.4 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.8
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.013909946
Required moles oxygen	0.066237837
Required N2 pres (psia)	13.6
Required JP-4S Vol. (ml)	108

RESULTS

PEAK BOMB PRESSURE		(psig)		(Pa)
XDUCER 1 PEAK PRES	26.4	(psig) 196	182021.0	(Pa)
XDUCER 2 PEAK PRES	29.1	(psig) 118	200636.7	(Pa)
XDUCER 3 PEAK PRES	23.9	(psig) 317	164784.1	(Pa)
XDUCER 4 PEAK PRES	24.0	(psig) 292	165473.6	(Pa)
AVG PEAK PRES	25.9	(psig)	178228.9	(Pa)

COMMENTS

AMBIENT CONDITION - QUASI STATIC THREAT CHARACTERIZATION
FIRST ROUND WAS MISFIRE - WAITED 30 MINUTES , CHECKED ROUND AND BREACH, NO PROBLEM FOUND RELOADED WITH NEW ROUND
PHOTO GLASS WAS FRAGGED - CRACKED ACROSS FACE - DAMAGED GLASS LEFT IN PLACE FOR TEST 5 BECAUSE NO PRSSURE WILL BE ON TANK

TEST # 5		TEST PRESSURE	13.6
DATE 6/14/89		TEST OXYGEN CONC.	21 %
TIME 1430		THREAT	30mm HEI
TEST PROCEDURE 2		PHOTOGRAPHY	ND

AMBIENT TEMP	107.0 (F)	566.7 (R)	41.7 (C)	
THERMOCOUPLE 1	107.0 (F)	566.7 (R)	41.7 (C)	
THERMOCOUPLE 2	108.0 (F)	567.7 (R)	42.2 (C)	
THERMOCOUPLE 3	106.0 (F)	565.7 (R)	41.1 (C)	
AVG TANK TEMP	107.0 (F)	566.7 (R)	41.7 (C)	
AMBIENT PRESSURE	27.8 (in Hg)	13.6 (psia)	1959.0 (psf)	94158.6 (Pa)
STATIC TANK PRES.		13.6 (psia)		93768.4 (Pa)
ELEVATED TANK PRES		0.0 (psia)		0.0 (Pa)
REDUCED TANK PRES		0.0 (psia)		0.0 (Pa)
FINAL TANK PRES		13.6 (psia)		93768.4 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.8	Moles Oxygen in air	0.013828123
Sample 2	Required moles oxygen	0.065848205
Sample 3	Required N2 pres (psia)	13.6
Sample 4	Required JP-4S Vol. (ml)	107

RESULTS

PEAK BOMB PRESSURE	(psig) *MS*		(Pa)
XDUCER 1 PEAK PRES	25.6 (psig) *195*	176505.2	(Pa)
XDUCER 2 PEAK PRES	28.1 (psig) *130*	193742.0	(Pa)
XDUCER 3 PEAK PRES	22.9 (psig) *316*	157889.4	(Pa)
XDUCER 4 PEAK PRES	22.9 (psig) *306*	157889.4	(Pa)
AVG PEAK PRES	24.9 (psig)	171506.5	(Pa)

COMMENTS

AMBIENT CONDITION - QUASI STATIC THREAT CHARACTERIZATION
PHOTO GLASS DAMAGE PRIOR TO TEST , DAMAGE FROM TEST 4

TEST # 6		TEST PRESSURE	8.4
DATE 6/14/89		TEST OXYGEN CONC.	21 %
TIME 1515		THREAT	30mm HEI
TEST PROCEDURE 3		PHOTOGRAPHY	ND

AMBIENT TEMP		104.0 (F)	563.7 (R)	40.0 (C)	
THERMOCOUPLE 1	/09	109.0 (F)	568.7 (R)	42.8 (C)	
THERMOCOUPLE 2	/09	109.0 (F)	568.7 (R)	42.8 (C)	
THERMOCOUPLE 3	/06	107.0 (F)	566.7 (R)	41.7 (C)	
AVG TANK TEMP		108.3 (F)	568.0 (R)	42.4 (C)	
AMBIENT PRESSURE		28.0 (In Hg)	13.7 (psia)	1973.1 (psf)	94836.0 (Pa)
STATIC TANK PRES.			13.7 (psia)		94457.8 (Pa)
ELEVATED TANK PRES			13.7 (psia)		94457.8 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.5 (psia)		58605.2 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.8	Moles Oxygen in air 0.008520851
Sample 2	Required moles oxygen 0.040575479
Sample 3	Required N2 pres (psia) 8.4
Sample 4	Required JP-4S Vol. (ml) 66

RESULTS

PEAK BOMB PRESSURE	(psig)		(Pa)
XDUCER 1 PEAK PRES	14.0 (psig)	15.6	96526.3 (Pa)
XDUCER 2 PEAK PRES	17.3 (psig)	17.6	119278.9 (Pa)
XDUCER 3 PEAK PRES	8.7 (psig)	25.6	59984.2 (Pa)
XDUCER 4 PEAK PRES	9.4 (psig)	23.1	64810.5 (Pa)
AVG PEAK PRES	12.4 (psig)		85150.0 (Pa)

COMMENTS

HIGH ALTITUDE- QUASI STATIC THREAT CHARACTERIZATION TEST
FAN DID NOT SUFFER AS MUCH DAMAGE - HOUSING CRACKED BUT STILL USEABLE, HOWEVER FAN WAS CHANGED OUT
THERMOCOUPLE 3 DAMAGED

TEST # 7		TEST PRESSURE	8.4
DATE 6/15/89		TEST OXYGEN CONC.	21 %
TIME 0820		THREAT	30mm HEI
TEST PROCEDURE 3		PHOTOGRAPHY	NO

AMBIENT TEMP		88.0 (F)	547.7 (R)	31.1 (C)		
THERMOCOUPLE 1	84	84.0 (F)	543.7 (R)	28.9 (C)		
THERMOCOUPLE 2	84	84.0 (F)	543.7 (R)	28.9 (C)		
THERMOCOUPLE 3	91	90.0 (F)	549.7 (R)	32.2 (C)		
AVG TANK TEMP		86.0 (F)	545.7 (R)	30.0 (C)		
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			13.8 (psia)		95147.3	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.6 (psia)		59294.7	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.9	Moles Oxygen in air	0.008869594
Sample 2	Required moles oxygen	0.042236164
Sample 3	Required N2 pres (psia)	8.4
Sample 4	Required JP-4S Vol. (ml)	69

RESULTS

PEAK BOMB PRESSURE	(psig)		(Pa)
XDUCER 1 PEAK PRES	15.7 (psig) 139	108247.3	(Pa)
XDUCER 2 PEAK PRES	19.2 (psig) 92	132378.9	(Pa)
XDUCER 3 PEAK PRES	11.5 (psig) 326	79289.4	(Pa)
XDUCER 4 PEAK PRES	12.0 (psig) 275	82736.8	(Pa)
AVG PEAK PRES	14.6 (psig)	100663.1	(Pa)

COMMENTS

HIGH ALTITUDE CONDITION - QUASI STATIC THREAT CHARACTERIZATION
FRAGMENT DAMAGE TO SEAL ON REAR PLATE CAUSED TANK TO LEAK - DAP WAS PLACED ON SEAL TO FILL IN VOIDS

TEST # 8		TEST PRESSURE	13.7
DATE 6/15/89		TEST OXYGEN CONC.	21 %
TIME 1315		THREAT	30mm HEI
TEST PROCEDURE 5		PHOTOGRAPHY	YES

AMBIENT TEMP		100.0	(F)	559.7	(R)	37.8	(C)
THERMOCOUPLE 1	98	97.0	(F)	556.7	(R)	36.1	(C)
THERMOCOUPLE 2	98	98.0	(F)	557.7	(R)	36.7	(C)
THERMOCOUPLE 3	99	99.0	(F)	558.7	(R)	37.2	(C)
AVG TANK TEMP		98.0	(F)	557.7	(R)	36.7	(C)
AMBIENT PRESSURE		28.0	(in Hg)	13.7	(psia)	1973.1 (psf)	94836.0 (Pa)
STATIC TANK PRES.				13.7	(psia)		94457.8 (Pa)
ELEVATED TANK PRES				13.7	(psia)		94457.8 (Pa)
REDUCED TANK PRES				13.7	(psia)		94457.8 (Pa)
FINAL TANK PRES				14.9	(psia)		102731.5 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.7
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.014154608
Required moles oxygen	0.067402894
Required N2 pres (psia)	13.7
Required JP-4S Vol. (ml)	109

RESULTS

PEAK BOMB PRESSURE	73.0	(psig)	503315.5 (Pa)
XDUCER 1 PEAK PRES	52.0	(psig) 113	358526.1 (Pa)
XDUCER 2 PEAK PRES	66.0	(psig) 63	455052.4 (Pa)
XDUCER 3 PEAK PRES	44.0	(psig) 291	303368.3 (Pa)
XDUCER 4 PEAK PRES	46.0	(psig) 229	317157.7 (Pa)
AVG PEAK PRES	52.0	(psig)	358526.1 (Pa)

COMMENTS

AMBIENT CONDITION - BASELINE 21 %
PSTATIC XDUCER LEFT OPEN TO TANK DURING SHOT

TEST # 9		TEST PRESSURE	18.0
DATE	6/15/89	TEST OXYGEN CONC.	21 %
TIME	1400	THREAT	30mm HEI
TEST PROCEDURE	4	PHOTOGRAPHY	YES

AMBIENT TEMP	103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 1	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 2	103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 3	103.0 (F)	562.7 (R)	39.4 (C)	
AVG TANK TEMP	102.7 (F)	562.3 (R)	39.3 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		15.7 (psia)		108247.3 (Pa)
ELEVATED TANK PRES		18.0 (psia)		124105.2 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.9 (psia)		109626.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.9
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.018442961
Required moles oxygen	0.087823625
Required N2 pres (psia)	18.0
Required JP-4S Vol. (ml)	143

RESULTS

PEAK BOMB PRESSURE	89.5 (psig)		617078.6 (Pa)
XDUCER 1 PEAK PRES	54.5 (psig)	152	375763.0 (Pa)
XDUCER 2 PEAK PRES	68.8 (psig)	199	474357.7 (Pa)
XDUCER 3 PEAK PRES	47.7 (psig)	281	328878.8 (Pa)
XDUCER 4 PEAK PRES	49.4 (psig)	298	340599.8 (Pa)
AVG PEAK PRES	55.1 (psig)		379899.8 (Pa)

COMMENTS

LOW ALTITUDE CONDITION - BASELINE 21%
LAST BOMB PRESSURE READING 89.3

TEST # 10		TEST PRESSURE	13.7
DATE 6/15/89		TEST OXYGEN CONC.	21 %
TIME 1430		THREAT	30mm HEI
TEST PROCEDURE 6		PHOTOGRAPHY	YES

AMBIENT TEMP	104.0 (F)	563.7 (R)	40.0 (C)		
THERMOCOUPLE 1 106	107.0 (F)	566.7 (R)	41.7 (C)		
THERMOCOUPLE 2 105	106.0 (F)	565.7 (R)	41.1 (C)		
THERMOCOUPLE 3 104	105.0 (F)	564.7 (R)	40.6 (C)		
AVG TANK TEMP	106.0 (F)	565.7 (R)	41.1 (C)		
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES		13.8 (psia)		95147.3	(Pa)
REDUCED TANK PRES		8.3 (psia)		57226.3	(Pa)
FINAL TANK PRES		8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.9
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.013954426
Required moles oxygen	0.066449647
Required N2 pres (psia)	13.7
Required JP-4S Vol. (ml)	108

RESULTS

PEAK BOMB PRESSURE	76.0 (psig)	523999.7	(Pa)
XDUCER 1 PEAK PRES	23.0 (psig) 90	158578.9	(Pa)
XDUCER 2 PEAK PRES	29.5 (psig) 53	203394.6	(Pa)
XDUCER 3 PEAK PRES	16.0 (psig) 207	110315.7	(Pa)
XDUCER 4 PEAK PRES	16.5 (psig) 205	113763.1	(Pa)
AVG PEAK PRES	21.3 (psig)	146513.1	(Pa)

COMMENTS

HIGH ALTITUDE- BASELINE TEST

Bomb Samples 75.8
76.0
76.0

TEST # 11		TEST PRESSURE	13.7
DATE 6/15/89		TEST OXYGEN CONC.	21 %
TIME 1540		THREAT	30mm HEI
TEST PROCEDURE 5		PHOTOGRAPHY	NO

AMBIENT TEMP	104.0 (F)	563.7 (R)	40.0 (C)		
THERMOCOUPLE 1 107	108.0 (F)	567.7 (R)	42.2 (C)		
THERMOCOUPLE 2 108	108.0 (F)	567.7 (R)	42.2 (C)		
THERMOCOUPLE 3 107	108.0 (F)	567.7 (R)	42.2 (C)		
AVG TANK TEMP	108.0 (F)	567.7 (R)	42.2 (C)		
AMBIENT PRESSURE	28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0	(Pa)
STATIC TANK PRES.		13.7 (psia)		94457.8	(Pa)
ELEVATED TANK PRES		13.7 (psia)		94457.8	(Pa)
REDUCED TANK PRES		13.7 (psia)		94457.8	(Pa)
FINAL TANK PRES		14.5 (psia)		99973.6	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.9	Moles Oxygen in air	0.013905262
Sample 2	Required moles oxygen	0.066215533
Sample 3	Required N2 pres (psia)	13.7
Sample 4	Required JP-4S Vol. (ml)	108

RESULTS

PEAK BOMB PRESSURE	77.1 (psig)	531583.9 (Pa)
XDUCER 1 PEAK PRES	35.3 (psig) 76.6	243384.1 (Pa)
XDUCER 2 PEAK PRES	51.3 (psig) 21.2	353699.8 (Pa)
XDUCER 3 PEAK PRES	23.3 (psig) 60	160647.3 (Pa)
XDUCER 4 PEAK PRES	27.6 (psig) 21.6	190294.6 (Pa)
AVG PEAK PRES	34.4 (psig)	237006.5 (Pa)

COMMENTS

AMBIENT CONDITION - BASELINE TEST 21%
T2 AND T3 DAMAGED

Bomb Samples 72.9
75.8
77.1

TEST # 12		TEST PRESSURE	16.0
DATE 6/16/89		TEST OXYGEN CONC.	21 %
TIME 0830		THREAT	30mm HEI
TEST PROCEDURE 4		PHOTOGRAPHY	NO

AMBIENT TEMP	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 1	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 2	83.0 (F)	542.7 (R)	28.3 (C)	
THERMOCOUPLE 3	87.0 (F)	546.7 (R)	30.6 (C)	
AVG TANK TEMP	84.7 (F)	544.3 (R)	29.3 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		16.0 (psia)		110315.7 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.9	Moles Oxygen in air 0.016935848
Sample 2	Required moles oxygen 0.080646895
Sample 3	Required N2 pres (psia) 16.0
Sample 4	Required JP-4S Vol. (ml) 131

RESULTS

PEAK BOMB PRESSURE	92.6 (psig)		638452.3 (Pa)
XDUCER 1 PEAK PRES	50.9 (psig)	126	350941.9 (Pa)
XDUCER 2 PEAK PRES	63.8 (psig)	49	439884.0 (Pa)
XDUCER 3 PEAK PRES	45.3 (psig)	259	312331.4 (Pa)
XDUCER 4 PEAK PRES	47.0 (psig)	220	324052.5 (Pa)
AVG PEAK PRES	51.8 (psig)		356802.4 (Pa)

COMMENTS

LOW ALTITUDE CONDITION - BASELINE TESTS
BOMB SAMPLE 1 - 92.6
BOMB SAMPLE 2 - 91.8

TEST # 13		TEST PRESSURE	13.8
DATE 6/16/89		TEST OXYGEN CONC.	21 %
TIME 0930		THREAT	30mm HEI
TEST PROCEDURE 6		PHOTOGRAPHY	ND

AMBIENT TEMP	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 1 92	92.0 (F)	551.7 (R)	33.3 (C)	
THERMOCOUPLE 2 91	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 3 93	94.0 (F)	553.7 (R)	34.4 (C)	
AVG TANK TEMP	92.0 (F)	551.7 (R)	33.3 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		13.8 (psia)		95147.3 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.7 (psia)		59984.2 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1 20.9	Moles Oxygen in air	0.014412996
Sample 2	Required moles oxygen	0.068633315
Sample 3	Required N2 pres (psia)	13.8
Sample 4	Required JP-4S Vol. (ml)	111

RESULTS

PEAK BOMB PRESSURE	76.8 (psig)		529515.5 (Pa)
XDUCER 1 PEAK PRES	22.9 (psig)	85	157889.4 (Pa)
XDUCER 2 PEAK PRES	29.6 (psig)	49	204084.1 (Pa)
XDUCER 3 PEAK PRES	17.3 (psig)	229	119278.9 (Pa)
XDUCER 4 PEAK PRES	17.7 (psig)	229	122036.8 (Pa)
AVG PEAK PRES	21.9 (psig)		150822.3 (Pa)

COMMENTS

HIGH ALTITUDE CONDITION
BOMB SAMPLE 1 74.2
BOMB SAMPLE 2 76.2
BOMB SAMPLE 3 76.8
LOST T1 THERMOCOUPLE
VACUUM PRESSURE WAS INCREASING BEFORE THE SHOT (POSSIBLE THERE WAS A LEAK)

TEST # 14		TEST PRESSURE	13.8
DATE 6/16/89		TEST OXYGEN CONC.	21 %
TIME 1106		THREAT	IGNITER
TEST PROCEDURE 5		PHOTOGRAPHY	YES

AMBIENT TEMP	89.0 (F)	548.7 (R)	31.7 (C)	
THERMOCOUPLE 1	87.0 (F)	546.7 (R)	30.6 (C)	
THERMOCOUPLE 2	92.0 (F)	551.7 (R)	33.3 (C)	
THERMOCOUPLE 3	92.0 (F)	551.7 (R)	33.3 (C)	
AVG TANK TEMP	90.3 (F)	550.0 (R)	32.4 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		13.8 (psia)		95147.3 (Pa)
REDUCED TANK PRES		13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES		14.5 (psia)		99973.6 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014456672
Sample 2	Required moles oxygen	0.068841293
Sample 3	Required N2 pres (psia)	13.8
Sample 4	Required JP-4S Vol. (ml)	112

RESULTS

PEAK BOMB PRESSURE	80.8 (psig)		557094.5 (Pa)
XDUCER 1 PEAK PRES	66.8 (psig)	680	460568.2 (Pa)
XDUCER 2 PEAK PRES	75.3 (psig)	761	519173.4 (Pa)
XDUCER 3 PEAK PRES	65.4 (psig)	617	450915.6 (Pa)
XDUCER 4 PEAK PRES	67.2 (psig)	641	463326.1 (Pa)
AVG PEAK PRES	68.7 (psig)		473495.8 (Pa)

COMMENTS

AMBIENT BASELINE USING AN IGNITER. - 21 %
FIRST BOMB SAMPLE 77
SECOND BOMB SAMPLE 79.7
THIRD BOMB SAMPLE 80.9
FAN BLADES MELTED DUE TO HEAT FROM THE EXPLOSION.

TEST # 15		TEST PRESSURE	13.8
DATE 6/19/89		TEST OXYGEN CONC.	21 %
TIME 0730		THREAT	IGNITER
TEST PROCEDURE 5		PHOTOGRAPHY	NO

AMBIENT TEMP	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 1	76.0 (F)	535.7 (R)	24.4 (C)	
THERMOCOUPLE 2	77.0 (F)	536.7 (R)	25.0 (C)	
THERMOCOUPLE 3	77.0 (F)	536.7 (R)	25.0 (C)	
AVG TANK TEMP	76.7 (F)	536.3 (R)	24.8 (C)	
AMBIENT PRESSURE	13.8 (in Hg)	6.8 (psia)	972.4 (psf)	46740.6 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		13.8 (psia)		95147.3 (Pa)
REDUCED TANK PRES		13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES		14.5 (psia)		99973.6 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014825049
Sample 2	Required moles oxygen	0.070595473
Sample 3	Required N2 pres (psia)	13.8
Sample 4	Required JP-4S Vol. (ml)	115

RESULTS

PEAK BOMB PRESSURE	77.9 (psig)		537099.7 (Pa)
XDUCER 1 PEAK PRES	66.0 (psig)	774	455052.4 (Pa)
XDUCER 2 PEAK PRES	74.4 (psig)	552	512968.2 (Pa)
XDUCER 3 PEAK PRES	64.5 (psig)	799	444710.3 (Pa)
XDUCER 4 PEAK PRES	66.7 (psig)	752	459878.7 (Pa)
AVG PEAK PRES	67.9 (psig)		468152.4 (Pa)

COMMENTS

6-16-89
THERMO COUPLES ACTING UP FOR THIS SHOT (GROUNDING PROBLEM)
BOMB SAMPLE #1
BOMB SAMPLE #2
IGNITER BOX NOT WORKING ON SIMULTOR
BEING REPLACED
6-19-89
AMBIENT CONDITION - BASELINE TEST - 21%
BOMB SAMPLE #1 63.3
BOMB SAMPLE #2 77.5
BOMB SAMPLE #3 77.9
VENTING OCCURRED AROUND IGNITER MOUNT

TEST # 16		TEST PRESSURE	14.2
DATE 6/19/89		TEST OXYGEN CONC.	21 %
TIME 0810		THREAT	IGNITER
TEST PROCEDURE 5		PHOTOGRAPHY	NO

AMBIENT TEMP		86.0 (F)	545.7 (R)	30.0 (C)	
THERMOCOUPLE 1	86	81.0 (F)	540.7 (R)	27.2 (C)	
THERMOCOUPLE 2	86	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 3	86	83.0 (F)	542.7 (R)	28.3 (C)	
AVG TANK TEMP		82.0 (F)	541.7 (R)	27.8 (C)	
AMBIENT PRESSURE		28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.			13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES			14.6 (psia)		100663.1 (Pa)
REDUCED TANK PRES			14.2 (psia)		97905.2 (Pa)
FINAL TANK PRES			14.2 (psia)		97905.2 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	20.9
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015104561
Required moles oxygen	0.071926482
Required N2 pres (psia)	14.2
Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	77.7 (psig)		535720.8 (Pa)
XDUCER 1 PEAK PRES	67.4 (psig)	737	464705.0 (Pa)
XDUCER 2 PEAK PRES	75.9 (psig)	541	523310.3 (Pa)
XDUCER 3 PEAK PRES	65.0 (psig)	783	448157.7 (Pa)
XDUCER 4 PEAK PRES	67.5 (psig)	735	465394.5 (Pa)
AVG PEAK PRES	69.0 (psig)		475391.9 (Pa)

COMMENTS

AMBIENT CONDITION 21 % IGNITER
BOMB SAMPLE 1 - 68.6
BOMB SAMPLE 2 - 77.5
BOMB SAMPLE 3 - 77.7
8802 SEAL AROUND IGNITER WAS BLOW OUT - VENTING OCCURRED

TEST # 17		TEST PRESSURE	15.0
DATE 6/19/89		TEST OXYGEN CONC.	15 %
TIME 0840		THREAT	IGNITER
TEST PROCEDURE 9		PHOTOGRAPHY	YES

AMBIENT TEMP		87.0 (F)	546.7 (R)	30.6 (C)	
THERMOCOUPLE 1	91	91.0 (F)	550.7 (R)	32.8 (C)	
THERMOCOUPLE 2	94	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 3	91	90.0 (F)	549.7 (R)	32.2 (C)	
AVG TANK TEMP		91.7 (F)	551.3 (R)	33.1 (C)	
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES			21.0 (psia)		144789.4 (Pa)
REDUCED TANK PRES			13.9 (psia)		95836.8 (Pa)
FINAL TANK PRES			14.6 (psia)		100663.1 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015675772
Sample 2	Required moles oxygen	0.104505146
Sample 3	Required N2 pres (psia)	21.0
Sample 4	Required JP-4S Vol. (ml)	121

RESULTS

PEAK BOMB PRESSURE	6.6 (psig)	Seconds	45505.2 (Pa)
XDUCER 1 PEAK PRES	47.1 (psig)	2.72	324741.9 (Pa)
XDUCER 2 PEAK PRES	47.1 (psig)	2.71	324741.9 (Pa)
XDUCER 3 PEAK PRES	46.2 (psig)	2.72	318536.7 (Pa)
XDUCER 4 PEAK PRES	46.0 (psig)	2.71	317157.7 (Pa)
AVG PEAK PRES	46.6 (psig)		321294.6 (Pa)

COMMENTS

AMBIENT CONDITION 15%
BOMB SAMPLE 1 -6.6
BOMB SAMPLE 2 -6.1
SEQUENCER WAS STARTED T -5 SEC

TEST # 18		TEST PRESSURE	15
DATE 6/19/89		TEST OXYGEN CONC.	15 %
TIME 0935		THREAT	IGNITER
TEST PROCEDURE 9		PHOTOGRAPHY	NO

AMBIENT TEMP		90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 1	95	96.0 (F)	555.7 (R)	35.6 (C)	
THERMOCOUPLE 2	96	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 3	94	96.0 (F)	555.7 (R)	35.6 (C)	
AVG TANK TEMP		96.7 (F)	556.3 (R)	35.9 (C)	
AMBIENT PRESSURE		28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.			13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES			21.0 (psia)		144789.4 (Pa)
REDUCED TANK PRES			14.3 (psia)		98594.7 (Pa)
FINAL TANK PRES			14.3 (psia)		98594.7 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015534888
Required moles oxygen	0.103565920
Required N2 pres (psia)	21.0
Required JP-4S Vol. (ml)	120

RESULTS

PEAK BOMB PRESSURE		(psig)	seconds	(Pa)
XDUCER 1 PEAK PRES	14.8	(psig)	44	102042.1 (Pa)
XDUCER 2 PEAK PRES	14.6	(psig)	44	100663.1 (Pa)
XDUCER 3 PEAK PRES	14.3	(psig)	44	98594.7 (Pa)
XDUCER 4 PEAK PRES	14.2	(psig)	44	97905.2 (Pa)
AVG PEAK PRES	14.5	(psig)		99801.3 (Pa)

COMMENTS

AMBIENT CONDITION - 15% IGNITER
NO BOMB SAMPLE RUN

TEST # 19		TEST PRESSURE	15
DATE 6/19/89		TEST OXYGEN CONC.	15 %
TIME 1005		THREAT	IGNITER
TEST PROCEDURE 9		PHOTOGRAPHY	YES

AMBIENT TEMP		93.0 (F)	552.7 (R)	33.9 (C)		
THERMOCOUPLE 1	99	96.0 (F)	555.7 (R)	35.6 (C)		
THERMOCOUPLE 2	101	99.0 (F)	558.7 (R)	37.2 (C)		
THERMOCOUPLE 3	97	96.0 (F)	555.7 (R)	35.6 (C)		
AVG TANK TEMP		97.0 (F)	556.7 (R)	36.1 (C)		
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			21.0 (psia)		144789.4	(Pa)
REDUCED TANK PRES			14.2 (psia)		97905.2	(Pa)
FINAL TANK PRES			14.7 (psia)		101352.6	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015525586
Required moles oxygen	0.103503905
Required N2 pres (psia)	21.0
Required JP-4S Vol. (ml)	120

RESULTS

		Seconds		
PEAK BOMB PRESSURE	24.0 (psig)	~~3.0~~	165473.6	(Pa)
XDUCER 1 PEAK PRES	41.3 (psig)	3.0	284752.5	(Pa)
XDUCER 2 PEAK PRES	41.2 (psig)	3.0	284063.0	(Pa)
XDUCER 3 PEAK PRES	41.3 (psig)	3.0	284752.5	(Pa)
XDUCER 4 PEAK PRES	41.0 (psig)	3.0	282684.1	(Pa)
AVG PEAK PRES	41.2 (psig)		284063.0	(Pa)

COMMENTS

AMBIENT CONDITION - 15%
BOMB SAMPLE 1 - 24
BOMB SAMPLE 2 - 6.8

TEST # 20		TEST PRESSURE	15
DATE	6/19/89	TEST OXYGEN CONC.	12 %
TIME	1200	THREAT	IGNITER
TEST PROCEDURE	9	PHOTOGRAPHY	YES

AMBIENT TEMP		94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 1	/02	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 2	/01	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 3	/01	102.0 (F)	561.7 (R)	38.9 (C)	
AVG TANK TEMP		102.0 (F)	561.7 (R)	38.9 (C)	
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			26.2 (psia)		180642.0 (Pa)
REDUCED TANK PRES			13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES	43		(psia)		(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015387377
Required moles oxygen	0.128228138
Required N2 pres (psia)	26.2
Required JP-4S Vol. (ml)	119

RESULTS

PEAK BOMB PRESSURE	(psig)	(Pa)
XDUCER 1 PEAK PRES	(psig)	(Pa)
XDUCER 2 PEAK PRES	(psig)	(Pa)
XDUCER 3 PEAK PRES	(psig)	(Pa)
XDUCER 4 PEAK PRES	(psig)	(Pa)
AVG PEAK PRES	(psig)	(Pa)

COMMENTS

AMBIENT CONDITION INERTING TEST 12% 02
NO EXPLOSION MEASURED AT THIS CONDITION.

TEST # 21		TEST PRESSURE	15
DATE	6/19/89	TEST OXYGEN CONC.	12 %
TIME	1215	THREAT	IGNITER
TEST PROCEDURE	9	PHOTOGRAPHY	NO

AMBIENT TEMP		100.0 (F)	559.7 (R)	37.8 (C)	
THERMOCOUPLE 1	103	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 2	102	103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 3	101	102.0 (F)	561.7 (R)	38.9 (C)	
AVG TANK TEMP		102.3 (F)	562.0 (R)	39.1 (C)	
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			26.2 (psia)		180642.0 (Pa)
REDUCED TANK PRES			13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES			14.3 (psia)		98594.7 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015378250
Sample 2	Required moles oxygen	0.128152084
Sample 3	Required N2 pres (psia)	26.2
Sample 4	Required JP-4S Vol. (ml)	119

RESULTS

PEAK BOMB PRESSURE	(psig)	(Pa)
XDUCER 1 PEAK PRES	(psig)	(Pa)
XDUCER 2 PEAK PRES	(psig)	(Pa)
XDUCER 3 PEAK PRES	(psig)	(Pa)
XDUCER 4 PEAK PRES	(psig)	(Pa)
AVG PEAK PRES	(psig)	(Pa)

COMMENTS

AMBIENT CONDITION 12% 02
BOMB SAMPLE #1 - 8 (DONE AT 15PSI)
BOMB SAMPLE #2 - 2.3
NO EXPLOSION MEASURED FOR THIS TEST EITHER. (SAME AS TEST 20)

TEST # 22		TEST PRESSURE	15
DATE	6/19/89	TEST OXYGEN CONC.	15 %
TIME	1249	THREAT	IGNITER
TEST PROCEDURE	9	PHOTOGRAPHY	NO

AMBIENT TEMP		101.0 (F)	560.7 (R)	38.3 (C)	
THERMOCOUPLE 1	101	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 2	100	100.0 (F)	559.7 (R)	37.8 (C)	
THERMOCOUPLE 3	102	102.0 (F)	561.7 (R)	38.9 (C)	
AVG TANK TEMP		101.3 (F)	561.0 (R)	38.5 (C)	
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			21.0 (psia)		144789.4 (Pa)
REDUCED TANK PRES			14.2 (psia)		97905.2 (Pa)
FINAL TANK PRES			14.2 (psia)		97905.2 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015405662
Required moles oxygen	0.102704414
Required N2 pres (psia)	21.0
Required JP-4S Vol. (ml)	119

RESULTS

		Seconds	
PEAK BOMB PRESSURE	13.9 (psig)		95836.8 (Pa)
XDUCER 1 PEAK PRES	35.0 (psig)	3.3	241315.7 (Pa)
XDUCER 2 PEAK PRES	34.9 (psig)	3.3	240626.2 (Pa)
XDUCER 3 PEAK PRES	34.9 (psig)	3.3	240626.2 (Pa)
XDUCER 4 PEAK PRES	34.7 (psig)	3.3	239247.2 (Pa)
AVG PEAK PRES	34.9 (psig)		240453.8 (Pa)

COMMENTS

AMBIENT CONDITION 15 % IGNITER
BOMB SAMPLE 1 - 13.9
BOMB SAMPLE - 7.8

TEST # 23		TEST PRESSURE	14.5
DATE 6/19/89		TEST OXYGEN CONC.	21 %
TIME 1330		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP		103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 1	105	106.0 (F)	565.7 (R)	41.1 (C)	
THERMOCOUPLE 2	107 105	108.0 (F)	567.7 (R)	42.2 (C)	
THERMOCOUPLE 3		106.0 (F)	565.7 (R)	41.1 (C)	
AVG TANK TEMP		106.7 (F)	566.3 (R)	41.5 (C)	
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			13.8 (psia)		95147.3 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014751897
Sample 2	Required moles oxygen	0.070247129
Sample 3	Required N2 pres (psia)	14.5
Sample 4	Required JP-4S Vol. (ml)	114

RESULTS

PEAK BOMB PRESSURE	78.9 (psig)		543994.5 (Pa)
XDUCER 1 PEAK PRES	31.0 (psig)	762	213736.7 (Pa)
XDUCER 2 PEAK PRES	36.0 (psig)	578	248210.4 (Pa)
XDUCER 3 PEAK PRES	28.8 (psig)	798	198568.3 (Pa)
XDUCER 4 PEAK PRES	32.5 (psig)	604	224078.8 (Pa)
AVG PEAK PRES	32.1 (psig)		221148.6 (Pa)

COMMENTS

HIGH ALTITUDE BASELINE 21% O2 IGNITER
BOMB SAMPLE 1- 78.9
BOMB SAMPLE 2- 77

TEST # 24		TEST PRESSURE	15
DATE 6/19/89		TEST OXYGEN CONC.	12 %
TIME 1400		THREAT	IGNITER
TEST PROCEDURE 9		PHOTOGRAPHY	NO

AMBIENT TEMP		103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 1	106	109.0 (F)	568.7 (R)	42.8 (C)	
THERMOCOUPLE 2	108	111.0 (F)	570.7 (R)	43.9 (C)	
THERMOCOUPLE 3	106	109.0 (F)	568.7 (R)	42.8 (C)	
AVG TANK TEMP		109.7 (F)	569.3 (R)	43.1 (C)	
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			26.2 (psia)		180642.0 (Pa)
REDUCED TANK PRES			14.2 (psia)		97905.2 (Pa)
FINAL TANK PRES			14.1 (psia)		97215.7 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015180171
Required moles oxygen	0.126501423
Required N2 pres (psia)	26.2
Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	(psig)	(Pa)
XDUCER 1 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 2 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 3 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 4 PEAK PRES	0.0 (psig)	0.0 (Pa)
AVG PEAK PRES	0.0 (psig)	0.0 (Pa)

COMMENTS

AMBIENT CONDITION 12% IGNITER
FUEL/OXYGEN RATIO REDUCED BY 57 % or 12/21 - 67 ml INJECTED INTO TANK
BOMB SAMPLE 1 - 5.1 PSIG
BOMB SAMPLE 2 - 2.5 PSIG
NO OVERPRESSURES OCCURRED

TEST # 25		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	21 %
TIME 0645		THREAT	IGNITER
TEST PROCEDURE 6		PHOTOGRAPHY	NO

AMBIENT TEMP	75.0 (F)	534.7 (R)	23.9 (C)	
THERMOCOUPLE 1 73	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 2 73	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 3 73	72.0 (F)	531.7 (R)	22.2 (C)	
AVG TANK TEMP	72.0 (F)	531.7 (R)	22.2 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		14.5 (psia)		99973.6 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015713770
Sample 2	Required moles oxygen	0.074827477
Sample 3	Required N2 pres (psia)	14.5
Sample 4	Required JP-4S Vol. (ml)	122

RESULTS

PEAK BOMB PRESSURE	79.5 (psig)		548131.3 (Pa)
XDUCER 1 PEAK PRES	31.0 (psig)	740	213736.7 (Pa)
XDUCER 2 PEAK PRES	38.4 (psig)	842	264757.8 (Pa)
XDUCER 3 PEAK PRES	30.0 (psig)	772	206842.0 (Pa)
XDUCER 4 PEAK PRES	31.4 (psig)	706	216494.6 (Pa)
AVG PEAK PRES	32.7 (psig)		225457.8 (Pa)

COMMENTS

HIGH ALTITUDE BASELINE TESTS 21% O2
BOMB SAMPLE 1 - 72.7
BOMB SAMPLE 2 - 78.9
BOMB SAMPLE 3 - 79.5
GOOD EXPLOSION

TEST # 26		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	21 %
TIME 0730		THREAT	IGNITER
TEST PROCEDURE 6		PHOTOGRAPHY	NO

AMBIENT TEMP		79.0 (F)	538.7 (R)	26.1 (C)		
THERMOCOUPLE 1	79	79.0 (F)	538.7 (R)	26.1 (C)		
THERMOCOUPLE 2	79	80.0 (F)	539.7 (R)	26.7 (C)		
THERMOCOUPLE 3	80	79.0 (F)	538.7 (R)	26.1 (C)		
AVG TANK TEMP		79.3 (F)	539.0 (R)	26.3 (C)		
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			14.5 (psia)		99973.6	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.3 (psia)		57226.3	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015499979
Required moles oxygen	0.073809422
Required N2 pres (psia)	14.5
Required JP-4S Vol. (ml)	120

RESULTS

PEAK BOMB PRESSURE	76.6 (psig)		528136.6 (Pa)
XDUCER 1 PEAK PRES	30.4 (psig)	770	209599.9 (Pa)
XDUCER 2 PEAK PRES	38.5 (psig)	574	265447.2 (Pa)
XDUCER 3 PEAK PRES	29.2 (psig)	773	201326.2 (Pa)
XDUCER 4 PEAK PRES	30.0 (psig)	754	206842.0 (Pa)
AVG PEAK PRES	32.0 (psig)		220803.8 (Pa)

COMMENTS

HIGH ALTITUDE CONDITION 21% O2
BOMB SAMPLE 1 -72.7
BOMB SAMPLE 2 - 76.6
BOMB SAMPLE 3 - 76
GOOD EXPLOSION

TEST # 27		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	15 %
TIME 0800		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	NO

AMBIENT TEMP	81.0 (F)	540.7 (R)	27.2 (C)	
THERMOCOUPLE 1 84	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 2 84	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 3 83	83.0 (F)	542.7 (R)	28.3 (C)	
AVG TANK TEMP	83.7 (F)	543.3 (R)	28.7 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		20.3 (psia)		139963.1 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.3 (psia)		57226.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015376360
Required moles oxygen	0.102509067
Required N2 pres (psia)	20.3
Required JP-4S Vol. (ml)	119

RESULTS

PEAK BOMB PRESSURE	48.0 (psig) seconds		330947.2 (Pa)
XDUCER 1 PEAK PRES	26.0 (psig) 1.4		179263.1 (Pa)
XDUCER 2 PEAK PRES	27.3 (psig) 1.3		188226.2 (Pa)
XDUCER 3 PEAK PRES	25.8 (psig) 1.4		177884.1 (Pa)
XDUCER 4 PEAK PRES	26.3 (psig) 1.4		181331.5 (Pa)
AVG PEAK PRES	26.4 (psig)		181676.2 (Pa)

COMMENTS

HIGH ALTITUDE INERTING TEST 15% O2 WITH REDUCED JP-4S BY 15/21 = 71% REDUCTION FROM WHAT IS SHOWN ABOVE
BOMB SAMPLE 1 - 1.4
BOMB SAMPLE 2 - 48
BOMB SAMPLES WERE CONDUCTER AT 14.7 PSI TANK PRESSURE SO RESULTS ONCE THE TANK PRESSURE IS REDUCED WILL BE SOMEWHAT LOWER.
GOOD RESULTS.

TEST # 28		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	15 %
TIME 0830		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP		83.0 (F)	542.7 (R)	28.3 (C)	
THERMOCOUPLE 1	87	88.0 (F)	547.7 (R)	31.1 (C)	
THERMOCOUPLE 2	88	88.0 (F)	547.7 (R)	31.1 (C)	
THERMOCOUPLE 3	87	87.0 (F)	546.7 (R)	30.6 (C)	
AVG TANK TEMP		87.7 (F)	547.3 (R)	30.9 (C)	
AMBIENT PRESSURE		28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			20.8 (psia)		143410.5 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.3 (psia)		57226.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015263988
Required moles oxygen	0.101759919
Required N2 pres (psia)	20.3
Required JP-4S Vol. (ml)	118

RESULTS

PEAK BOMB PRESSURE	42.0 (psig)	seconds	289578.8 (Pa)
XDUCER 1 PEAK PRES	24.3 (psig)	1.61	167542.0 (Pa)
XDUCER 2 PEAK PRES	24.8 (psig)	1.59	170989.4 (Pa)
XDUCER 3 PEAK PRES	24.1 (psig)	1.61	166163.1 (Pa)
XDUCER 4 PEAK PRES	24.3 (psig)	1.61	167542.0 (Pa)
AVG PEAK PRES	24.4 (psig)		168059.1 (Pa)

COMMENTS

HIGH ALTITUDE INERTING TEST 15% O2
INJECTED A REDUCED AMOUNT OF JP-4S (71%) 84 ML
BOMB SAMPLES RUN AT A TANK PRESSURE OF 14.8 PSIA
BOMB SAMPLE 1 - 38.1
BOMB SAMPLE 2 - 42
GOOD TEST

TEST # 29		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	15 %
TIME 0930		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	NO

AMBIENT TEMP		86.0 (F)	545.7 (R)	30.0 (C)		
THERMOCOUPLE 1	91	92.0 (F)	551.7 (R)	33.3 (C)		
THERMOCOUPLE 2	92	93.0 (F)	552.7 (R)	33.9 (C)		
THERMOCOUPLE 3	90	91.0 (F)	550.7 (R)	32.8 (C)		
AVG TANK TEMP		92.0 (F)	551.7 (R)	33.3 (C)		
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			20.3 (psia)		139963.1	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015144090
Sample 2	Required moles oxygen	0.100960601
Sample 3	Required N2 pres (psia)	20.3
Sample 4	Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	42.2 (psig)	seconds	290957.7	(Pa)
XDUCER 1 PEAK PRES	24.5 (psig)	1.72	168921.0	(Pa)
XDUCER 2 PEAK PRES	25.0 (psig)	1.76	172368.3	(Pa)
XDUCER 3 PEAK PRES	24.2 (psig)	1.74	166852.5	(Pa)
XDUCER 4 PEAK PRES	24.3 (psig)	1.71	167542.0	(Pa)
AVG PEAK PRES	24.5 (psig)		168921.0	(Pa)

COMMENTS

HIGH ALTITUDE INERTING TEST 15% O2
REDUCED AMOUNT OF JP-4S BY 71% FROM THE ABOVE NUMBER (83.6)
BOMB SAMPLES CONDUCTED AT A SIMULATOR PRESSURE OF 14.8 PSIA
BOMB SAMPLE 1 - 36.3
BOMB SAMPLE 2 - 42.2
GOOD TEST

TEST # 30		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	12 %
TIME 1000		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	ND

AMBIENT TEMP	90.0 (F)	549.7 (R)	32.2 (C)		
THERMOCOUPLE 1 94	94.0 (F)	553.7 (R)	34.4 (C)		
THERMOCOUPLE 2 96	96.0 (F)	555.7 (R)	35.6 (C)		
THERMOCOUPLE 3 94	94.0 (F)	553.7 (R)	34.4 (C)		
AVG TANK TEMP	94.7 (F)	554.3 (R)	34.8 (C)		
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8	(Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES		8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015071239
Required moles oxygen	0.125593655
Required N2 pres (psia)	25.3
Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	2.1 (psig)	seconds	14478.9	(Pa)
XDUCER 1 PEAK PRES	9.2 (psig)	4.32	63431.5	(Pa)
XDUCER 2 PEAK PRES	9.2 (psig)	4.32	63431.5	(Pa)
XDUCER 3 PEAK PRES	9.1 (psig)	4.32	62742.1	(Pa)
XDUCER 4 PEAK PRES	9.2 (psig)	4.32	63431.5	(Pa)
AVG PEAK PRES	9.2 (psig)		63259.2	(Pa)

COMMENTS

BOMB VENT WAS OPWN MANUALY FOR THE FIRST BOMB SAMPLE ?
HIGH ALTITUDE INERTING TEST 12% 02
AMOUNT OF JP-4S USED REDUCED BY 12\21% FROM THE ABOVE VALUE (67)
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - .4
BOMB SAMPLE 2 - 1.?
BOMB SAMPLE 3 - 2.1
GOOD TEST

TEST # 31		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	12 %
TIME 1115		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 1 98	99.0 (F)	558.7 (R)	37.2 (C)	
THERMOCOUPLE 2 99	101.0 (F)	560.7 (R)	38.3 (C)	
THERMOCOUPLE 3 98	97.0 (F)	556.7 (R)	36.1 (C)	
AVG TANK TEMP	99.0 (F)	558.7 (R)	37.2 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014954338
Sample 2	Required moles oxygen	0.124619486
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	116

RESULTS

PEAK BOMB PRESSURE	5.9 (psig)	seconds	40678.9 (Pa)
XDUCER 1 PEAK PRES	15.4 (psig)	2.94	106178.9 (Pa)
XDUCER 2 PEAK PRES	15.4 (psig)	2.93	106178.9 (Pa)
XDUCER 3 PEAK PRES	15.4 (psig)	2.93	106178.9 (Pa)
XDUCER 4 PEAK PRES	15.4 (psig)	2.94	106178.9 (Pa)
AVG PEAK PRES	15.4 (psig)		106178.9 (Pa)

COMMENTS

HIGH ALTITUDE INERT TEST 12 % O2
REDUCED AMOUNT OF JP-4S BY 57% TO 66ML
BOMB SAMPLES RUN AT 14.5PSIA
BOMB SAMPLE 1 - 1.6
BOMB SAMPLE 2 - 1.8
BOMB SAMPLE 3 - 5.9
GOOD TEST

TEST # 32		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	12 %
TIME 1140		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP		97.0 (F)	556.7 (R)	36.1 (C)		
THERMOCOUPLE 1	/00	101.0 (F)	560.7 (R)	38.3 (C)		
THERMOCOUPLE 2	/01	103.0 (F)	562.7 (R)	39.4 (C)		
THERMOCOUPLE 3	/00	102.0 (F)	561.7 (R)	38.9 (C)		
AVG TANK TEMP		102.0 (F)	561.7 (R)	38.9 (C)		
AMBIENT PRESSURE		28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			25.3 (psia)		174436.8	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen In air	0.014874464
Sample 2	Required moles oxygen	0.123953867
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	115

RESULTS

PEAK BOMB PRESSURE	3.7 (psig)	seconds	25510.5	(Pa)
XDUCER 1 PEAK PRES	9.9 (psig)	3.85	68257.9	(Pa)
XDUCER 2 PEAK PRES	9.9 (psig)	3.85	68257.9	(Pa)
XDUCER 3 PEAK PRES	9.8 (psig)	3.85	67568.4	(Pa)
XDUCER 4 PEAK PRES	9.9 (psig)	3.85	68257.9	(Pa)
AVG PEAK PRES	9.9 (psig)		68085.5	(Pa)

COMMENTS

HIGH ALTITUDE INERT TEST 12 % O2
AMOUNT OF JP-4S REDUCED BY 57% FROM THE AMOUNT SHOWN ABOVE TO 66.
BOMB SAMPLES RUN AT 14.5 PSIA
BOMB SAMPLE 1 - 1.2
BOMB SAMPLE 2 - 1.8
BOMB SAMPLE 3 - 3.7
GOOD TEST

TEST # 33		TEST PRESSURE	14.5
DATE 6/20/89		TEST OXYGEN CONC.	9 %
TIME 1025		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	NO

AMBIENT TEMP		98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 1	/02	103.0 (F)	562.7 (R)	39.4 (C)	
THERMOCOUPLE 2	/02	104.0 (F)	563.7 (R)	40.0 (C)	
THERMOCOUPLE 3	/01	103.0 (F)	562.7 (R)	39.4 (C)	
AVG TANK TEMP		103.3 (F)	563.0 (R)	39.6 (C)	
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES			33.8 (psia)		233042.0 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014839238
Sample 2	Required moles oxygen	0.164880417
Sample 3	Required N2 pres (psia)	33.8
Sample 4	Required JP-4S Vol. (ml)	115

RESULTS

PEAK BOMB PRESSURE	4.5 (psig)	31026.3 (Pa)
XDUCER 1 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 2 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 3 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 4 PEAK PRES	0.0 (psig)	0.0 (Pa)
AVG PEAK PRES	0.0 (psig)	0.0 (Pa)

COMMENTS

HIGH ALTITUDE INERT TEST 9% O2
AMOUNT OF JP-4S REDUCED TO 9/21 = 42% OF ABOVE AMOUNT(49).
BOMB TESTS DONE AT 14.5 PSIA
BOMB SAMPLE 1 - 4.5
BOMB SAMPLE 2 - 4.5
NO MEASURABLE PRESSURE RISE

TEST # 34		TEST PRESSURE	15.7
DATE	6/20/89	TEST OXYGEN CONC.	21 %
TIME	1300	THREAT	IGNITER
TEST PROCEDURE	4	PHOTOGRAPHY	NO

AMBIENT TEMP	100.0 (F)	559.7 (R)	37.8 (C)	
THERMOCOUPLE 1	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 2	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 3	102.0 (F)	561.7 (R)	38.9 (C)	
AVG TANK TEMP	102.0 (F)	561.7 (R)	38.9 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		15.7 (psia)		108247.3 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016105454
Sample 2	Required moles oxygen	0.076692639
Sample 3	Required N2 pres (psia)	15.7
Sample 4	Required JP-4S Vol. (ml)	125

RESULTS

PEAK BOMB PRESSURE	85.9 (psig)		592257.6 (Pa)
XDUCER 1 PEAK PRES	73.7 (psig)	786	508141.8 (Pa)
XDUCER 2 PEAK PRES	81.4 (psig)	578	561231.3 (Pa)
XDUCER 3 PEAK PRES	72.1 (psig)	808	497110.3 (Pa)
XDUCER 4 PEAK PRES	74.8 (psig)	744	515726.1 (Pa)
AVG PEAK PRES	75.5 (psig)		520552.4 (Pa)

COMMENTS

LOW ALTITUDE AMBIENT 21% O2
BOMB SAMPLE 1 - 85.9
BOMB SAMPLE 2 - 81.8
GOOD TEST

TEST # 35		TEST PRESSURE	15.7
DATE 6/20/89		TEST OXYGEN CONC.	21 %
TIME 1315		THREAT	IGNITER
TEST PROCEDURE 4		PHOTOGRAPHY	NO

AMBIENT TEMP	102.0 (F)	561.7 (R)	38.9 (C)	
THERMOCOUPLE 1 107	107.0 (F)	566.7 (R)	41.7 (C)	
THERMOCOUPLE 2 107	108.0 (F)	567.7 (R)	42.2 (C)	
THERMOCOUPLE 3 106	107.0 (F)	566.7 (R)	41.7 (C)	
AVG TANK TEMP	107.3 (F)	567.0 (R)	41.9 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		15.7 (psia)		108247.3 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015953963
Sample 2	Required moles oxygen	0.075971254
Sample 3	Required N2 pres (psia)	15.7
Sample 4	Required JP-4S Vol. (ml)	123

RESULTS

PEAK BOMB PRESSURE	84.0 (psig)		579157.6 (Pa)
XDUCER 1 PEAK PRES	72.9 (psig)	788	502626.1 (Pa)
XDUCER 2 PEAK PRES	81.2 (psig)	579	559852.3 (Pa)
XDUCER 3 PEAK PRES	71.5 (psig)	811	492973.4 (Pa)
XDUCER 4 PEAK PRES	74.1 (psig)	734	510899.7 (Pa)
AVG PEAK PRES	74.9 (psig)		516587.9 (Pa)

COMMENTS

LOW ALTITUDE AMBIENT 21% O2
BOMB SAMPLE 1 - 83.8
BOMB SAMPLE 2 - 84
GOOD TEST VERY REPEATABLE COMPAIRED TO TEST 34.

TEST # 36		TEST PRESSURE	15.7
DATE 6/20/89		TEST OXYGEN CONC.	21 %
TIME 1330		THREAT	IGNITER
TEST PROCEDURE 4		PHOTOGRAPHY	YES

AMBIENT TEMP	102.0 (F)	561.7 (R)	38.9 (C)		
THERMOCOUPLE 1 //0	112.0 (F)	571.7 (R)	44.4 (C)		
THERMOCOUPLE 2 ///	113.0 (F)	572.7 (R)	45.0 (C)		
THERMOCOUPLE 3 //0	112.0 (F)	571.7 (R)	44.4 (C)		
AVG TANK TEMP	112.3 (F)	572.0 (R)	44.6 (C)		
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES		15.7 (psia)		108247.3	(Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3	(Pa)
FINAL TANK PRES		15.6 (psia)		107557.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015814506
Sample 2	Required moles oxygen	0.075307174
Sample 3	Required N2 pres (psia)	15.7
Sample 4	Required JP-4S Vol. (ml)	122

RESULTS

PEAK BOMB PRESSURE	83.2 (psig)		573641.8 (Pa)
XDUCER 1 PEAK PRES	71.2 (psig)	793	490905.0 (Pa)
XDUCER 2 PEAK PRES	79.9 (psig)	593	550889.2 (Pa)
XDUCER 3 PEAK PRES	69.9 (psig)	8/0	481941.9 (Pa)
XDUCER 4 PEAK PRES	72.4 (psig)	749	499178.7 (Pa)
AVG PEAK PRES	73.4 (psig)		505728.7 (Pa)

COMMENTS

LOW ALTITUDE AMBIENT 21 % O2
BOMB SAMPLE 1 - 83.2
BOMB SAMPLE 2 -
GOOD TEST

TEST # 37		TEST PRESSURE	15.7
DATE 6/21/89		TEST OXYGEN CONC.	15 %
TIME 0645		THREAT	IGNITER
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP		72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 1	73	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 2	72	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 3	71	70.0 (F)	529.7 (R)	21.1 (C)	
AVG TANK TEMP		71.3 (F)	531.0 (R)	21.9 (C)	
AMBIENT PRESSURE		28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0 (Pa)
STATIC TANK PRES.			13.7 (psia)		94457.8 (Pa)
ELEVATED TANK PRES			21.9 (psia)		150994.7 (Pa)
REDUCED TANK PRES			15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES			15.9 (psia)		109626.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.017035581
Sample 2	Required moles oxygen	0.113570542
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	132

RESULTS

PEAK BOMB PRESSURE	29.3 (psig)	sec.	202015.7 (Pa)
XDUCER 1 PEAK PRES	63.3 (psig)	.80	436436.6 (Pa)
XDUCER 2 PEAK PRES	64.1 (psig)	.77	441952.4 (Pa)
XDUCER 3 PEAK PRES	62.9 (psig)	.81	433678.7 (Pa)
XDUCER 4 PEAK PRES	63.0 (psig)	.79	434368.2 (Pa)
AVG PEAK PRES	63.3 (psig)		436609.0 (Pa)

COMMENTS

LOW ALITITUDE INERT CONDITION TEST 15 % O2
AMOUNT OF JP-4S USED WAS REDUCED TO ACCOUNT FOR THE REDUCED AMOUNT OF O2 TO 94ML.
BOMB SAMPLE 1 - 3.4
BOMB SAMPLE 2 - 29.3
BOMB SAMPLE 3 - 24.2
GOOD TEST ITS HARDER TO MAINTAIN PRESSURES WITH THE RAPIDLY CHANGING TEMPERATURES IN THE EARLY MORNING

TEST # 38		TEST PRESSURE	15.7
DATE 6/21/89		TEST OXYGEN CONC.	15 %
TIME 0715		THREAT	IGNITER
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	74.0 (F)	533.7 (R)	23.3 (C)	
THERMOCOUPLE 1	78.0 (F)	537.7 (R)	25.6 (C)	
THERMOCOUPLE 2	79.0 (F)	538.7 (R)	26.1 (C)	
THERMOCOUPLE 3	78.0 (F)	537.7 (R)	25.6 (C)	
AVG TANK TEMP	78.3 (F)	538.0 (R)	25.7 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		21.9 (psia)		150994.7 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016813930
Sample 2	Required moles oxygen	0.112092867
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	130

RESULTS

PEAK BOMB PRESSURE	26.6 (psig)		183399.9 (Pa)
XDUCER 1 PEAK PRES	60.3 (psig)		415752.4 (Pa)
XDUCER 2 PEAK PRES	60.8 (psig)		419199.8 (Pa)
XDUCER 3 PEAK PRES	60.0 (psig)		413684.0 (Pa)
XDUCER 4 PEAK PRES	60.0 (psig)		413684.0 (Pa)
AVG PEAK PRES	60.3 (psig)		415580.0 (Pa)

COMMENTS

LOW ALTITUDE INERT CONDITION 15% O2
AMOUNT OF JP-4S REDUCED TO 93 ML TO ACOUNT FOR LESS O2
BOMB SAMPLE 1 - 7
BOMB SAMPLE 2 - 26.6
BOMB SAMPLE 3 - 24
GOOD TEST

TEST # 39		TEST PRESSURE	15.7
DATE 6/21/89		TEST OXYGEN CONC.	15 %
TIME 0830		THREAT	IGNITER
TEST PROCEDURE 7		PHOTOGRAPHY	YES

AMBIENT TEMP	81.0 (F)	540.7 (R)	27.2 (C)		
THERMOCOUPLE 1 83	83.0 (F)	542.7 (R)	28.3 (C)		
THERMOCOUPLE 2 81	83.0 (F)	542.7 (R)	28.3 (C)		
THERMOCOUPLE 3 83	83.0 (F)	542.7 (R)	28.3 (C)		
AVG TANK TEMP	83.0 (F)	542.7 (R)	28.3 (C)		
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8	(Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8	(Pa)
ELEVATED TANK PRES		21.9 (psia)		150994.7	(Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3	(Pa)
FINAL TANK PRES		15.7 (psia)		108247.3	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016669339
Sample 2	Required moles oxygen	0.111128929
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	129

RESULTS

PEAK BOMB PRESSURE	34.8 (psig)		239936.7	(Pa)
XDUCER 1 PEAK PRES	61.5 (psig)	1.82	424026.1	(Pa)
XDUCER 2 PEAK PRES	62.5 (psig)	1.80	430920.8	(Pa)
XDUCER 3 PEAK PRES	61.2 (psig)	1.83	421957.7	(Pa)
XDUCER 4 PEAK PRES	61.5 (psig)	1.82	424026.1	(Pa)
AVG PEAK PRES	61.7 (psig)		425232.7	(Pa)

COMMENTS

LOW ALTITUDE INERTING TEST CONDITION USING 15% O2
AMOUNT OF JP-4S REDUCED TO 92ML TO ACOUNT FOR THE REDUCED AMOUNT OF O2
BOMB SAMPLE 1 - 2.1
BOMB SAMPLE 2 - 34.8
BOMB SAMPLE 3 - 31.2
GOOD TEST
TEST 39 AND 38 HAD VERY CLOSELY THE SAME PEAK PRESSURES I WOULD GUESS THAT TEST 37 WAS HIGHER BECAUSE THE INITIAL PRESSURE WAS SLIGHTLY HIGHER.

TEST # 40		TEST PRESSURE	15.7
DATE 6/21/89		TEST OXYGEN CONC.	12 %
TIME 0900		THREAT	IGNITER
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP		82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 1	89	89.0 (F)	548.7 (R)	31.7 (C)	
THERMOCOUPLE 2	91	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 3	88	88.0 (F)	547.7 (R)	31.1 (C)	
AVG TANK TEMP		89.0 (F)	548.7 (R)	31.7 (C)	
AMBIENT PRESSURE		28.6 (in Hg)	14.0 (psia)	2015.3 (psf)	96868.2 (Pa)
STATIC TANK PRES.			14.0 (psia)		96526.3 (Pa)
ELEVATED TANK PRES			27.4 (psia)		188915.7 (Pa)
REDUCED TANK PRES			15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES			15.8 (psia)		108936.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016487051
Sample 2	Required moles oxygen	0.137392094
Sample 3	Required N2 pres (psia)	27.4
Sample 4	Required JP-4S Vol. (ml)	128

RESULTS

PEAK BOMB PRESSURE	2.3 (psig)	15857.9 (Pa)
XDUCER 1 PEAK PRES	(psig)	(Pa)
XDUCER 2 PEAK PRES	(psig)	(Pa)
XDUCER 3 PEAK PRES	(psig)	(Pa)
XDUCER 4 PEAK PRES	(psig)	(Pa)
AVG PEAK PRES	(psig)	(Pa)

COMMENTS

LOW ALTITUDE INERTING TEST 12% O2
AMOUNT OF JP-4S REDUCED FROM THAT SHOWN ABOVE TO 73 ML TO ACCOUNT FOR REDUCED O2.
BOMB SAMPLE DONE AT 15.7 PSIA AS WERE TESTS 37, 38 AND 39.
BOMB SAMPLE 1- 2.1
BOMB SAMPLE 2- 2.3
BOMB SAMPLE 3 - 2.3
NO INITIATION OF EXPLOSION

TEST # 41		TEST PRESSURE	15.7
DATE 6/21/89		TEST OXYGEN CONC.	12 %
TIME 0925		THREAT	IGNITER
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 1	89.0 (F)	548.7 (R)	31.7 (C)	
THERMOCOUPLE 2	89.0 (F)	548.7 (R)	31.7 (C)	
THERMOCOUPLE 3	87.0 (F)	546.7 (R)	30.6 (C)	
AVG TANK TEMP	88.3 (F)	548.0 (R)	31.3 (C)	
AMBIENT PRESSURE	28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		27.4 (psia)		188915.7 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016507108
Sample 2	Required moles oxygen	0.137559237
Sample 3	Required N2 pres (psia)	27.4
Sample 4	Required JP-4S Vol. (ml)	128

RESULTS

PEAK BOMB PRESSURE	4.3 (psig)	29647.4 (Pa)
XDUCER 1 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 2 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 3 PEAK PRES	0.0 (psig)	0.0 (Pa)
XDUCER 4 PEAK PRES	0.0 (psig)	0.0 (Pa)
AVG PEAK PRES	0.0 (psig)	0.0 (Pa)

COMMENTS

LOW ALTITUDE INERTING CONDITION USING 12 % O2
THE AOMUNT OF JP-4S USED IN THIS TEST WAS REDUCED TO 73 ML TO ACCOUNT FOR REDUCED O2.
BOMB SAMPLES RUN AT 15.7 PSIA
BOMB SAMPLE 1 - 4.3
BOMB SAMPLE 2 - 2.3
NO IGNITION OF VAPORS IN THE ULLAGE

TEST # 42		TEST PRESSURE	14.5
DATE 6/21/89		TEST OXYGEN CONC.	21 %
TIME 0950		THREAT	IGNITER
TEST PROCEDURE 6		PHOTOGRAPHY	YES

AMBIENT TEMP	85.0 (F)	544.7 (R)	29.4 (C)		
THERMOCOUPLE 1	89.0 (F)	548.7 (R)	31.7 (C)		
THERMOCOUPLE 2	90.0 (F)	549.7 (R)	32.2 (C)		
THERMOCOUPLE 3	88.0 (F)	547.7 (R)	31.1 (C)		
AVG TANK TEMP	89.0 (F)	548.7 (R)	31.7 (C)		
AMBIENT PRESSURE	28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8	(Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8	(Pa)
ELEVATED TANK PRES		14.5 (psia)		99973.6	(Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES		8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015226894	
Sample 2	Required moles oxygen	0.072509021	
Sample 3	Required N2 pres (psia)	14.5	
Sample 4	Required JP-4S Vol. (ml)	118	

RESULTS

PEAK BOMB PRESSURE	81.4 (psig)		561231.3 (Pa)
XDUCER 1 PEAK PRES	30.0 (psig)	738	206842.0 (Pa)
XDUCER 2 PEAK PRES	36.7 (psig)	377	253036.7 (Pa)
XDUCER 3 PEAK PRES	29.1 (psig)	764	200636.7 (Pa)
XDUCER 4 PEAK PRES	31.4 (psig)	571	216494.6 (Pa)
AVG PEAK PRES	31.8 (psig)		219252.5 (Pa)

COMMENTS

HIGH ALTITUDE TEST AT AMBIENT CONDITIONS 21% O2
WE ARE CONDUCTING THIS TEST AGAIN IN ORDER TO OBTAINA GOOD PHOTO RECORD
BOMB SAMPLES WERE CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 62.1
BOMB SAMPLE 2 - 79.3
BOMB SAMPLE 3 - 81.4
BOMB SAMPLE 4 - 77.3
GOOD TEST

TEST # 43		TEST PRESSURE	14.5
DATE 6/21/89		TEST OXYGEN CONC.	15 %
TIME 1100		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP	84.0 (F)	543.7 (R)	28.9 (C)	
THERMOCOUPLE 1 94	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 2 97	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 3 93	94.0 (F)	553.7 (R)	34.4 (C)	
AVG TANK TEMP	94.0 (F)	553.7 (R)	34.4 (C)	
AMBIENT PRESSURE	28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		20.3 (psia)		139963.1 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015089386
Sample 2	Required moles oxygen	0.100595905
Sample 3	Required N2 pres (psia)	20.3
Sample 4	Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	46.9 (psig)		323363.0 (Pa)
XDUCER 1 PEAK PRES	25.7 (psig)	1.37	177194.6 (Pa)
XDUCER 2 PEAK PRES	27.0 (psig)	1.32	186157.8 (Pa)
XDUCER 3 PEAK PRES	25.5 (psig)	1.37	175815.7 (Pa)
XDUCER 4 PEAK PRES	26.0 (psig)	1.3√	179263.1 (Pa)
AVG PEAK PRES	26.1 (psig)		179607.8 (Pa)

COMMENTS

HIGH ALTITUDE INERT TEST FOR THE PHOTO RECORD (15% O2).
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
A REDUCED AMOUNT OD JP-4S WAS USED TO ACOUNT FOR REDUCED O2 LEVEL (84ML)
BOMB SAMPLE 1 - 4.3
BOMB SAMPLE 2 -
BOMB SAMPLE 3 - 46.3
BOMB SAMPLE 4 - 46.9
GOOD TEST

TEST # 44		TEST PRESSURE	14.5
DATE 6/21/89		TEST OXYGEN CONC.	12 %
TIME 1130		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP		87.0 (F)	546.7 (R)	30.6 (C)	
THERMOCOUPLE 1	95	97.0 (F)	556.7 (R)	36.1 (C)	
THERMOCOUPLE 2	97	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 3	95	96.0 (F)	555.7 (R)	35.6 (C)	
AVG TANK TEMP		97.0 (F)	556.7 (R)	36.1 (C)	
AMBIENT PRESSURE		28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.			13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES			25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015008066
Sample 2	Required moles oxygen	0.125067218
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	116

RESULTS

PEAK BOMB PRESSURE	7.8 (psig)	Secs	53778.9 (Pa)
XDUCER 1 PEAK PRES	10.0 (psig)	4.20	68947.3 (Pa)
XDUCER 2 PEAK PRES	10.1 (psig)	4.19	69636.8 (Pa)
XDUCER 3 PEAK PRES	10.0 (psig)	4.22	68947.3 (Pa)
XDUCER 4 PEAK PRES	10.0 (psig)	4.22	68947.3 (Pa)
AVG PEAK PRES	10.0 (psig)		69119.7 (Pa)

COMMENTS

HIGH ALTITUDE INERT CONDITION 12% O2 FOR PHOTO RECORD
JP-4S USED LESS THAN ABOVE (66ML).
BOMB SAMPLES CONDUCTED AT 14.5 PSIA.
BOMB SAMPLE 1 - 1.0
BOMB SAMPLE 2 - 2.1
BOMB SAMPLE 3 - 4.9
BOMB SAMPLE 4 - 7.8
BOMB SAMPLE 5 - 1.8
GOOD TEST

TEST # 45		TEST PRESSURE	14.5
DATE 6/21/89		TEST OXYGEN CONC.	21 %
TIME 1320		THREAT	IGNITER
TEST PROCEDURE 6		PHOTOGRAPHY	YES

AMBIENT TEMP	91.0 (F)	550.7 (R)	32.8 (C)	
THERMOCOUPLE 1 95	95.0 (F)	554.7 (R)	35.0 (C)	
THERMOCOUPLE 2 95	96.0 (F)	555.7 (R)	35.6 (C)	
THERMOCOUPLE 3 94	94.0 (F)	553.7 (R)	34.4 (C)	
AVG TANK TEMP	95.0 (F)	554.7 (R)	35.0 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		14.5 (psia)		99973.6 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015062181
Sample 2	Required moles oxygen	0.071724674
Sample 3	Required N2 pres (psia)	14.5
Sample 4	Required JP-4S Vol. (ml)	116

RESULTS

PEAK BOMB PRESSURE	78.3 (psig)		539857.6 (Pa)
XDUCER 1 PEAK PRES	30.5 (psig)	747	210289.4 (Pa)
XDUCER 2 PEAK PRES	37.0 (psig)	559	255105.1 (Pa)
XDUCER 3 PEAK PRES	30.7 (psig)	541	211668.3 (Pa)
XDUCER 4 PEAK PRES	32.9 (psig)	541	226836.7 (Pa)
AVG PEAK PRES	32.8 (psig)		225974.9 (Pa)

COMMENTS

HIGH ALTITUDE AMBIENT CONDITION 21% O2. PHOTO RECORD
BOMB SAMPLES CONDUCTED AT 14.5 PSI
BOMB SAMPLE 1 - 72.7
BOMB SAMPLE 2 - 77.7
BOMB SAMPLE 3 - 78.3
BOMB SAMPLE 4 - 77.7
GOOD TEST CAMERA RAN AT LAST!

TEST # 46		TEST PRESSURE	14.5
DATE 6/21/89		TEST OXYGEN CONC.	15 %
TIME 1350		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP	92.0 (F)	551.7 (R)	33.3 (C)	
THERMOCOUPLE 1 97	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 2 97	98.0 (F)	557.7 (R)	36.7 (C)	
THERMOCOUPLE 3 96	97.0 (F)	556.7 (R)	36.1 (C)	
AVG TANK TEMP	97.7 (F)	557.3 (R)	36.5 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		20.3 (psia)		139963.1 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.014990114
Sample 2	Required moles oxygen	0.099934094
Sample 3	Required N2 pres (psia)	20.3
Sample 4	Required JP-4S Vol. (ml)	116

RESULTS

PEAK BOMB PRESSURE	45.3 (psig) 5ECS	312331.4 (Pa)
XDUCER 1 PEAK PRES	25.3 (psig) 1.58	174436.8 (Pa)
XDUCER 2 PEAK PRES	26.0 (psig) 1.55	179263.1 (Pa)
XDUCER 3 PEAK PRES	24.8 (psig) 1.59	170989.4 (Pa)
XDUCER 4 PEAK PRES	25.1 (psig) 1.57	173057.8 (Pa)
AVG PEAK PRES	25.3 (psig)	174436.8 (Pa)

COMMENTS

HIGH ALTITUDE INERT CONDITION TEST 15% O2
AMOUNT OF JP-4S REDUCED TO 83 ML.
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 43.2
BOMB SAMPLE 2 - 45.3
BOMB SAMPLE 3 - 44.5
GOOD TEST CAMERA RAN VERY REPEATABLE DATA.

TEST # 47		TEST PRESSURE	14.5
DATE 6/22/89		TEST OXYGEN CONC.	12 %
TIME 0715		THREAT	IGNITER
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP		66.0 (F)	525.7 (R)	18.9 (C)	
THERMOCOUPLE 1	67	65.0 (F)	524.7 (R)	18.3 (C)	
THERMOCOUPLE 2	64	63.0 (F)	522.7 (R)	17.2 (C)	
THERMOCOUPLE 3	66	65.0 (F)	524.7 (R)	18.3 (C)	
AVG TANK TEMP		64.3 (F)	524.0 (R)	18.0 (C)	
AMBIENT PRESSURE		28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.			13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES			25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES			8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015943678
Sample 2	Required moles oxygen	0.132863980
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	123

RESULTS

			sec.	
PEAK BOMB PRESSURE	5.3 (psig)			36542.1 (Pa)
XDUCER 1 PEAK PRES	17.8 (psig)	2.87		122726.3 (Pa)
XDUCER 2 PEAK PRES	18.2 (psig)	2.87		125484.1 (Pa)
XDUCER 3 PEAK PRES	17.6 (psig)	2.78		121347.3 (Pa)
XDUCER 4 PEAK PRES	17.6 (psig)	2.88		121347.3 (Pa)
AVG PEAK PRES	17.8 (psig)			122726.3 (Pa)

COMMENTS

HIGH ALTITUDE INERTING CONDITION 12% O2
AMOUNT OF JP-4S REDUCED TO 70 ML
BOMB SAMPLES CONDUCTED AT 14.5
BOMB SAMPLE 1 - 1.2
BOMB SAMPLE 2 - 5.3
BOMB SAMPLE 3 - 1.6
GOOD TEST A LITTLE HIGHER PRESSURE THAN ANTICIPATED DON'T KNOW WHY YET.

TEST # 48		TEST PRESSURE	14.5
DATE 6/22/89		TEST OXYGEN CONC.	9 %
TIME 0930		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 1 84	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 2 84	82.0 (F)	541.7 (R)	27.8 (C)	
THERMOCOUPLE 3 82	79.0 (F)	538.7 (R)	26.1 (C)	
AVG TANK TEMP	81.0 (F)	540.7 (R)	27.2 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		14.0 (psia)		96526.3 (Pa)
ELEVATED TANK PRES		33.5 (psia)		230973.6 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015452199
Sample 2	Required moles oxygen	0.171691095
Sample 3	Required N2 pres (psia)	33.8
Sample 4	Required JP-4S Vol. (ml)	120

RESULTS

PEAK BOMB PRESSURE	2.1 (psig)		14478.9 (Pa)
XDUCER 1 PEAK PRES	1.9 (psig)	97.8	13100.0 (Pa)
XDUCER 2 PEAK PRES	2.4 (psig)	63.0	16547.4 (Pa)
XDUCER 3 PEAK PRES	1.5 (psig)	199	10342.1 (Pa)
XDUCER 4 PEAK PRES	1.7 (psig)	199	11721.0 (Pa)
AVG PEAK PRES	1.9 (psig)		12927.6 (Pa)

COMMENTS

HIGH ALTITUDE INERT CONDITION 30MIKE MIKE 9% O2
AMOUNT OF JP-4S REDUCED TO 51 ML
MEASURED O2 LEVEL AT END OF PIPE 8%
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 2.1
BOMB SAMPLE 2 - 2.1
GOOD TEST VERY LOW PRESSURE LOWER THAN EXPECTED.

TEST # 49		TEST PRESSURE	14.5
DATE 6/22/89		TEST OXYGEN CONC.	9 %
TIME 1200		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	NO

AMBIENT TEMP		91.0 (F)	550.7 (R)	32.8 (C)		
THERMOCOUPLE 1	70	90.0 (F)	549.7 (R)	32.2 (C)		
THERMOCOUPLE 2	91	90.0 (F)	549.7 (R)	32.2 (C)		
THERMOCOUPLE 3	90	90.0 (F)	549.7 (R)	32.2 (C)		
AVG TANK TEMP		90.0 (F)	549.7 (R)	32.2 (C)		
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			33.8 (psia)		233042.0	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015199193
Sample 2	Required moles oxygen	0.168879918
Sample 3	Required N2 pres (psia)	33.8
Sample 4	Required JP-4S Vol. (ml)	118

RESULTS

PEAK BOMB PRESSURE	2.1 (psig)		14478.9 (Pa)
XDUCER 1 PEAK PRES	2.0 (psig)	89.2	13789.5 (Pa)
XDUCER 2 PEAK PRES	2.6 (psig)	55.4	17926.3 (Pa)
XDUCER 3 PEAK PRES	1.6 (psig)	20.2	11031.6 (Pa)
XDUCER 4 PEAK PRES	1.7 (psig)	187.4	11721.0 (Pa)
AVG PEAK PRES	2.0 (psig)		13617.1 (Pa)

COMMENTS

HIGH ALTITUDE INERT CONDITION 9% 02
O2 METER READ 8% WHEN MEASURED AT DUMP VALVE
JP-4S REDUCED TO 51 ML
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 1.8
BOMB SAMPLE 2 - 2.1
THIS LOW PRESSURE IS BAFFELING ME I PULLED THE PRESSURES OFF THE TAPE AND THEY AGREE WITH THE NICOLET. I NEVER DREAMED THAT THERE WOULD BE AN EFFECT LIKE THIS AT THIS LOW OXYGEN LEVEL. 8.4+5.5=13.9 THIS CORRESPONDS TO AN OVER PRESSURE GENERATED BY THE ROUND OF 7.5 PSI.
GOOD AGREEMENT WITH TEST 48.

TEST # 50		TEST PRESSURE	14.5
DATE 6/22/89		TEST OXYGEN CONC.	9 %
TIME 1245		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	ND

AMBIENT TEMP		93.0 (F)	552.7 (R)	33.9 (C)		
THERMOCOUPLE 1	93	93.0 (F)	552.7 (R)	33.9 (C)		
THERMOCOUPLE 2	93	93.0 (F)	552.7 (R)	33.9 (C)		
THERMOCOUPLE 3	92	93.0 (F)	552.7 (R)	33.9 (C)		
AVG TANK TEMP		93.0 (F)	552.7 (R)	33.9 (C)		
AMBIENT PRESSURE		28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4	(Pa)
STATIC TANK PRES.			13.8 (psia)		95147.3	(Pa)
ELEVATED TANK PRES			33.8 (psia)		233042.0	(Pa)
REDUCED TANK PRES			8.4 (psia)		57915.8	(Pa)
FINAL TANK PRES			8.4 (psia)		57915.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015116688
Sample 2	Required moles oxygen	0.167963205
Sample 3	Required N2 pres (psia)	33.8
Sample 4	Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	6.2 (psig)		42747.3	(Pa)
XDUCER 1 PEAK PRES	1.8 (psig)	103	12410.5	(Pa)
XDUCER 2 PEAK PRES	2.5 (psig)	57.8	17236.8	(Pa)
XDUCER 3 PEAK PRES	1.6 (psig)	221	11031.6	(Pa)
XDUCER 4 PEAK PRES	1.7 (psig)	202	11721.0	(Pa)
AVG PEAK PRES	1.9 (psig)		13100.0	(Pa)

COMMENTS

HIGH ALTITUDE INERTING TEST 9% O2 USING 30 MM
AMOUNT OF JP-4S REDUCED TO 50 ML
OXYGEN METER READING 8.SOMETHING OUT THE PIPE WHEN VENTING
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 6.2
BOMB SAMPLE 2 -2.9
GOOD TEST. INITIAL PRESSURE WAS -5.4 PSIG. VERY GOOD AGREEMENT WITH TEST 48 AND 49.

TEST # 51		TEST PRESSURE	14.5
DATE 6/22/89		TEST OXYGEN CONC.	12 %
TIME 1415		THREAT	30mm HEI
TEST PROCEDURE 9		PHOTOGRAPHY	YES

AMBIENT TEMP		9.0 (F)	468.7 (R)	-12.8 (C)		
THERMOCOUPLE 1	94	94.0 (F)	553.7 (R)	34.4 (C)		
THERMOCOUPLE 2	94	94.0 (F)	553.7 (R)	34.4 (C)		
THERMOCOUPLE 3	94	94.0 (F)	553.7 (R)	34.4 (C)		
AVG TANK TEMP		94.0 (F)	553.7 (R)	34.4 (C)		
AMBIENT PRESSURE		28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0	(Pa)
STATIC TANK PRES.			13.7 (psia)		94457.8	(Pa)
ELEVATED TANK PRES			25.3 (psia)		174436.8	(Pa)
REDUCED TANK PRES			13.7 (psia)		94457.8	(Pa)
FINAL TANK PRES			13.9 (psia)		95836.8	(Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015089386
Required moles oxygen	0.125744881
Required N2 pres (psia)	25.3
Required JP-4S Vol. (ml)	117

RESULTS

PEAK BOMB PRESSURE	5.1 (psig)		35163.1 (Pa)
XDUCER 1 PEAK PRES	8.8 (psig)	122	60673.7 (Pa)
XDUCER 2 PEAK PRES	9.5 (psig)	69	65500.0 (Pa)
XDUCER 3 PEAK PRES	8.6 (psig)	182	59294.7 (Pa)
XDUCER 4 PEAK PRES	8.6 (psig)	169	59294.7 (Pa)
AVG PEAK PRES	8.9 (psig)		61190.8 (Pa)

COMMENTS

AMBIENT INERTING AT 12% O2
AMOUNT OF JP-4S REDUCED TO 67 ML
OXYGEN METER MEASURED 12% AT VENTING PIPE.
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 2.1
BOMB SAMPLE 2 - 1.2
BOMB SAMPLE 3 - 4.5
BOMB SAMPLE 4 - 5.1
THERE WAS OBVIOUSLY SOME COMBUSTION OCCURING DURING THIS SHOT. BLACK SMOKE CAME OUT OF THE SIMULATOR.
GOOD TEST.

TEST # 52		TEST PRESSURE	14.5
DATE 6/23/89		TEST OXYGEN CONC.	12 %
TIME 0725		THREAT	30mm HEI
TEST PROCEDURE 9		PHOTOGRAPHY	ND

AMBIENT TEMP	77.0 (F)	536.7 (R)	25.0 (C)	
THERMOCOUPLE 1	75.0 (F)	534.7 (R)	23.9 (C)	
THERMOCOUPLE 2	75.0 (F)	534.7 (R)	23.9 (C)	
THERMOCOUPLE 3	75.0 (F)	534.7 (R)	23.9 (C)	
AVG TANK TEMP	75.0 (F)	534.7 (R)	23.9 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES		13.9 (psia)		95836.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015625601
Sample 2	Required moles oxygen	0.130213343
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	121

RESULTS

PEAK BOMB PRESSURE	6.4 (psig)	44126.3 (Pa)
XDUCER 1 PEAK PRES	8.7 (psig)	59984.2 (Pa)
XDUCER 2 PEAK PRES	9.6 (psig)	66189.4 (Pa)
XDUCER 3 PEAK PRES	8.4 (psig)	57915.8 (Pa)
XDUCER 4 PEAK PRES	8.5 (psig)	58605.2 (Pa)
AVG PEAK PRES	8.8 (psig)	60673.7 (Pa)

COMMENTS

AMBIENT INERTING WITH 12% O2
AMOUNT OF JP-4S REDUCED TO 69 ML
12 % OXYGEN MEASURED AT THE DUMP PIPE WHIN REDUCING THE PRESSURE TO 14.5
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 - 1.2
BOMB SAMPLE 2 -6.4
TEMPERATURES AT THE TIME OF SHOT
T1 - 77
T2 -78
T3 -76
TIME OF PEAK PRESSURE OCCURENCE
xd1 - 105, xd2 - 73,xd3 - 169, xd4 - 169 mS

TEST # 53		TEST PRESSURE	14.5
DATE 6/23/89		TEST OXYGEN CONC.	12 %
TIME 0800		THREAT	30mm HEI
TEST PROCEDURE 9		PHOTOGRAPHY	NO

AMBIENT TEMP	83.0 (F)	542.7 (R)	28.3 (C)	
THERMOCOUPLE 1	80.0 (F)	539.7 (R)	26.7 (C)	
THERMOCOUPLE 2	80.0 (F)	539.7 (R)	26.7 (C)	
THERMOCOUPLE 3	79.0 (F)	538.7 (R)	26.1 (C)	
AVG TANK TEMP	79.7 (F)	539.3 (R)	26.5 (C)	
AMBIENT PRESSURE	28.2 (in Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		13.8 (psia)		95147.3 (Pa)
FINAL TANK PRES		13.9 (psia)		95836.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015490399
Sample 2	Required moles oxygen	0.129086659
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	120

RESULTS

PEAK BOMB PRESSURE	4.9 (psig)	33784.2 (Pa)
XDUCER 1 PEAK PRES	9.4 (psig)	64810.5 (Pa)
XDUCER 2 PEAK PRES	10.1 (psig)	69636.8 (Pa)
XDUCER 3 PEAK PRES	9.1 (psig)	62742.1 (Pa)
XDUCER 4 PEAK PRES	9.1 (psig)	62742.1 (Pa)
AVG PEAK PRES	9.4 (psig)	64982.9 (Pa)

COMMENTS

AMBIENT CONDITION INERTING TO 12% OXYGEN
AMOUNT OF JP-4S REDUCED TO 69ML
12% OXYGEN MEASURED AT THE DUMP PIPE WHEN REDUCING THE PRESSURE
BOMB SAMPLES CONDUCTED AT 14.5 PSIA
BOMB SAMPLE 1 -1.4
BOMB SAMPLE 2 - 4.9
BOMB SAMPLE 3 - 2.1
TEMPERATURES AT THE TIME OF TEST
T1 - 82
T2 - 82
T3 - 80
TIME OF PEAK PRESSURE OCCURANCE
xd1 - 93, xd2 - 72, xd3 - 179, xd4 - 161 mS

TEST # 54		TEST PRESSURE	16
DATE 6/23/89		TEST OXYGEN CONC.	12 %
TIME 0900		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	86.0 (F)	545.7 (R)	30.0 (C)	
THERMOCOUPLE 1	85.0 (F)	544.7 (R)	29.4 (C)	
THERMOCOUPLE 2	86.0 (F)	545.7 (R)	30.0 (C)	
THERMOCOUPLE 3	83.0 (F)	542.7 (R)	28.3 (C)	
AVG TANK TEMP	84.7 (F)	544.3 (R)	29.3 (C)	
AMBIENT PRESSURE	27.8 (in Hg)	13.6 (psia)	1959.0 (psf)	94158.6 (Pa)
STATIC TANK PRES.		13.6 (psia)		93768.4 (Pa)
ELEVATED TANK PRES		27.9 (psia)		192363.1 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016935848
Sample 2	Required moles oxygen	0.141132066
Sample 3	Required N2 pres (psia)	27.9
Sample 4	Required JP-4S Vol. (ml)	131

RESULTS

PEAK BOMB PRESSURE	5.5 (psig)	37921.0 (Pa)
XDUCER 1 PEAK PRES	10.4 (psig)	71705.2 (Pa)
XDUCER 2 PEAK PRES	10.9 (psig)	75152.6 (Pa)
XDUCER 3 PEAK PRES	10.0 (psig)	68947.3 (Pa)
XDUCER 4 PEAK PRES	10.1 (psig)	69636.8 (Pa)
AVG PEAK PRES	10.4 (psig)	71360.5 (Pa)

COMMENTS

LOW ALTITUDE INERTING CONDITION 12% OXYGEN
AMOUNT OF JP-4S REDICED TO 75 ML
11% OXYGEN CONCENTRATION MEASURED
BOMB SAMPLED CONDUCTED AT 16 PSIA
BOMB SAMPLE 1 - 5.5
BOMB SAMPLE 2 - 3.5
TEMPERATURES AT THE TIME OF TEST
T1 - 87
T2 - 87
T3 - 85
TIME OF OCCURANCE FOR PEAK PRESSURE
xd1 - 91.2, xd2 - 67, xd3 - 146, xd4 - 134 mS

TEST # 55		TEST PRESSURE	16
DATE 6/23/89		TEST OXYGEN CONC.	12 %
TIME 1000		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	86.0 (F)	545.7 (R)	30.0 (C)	
THERMOCOUPLE 1	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 2	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 3	88.0 (F)	547.7 (R)	31.1 (C)	
AVG TANK TEMP	89.3 (F)	549.0 (R)	31.9 (C)	
AMBIENT PRESSURE	27.8 (In Hg)	13.6 (psia)	1959.0 (psf)	94158.6 (Pa)
STATIC TANK PRES.		13.6 (psia)		93768.4 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016791889
Sample 2	Required moles oxygen	0.139932407
Sample 3	Required N2 pres (psia)	27.9
Sample 4	Required JP-4S Vol. (ml)	130

RESULTS

PEAK BOMB PRESSURE	3.1 (psig)	21373.7 (Pa)
XDUCER 1 PEAK PRES	11.8 (psig)	81357.9 (Pa)
XDUCER 2 PEAK PRES	12.6 (psig)	86873.6 (Pa)
XDUCER 3 PEAK PRES	11.7 (psig)	80668.4 (Pa)
XDUCER 4 PEAK PRES	11.6 (psig)	79978.9 (Pa)
AVG PEAK PRES	11.9 (psig)	82219.7 (Pa)

COMMENTS

LOW ALTITUDE INERT CONDITION 12% OXYGEN
AMOUNT OF JP-4S REDUCED TO 74 ML
12% OXYGEN READING AT DUMP PIPE
BOMB SAMPLES CONDUCTED AT 16 PSIA
BOMB SAMPLE 1 - 2.5
BOMB SAMPLE 2 - 3.1
TEMPERATURES AT TIME OF TEST
T1 - 91
T2 - 91
T3 - 88
TIME OF OCCURANCE OF PEAK PRESSURE
xd1 - 103, xd2 - 77, xd3 - 166, xd4 - 156mS
THERE IS AN ERROR IN THE CALCULATION OF THE PSI TO TAKE THE TANK TO WITH N2 WILL CORREDRT IT FOR NEXT TEST

TEST # 56		TEST PRESSURE	16
DATE 6/23/89		TEST OXYGEN CONC.	12 %
TIME 1130		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	YES

AMBIENT TEMP	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 1	93.0 (F)	552.7 (R)	33.9 (C)	
THERMOCOUPLE 2	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 3	92.0 (F)	551.7 (R)	33.3 (C)	
AVG TANK TEMP	93.0 (F)	552.7 (R)	33.9 (C)	
AMBIENT PRESSURE	28.0 (in Hg)	13.7 (psia)	1973.1 (psf)	94836.0 (Pa)
STATIC TANK PRES.		13.7 (psia)		94457.8 (Pa)
ELEVATED TANK PRES		24.0 (psia)		165473.6 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016680484
Sample 2	Required moles oxygen	0.139004032
Sample 3	Required N2 pres (psia)	27.9
Sample 4	Required JP-4S Vol. (ml)	129

RESULTS

PEAK BOMB PRESSURE	10.0 (psig)	68947.3 (Pa)
XDUCER 1 PEAK PRES	12.1 (psig)	83426.3 (Pa)
XDUCER 2 PEAK PRES	13.2 (psig)	91010.5 (Pa)
XDUCER 3 PEAK PRES	11.6 (psig)	79978.9 (Pa)
XDUCER 4 PEAK PRES	11.7 (psig)	80668.4 (Pa)
AVG PEAK PRES	12.2 (psig)	83771.0 (Pa)

COMMENTS

LOW ALTITUDE INERTING CONDITION TEST 12 % OXYGEN.
12.5% OXYGEN MEASURED AT DUMP PIPE.
AMOUNT OF JP-4S USED REDUCED TO 74 ML.
BOMB SAMPLES CONDUCTED AT 16 PSIA.
BOMB SAMPLE 1 - 10
BOMB SAMPLE 2 - 4.3
TEMPERATURES AT TIME OF TEST
T1 - 93
T2 - 94
T3 - 92
TIMES OF PEAK PRESSURES
xd1 - 97, xd2 - 70, xd3 - 151, xd4 - 151 mS

TEST # 57		TEST PRESSURE	14.5
DATE 6/26/89		TEST OXYGEN CONC.	12 %
TIME 0700		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	YES

AMBIENT TEMP	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 1	73.0 (F)	532.7 (R)	22.8 (C)	
THERMOCOUPLE 2	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 3	71.0 (F)	530.7 (R)	21.7 (C)	
AVG TANK TEMP	72.0 (F)	531.7 (R)	22.2 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.6 (psia)		59294.7 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015713770
Sample 2	Required moles oxygen	0.130948085
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	122

RESULTS

PEAK BOMB PRESSURE	4.1 (psig)	28268.4 (Pa)
XDUCER 1 PEAK PRES	19.4 (psig)	133757.8 (Pa)
XDUCER 2 PEAK PRES	24.0 (psig)	165473.6 (Pa)
XDUCER 3 PEAK PRES	15.6 (psig)	107557.8 (Pa)
XDUCER 4 PEAK PRES	16.5 (psig)	113763.1 (Pa)
AVG PEAK PRES	18.9 (psig)	130138.1 (Pa)

COMMENTS

HIGH ALTITUDE INERTING CONDITION 12% OXYGEN
12% OXYGEN MEASURED AT END OF DUMP PIPE
AMOUNT OF JP-4S REDUCED TO 70 ML
BOMB SAMPLES CONDUCTED AT 14.5
BOMB SAMPLE 1 - 0.8
BOMB SAMPLE 2 - 3.5, BOMB SAMPLE 3 -4.1
TEMPERATURES AT TIME OF TEST
T1 - 76
T2 - 76
T3 - 74
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 137, xd2 - 112, xd3 - 251, xd4 - 237mS.

I SUSPECT THAT THERE WAS A LEAK IN THE SIMULATOR.

TEST # 58		TEST PRESSURE	15.7
DATE 6/26/89		TEST OXYGEN CONC.	15 %
TIME 0845		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	YES

AMBIENT TEMP	76.0 (F)	535.7 (R)	24.4 (C)	
THERMOCOUPLE 1	80.0 (F)	539.7 (R)	26.7 (C)	
THERMOCOUPLE 2	80.0 (F)	539.7 (R)	26.7 (C)	
THERMOCOUPLE 3	78.0 (F)	537.7 (R)	25.6 (C)	
AVG TANK TEMP	79.3 (F)	539.0 (R)	26.3 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		21.9 (psia)		150994.7 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.8 (psia)		108936.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016782736
Sample 2	Required moles oxygen	0.111884904
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	130

RESULTS

PEAK BOMB PRESSURE	39.5 (psig)	272342.0 (Pa)
XDUCER 1 PEAK PRES	49.8 (psig)	343357.7 (Pa)
XDUCER 2 PEAK PRES	54.6 (psig)	376452.4 (Pa)
XDUCER 3 PEAK PRES	47.5 (psig)	327499.8 (Pa)
XDUCER 4 PEAK PRES	47.5 (psig)	327499.8 (Pa)
AVG PEAK PRES	49.9 (psig)	343702.5 (Pa)

COMMENTS

LOW ALTITUDE 15% OXYGEN INERTING TEST
13.5 - 14%OXYGEN MEASURED AT THE DUMP PIPE
AMOUNT OF JP-4S REDUCED TO 93 ML
BOMB SAMPLES CONDUCTED AT 15.7 PSIA INDICATED
BOMB SAMPLE 1 - 7.6
BOMB SAMPLE 2 - 2.0, BOMB SAMPLE 3 - 2.1, BOMB SAMPLE 4 - 2.1, BOMB SAMPLE 5 - 6.6, BOMB SAMPLE 6 - 14.3, BOMB SAMPLE 7 - 39.5
TEMPERATRUES AT TIME OF SHOT
T1 - 82
T2 - 82
T3 - 79
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 253, xd2 - 212, xd3 - 363, xd4 - 354mS

TEST # 59		TEST PRESSURE	15.7
DATE 6/26/89		TEST OXYGEN CONC.	9 %
TIME 1000		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	ND

AMBIENT TEMP	83.0 (F)	542.7 (R)	28.3 (C)	
THERMOCOUPLE 1	90.0 (F)	549.7 (R)	32.2 (C)	
THERMOCOUPLE 2	91.0 (F)	550.7 (R)	32.8 (C)	
THERMOCOUPLE 3	89.0 (F)	548.7 (R)	31.7 (C)	
AVG TANK TEMP	90.0 (F)	549.7 (R)	32.2 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		36.6 (psia)		252347.2 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016457057
Sample 2	Required moles oxygen	0.182856187
Sample 3	Required N2 pres (psia)	36.6
Sample 4	Required JP-4S Vol. (ml)	127

RESULTS

PEAK BOMB PRESSURE	8.4 (psig)	57915.8 (Pa)
XDUCER 1 PEAK PRES	10.4 (psig)	71705.2 (Pa)
XDUCER 2 PEAK PRES	10.9 (psig)	75152.6 (Pa)
XDUCER 3 PEAK PRES	9.7 (psig)	66878.9 (Pa)
XDUCER 4 PEAK PRES	9.6 (psig)	66189.4 (Pa)
AVG PEAK PRES	10.2 (psig)	69981.5 (Pa)

COMMENTS

LOW ALTITUDE INERTING CONDITION 9% OXYGEN
8.0 %OXYGEN MEASURED AT THE DUMP PIPE.
AMOUNT OF JP-42 REDUCED TO 54 ML
BOMB SAMPLES CONDUCTED AT 15.7 PSIA
BOMB SAMPLE 1 - 3.7, B. S. 2 - 2.3, B. S. 3 - 4.1, B. S. 4 - 8.4.
TEMPERATURES AT TIME OF TEST
T1 - 91
T2 - 91
T3 - 90
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 504, xd2 - 495, xd3 - 613, xd4 - 612mS.
ZERO TIME MEANINGLESS, DIDN'T GET A SIGNAL

TEST # 60		TEST PRESSURE	15.7
DATE 6/26/89		TEST OXYGEN CONC.	9 %
TIME 1230		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	YES

AMBIENT TEMP	87.0 (F)	546.7 (R)	30.6 (C)	
THERMOCOUPLE 1	92.0 (F)	551.7 (R)	33.3 (C)	
THERMOCOUPLE 2	93.0 (F)	552.7 (R)	33.9 (C)	
THERMOCOUPLE 3	90.0 (F)	549.7 (R)	32.2 (C)	
AVG TANK TEMP	91.7 (F)	551.3 (R)	33.1 (C)	
AMBIENT PRESSURE	28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		36.6 (psia)		252347.2 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016407308
Sample 2	Required moles oxygen	0.182303421
Sample 3	Required N2 pres (psia)	36.6
Sample 4	Required JP-4S Vol. (ml)	127

RESULTS

PEAK BOMB PRESSURE	6.8 (psig)	46884.2 (Pa)
XDUCER 1 PEAK PRES	(psig)	(Pa)
XDUCER 2 PEAK PRES	(psig)	(Pa)
XDUCER 3 PEAK PRES	(psig)	(Pa)
XDUCER 4 PEAK PRES	(psig)	(Pa)
AVG PEAK PRES	(psig)	(Pa)

COMMENTS

LOW ALTITUDE INERTING 9 % OXYGEN
8.0 % OXYGEN MEASURED AT THE DUMP PIPE
REDUCED JP-4S TO 54 ML
BOMB SAMPLES CONDUCTED AT 15.7 PSIA INDICATED
BOMB SAMPLE 1 - 6.8, B. S. 2 - 2.3, B. S. 3 -2.0, B. S. 4 - 4.1, B. S. 5 - 5.9
TEMPERATURES AT TIME OF TEST
T1 - 93
T2 - 93
T3 - 92
TIME OF OCCURENCE OF PEAK PRESSURE

TEST # 61		TEST PRESSURE	15.7
DATE 6/26/89		TEST OXYGEN CONC.	9 %
TIME 1330		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	92.0 (F)	551.7 (R)	33.3 (C)	
THERMOCOUPLE 1	94.0 (F)	553.7 (R)	34.4 (C)	
THERMOCOUPLE 2	95.0 (F)	554.7 (R)	35.0 (C)	
THERMOCOUPLE 3	93.0 (F)	552.7 (R)	33.9 (C)	
AVG TANK TEMP	94.0 (F)	553.7 (R)	34.4 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		36.6 (psia)		252347.2 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016338162
Sample 2	Required moles oxygen	0.181535139
Sample 3	Required N2 pres (psia)	36.6
Sample 4	Required JP-4S Vol. (ml)	126

RESULTS

PEAK BOMB PRESSURE	4.9 (psig)	33784.2 (Pa)
XDUCER 1 PEAK PRES	10.2 (psig)	70326.3 (Pa)
XDUCER 2 PEAK PRES	11.2 (psig)	77221.0 (Pa)
XDUCER 3 PEAK PRES	9.9 (psig)	68257.9 (Pa)
XDUCER 4 PEAK PRES	10.1 (psig)	69636.8 (Pa)
AVG PEAK PRES	10.4 (psig)	71360.5 (Pa)

COMMENTS

LOW ALTITUDE INERTING TEST 9% OXYGEN
8.0 % OXYGEN READING AT DUMP PIPE
AMOUNT OF JP-4S USED 54 ML
BOMB SAMPLES CONDUCTED AT 15.7 PSIA INDICATED
BOMB SAMPLE 1 - 3.3, BS2 - 2.1, BS3 - 4.9, BS4 - 2.1, BS5 - 2.1, BS6 - 2.1
TEMPERATURES AT TIME OF TEST
T1 - 95
T2 - 95
T3 - 93
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 80, xd2 - 57, xd3 - 138, xd4 - 138mS.

TEST # 62		TEST PRESSURE	15.7
DATE 6/26/89		TEST OXYGEN CONC.	15 %
TIME 1400		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	95.0 (F)	554.7 (R)	35.0 (C)	
THERMOCOUPLE 1	96.0 (F)	555.7 (R)	35.6 (C)	
THERMOCOUPLE 2	96.0 (F)	555.7 (R)	35.6 (C)	
THERMOCOUPLE 3	95.0 (F)	554.7 (R)	35.0 (C)	
AVG TANK TEMP	95.7 (F)	555.3 (R)	35.4 (C)	
AMBIENT PRESSURE	28.2 (In Hg)	13.8 (psia)	1987.2 (psf)	95513.4 (Pa)
STATIC TANK PRES.		13.8 (psia)		95147.3 (Pa)
ELEVATED TANK PRES		21.9 (psia)		150994.7 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016289129
Sample 2	Required moles oxygen	0.108594191
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	126

RESULTS

PEAK BOMB PRESSURE	39.8 (psig)	274410.4 (Pa)
XDUCER 1 PEAK PRES	45.8 (psig)	315778.8 (Pa)
XDUCER 2 PEAK PRES	55.5 (psig)	382657.7 (Pa)
XDUCER 3 PEAK PRES	42.1 (psig)	290268.3 (Pa)
XDUCER 4 PEAK PRES	43.8 (psig)	301989.3 (Pa)
AVG PEAK PRES	46.8 (psig)	322673.5 (Pa)

COMMENTS

LOW ALTITUDE INERTING TEST 15% OXYGEN
13 %OXYGEN MEASURED AT END OF DUMP PIPE
AMOUNT OF JP-4S USED 90 ML
BOMB SAMPLES CONDECTED AT 15.7 PSIA INDICATED
BOMB SAMPLE 1 - 2.0, BS2 - 2.3, BS3 - 8.6, BS4 - 4.9, BS5 - 7.0, BS6 - 33.4, BS7 - 39.8
TEMPERATURES AT TIME OF TEST
T1 - 94
T2 - 97
T3 - 96
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 217, xd2 - 168, xd3 - 379, xd4 - 351mS. ZERO TIME LOST.
THERMOCOUPLES NOT READING WRIGHT I USED T2 FOR MY READING. TURNS OUT THE GROUND WIRE WAS OFF.

TEST # 63		TEST PRESSURE	14.5
DATE 6/27/89		TEST OXYGEN CONC.	12 %
TIME 0715		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	NO

AMBIENT TEMP	72.0 (F)	531.7 (R)	22.2 (C)	
THERMOCOUPLE 1	73.0 (F)	532.7 (R)	22.8 (C)	
THERMOCOUPLE 2	74.0 (F)	533.7 (R)	23.3 (C)	
THERMOCOUPLE 3	73.0 (F)	532.7 (R)	22.8 (C)	
AVG TANK TEMP	73.3 (F)	533.0 (R)	23.0 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.5 (psia)		58605.2 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Moles Oxygen in air	0.015674461
Required moles oxygen	0.130620512
Required N2 pres (psia)	25.3
Required JP-4S Vol. (ml)	121

RESULTS

PEAK BOMB PRESSURE	3.3 (psig)	22752.6 (Pa)
XDUCER 1 PEAK PRES	3.6 (psig)	24821.0 (Pa)
XDUCER 2 PEAK PRES	4.5 (psig)	31026.3 (Pa)
XDUCER 3 PEAK PRES	2.9 (psig)	19994.7 (Pa)
XDUCER 4 PEAK PRES	2.9 (psig)	19994.7 (Pa)
AVG PEAK PRES	3.5 (psig)	23959.2 (Pa)

COMMENTS

HIGH ALTITUDE INERTING CONDITION 12 % OXYGEN
12 % OXYGEN MEASURED AT DUMP PIPE
AMOUNT OF JP-4S USED WAS 69 ML
BOMB SAMPLES CONDUCTED AT 14.5 PSIA INDICATED
BOMB SAMPLE 1 - 1.0, BS2 - 1.0, BS3 - 1.6, BS4 - 3.3, BS5 - 1.0, BS6 - 1.0, BS7 - 1.6, BS8 - 2.5, BS9 - 3.1, BS10 - 3.1
TEMPERATURES AT TIME OF TEST
T1 - 74
T2 - 74
T3 - 75
TIME OF OCCURANCE OF PEAK PRESSURE
xd1 - 101, xd2 - 79, xd3 - 189, xd4 - 189mS
-5.4 PSIG INITIAL PRESSURE

TEST # 64		TEST PRESSURE	14.5
DATE 6/27/89		TEST OXYGEN CONC.	12 %
TIME 0810		THREAT	30mm HEI
TEST PROCEDURE 8		PHOTOGRAPHY	ND

AMBIENT TEMP	75.0 (F)	534.7 (R)	23.9 (C)	
THERMOCOUPLE 1	77.0 (F)	536.7 (R)	25.0 (C)	
THERMOCOUPLE 2	78.0 (F)	537.7 (R)	25.6 (C)	
THERMOCOUPLE 3	77.0 (F)	536.7 (R)	25.0 (C)	
AVG TANK TEMP	77.3 (F)	537.0 (R)	25.2 (C)	
AMBIENT PRESSURE	28.4 (In Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		25.3 (psia)		174436.8 (Pa)
REDUCED TANK PRES		8.4 (psia)		57915.8 (Pa)
FINAL TANK PRES		8.4 (psia)		57915.8 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.015557706
Sample 2	Required moles oxygen	0.129647553
Sample 3	Required N2 pres (psia)	25.3
Sample 4	Required JP-4S Vol. (ml)	120

RESULTS

PEAK BOMB PRESSURE	4.5 (psig)	31026.3 (Pa)
XDUCER 1 PEAK PRES	5.1 (psig)	35163.1 (Pa)
XDUCER 2 PEAK PRES	5.9 (psig)	40678.9 (Pa)
XDUCER 3 PEAK PRES	4.7 (psig)	32405.2 (Pa)
XDUCER 4 PEAK PRES	4.7 (psig)	32405.2 (Pa)
AVG PEAK PRES	5.1 (psig)	35163.1 (Pa)

COMMENTS

HIGH ALTITUDE INERTING TEST 12 % OXYGEN
12 % OXYGEN MEASURED AT DUMP PIPE
JP-4S REDUCED TO 69 ML
BOMB SAMPLES CONDUCTED AT 14.5 PSIA INDICATED
BOMB SAMPLE 1 - 4.1, BS2 - 2.5, BS3 - 1.2, BS4 - 1.0, BS5 - 1.0, BS6 - 2.1, BS7 - 3.5, BS8 - 1.2, BS9 - 2.0, BS10 - 4.5
TEMPERATURES AT TIME OF TEST
T1 - 79
T2 - 77
T3 - 79
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 123, xd2 - 98, xd3 - 231, xd4 - 218mS

TEST # 65		TEST PRESSURE	15.7
DATE 6/27/89		TEST OXYGEN CONC.	15 %
TIME 0845		THREAT	30mm HEI
TEST PROCEDURE 7		PHOTOGRAPHY	NO

AMBIENT TEMP	80.0 (F)	539.7 (R)	26.7 (C)	
THERMOCOUPLE 1	81.0 (F)	540.7 (R)	27.2 (C)	
THERMOCOUPLE 2	81.0 (F)	540.7 (R)	27.2 (C)	
THERMOCOUPLE 3	81.0 (F)	540.7 (R)	27.2 (C)	
AVG TANK TEMP	81.0 (F)	540.7 (R)	27.2 (C)	
AMBIENT PRESSURE	28.4 (in Hg)	13.9 (psia)	2001.3 (psf)	96190.8 (Pa)
STATIC TANK PRES.		13.9 (psia)		95836.8 (Pa)
ELEVATED TANK PRES		20.3 (psia)		139963.1 (Pa)
REDUCED TANK PRES		15.7 (psia)		108247.3 (Pa)
FINAL TANK PRES		15.7 (psia)		108247.3 (Pa)

OXYGEN CONCENTRATION (%)

Sample 1	Moles Oxygen in air	0.016731001
Sample 2	Required moles oxygen	0.111540008
Sample 3	Required N2 pres (psia)	21.9
Sample 4	Required JP-4S Vol. (ml)	129

RESULTS

PEAK BOMB PRESSURE	51.0 (psig)	351631.4 (Pa)
XDUCER 1 PEAK PRES	48.3 (psig)	333015.6 (Pa)
XDUCER 2 PEAK PRES	58.0 (psig)	399894.5 (Pa)
XDUCER 3 PEAK PRES	43.9 (psig)	302678.8 (Pa)
XDUCER 4 PEAK PRES	45.9 (psig)	316468.3 (Pa)
AVG PEAK PRES	49.0 (psig)	338014.3 (Pa)

COMMENTS

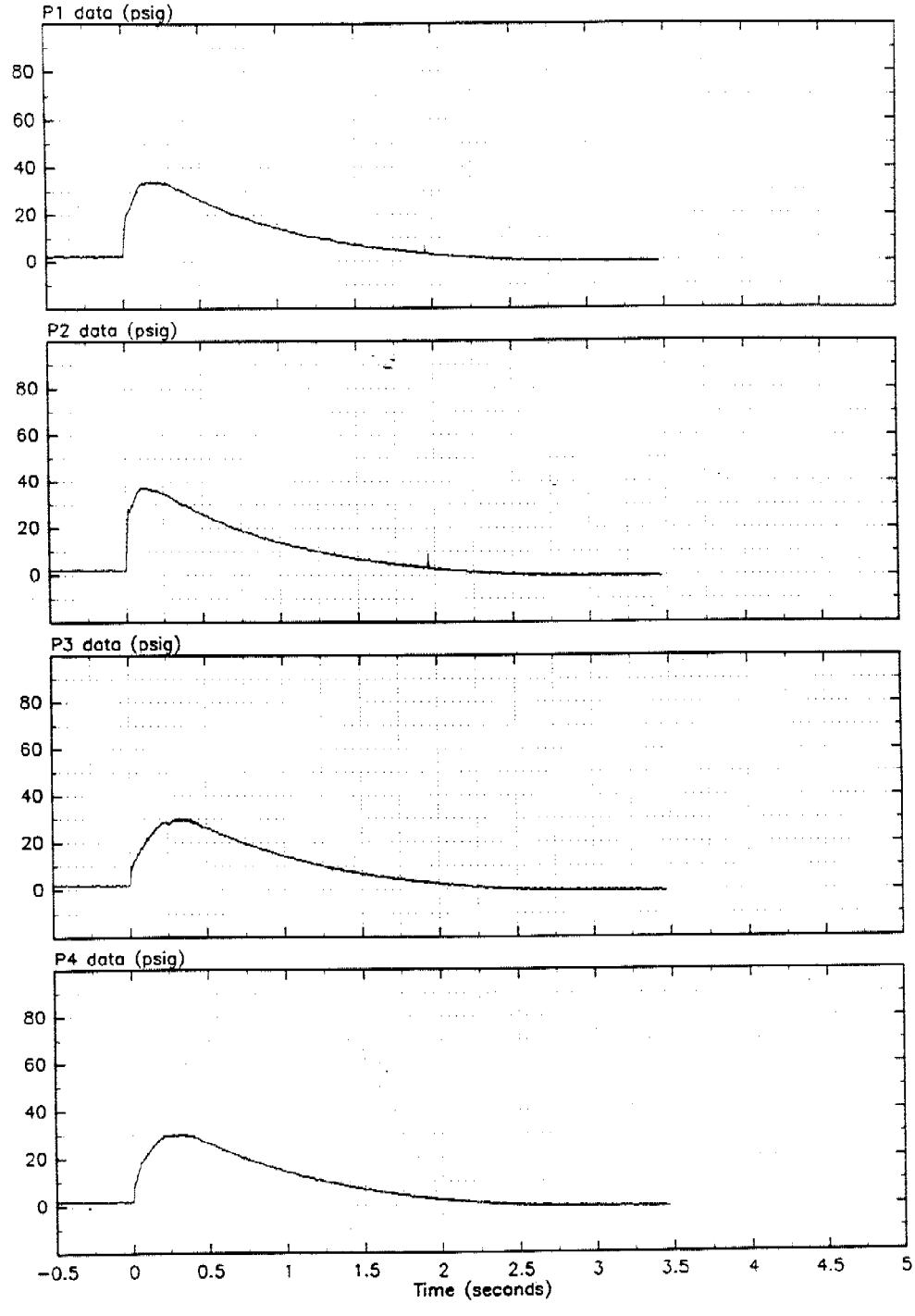
LOW ALTITUDE INERTING TEST 15% OXYGEN
15 % OXYGEN MEASURED AT END OF PIPE
JP-4S REDUCED TO 92 ML
BOMB SAMPLES CONDUCTED AT 15.7
BOMB SAMPLE 1- 2.0, BS2- 2.0, BS3- 2.0, BS4- 2.1, BS5- 6.6, BS6- 14.1, BS7- 39.1, BS8- 51
TEMPERATURES AT TIME OF TEST
T1 - 82
T2 - 81
T3 - 82
TIME OF OCCURANCE OF PEAK PRESSURES
xd1 - 121, xd2 - 76, xd3 - 250, xd4 - 212 mS.

Appendix B

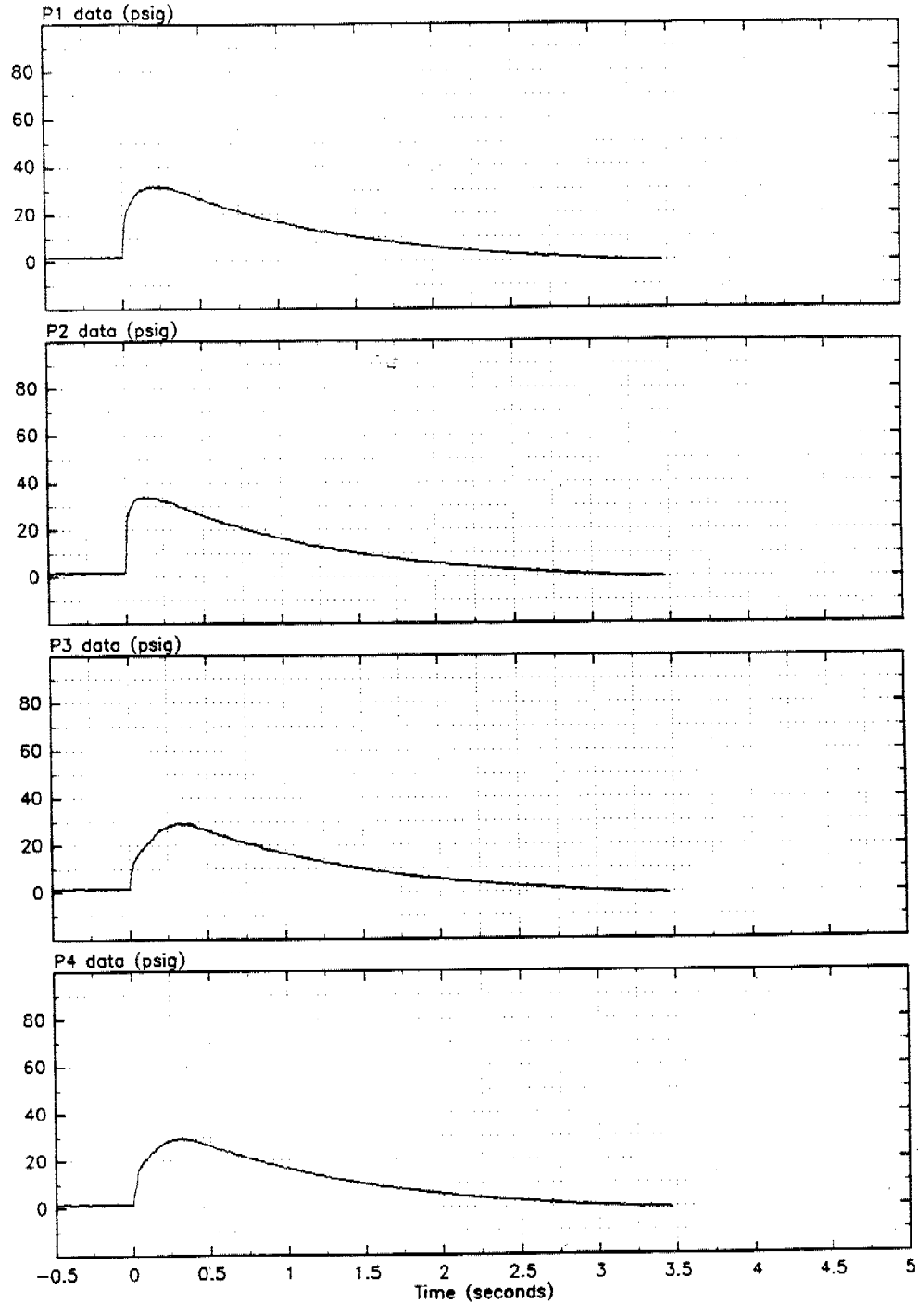
PRESSURE TRACES

There are no pressure traces for tests 1, 20, 21, 24, 33, 40, and 41. Because of the length of the time constant, the pressure transducers selected for test 1 recorded no information. No combustion pressures were measured for the remaining tests listed above.

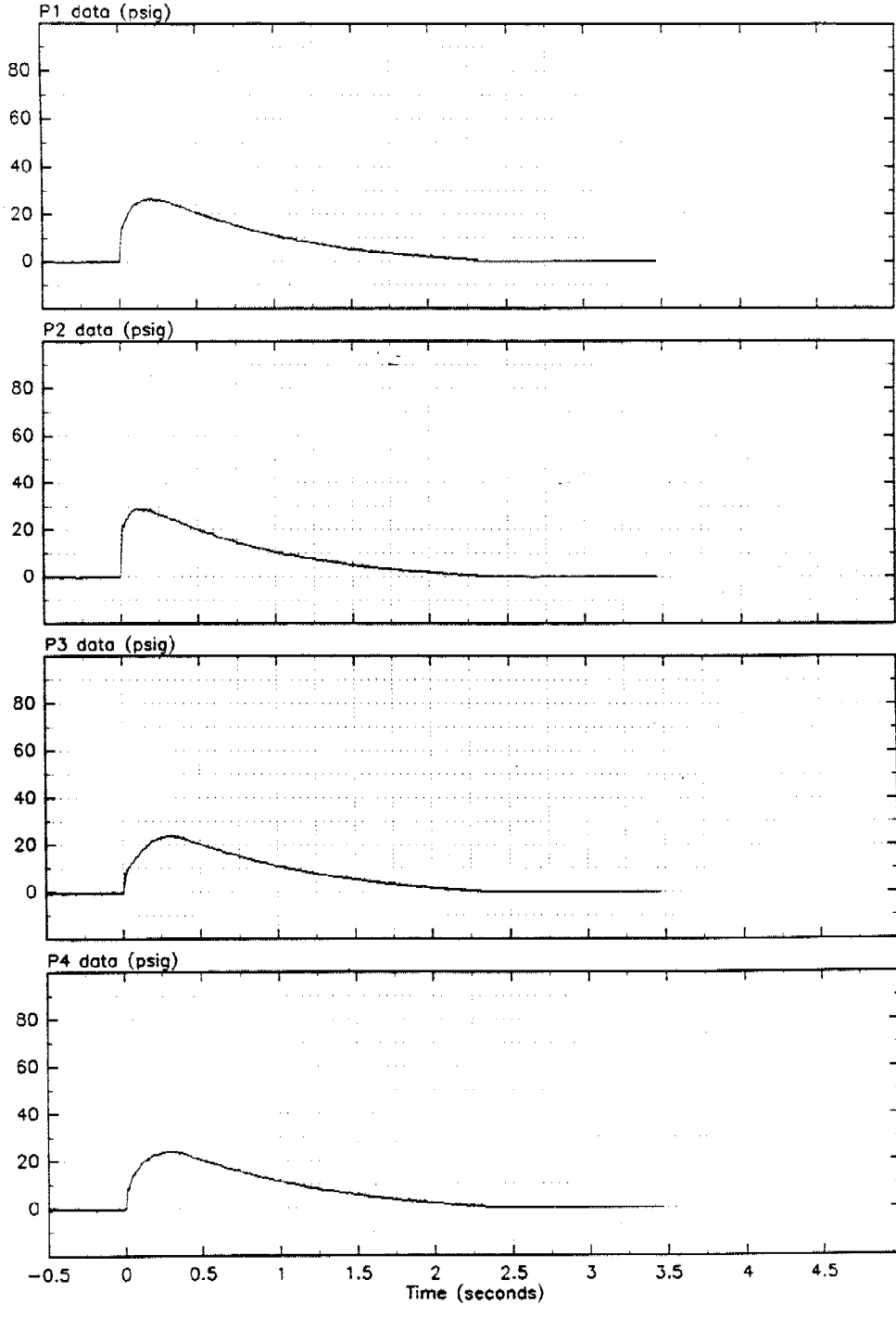
Test #2


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

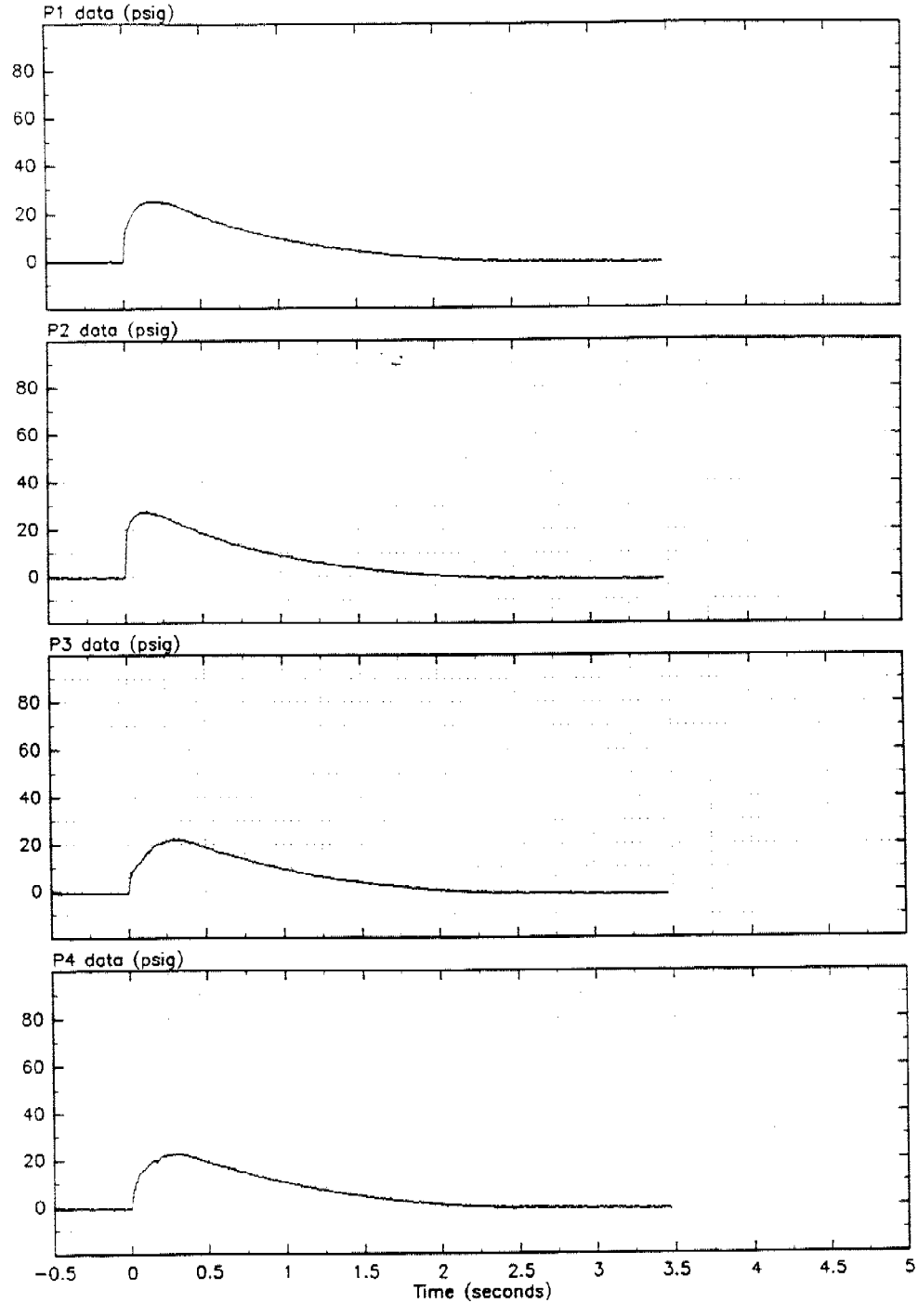
Test #3


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

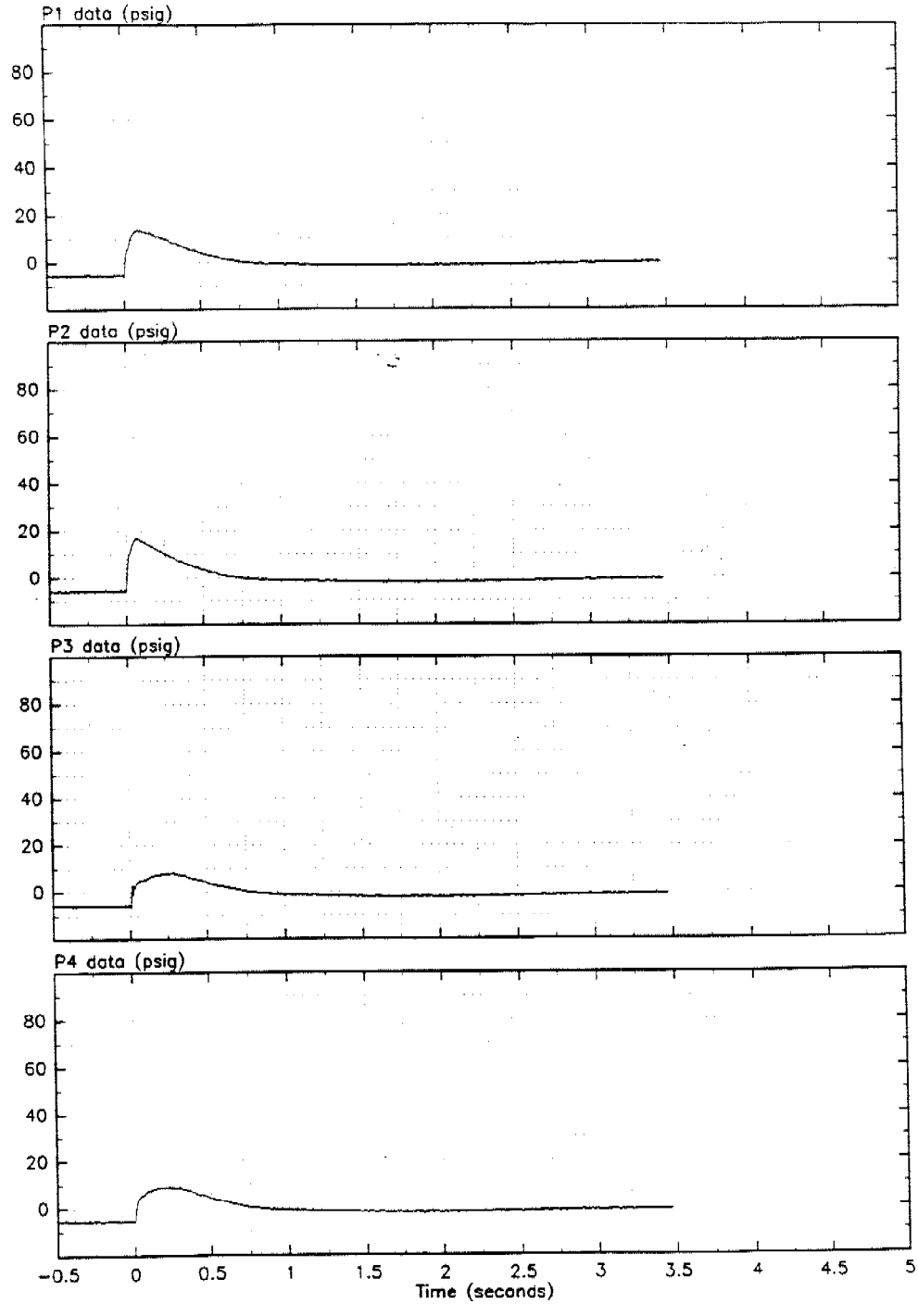
Test #4


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

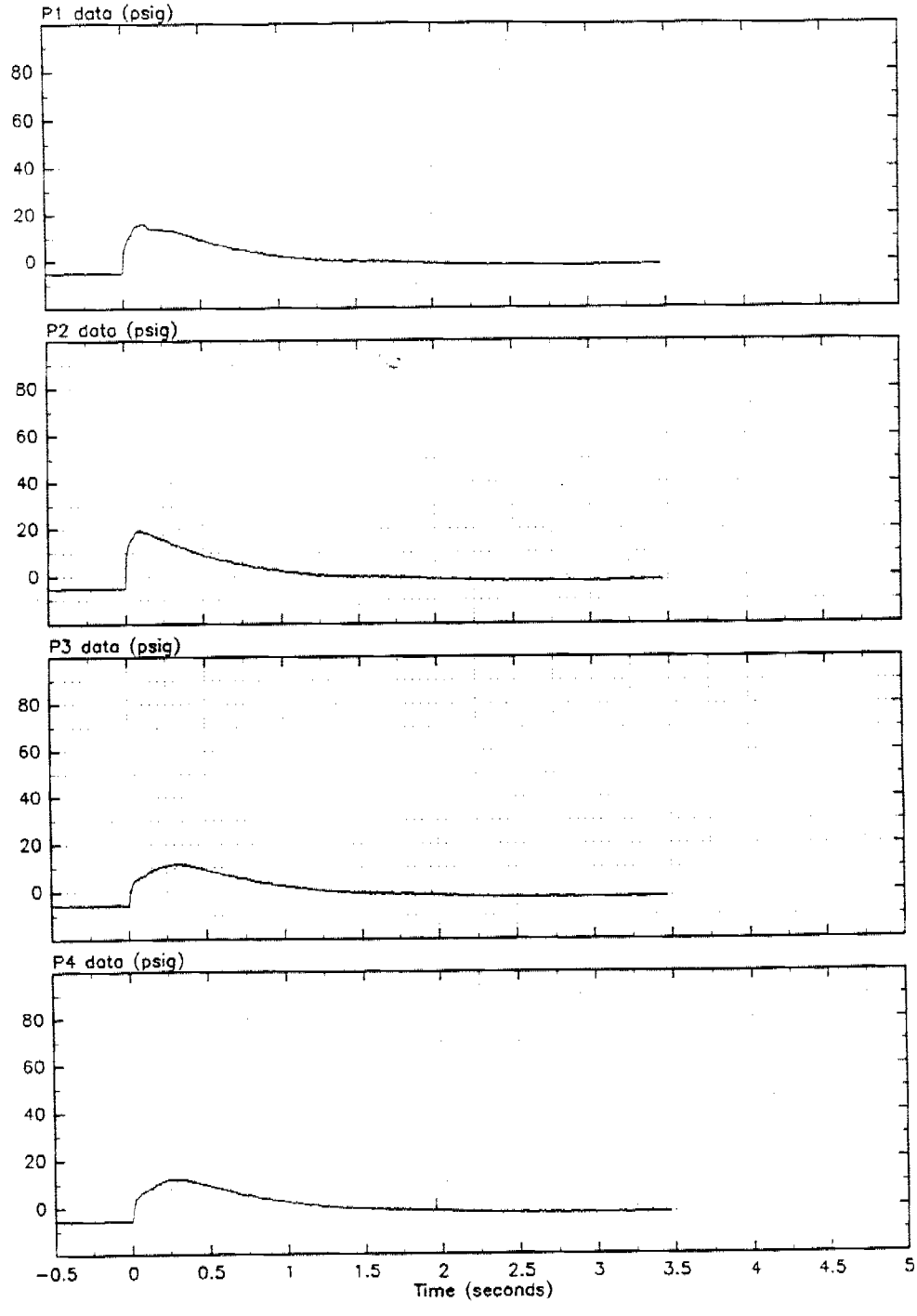
Test #5


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

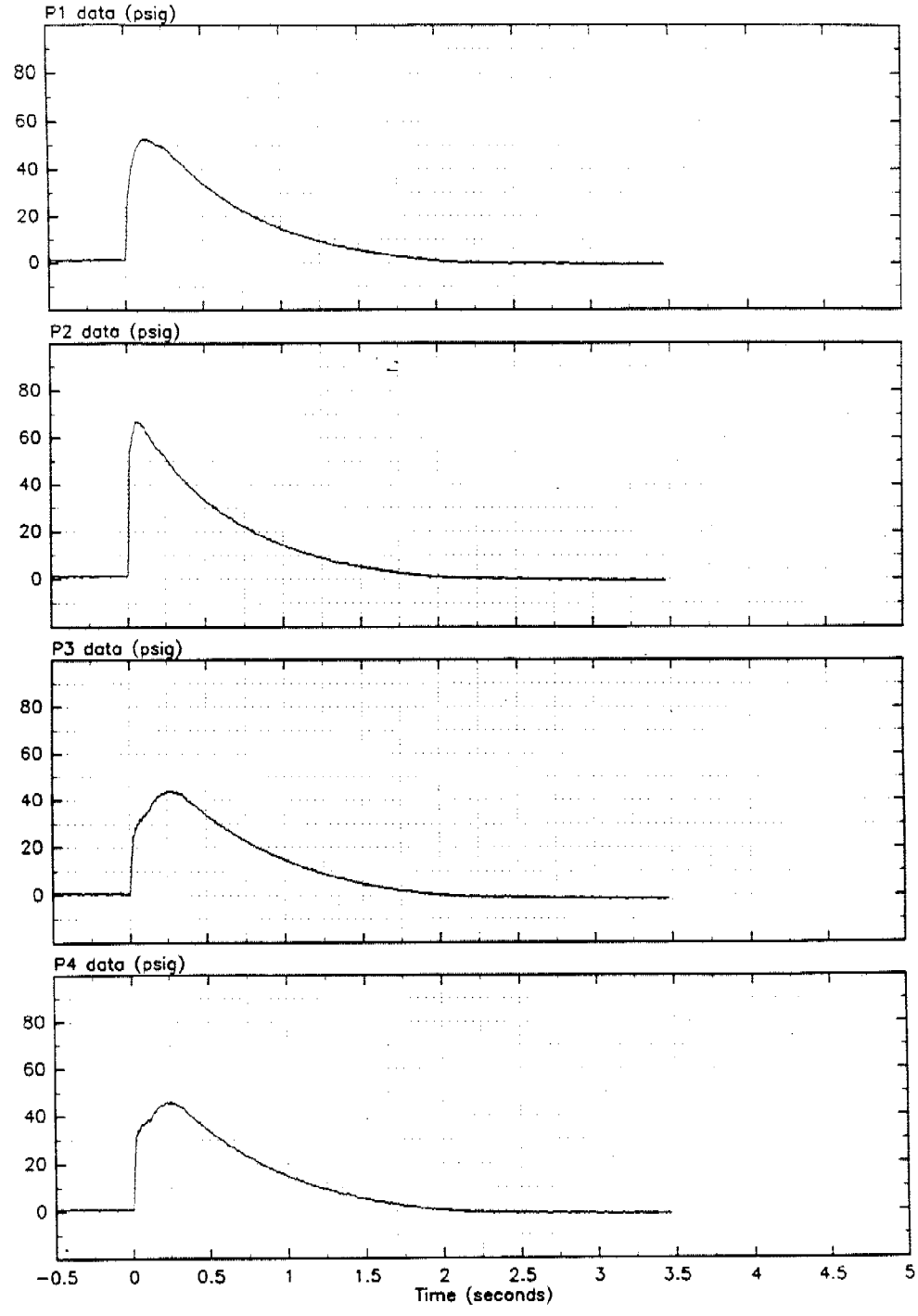
Test #6


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

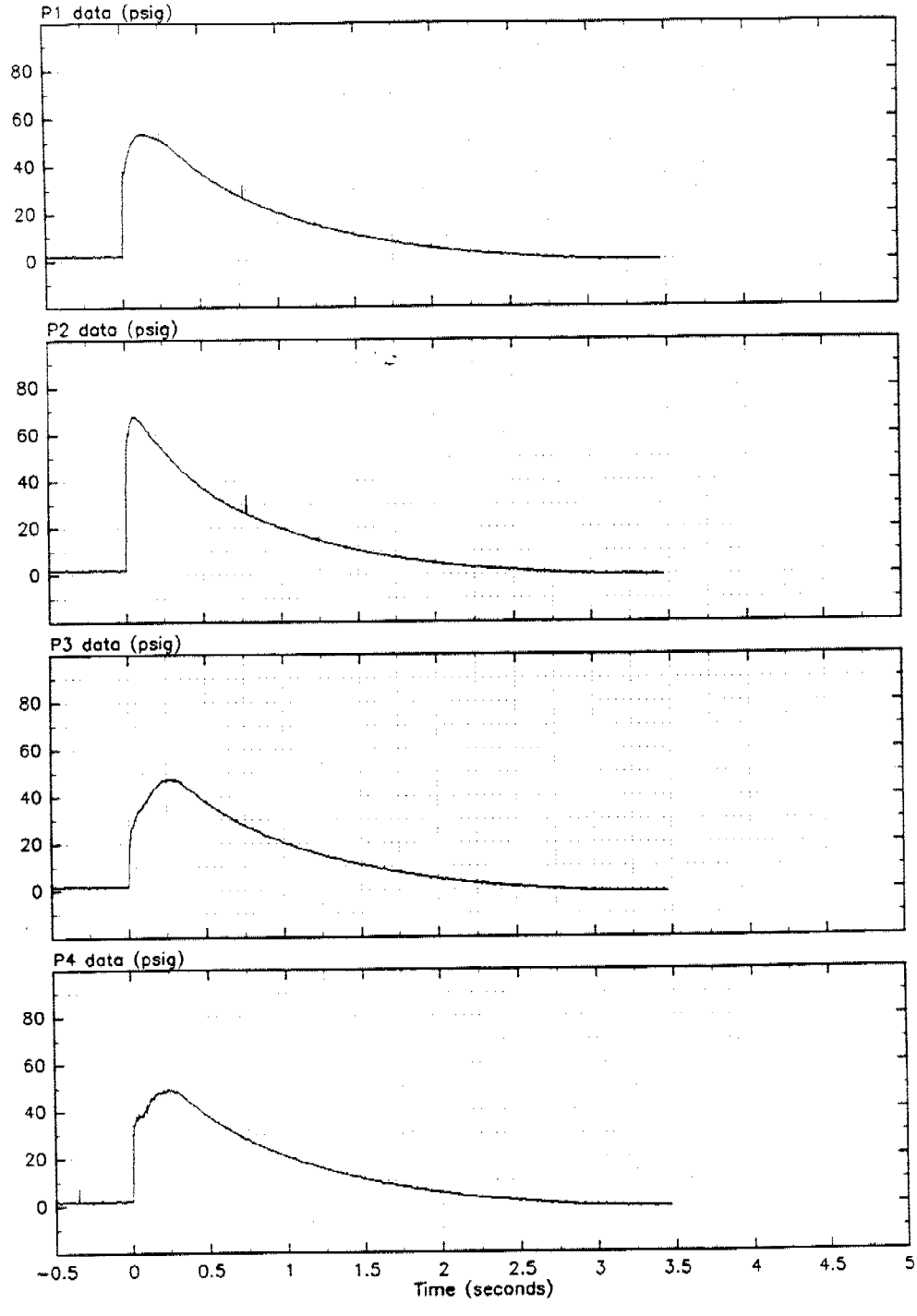
Test #7


P1 data (psig)
80
60
40
20
0
P2 data (psig)
80
60
40
20
0
P3 data (psig)
80
60
40
20
0
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

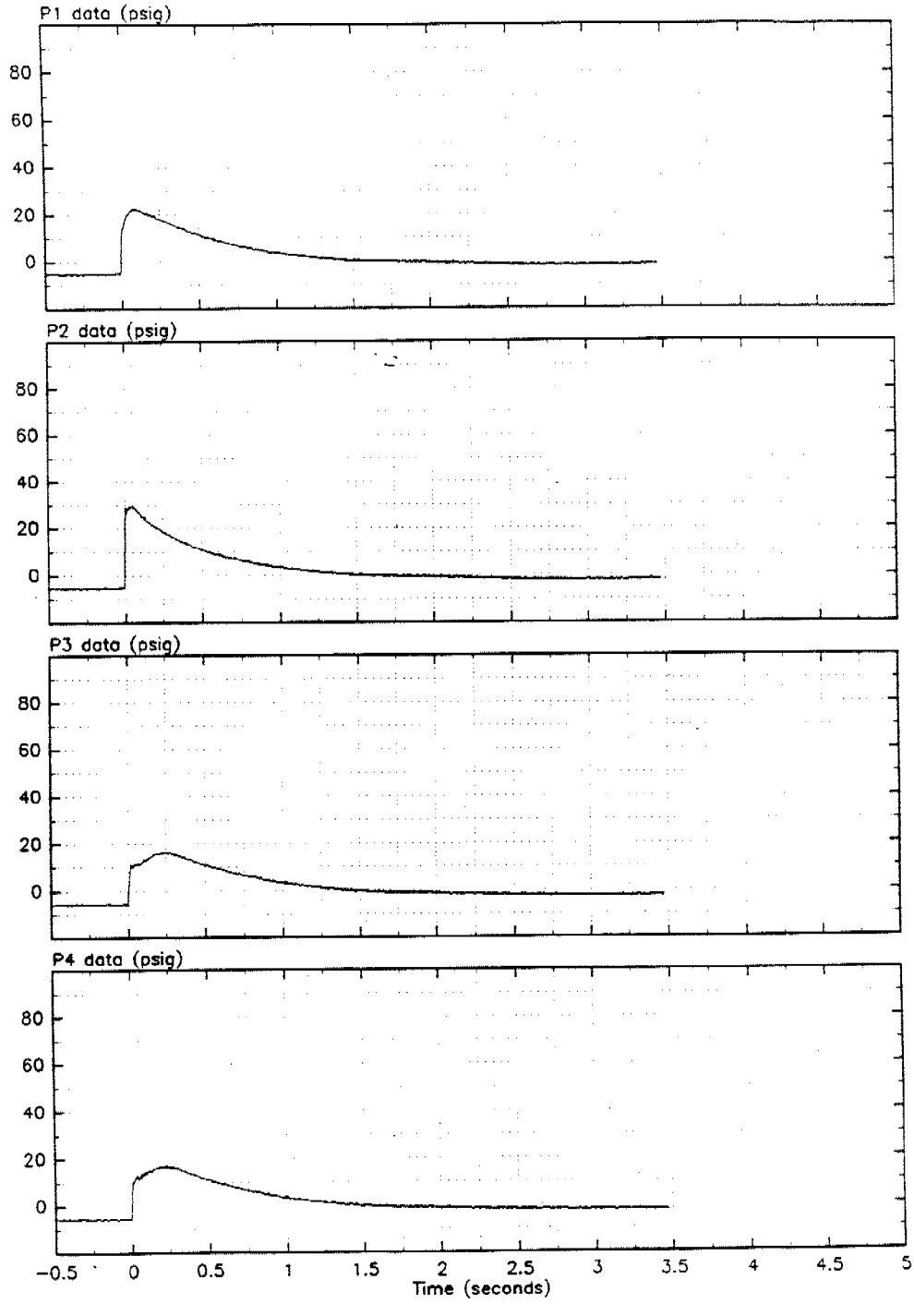
Test #8


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

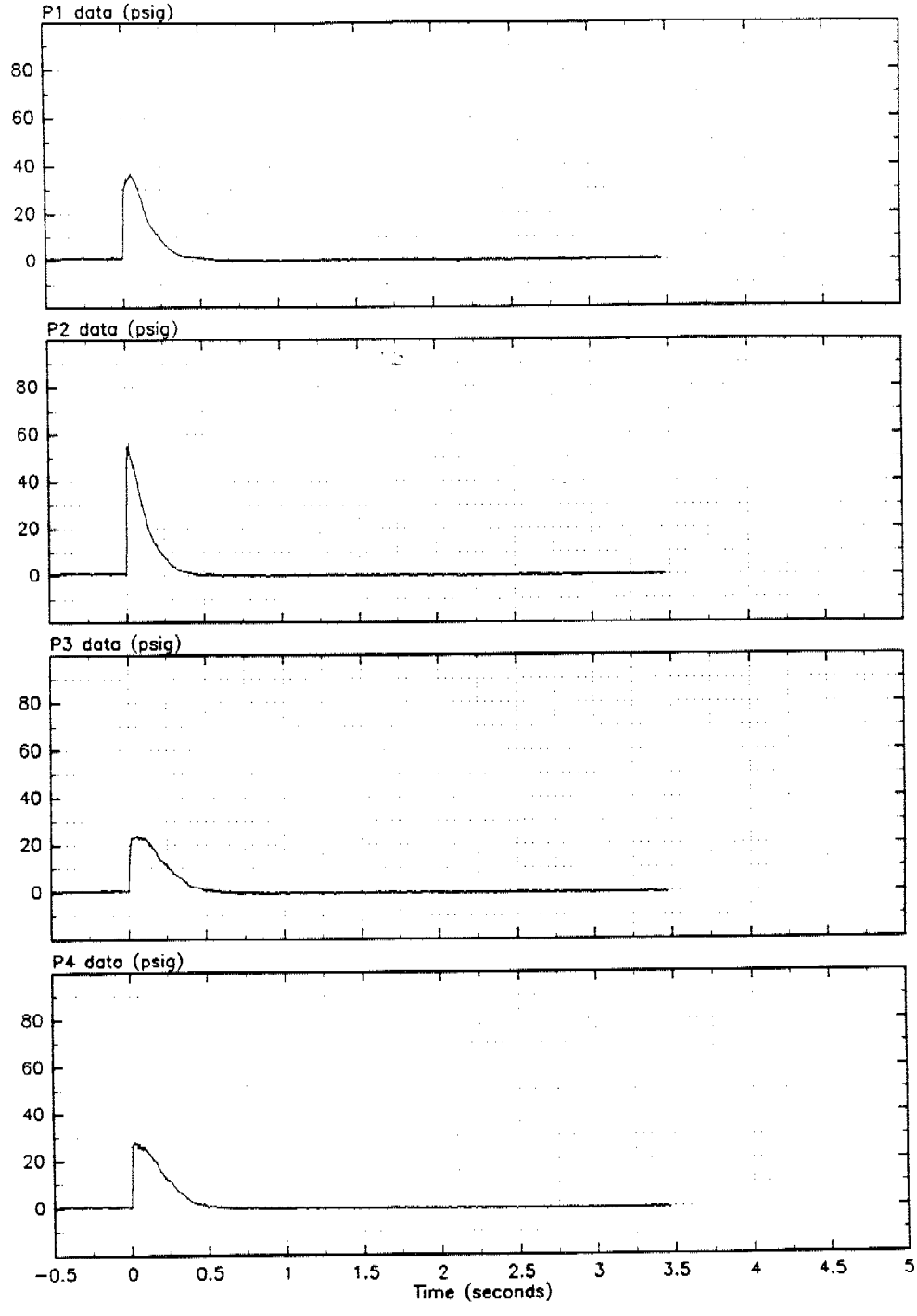
Test #9


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

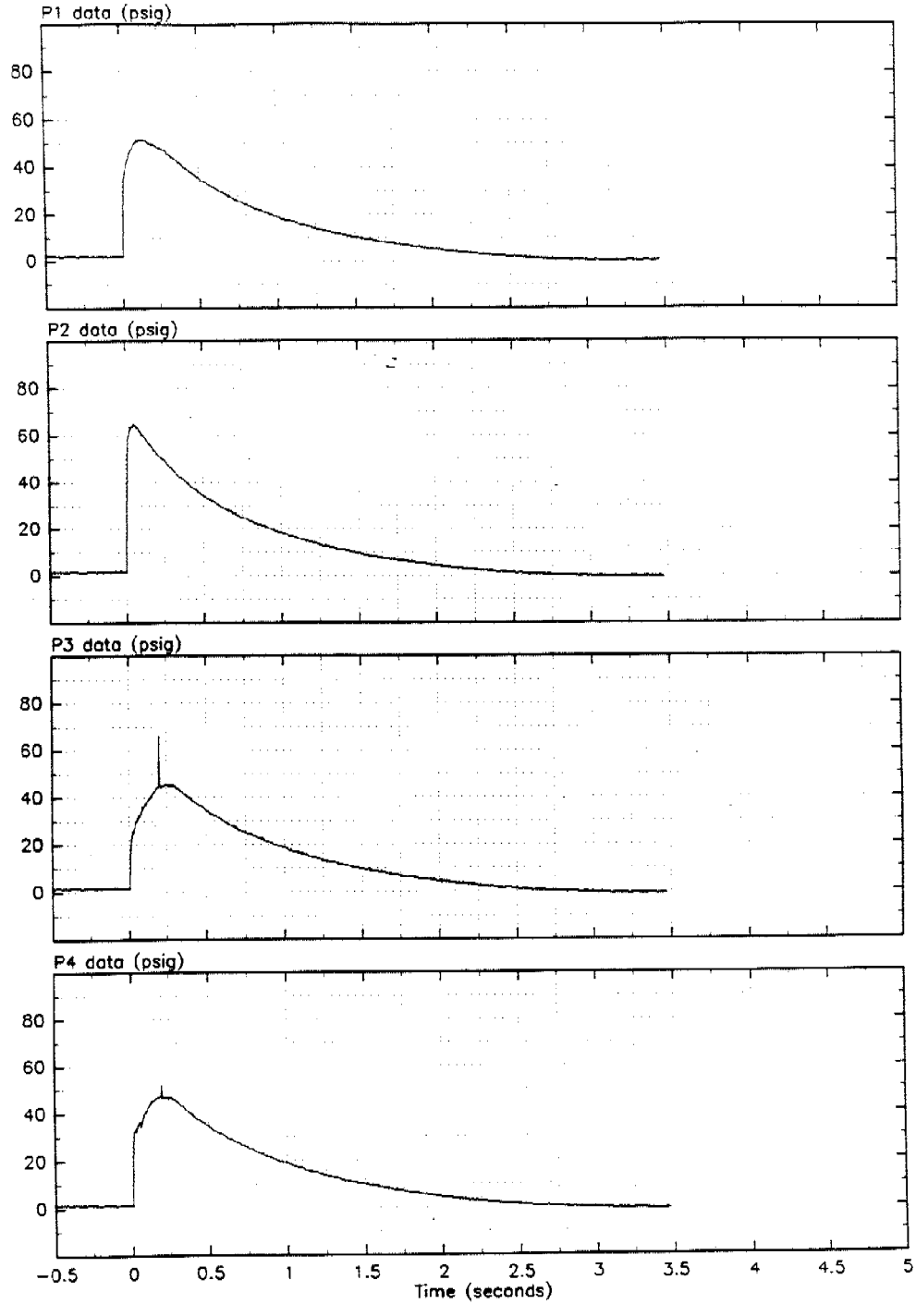
Test #10


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

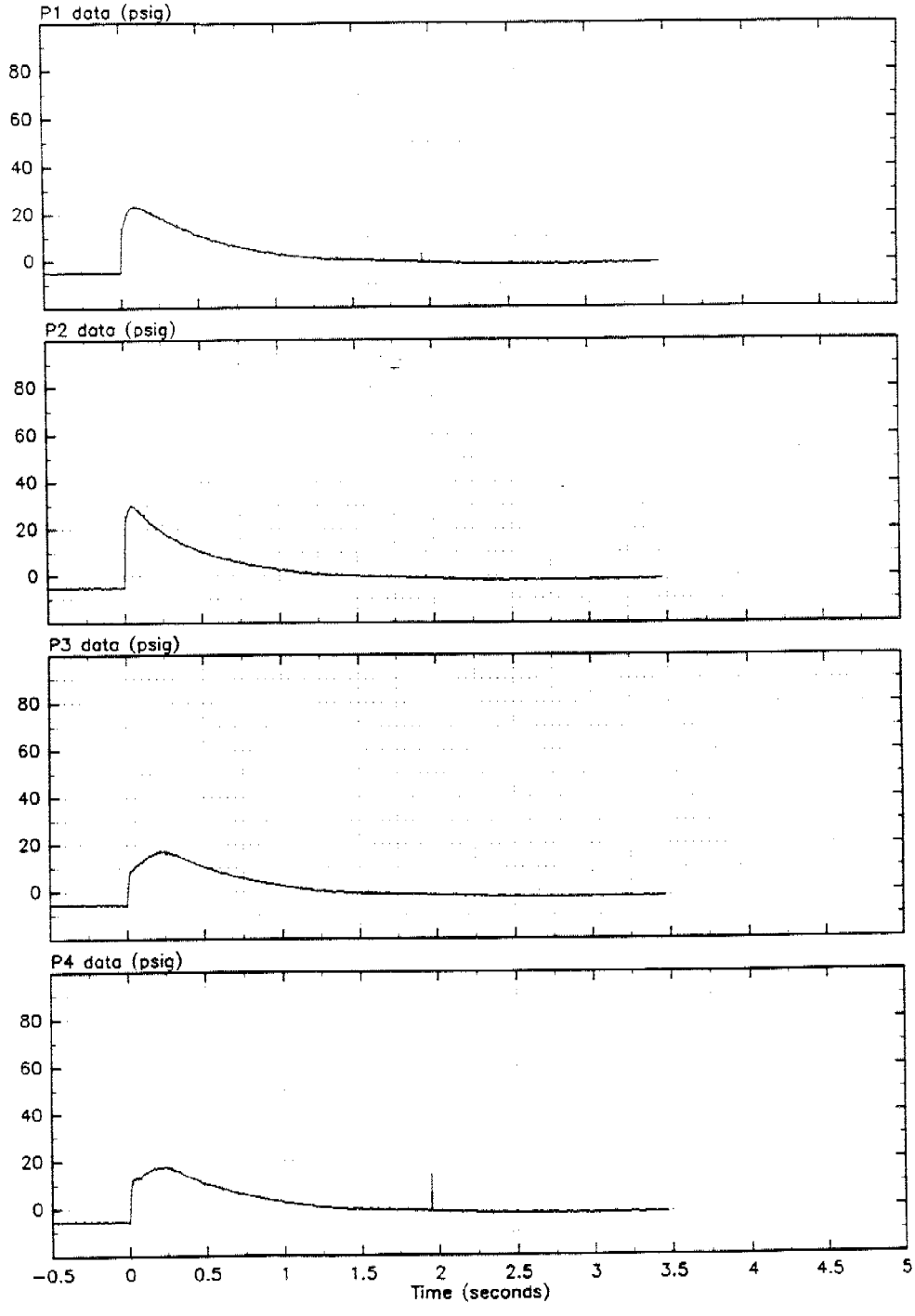
Test #11


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

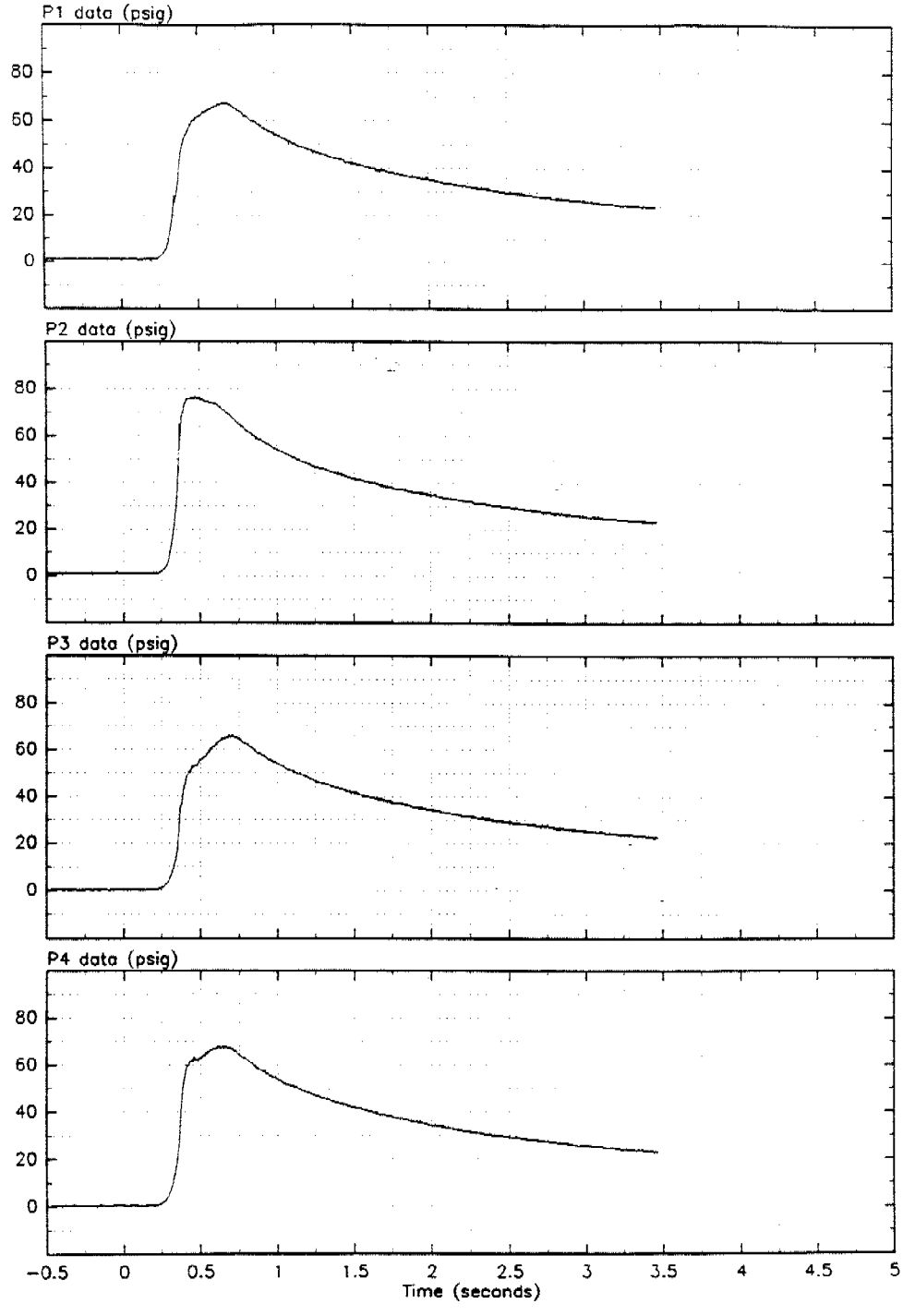
Test #12


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

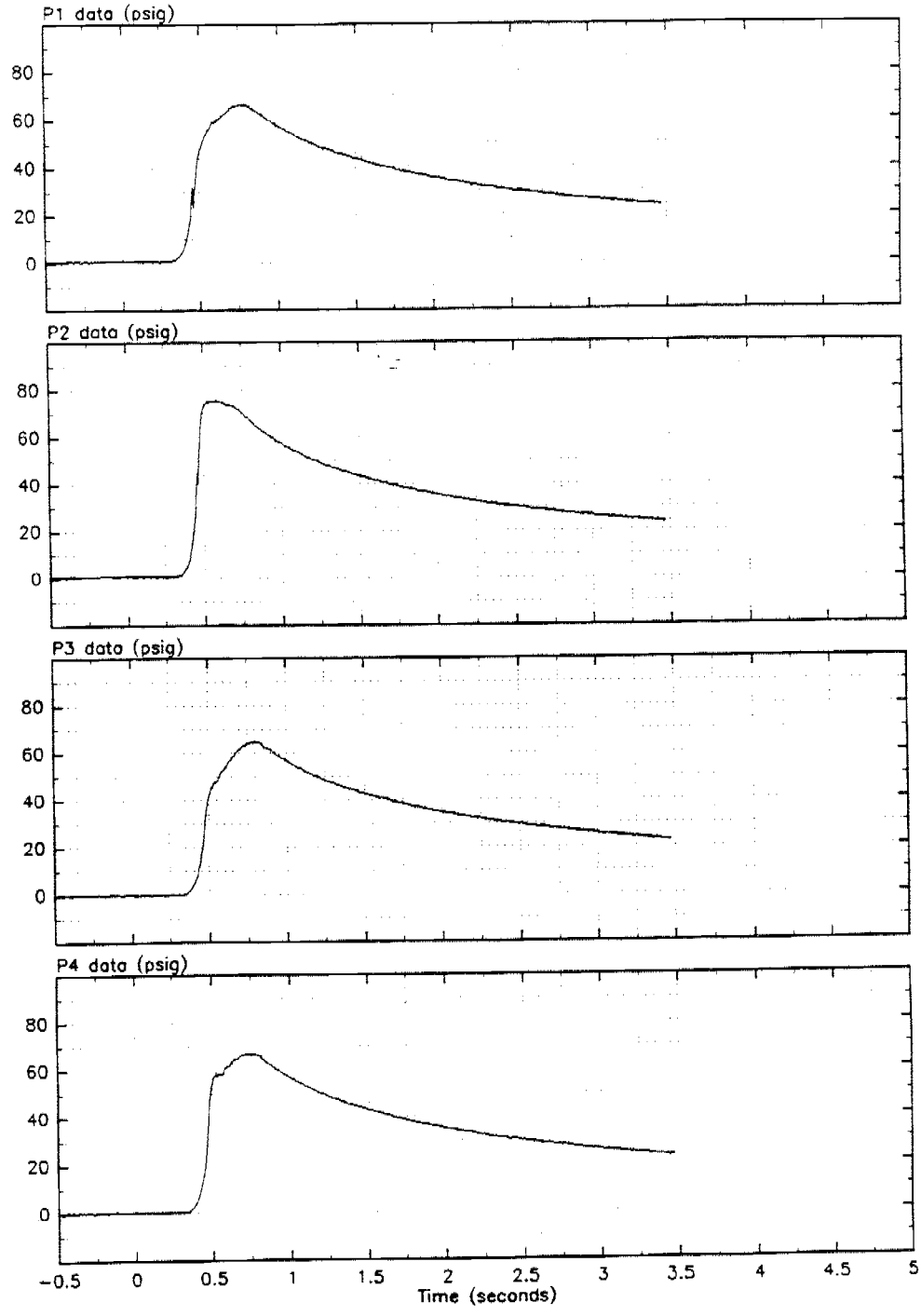
Test #13


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

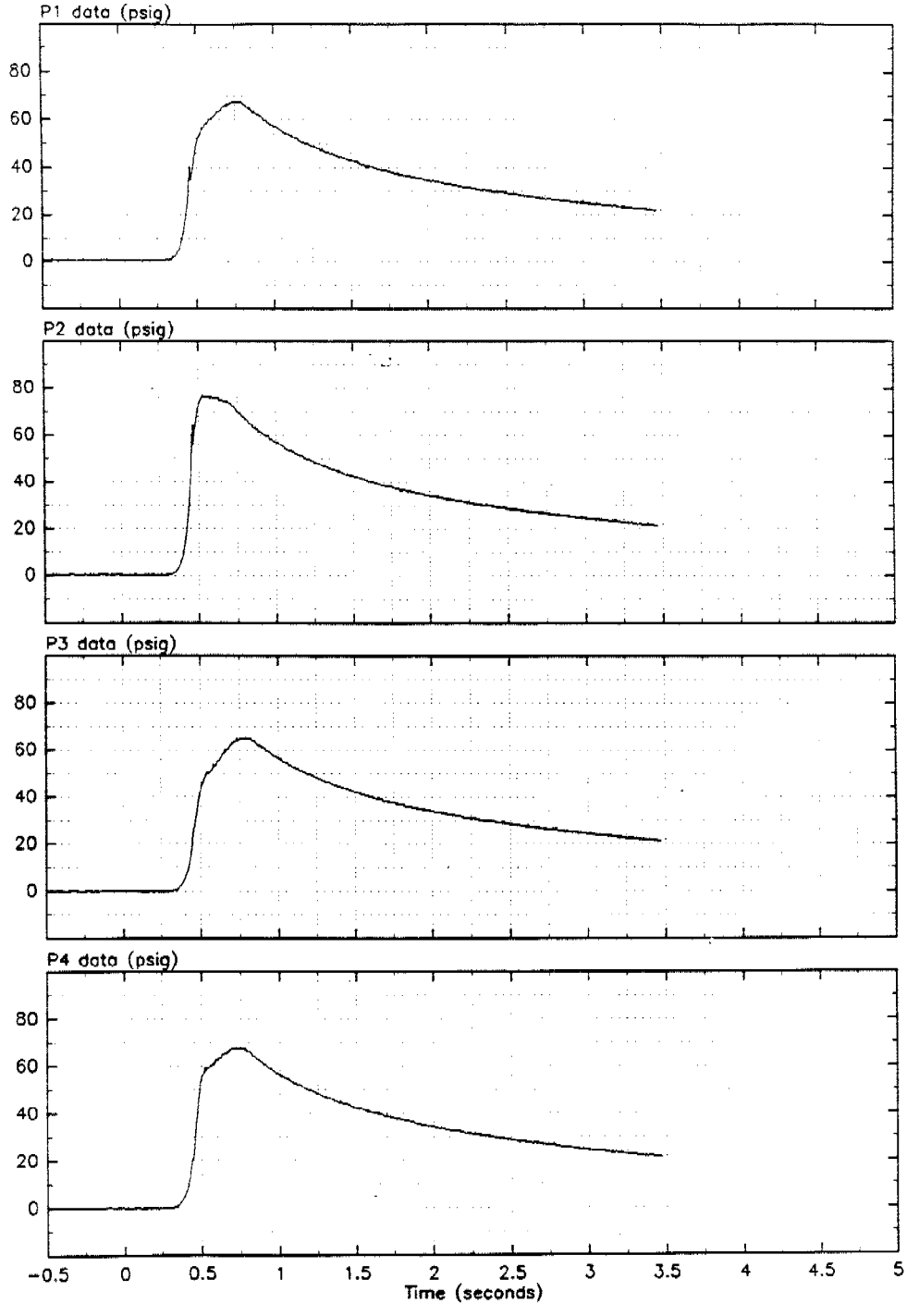
Test #14


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

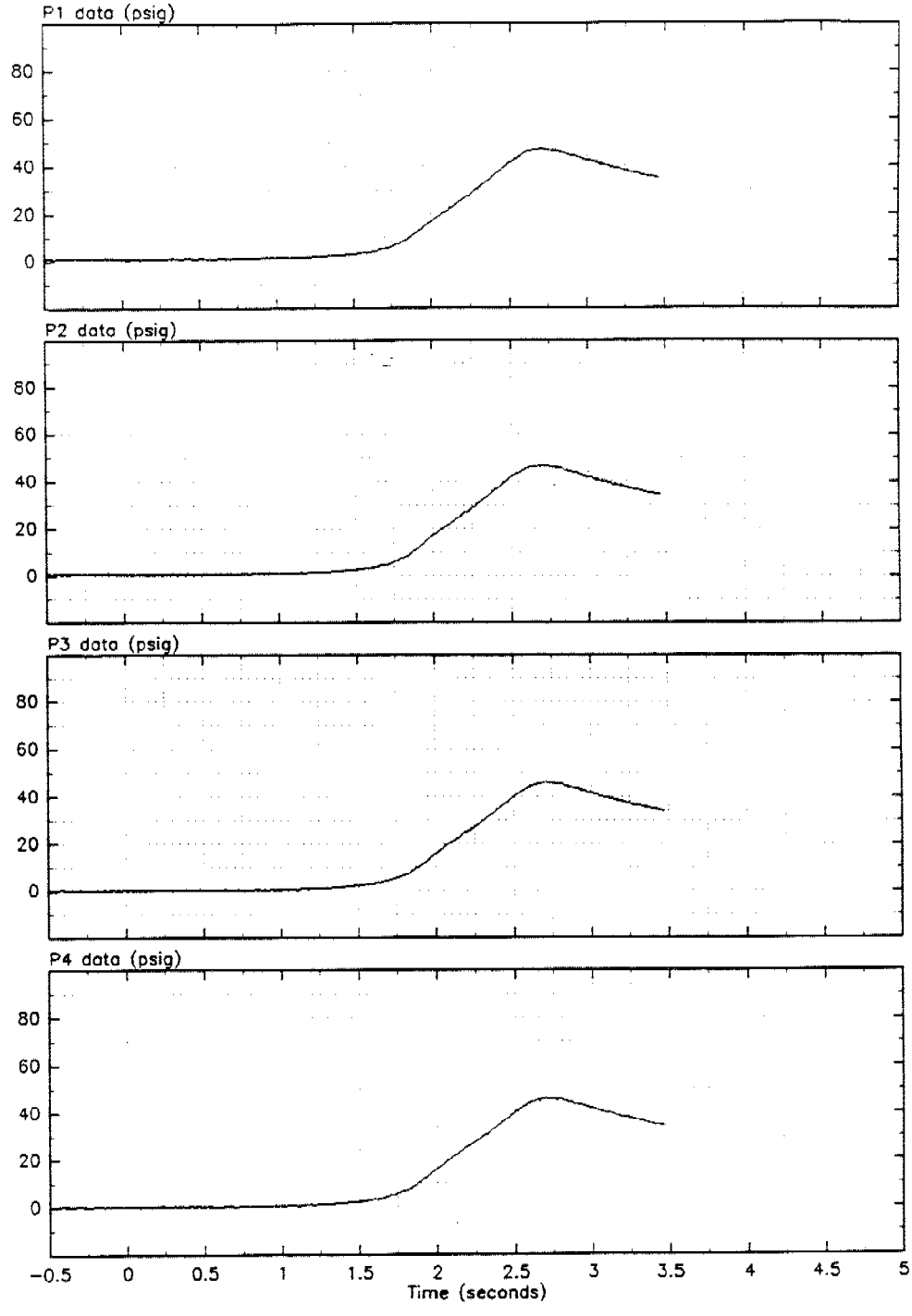
Test #15


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

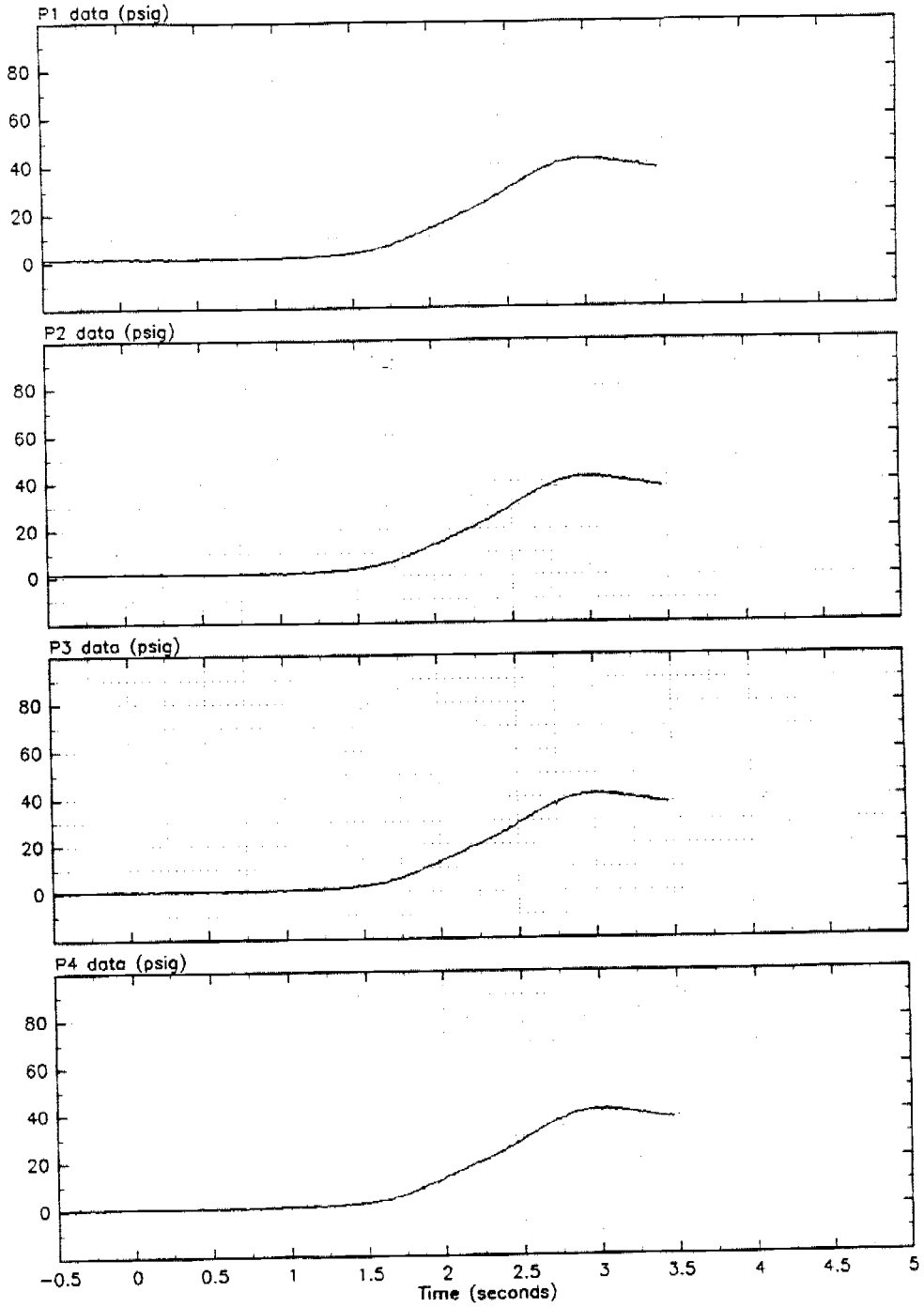
Test #16


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

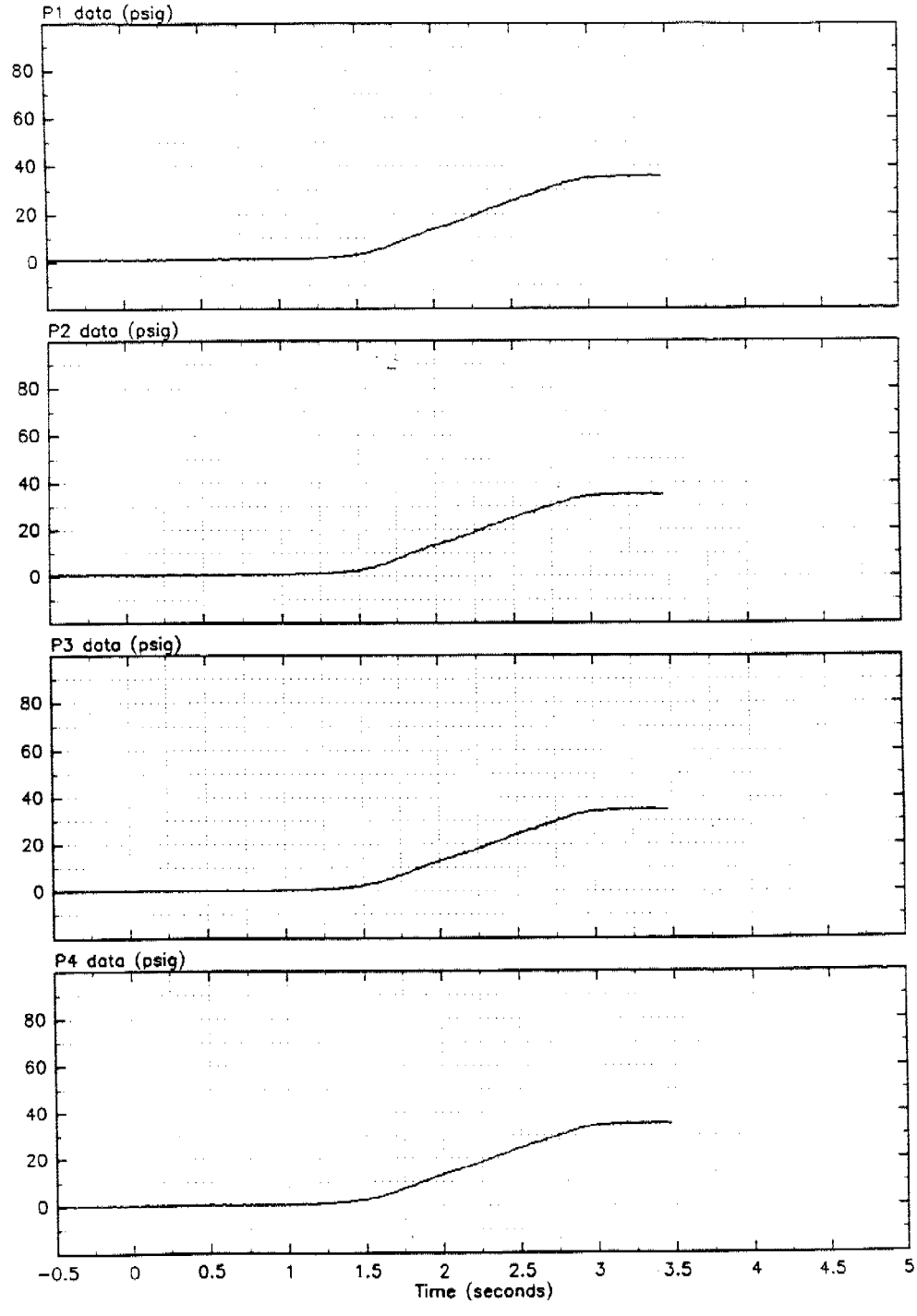
Test #17


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

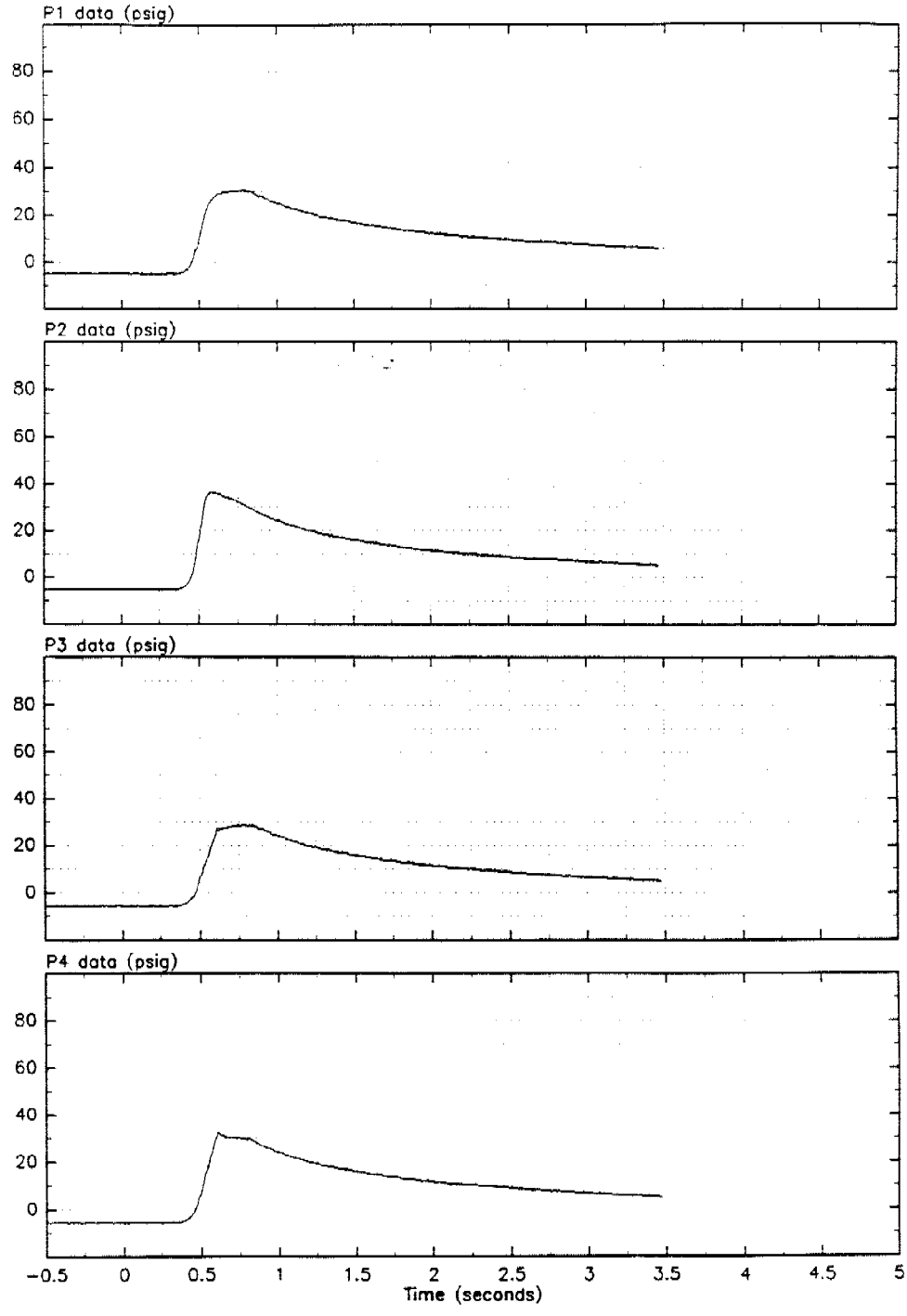
Test #19


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

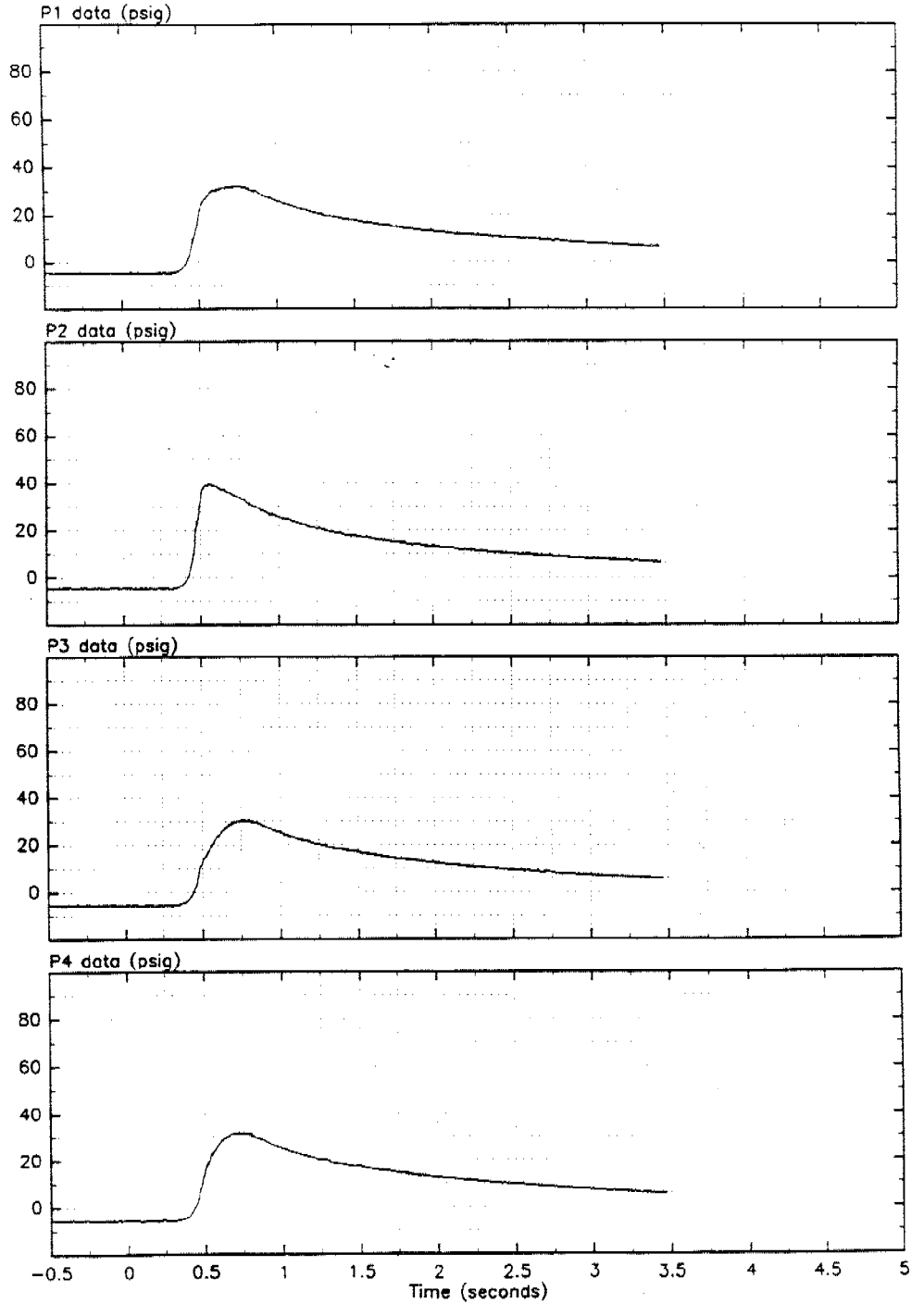
Test #22


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

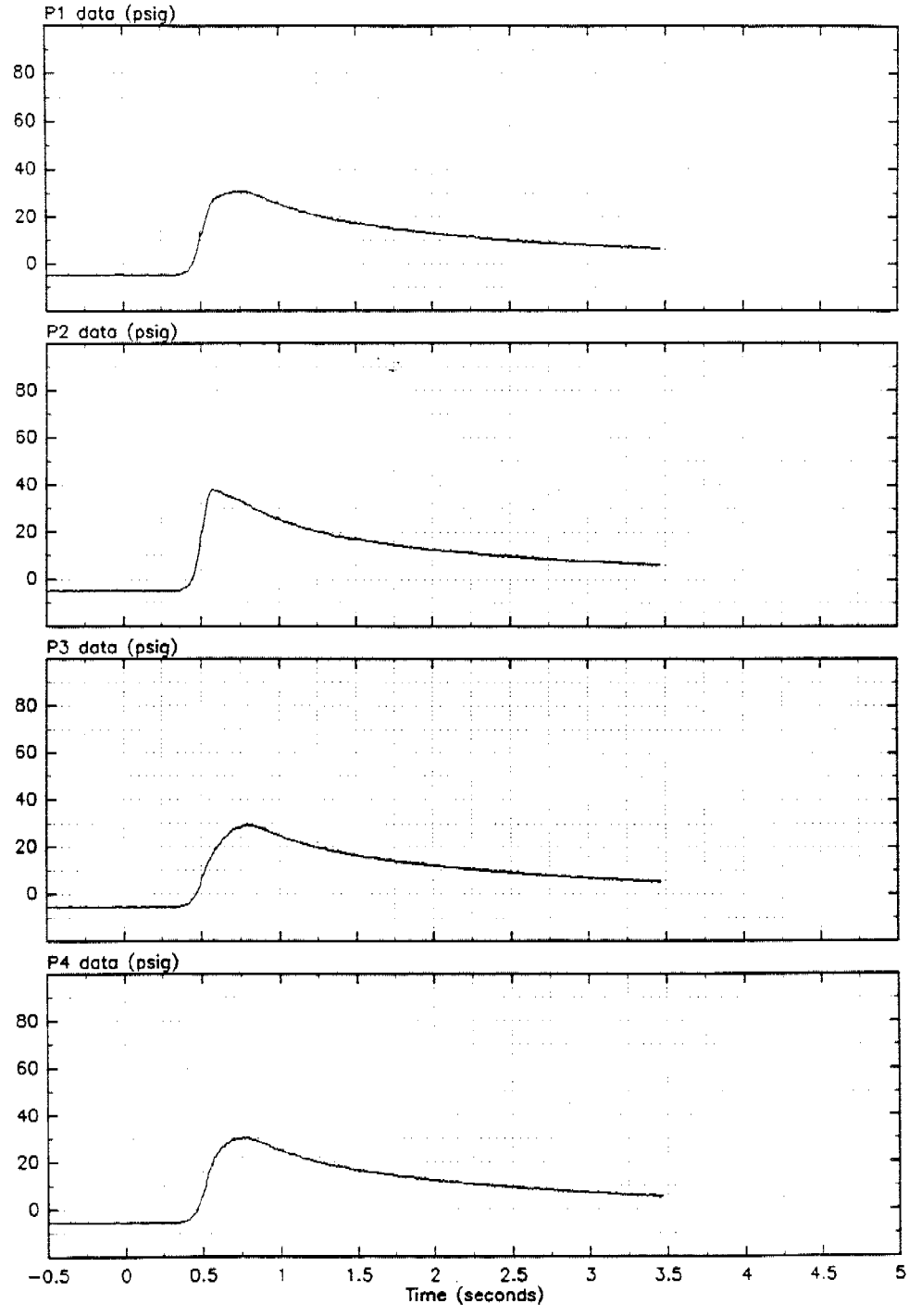
Test #23


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

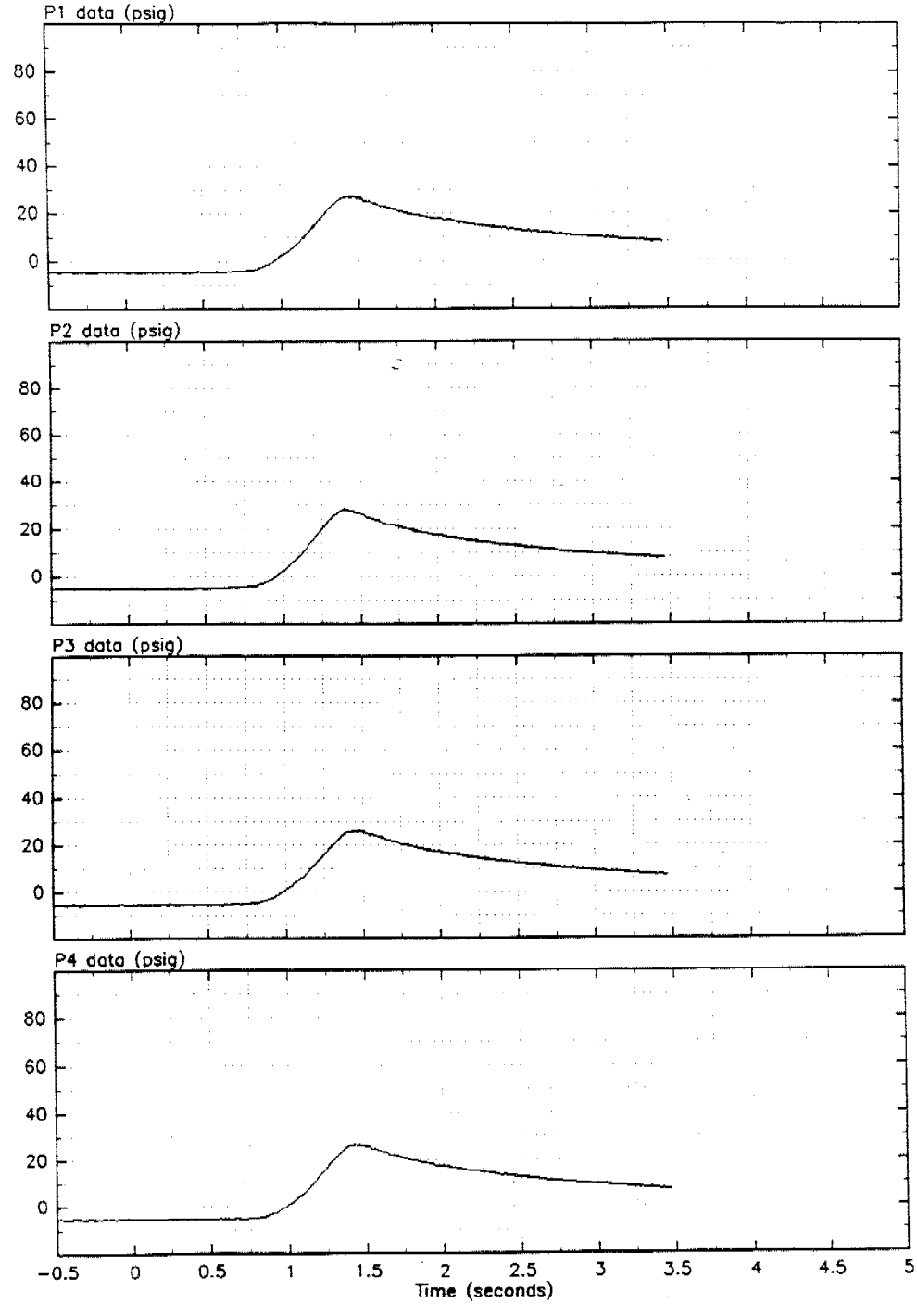
Test #25


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

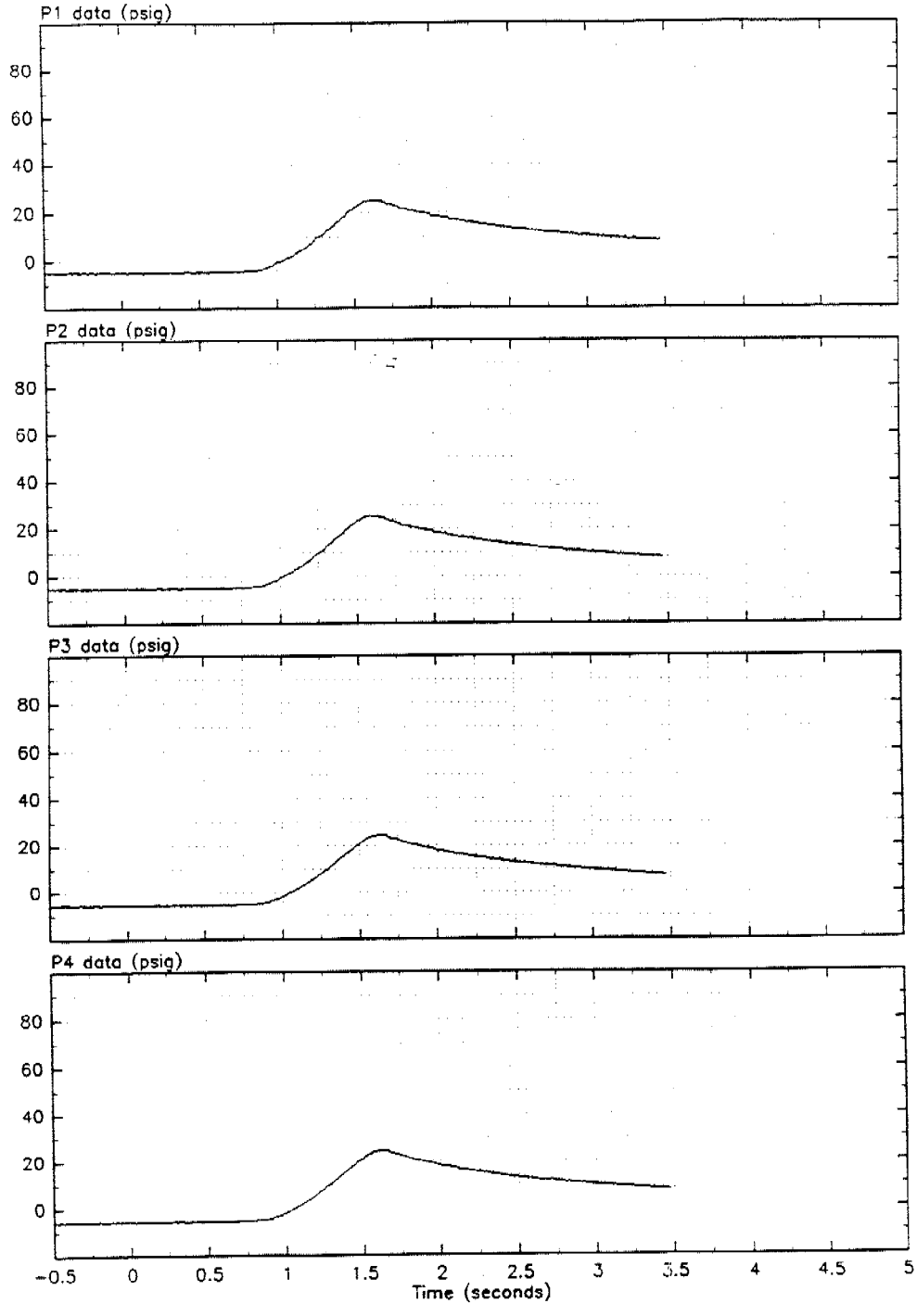
Test #26


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

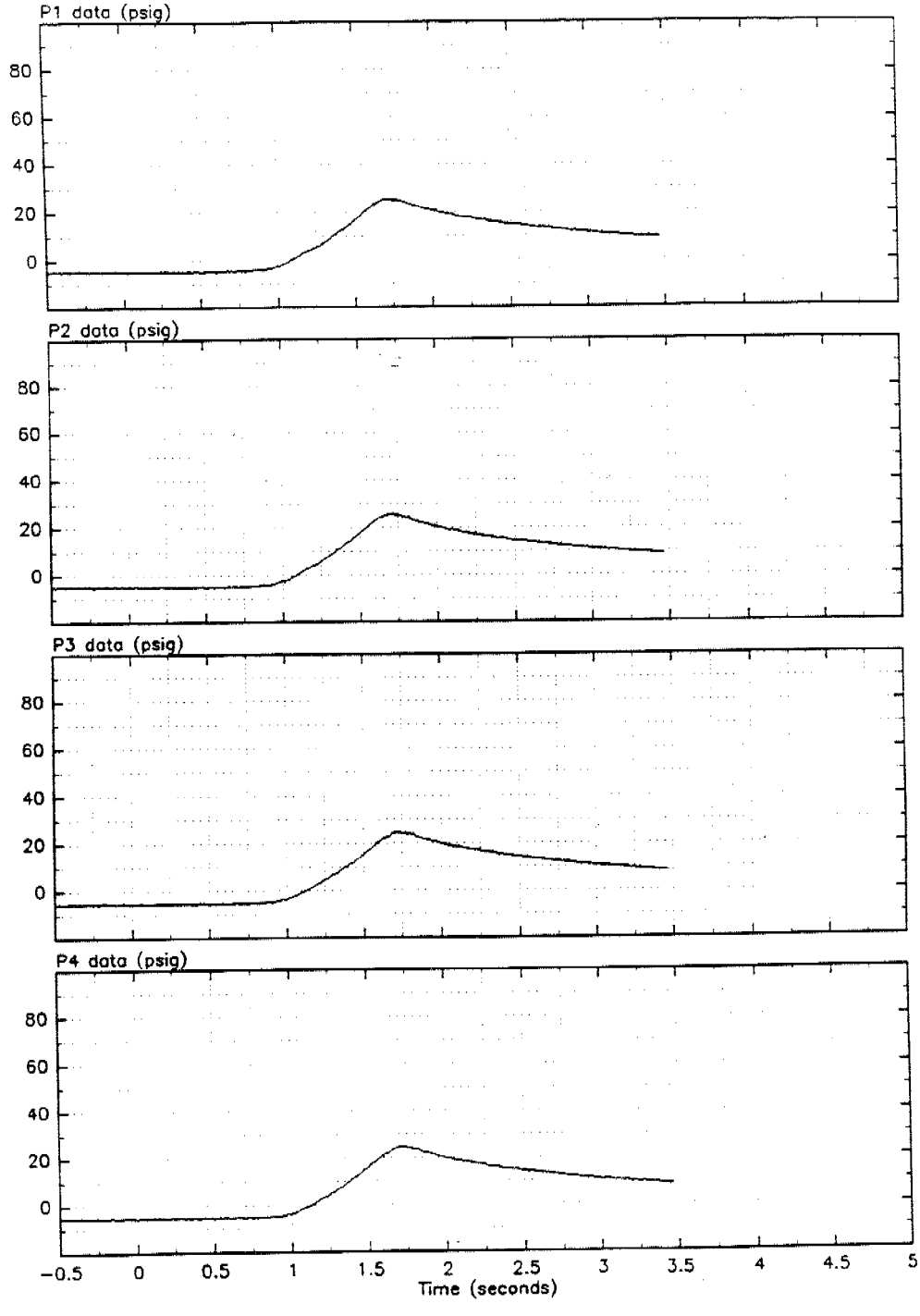
Test #27


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

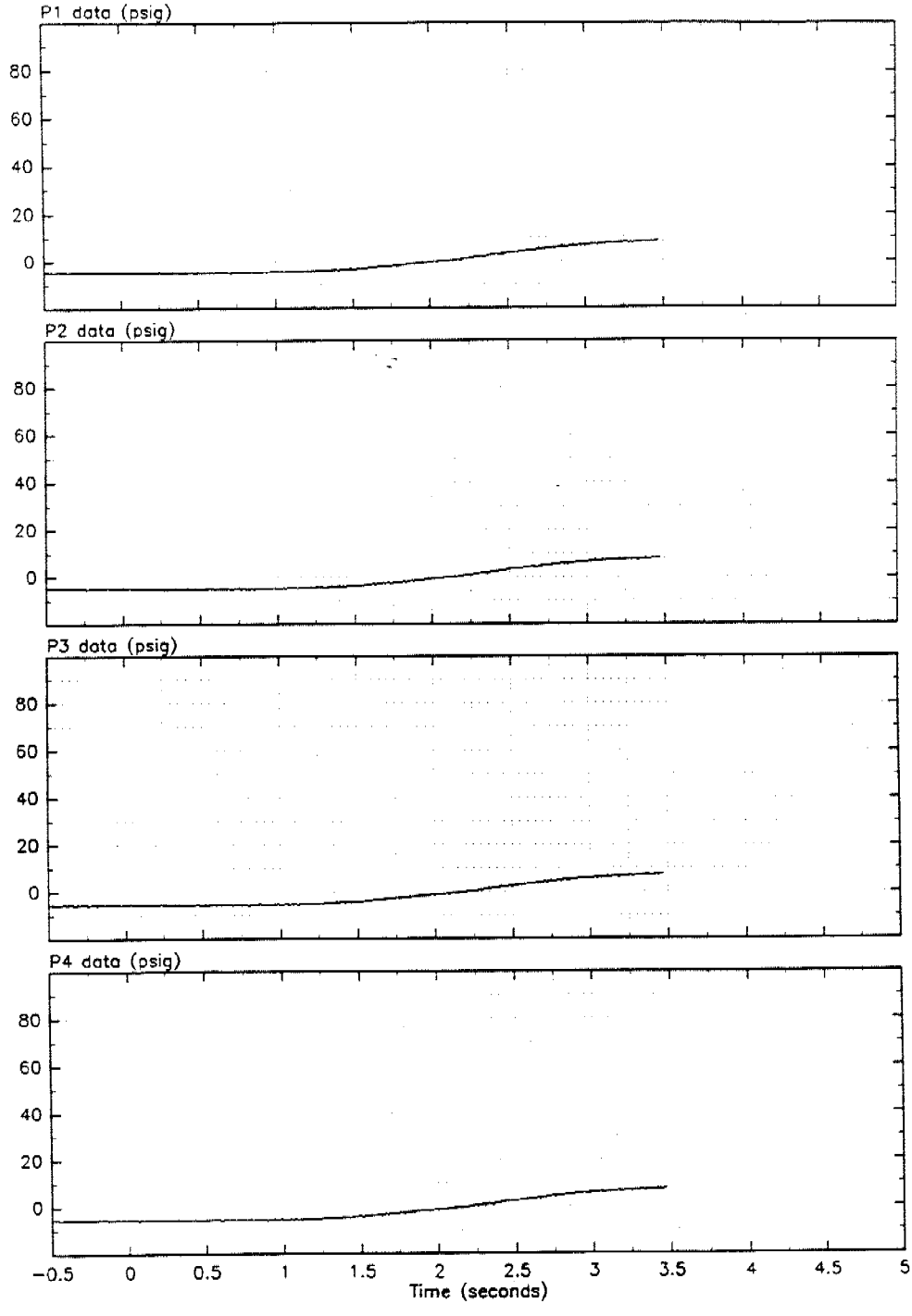
Test #28


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

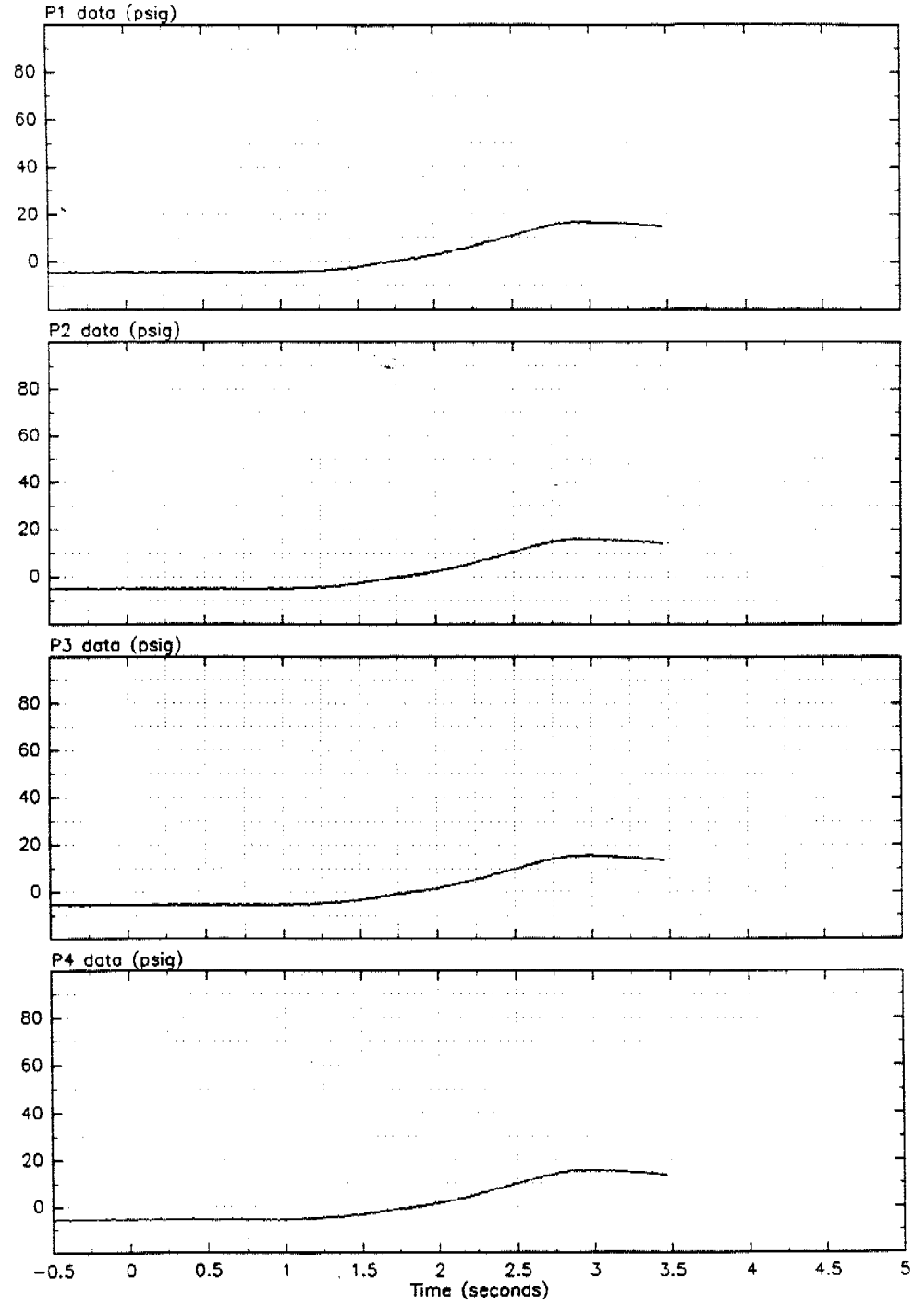
Test #29


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

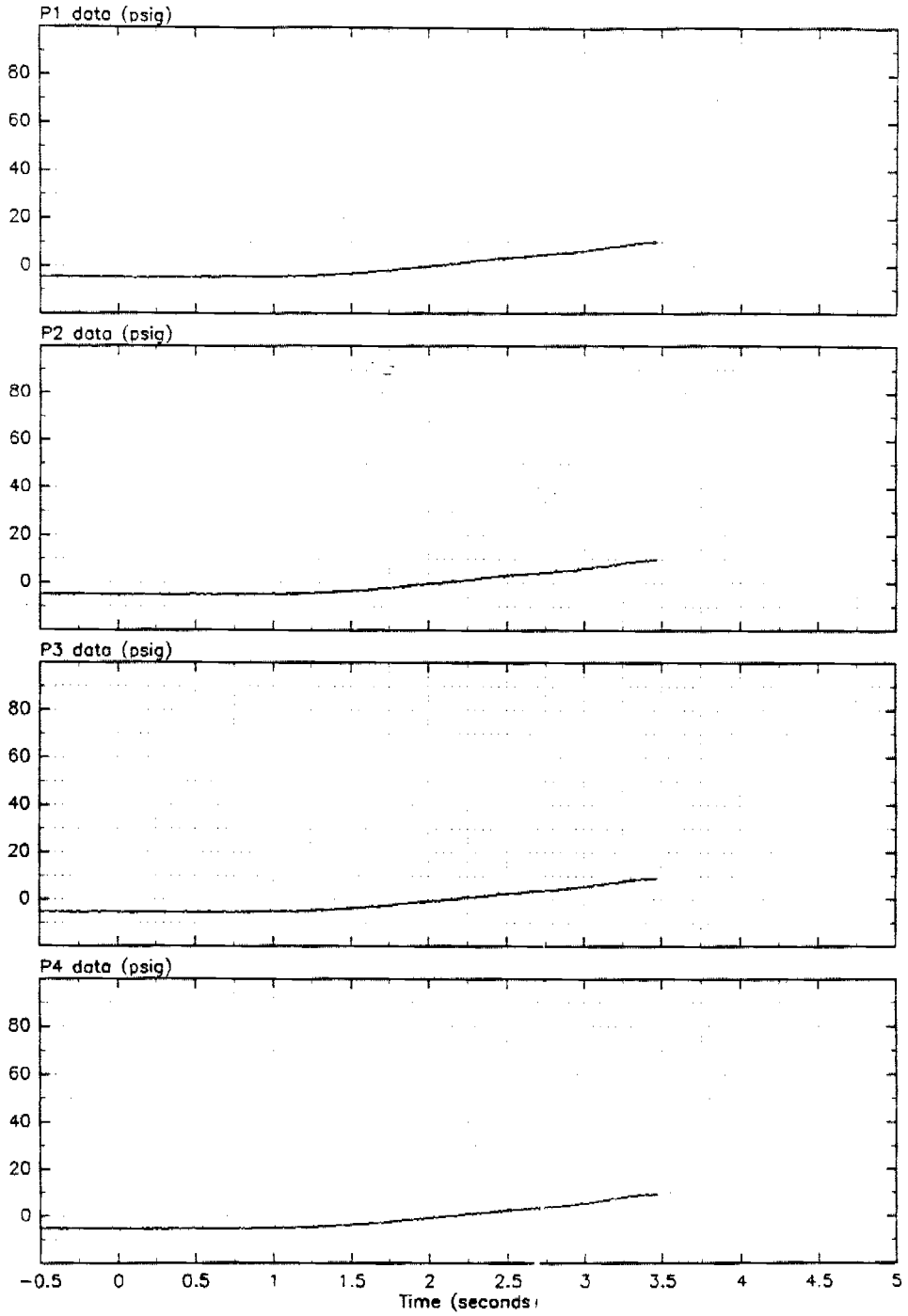
Test #30


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

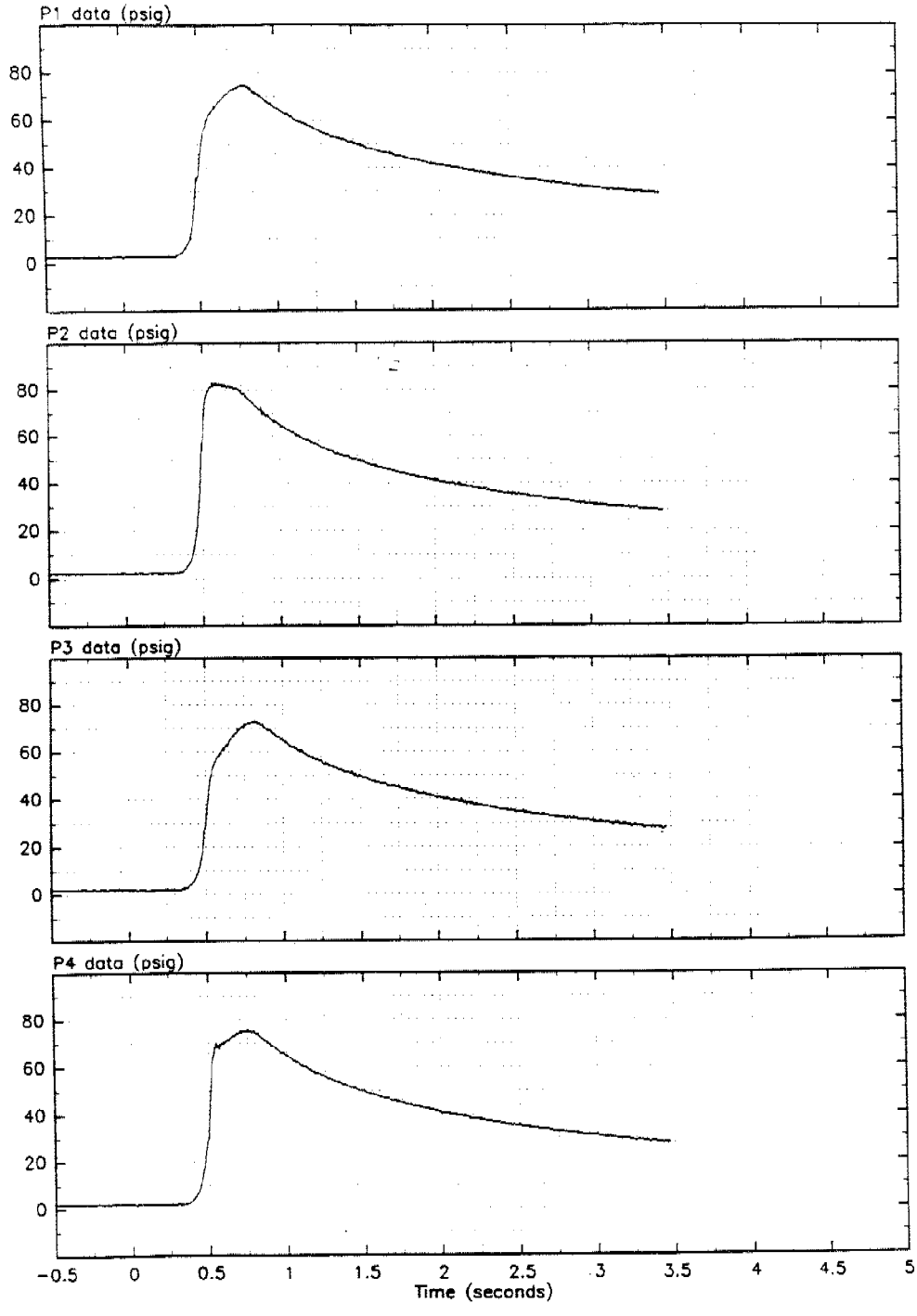
Test #31


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

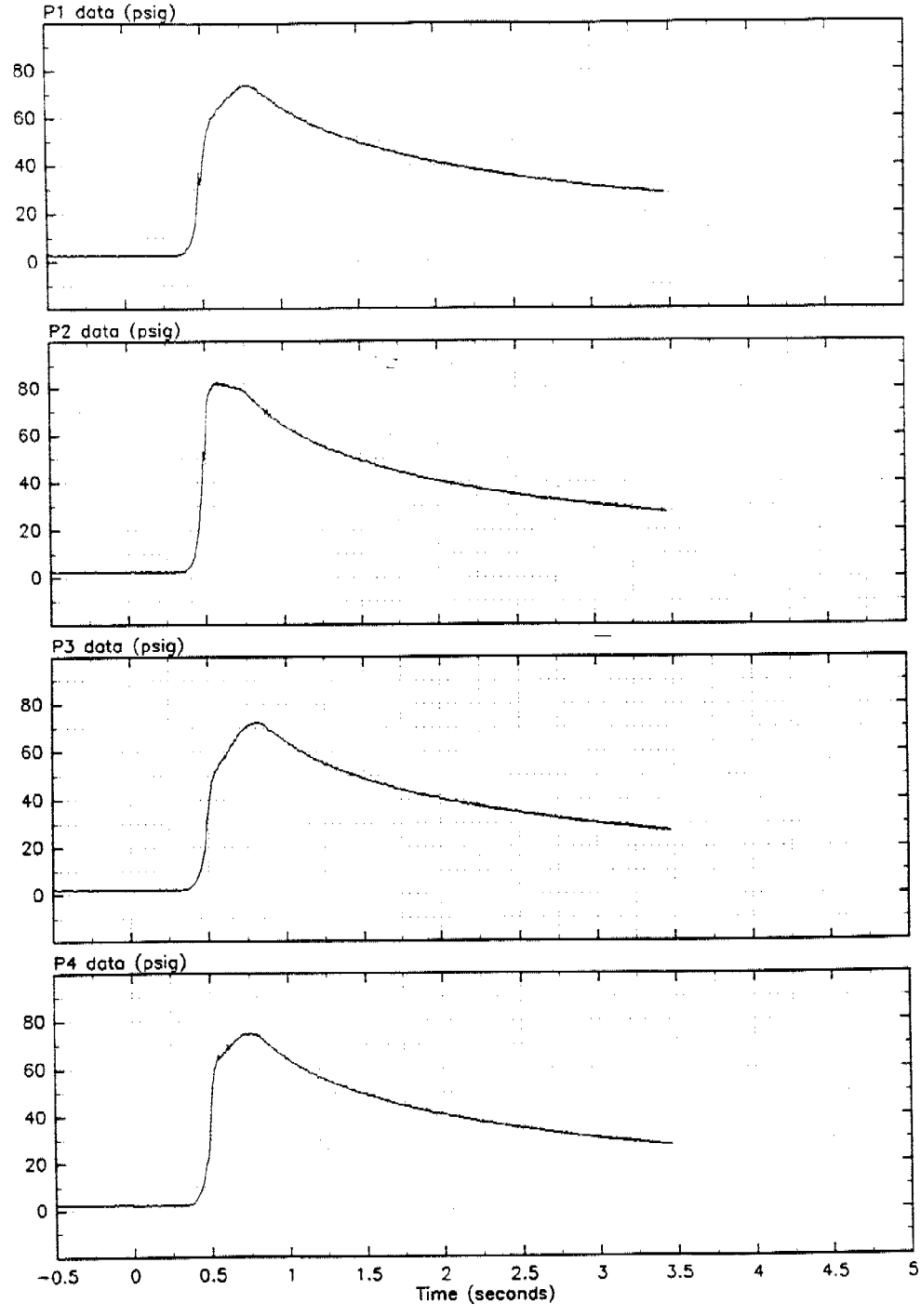
Test #32


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

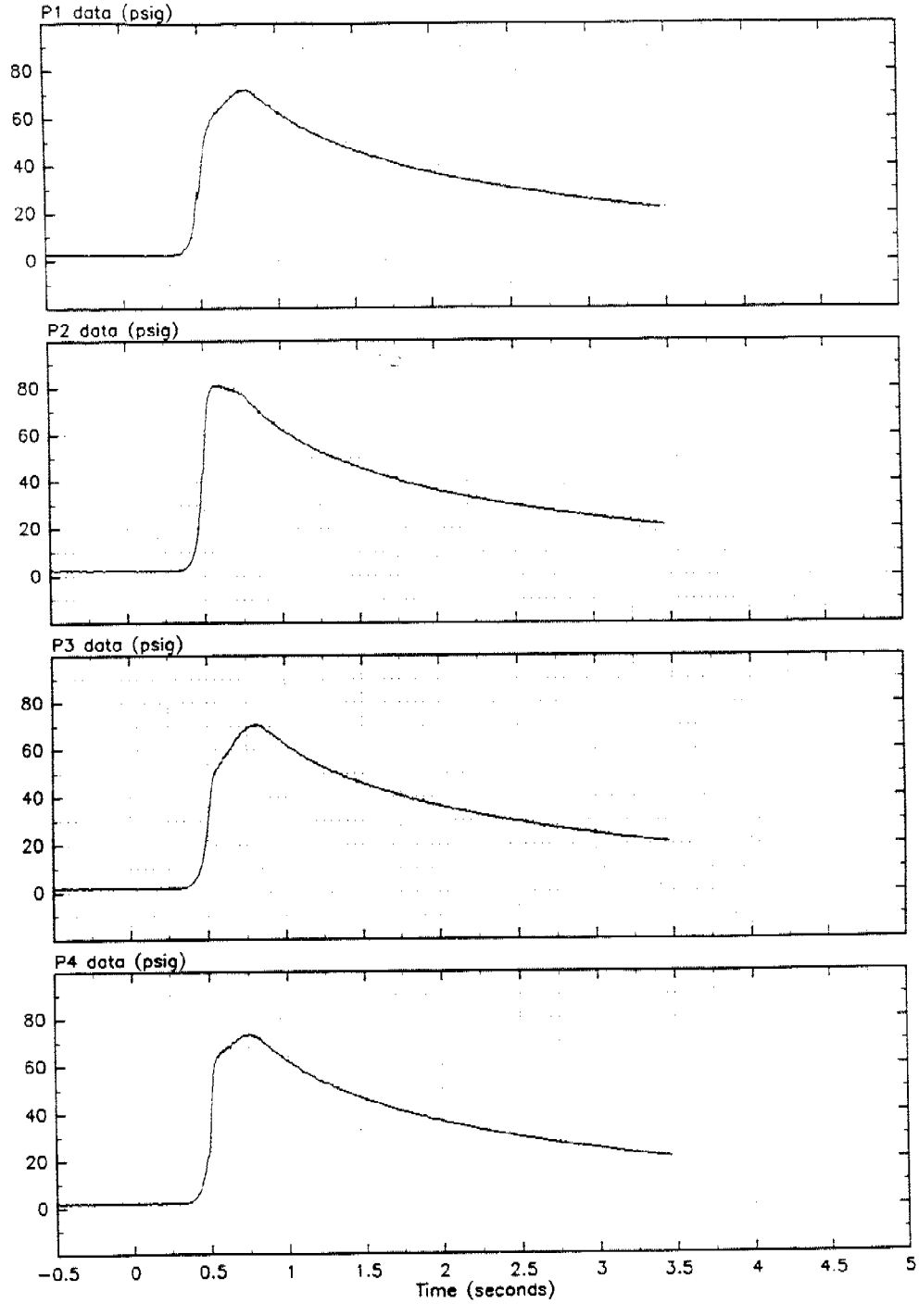
Test #34


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

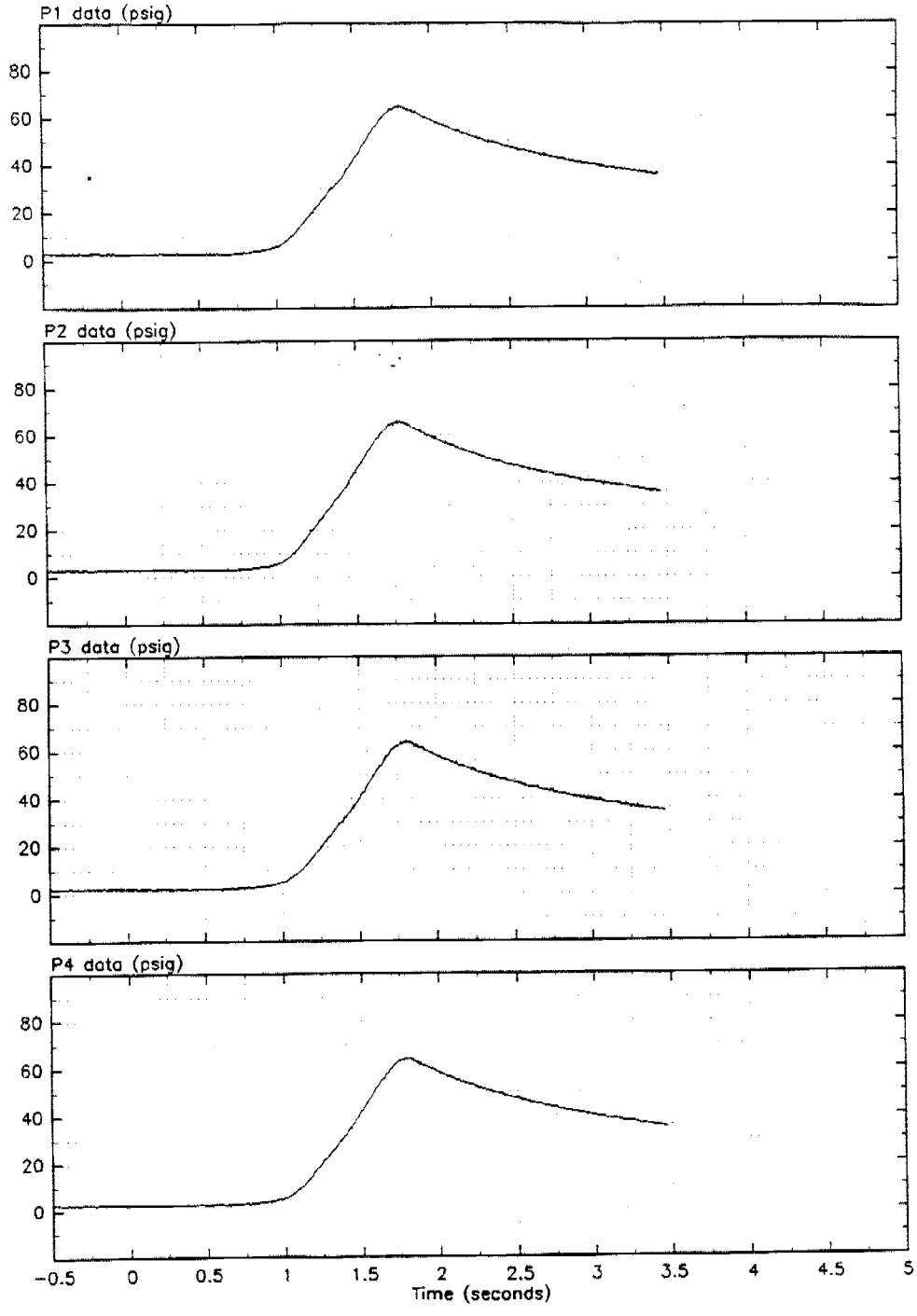
Test #35


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

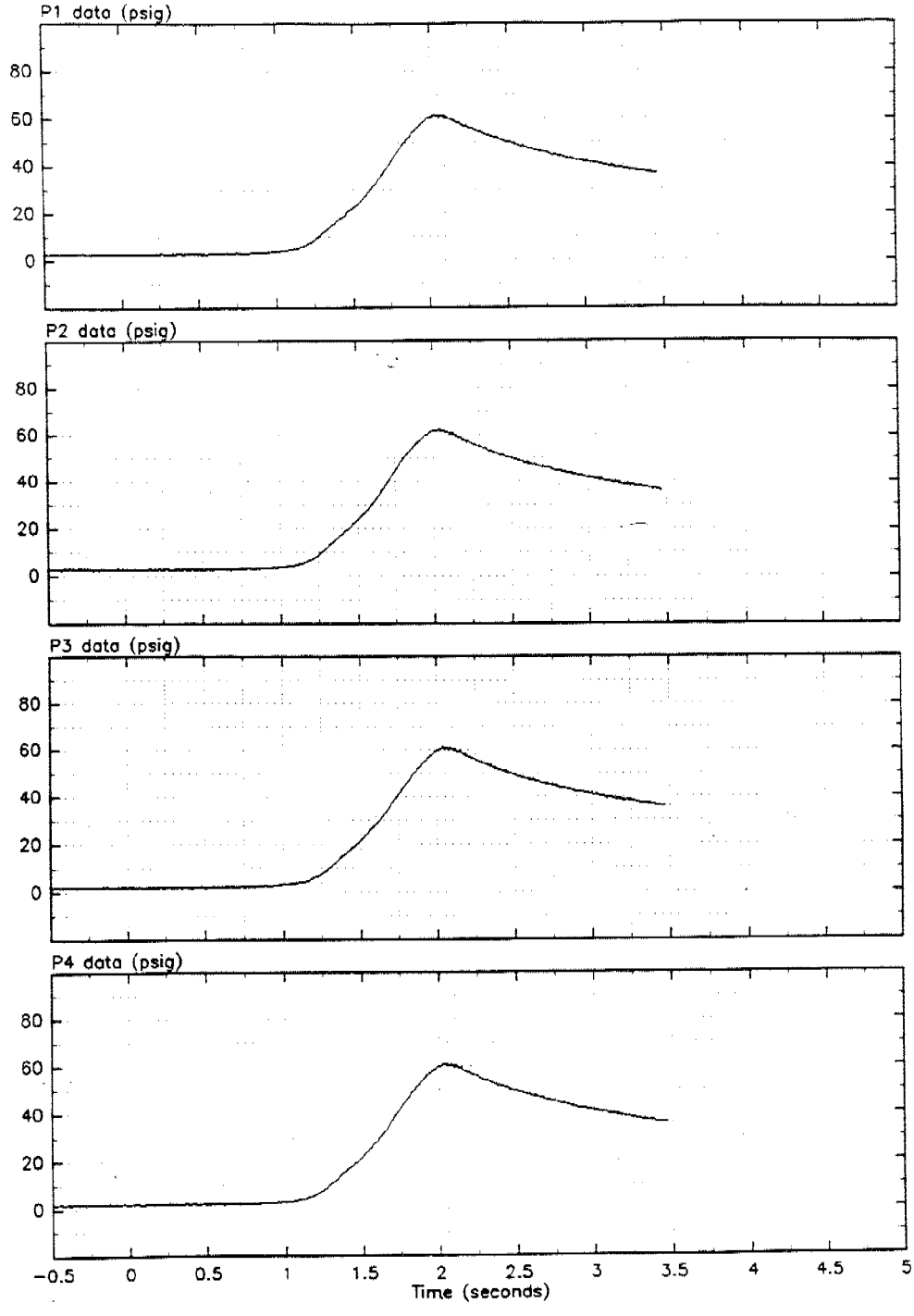
Test #36


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

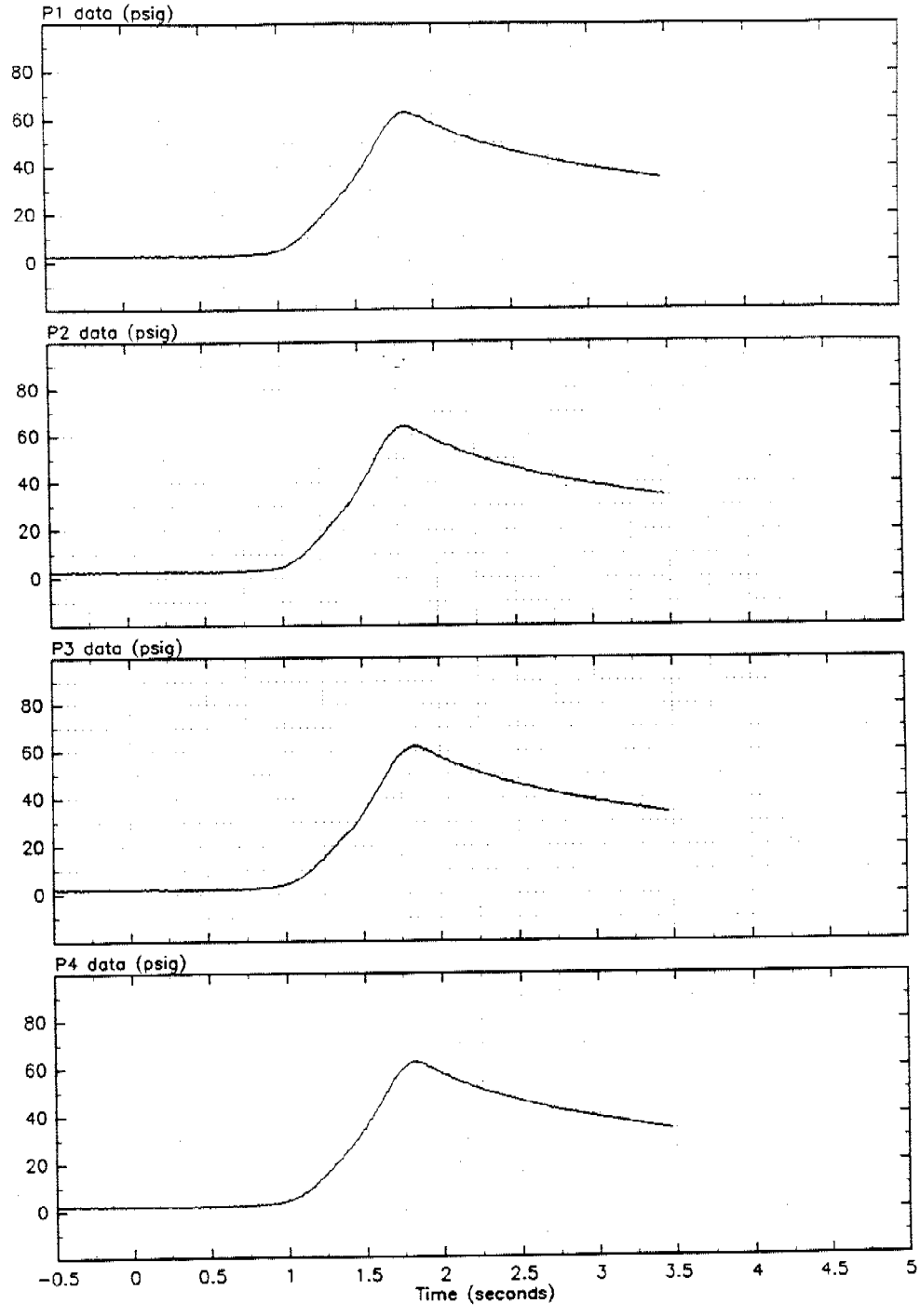
Test #37


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

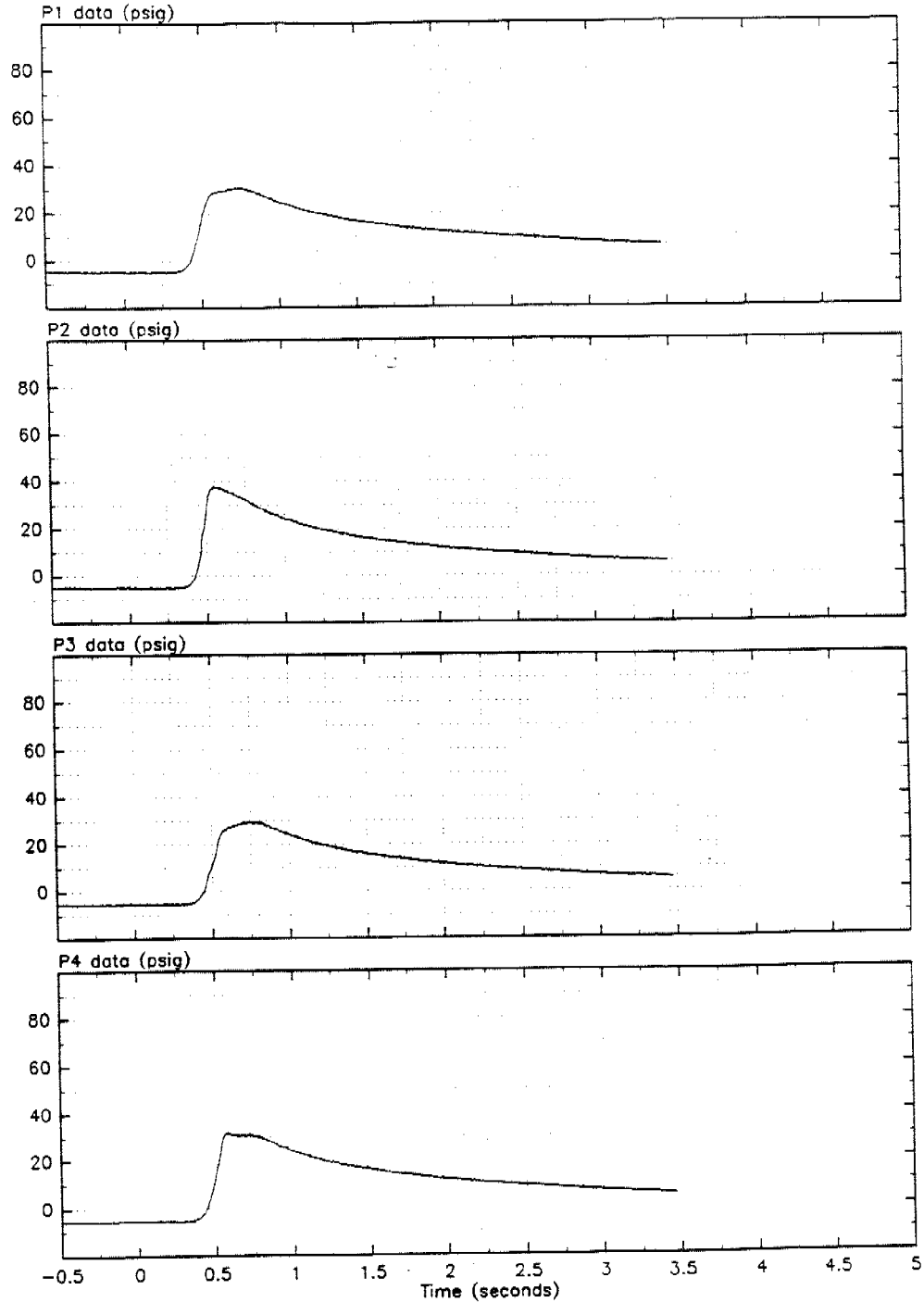
Test #38


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

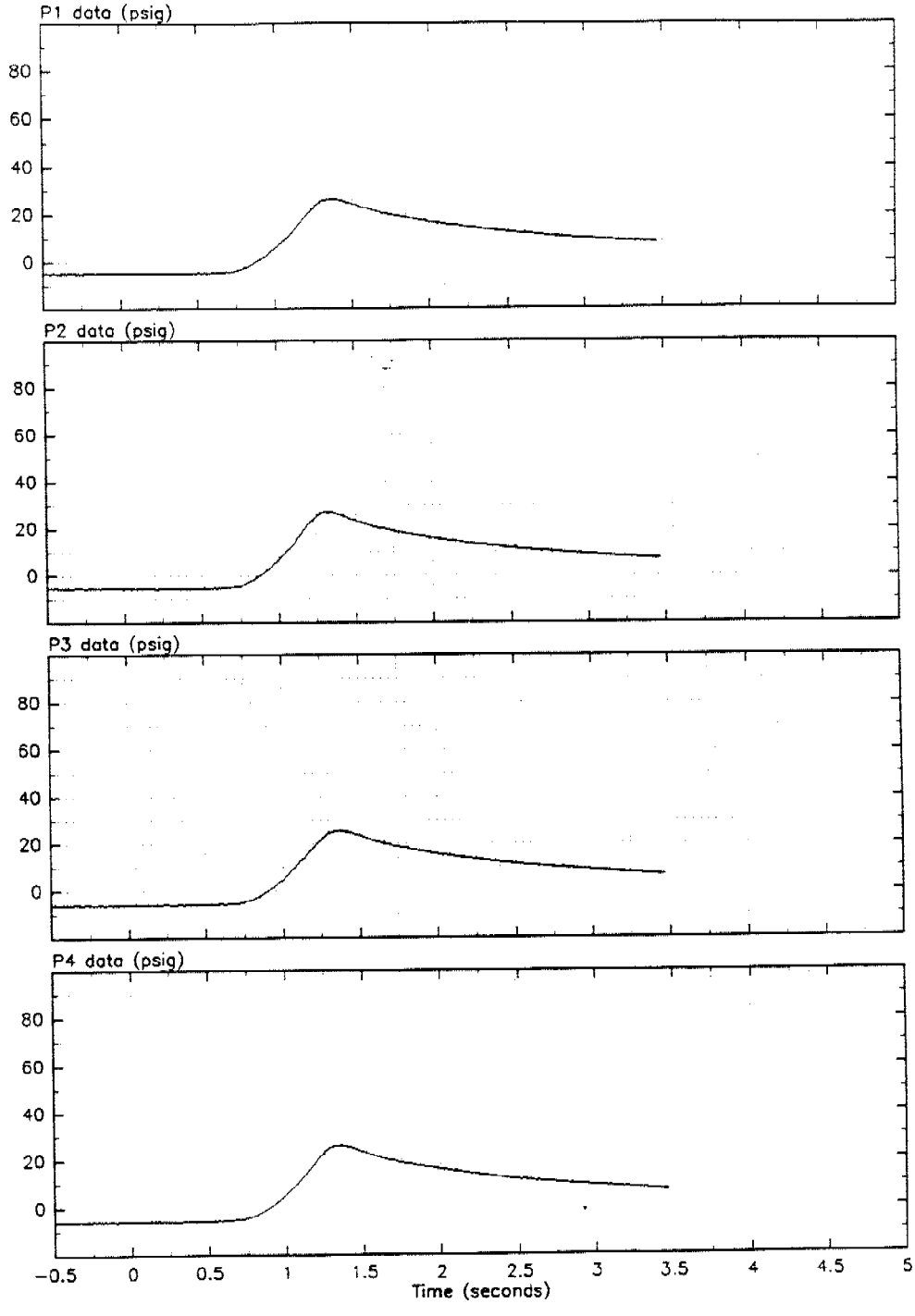
Test #39


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

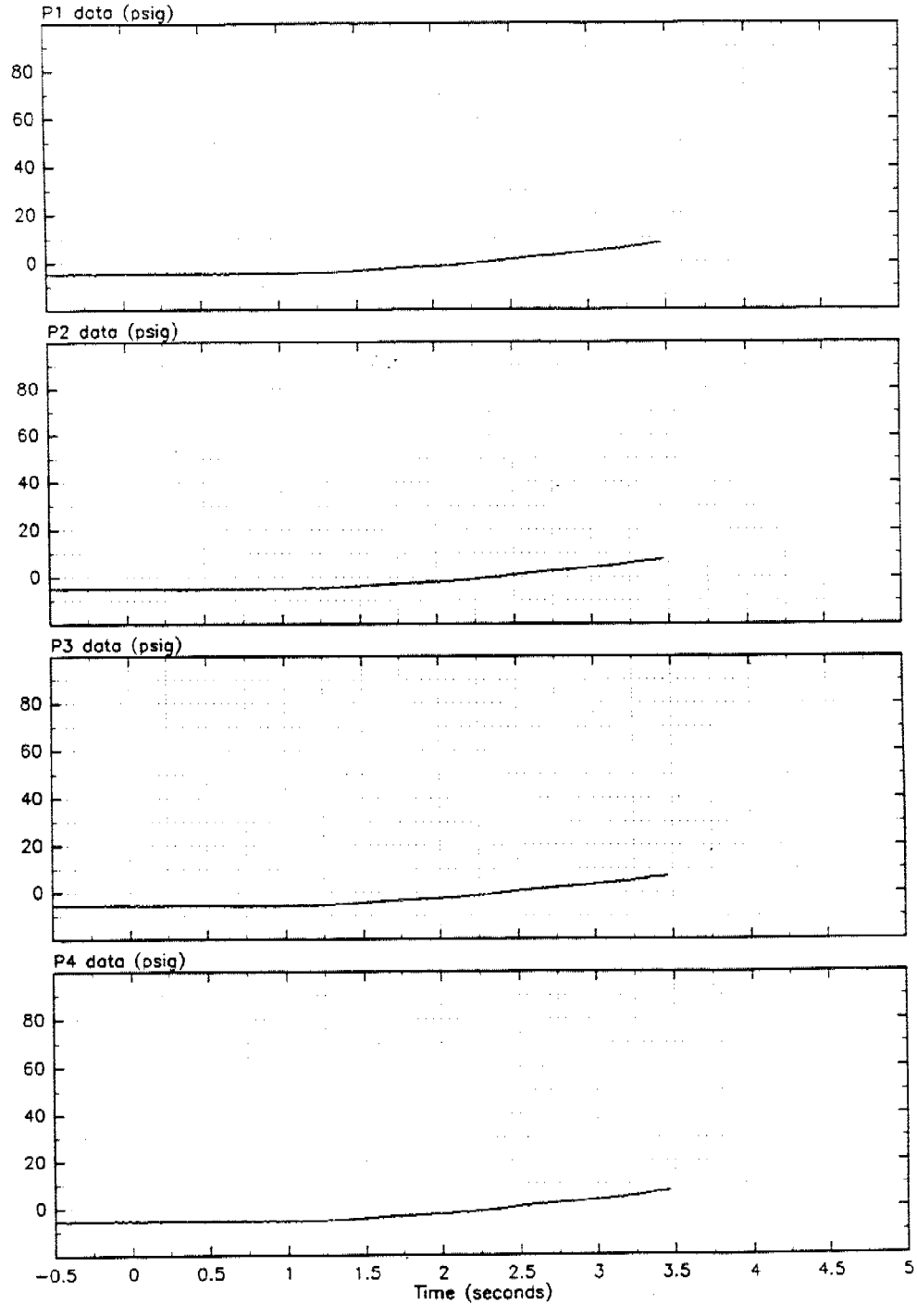
Test #42


P1 data (psig)
80
60
40
20
0
P2 data (psig)
80
60
40
20
0
P3 data (psig)
80
60
40
20
0
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

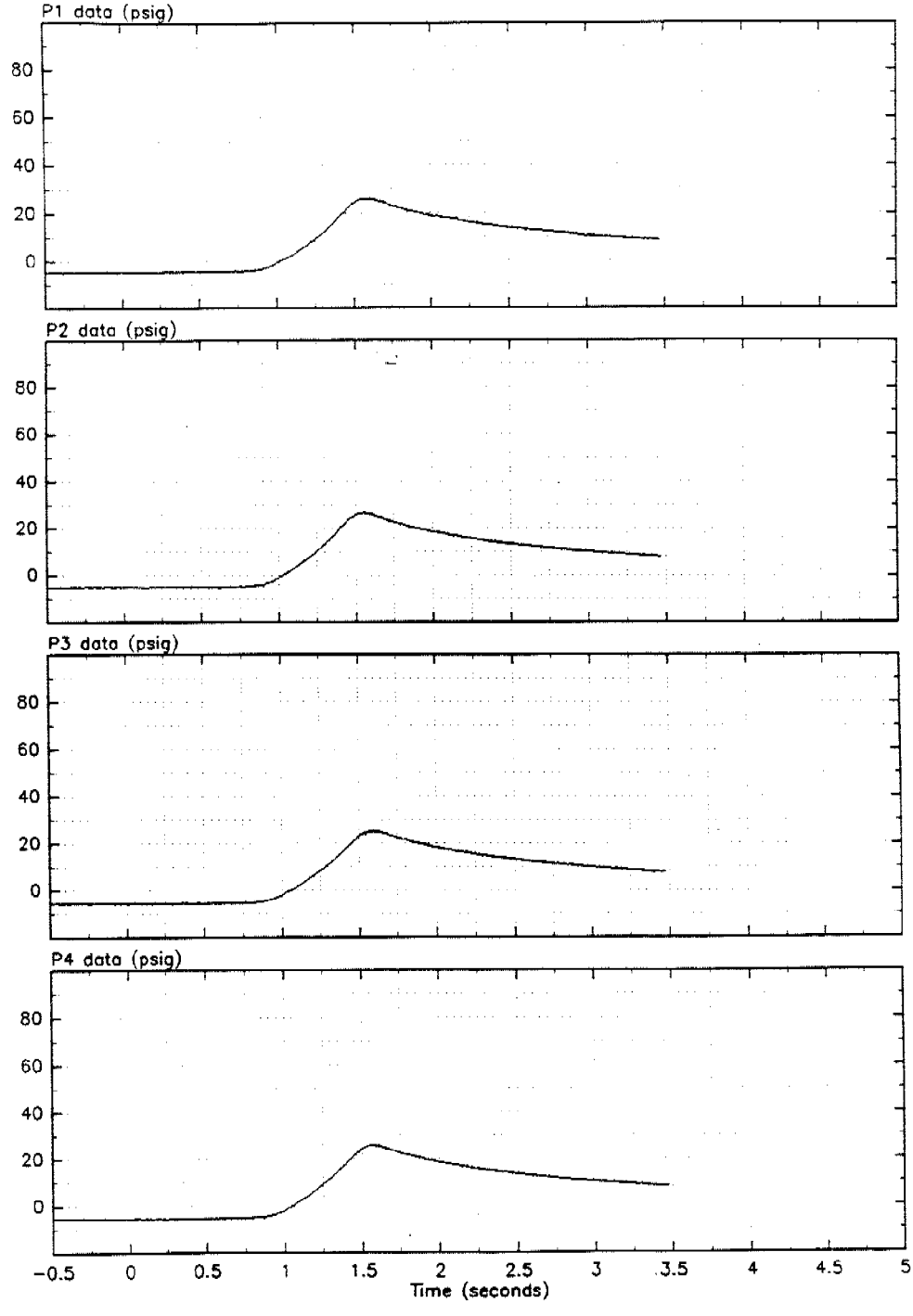
Test #43


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

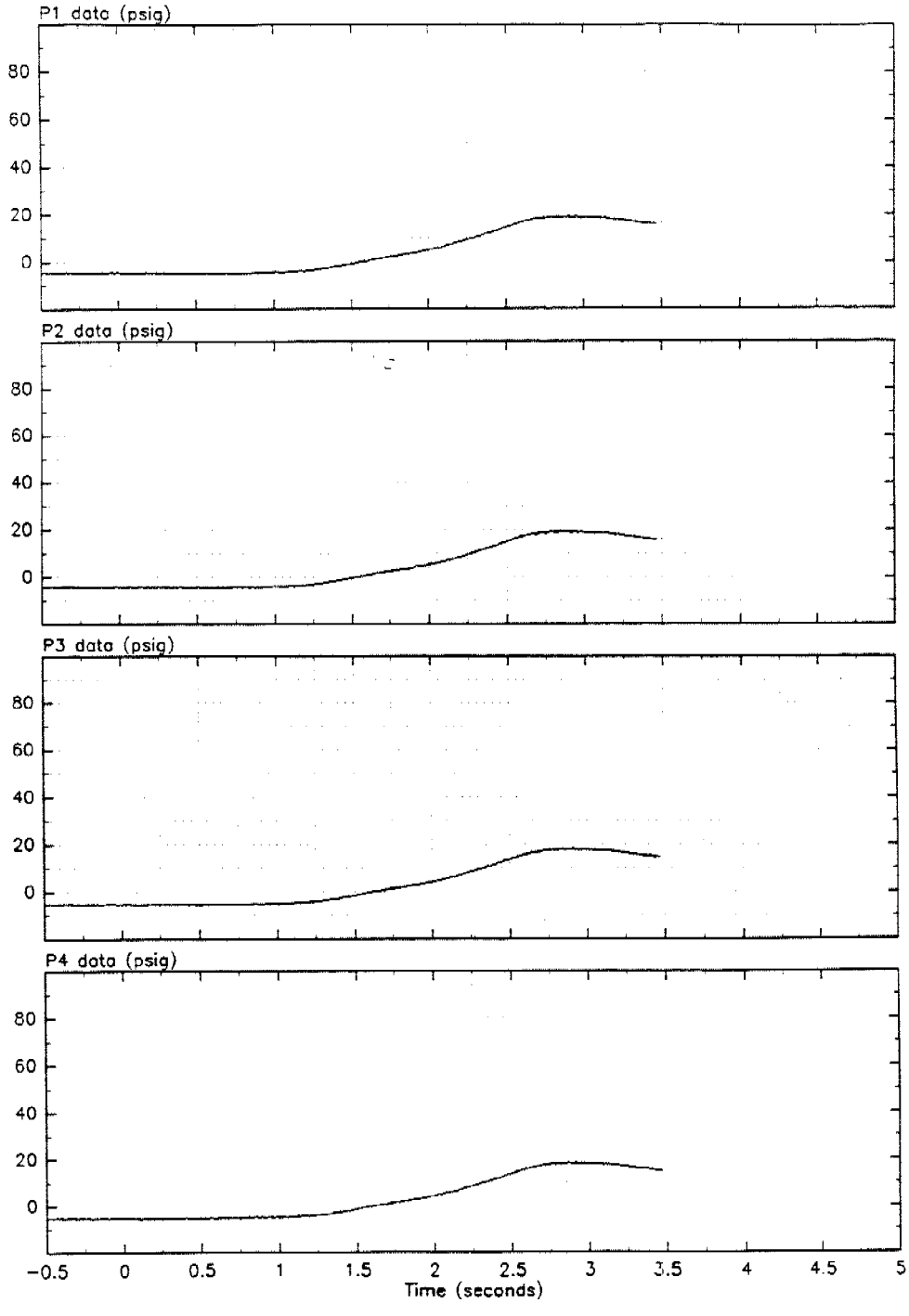
Test #44


P1 data (psig)
80
60
40
20
0
P2 data (psig)
80
60
40
20
0
P3 data (psig)
80
60
40
20
0
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

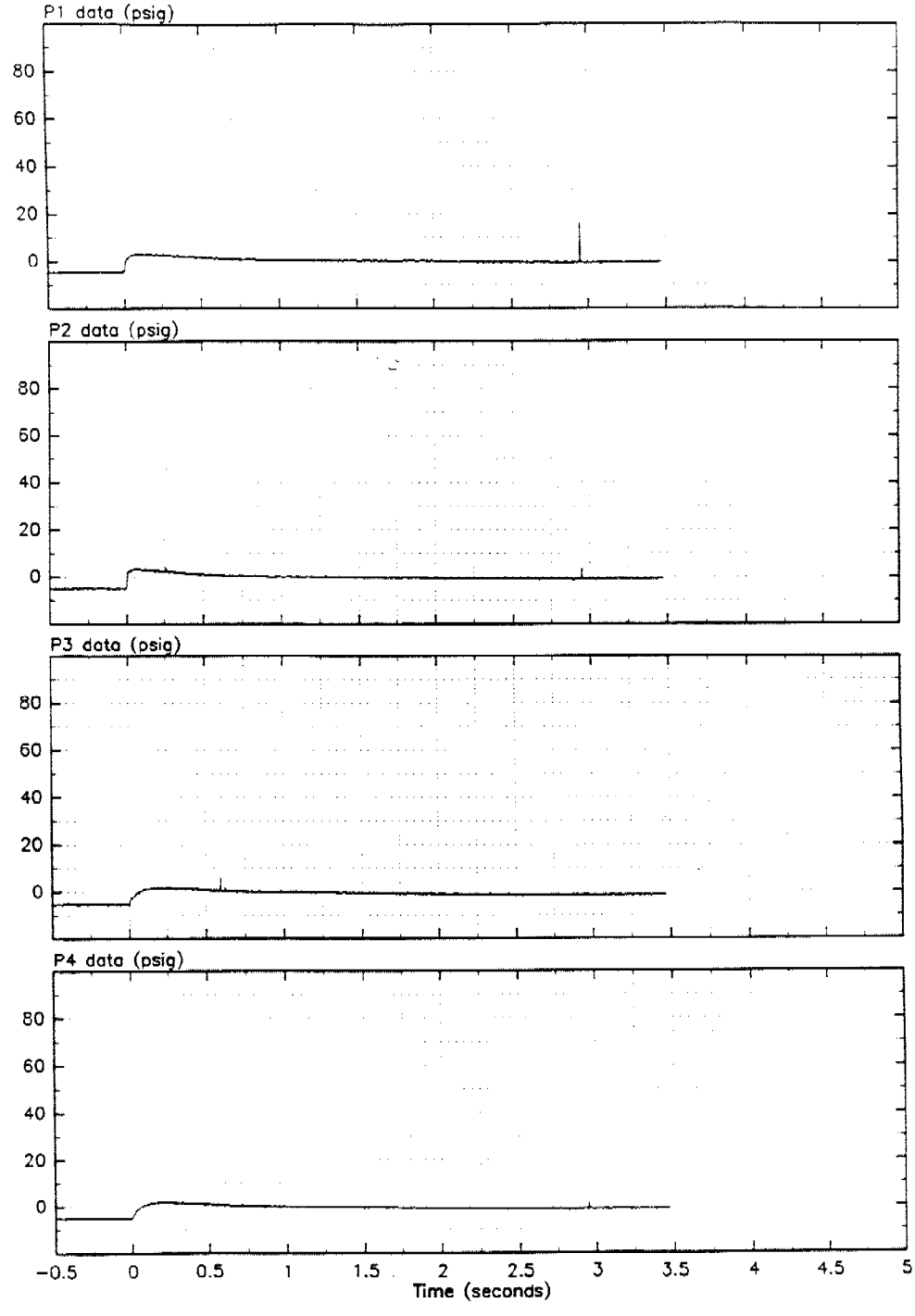
Test #46


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

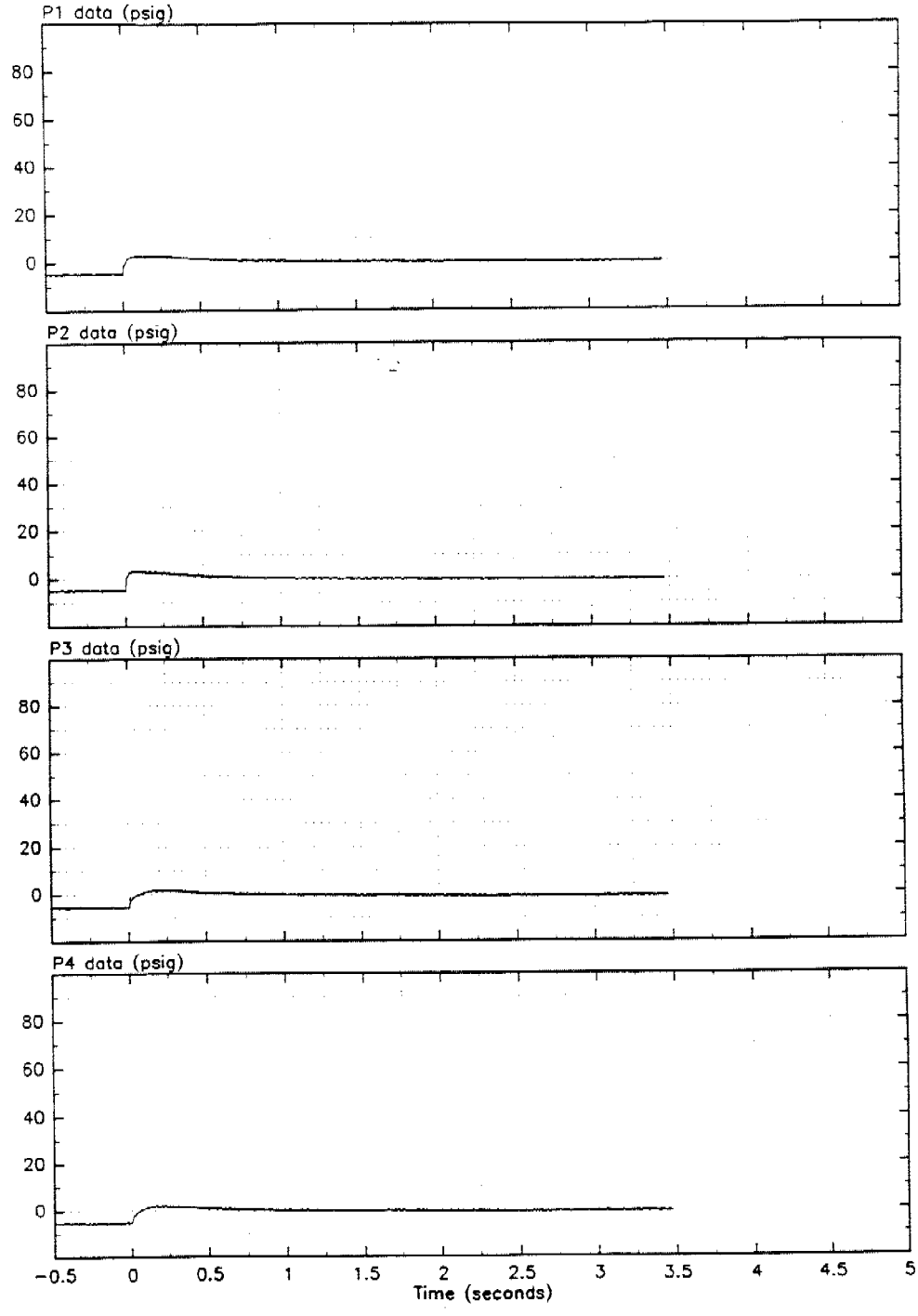
Test #47


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

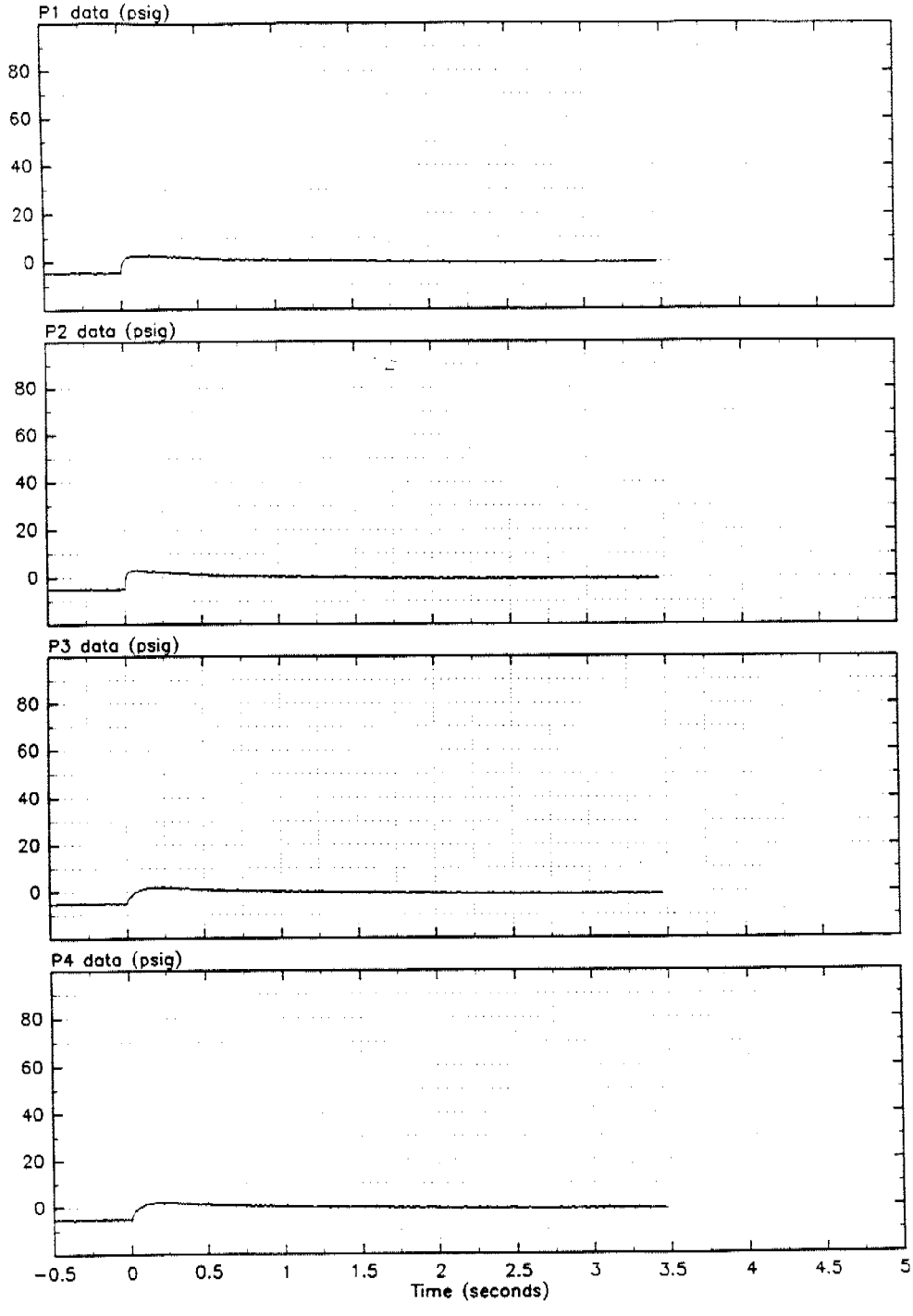
Test #48


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

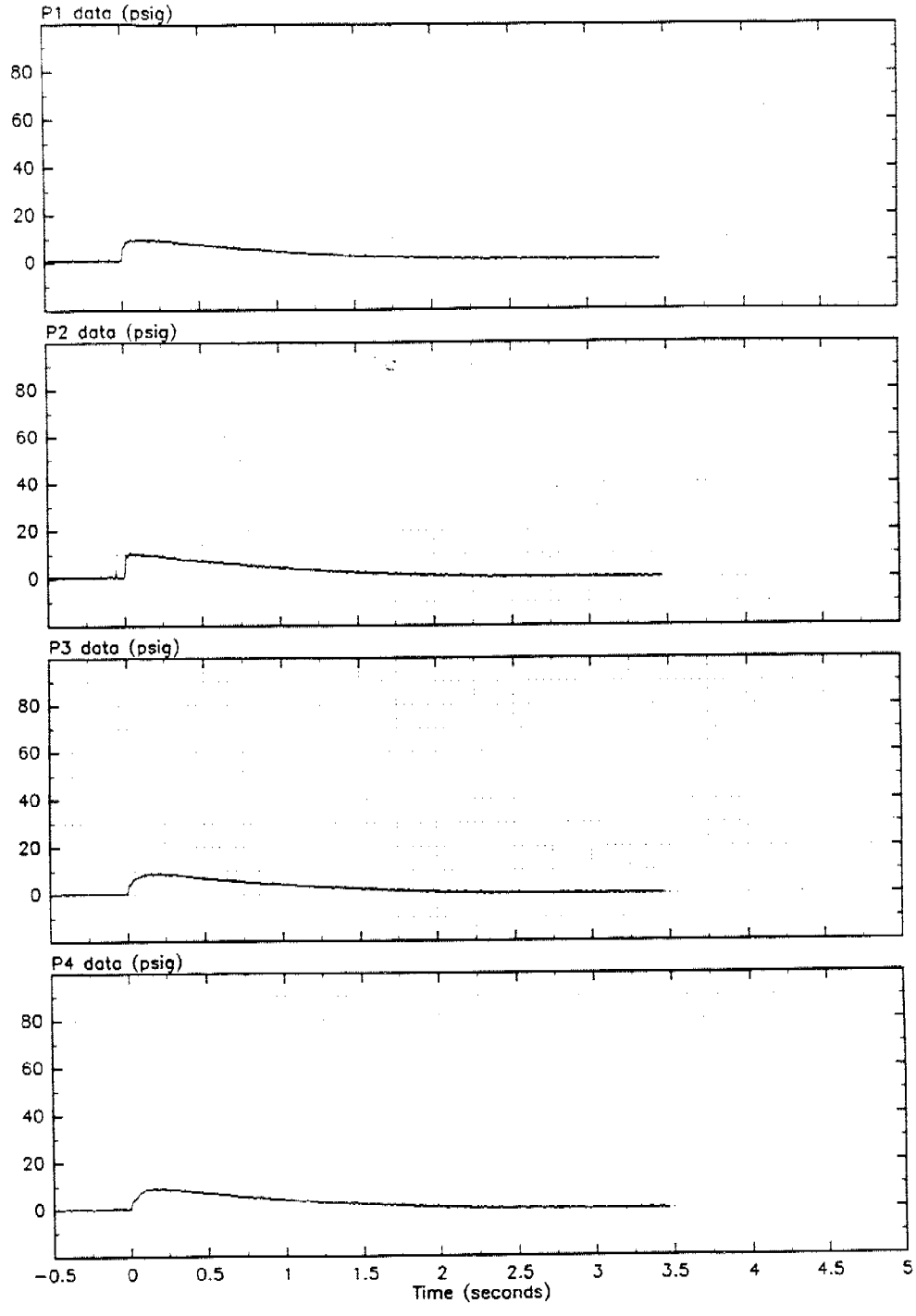
Test #49


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

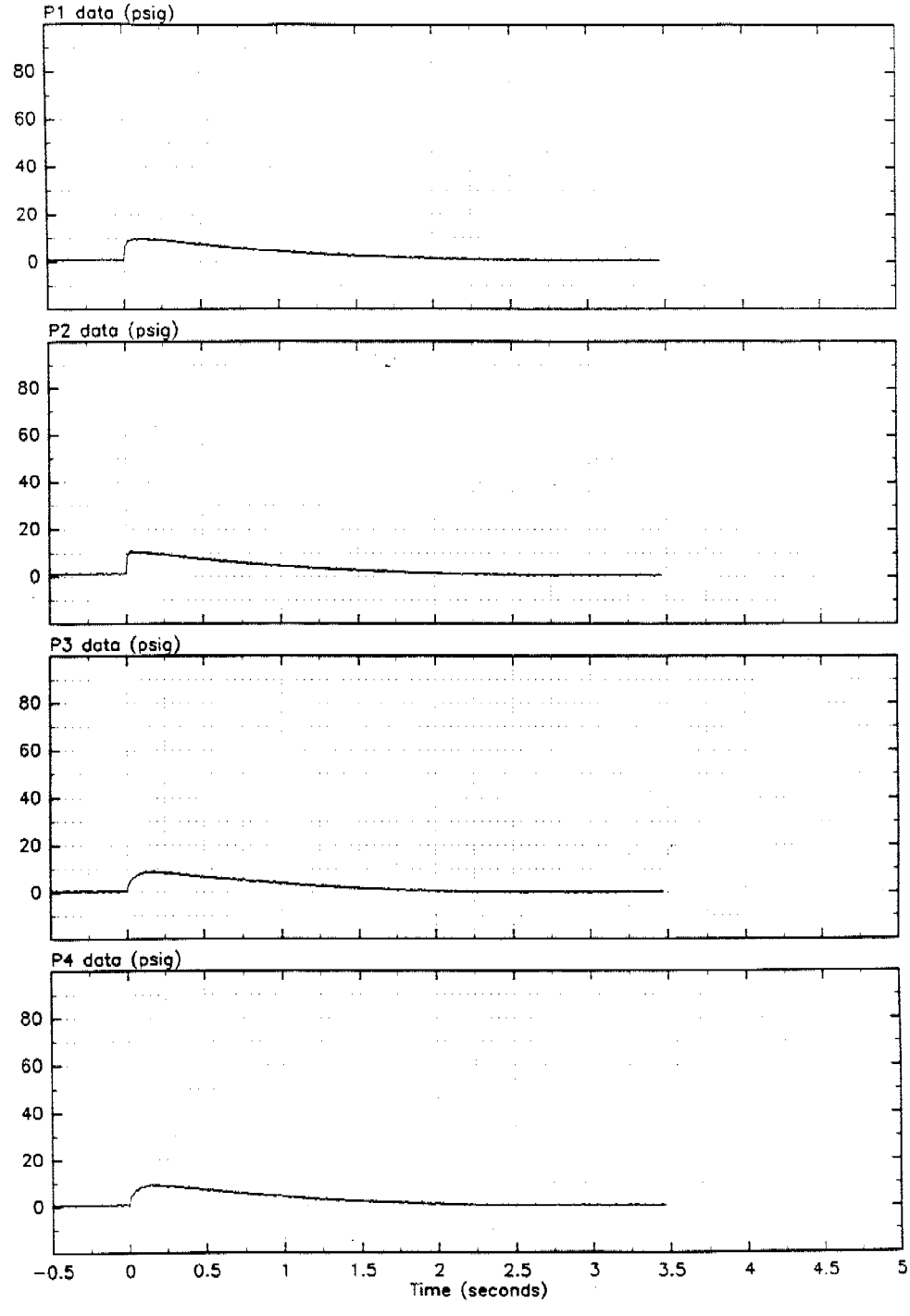
Test #50


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

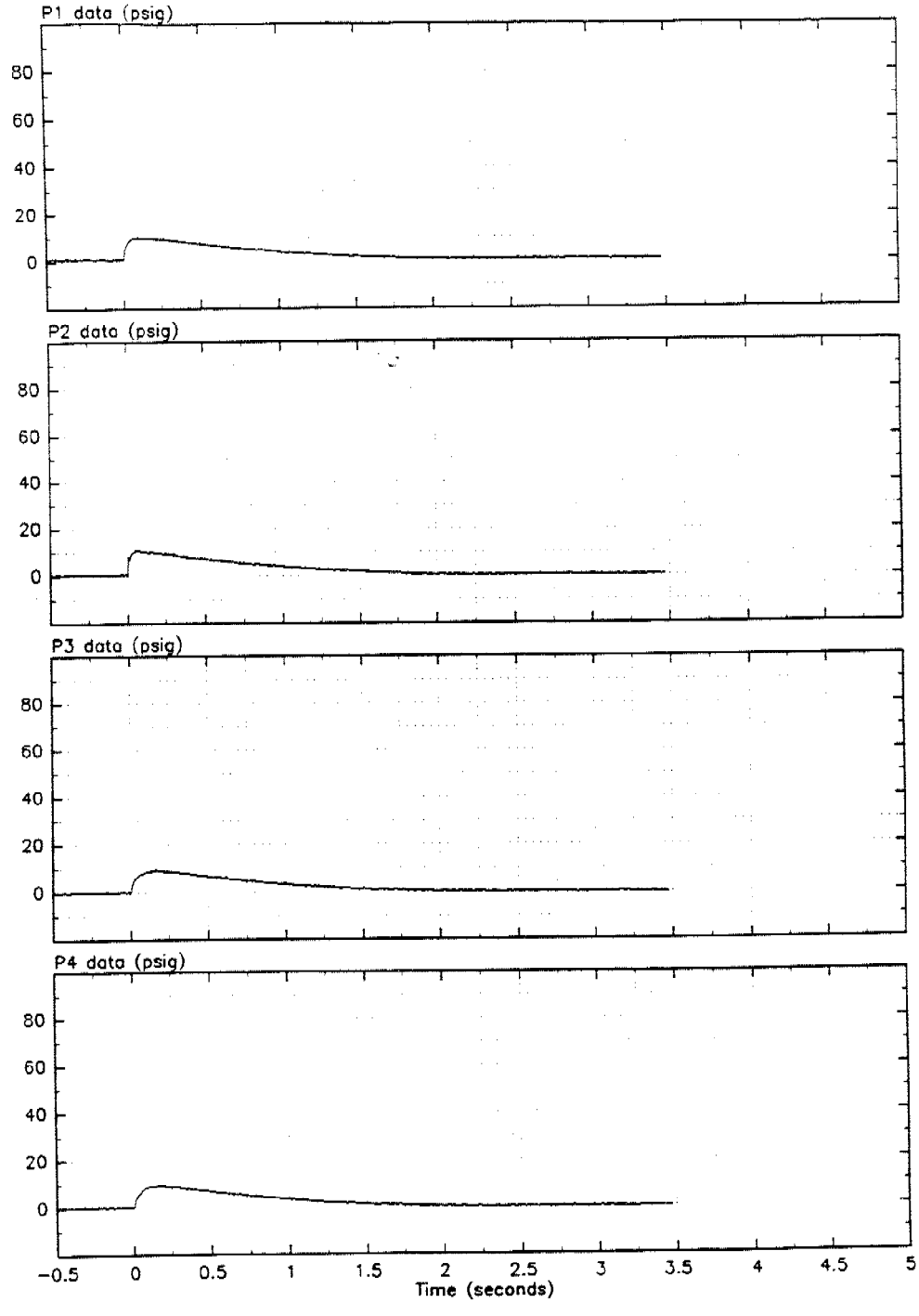
Test #51


P1 data (psig)
80
60
40
20
0
P2 data (psig)
80
60
40
20
0
P3 data (psig)
80
60
40
20
0
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

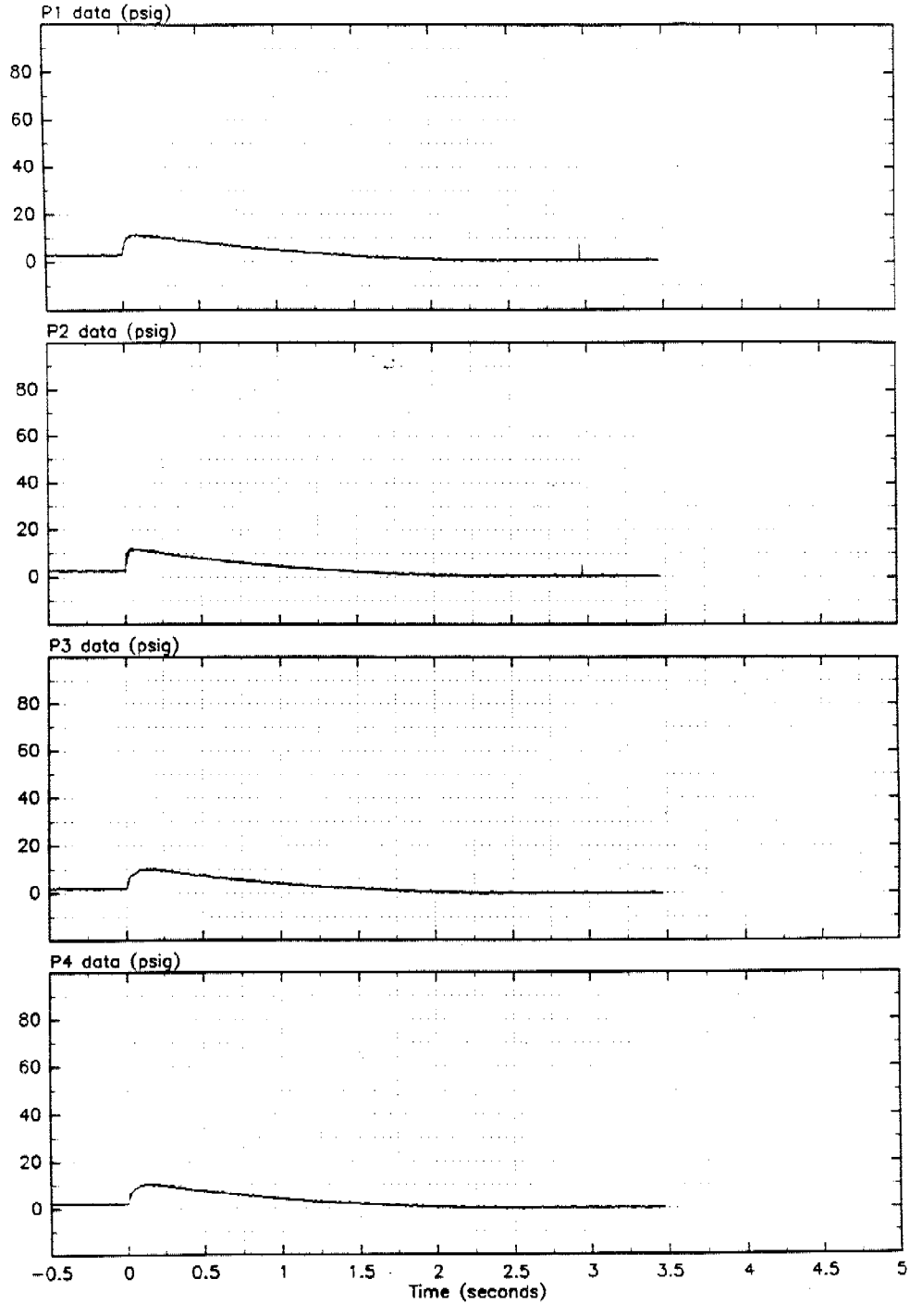
Test #52


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

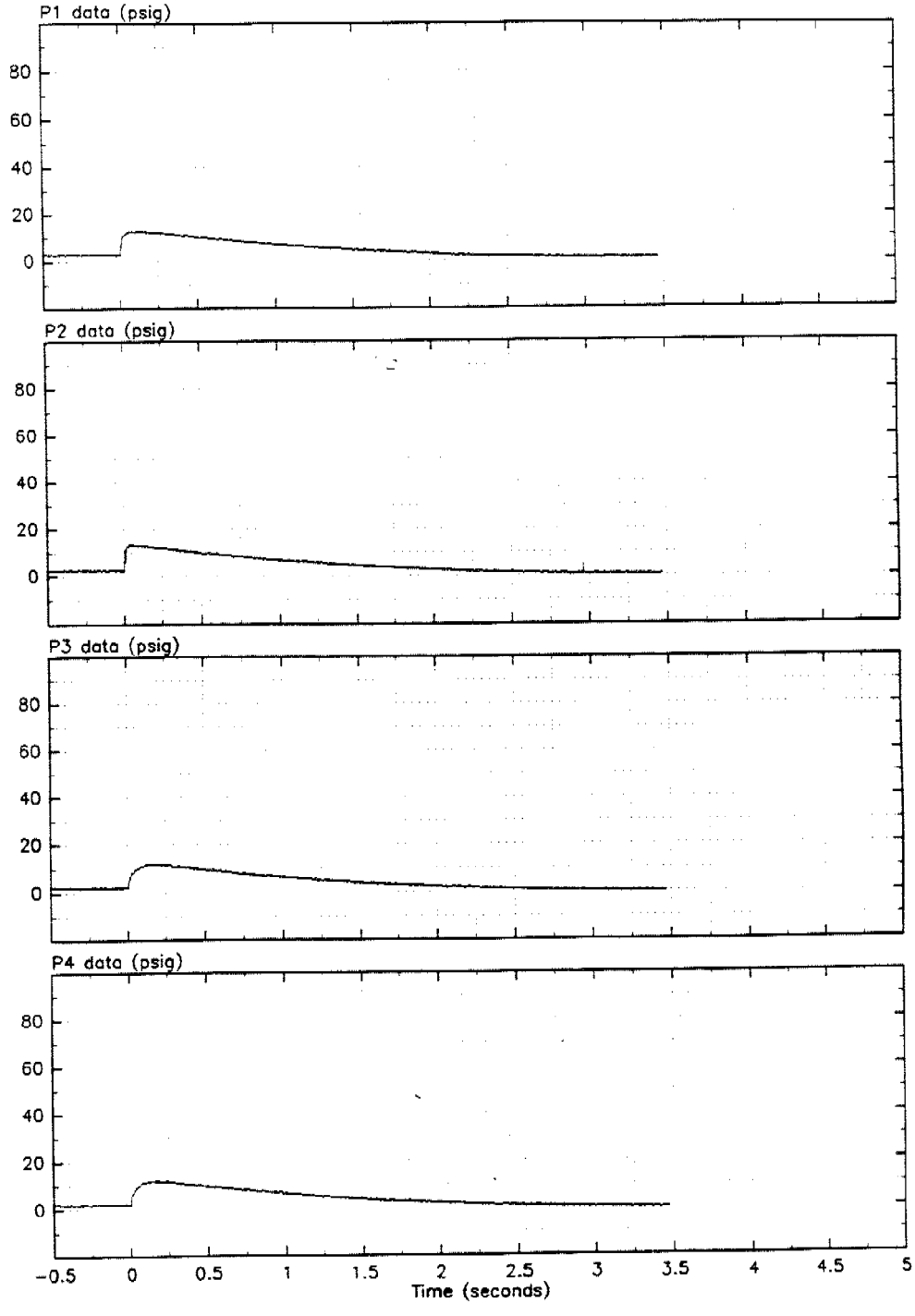
Test #53


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

Test #54


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

Test #55


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
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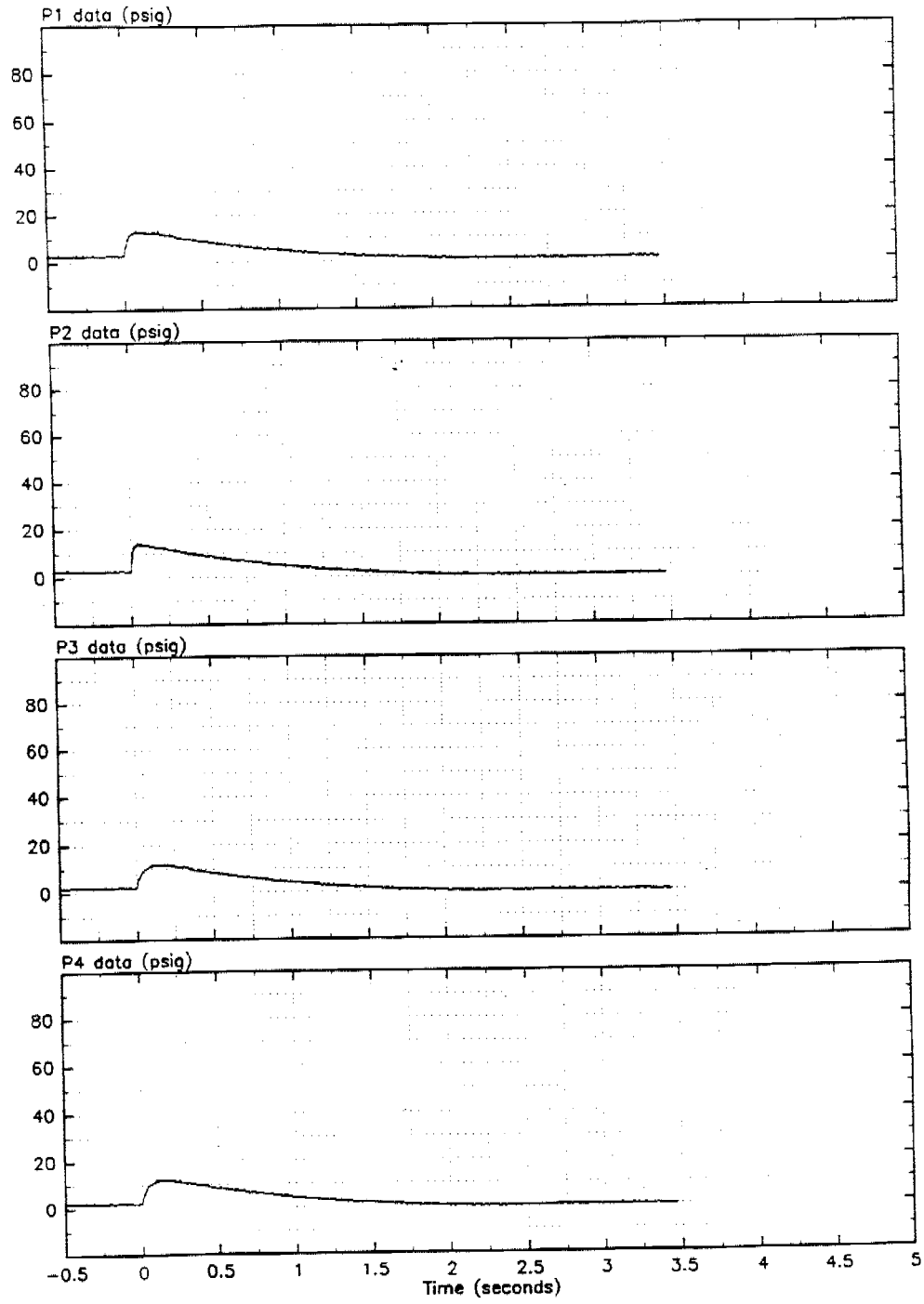
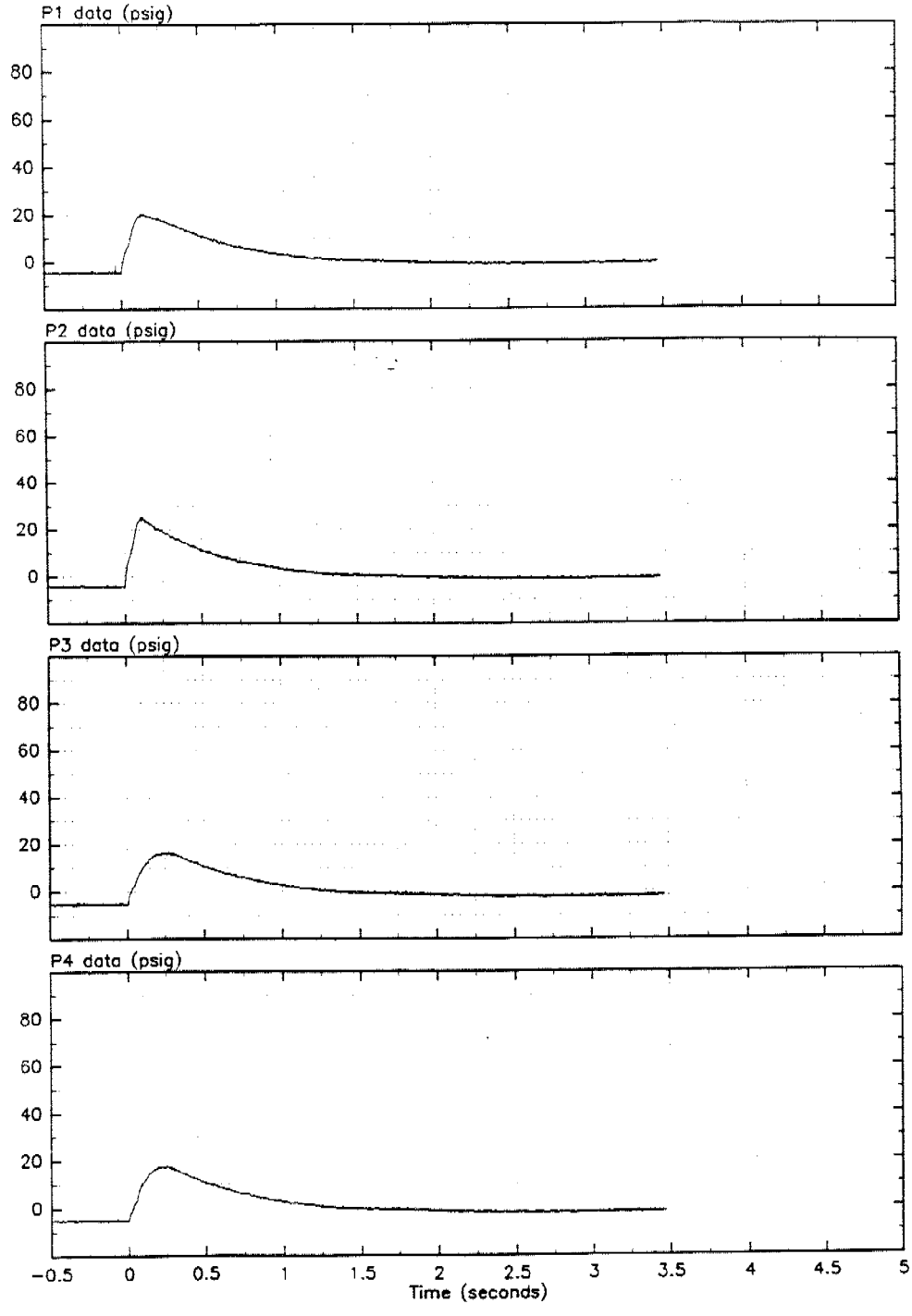
3
3.5
4
4.5
5
Time (seconds)

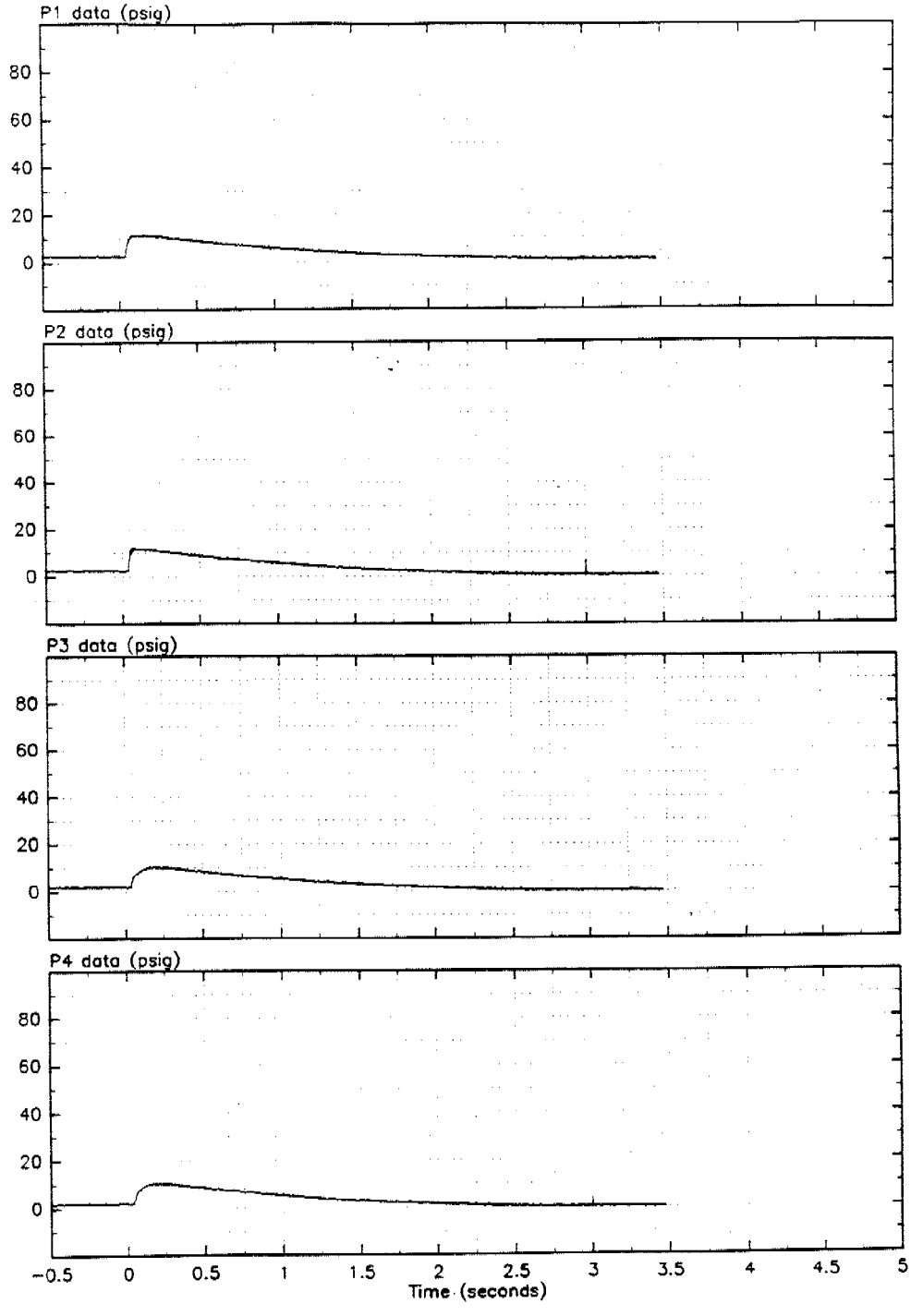
Test #56


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

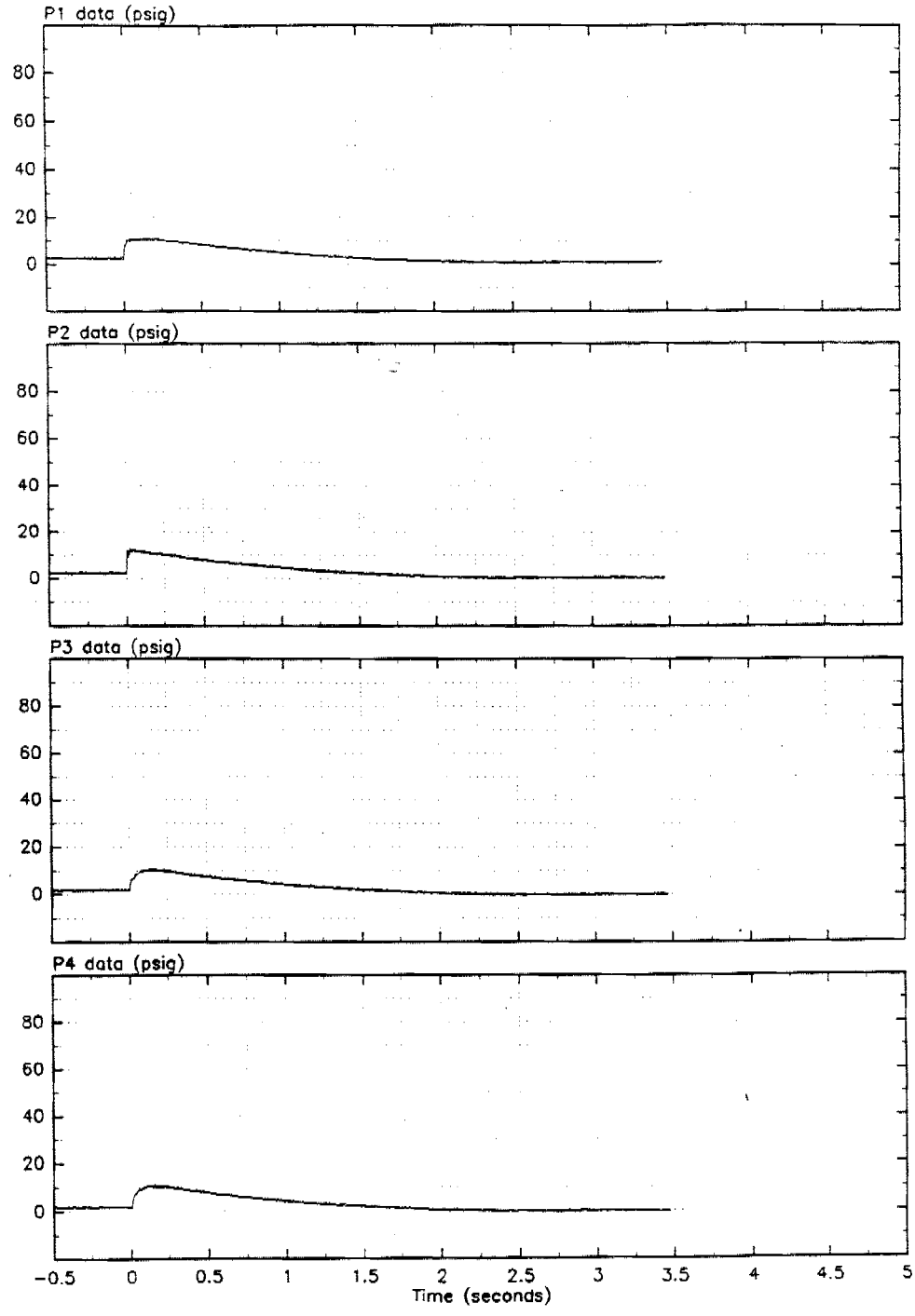
Test #57


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

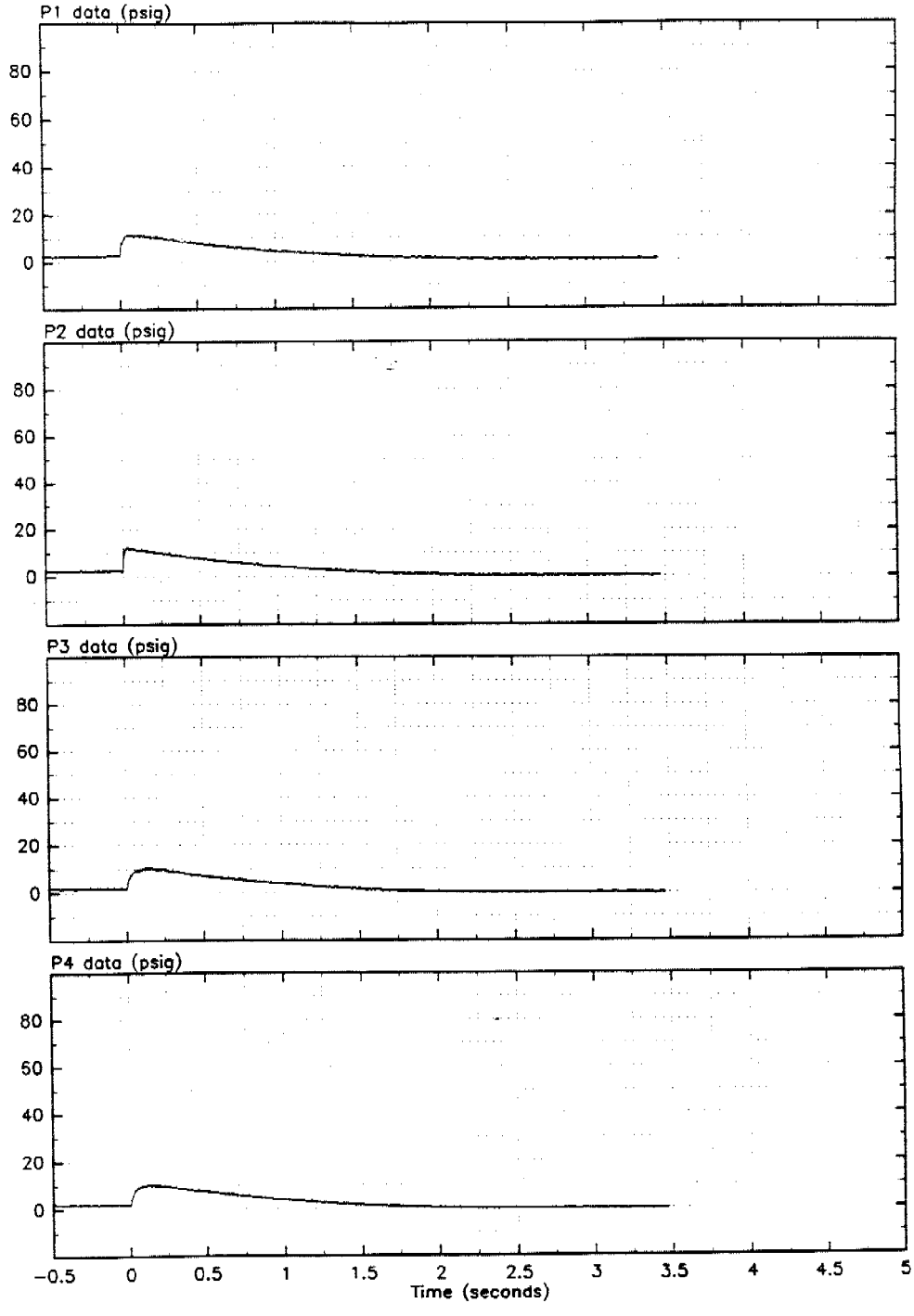
Test #59


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

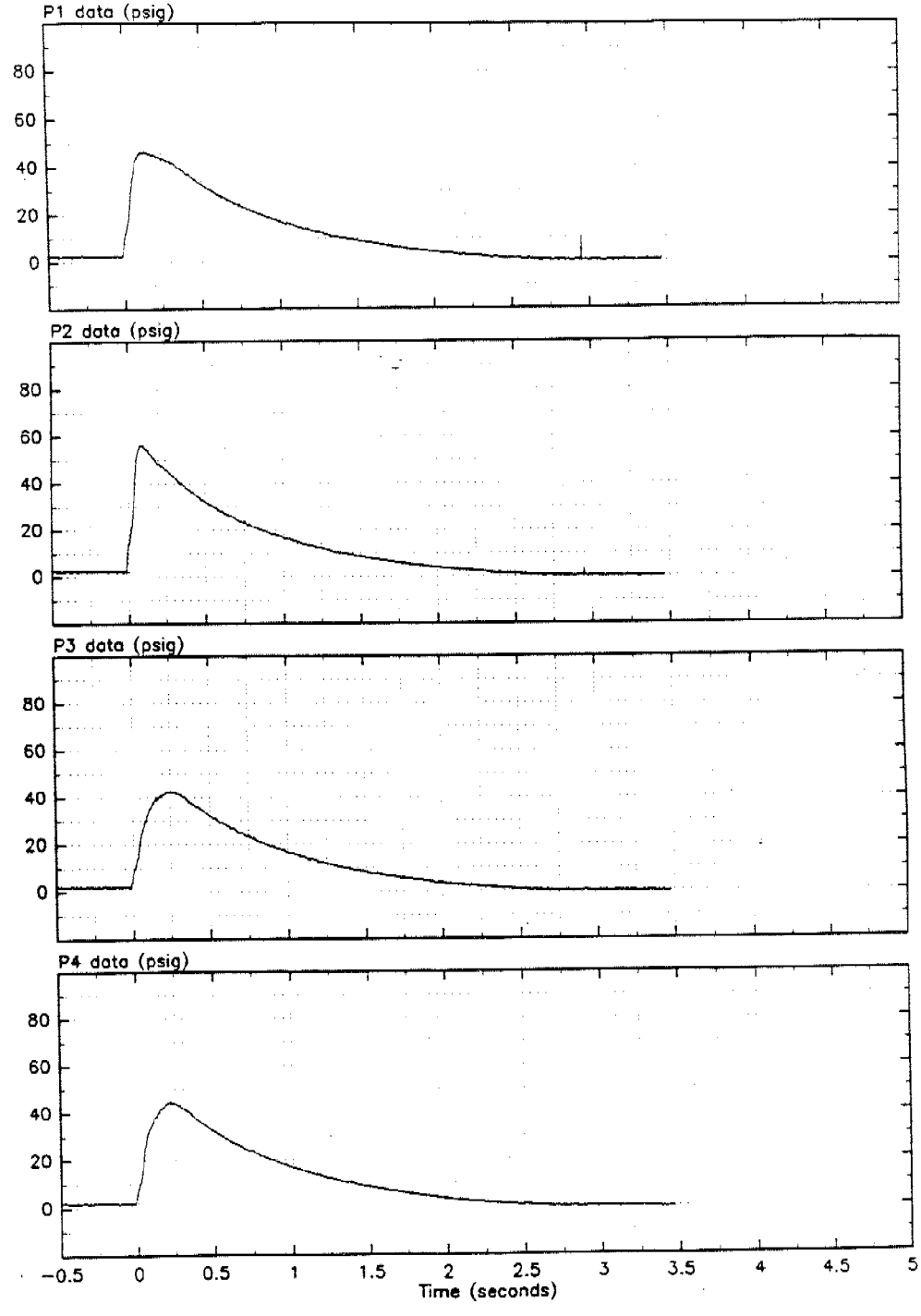
Test #60


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

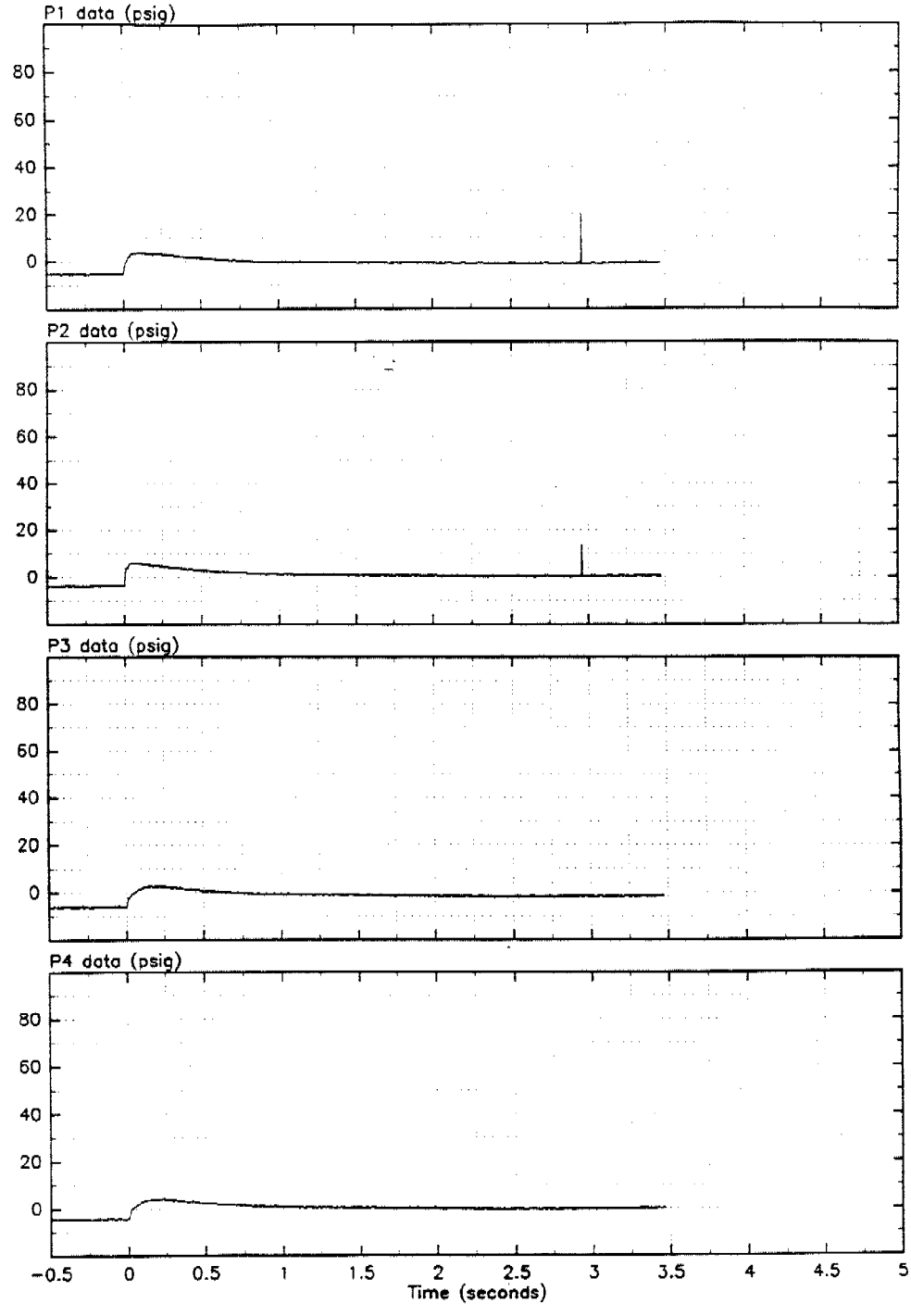
Test #61


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

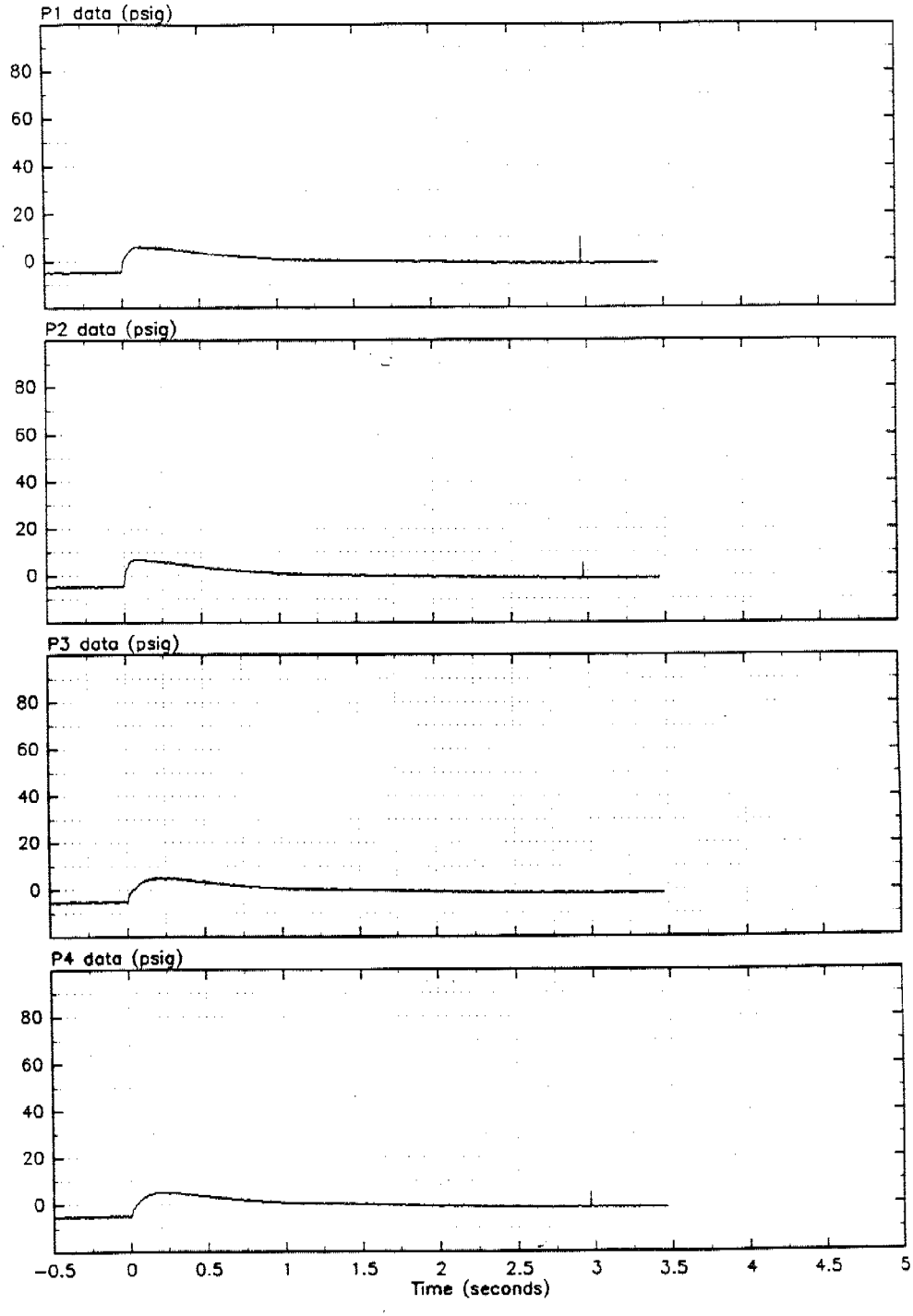
Test #62


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

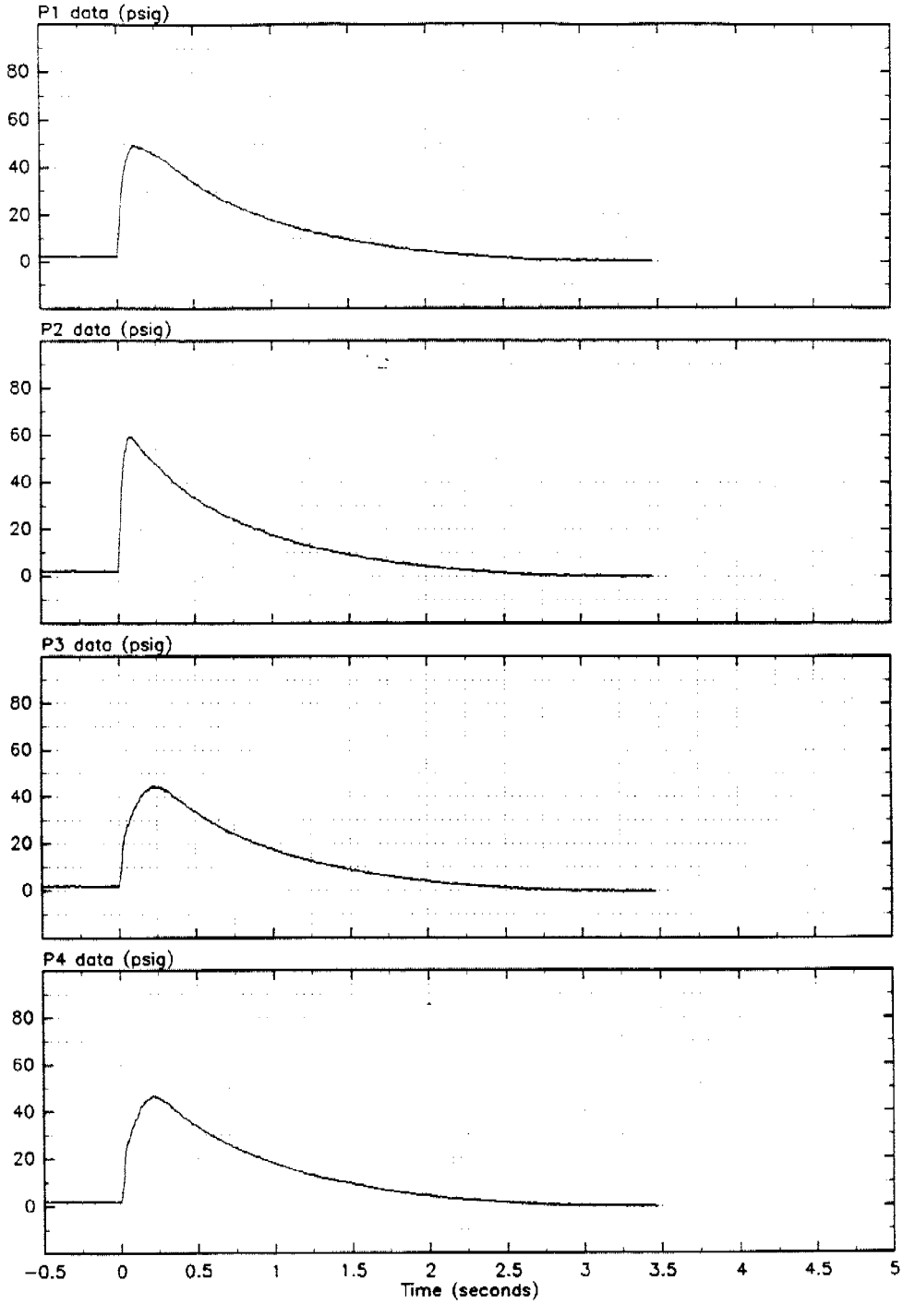
Test #63


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

Test #64


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

Test #65


P1 data (psig)
P2 data (psig)
P3 data (psig)
P4 data (psig)
80
60
40
20
0
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (seconds)

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