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EVALUATION TEST REPORT
of
HOT WIRE INITIATORS
Loaded with
Non-Conductive Propellant (SOS-200)

By G. Drinkard and H. Martin

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SUMMARY

Each of 80 test specimens was subjected to the Hermetic Seal, Insulation Resistance, Bridgewire Resistance, Environmental Seal, Dielectric Strength Tests, Interbridgewire Resistance and Capacitance Tests, and all performed within the specification requirements.

The test specimens were then subjected to an electrostatic pulse of 25,000 volts DC, after which the units were again tested for interbridge resistance and capacitance. No significant shift in interbridgewire resistance of capacitance was noted as a result of the electrostatic discharge.

A Bruceton was performed. Thirty (30) specimens were tested for No-Fire Current at +300°F and thirty (30) specimens were tested for All-Fire Current at -260°F. The no-fire was 1.519 amperes at 300°F. The all-fire current at 99.9% reliability was 2.695 amperes.

Thirty (30) specimens which did not fire during the all-fire and no-fire Bruceton tests were fired at 3.5 amps. closed bomb at ambient temperature. All the units fired successfully. Six units produced pressures in excess of the specification requirements and four units ignited slower than specification requirements.

Twenty (20) specimens were subjected to Humidity Tests, Vibration Tests at temperatures of -260°F and +300°F in each of three axes, and to Temperature Cycling Tests consisting of 20 cycles of -260°F for one hour, followed by +300°F for one half hour.

At the completion of these tests, each unit was inspected and visually accepted prior to being subjected to a Leakage Test and an Environmental Seal Test. One unit leaked at the connector end during the leakage test. The unit was fired at high temperature (+300°F)

and subjected to a thorough leak test to determine if a leakage did exist. The unit did not leak and as a result of post-fire leak tests, which demonstrated the soundness of the initiator construction, the unit was accepted.

Ten (10) virgin specimens were subjected to a High Temperature Firing Test (300°F in a 10cc bomb). Eight (8) were fired at 3.5 amps and two (2) at 22 amps. All the specimens performed within requirements.

Ten (10) virgin specimens were subjected to a Low Temperature Firing Test (-265°F/10cc). Eight (8) units were fired at 3.5 amps. and two (2) at 22 amps.

All the specimens performed within the requirements except unit S/N 0338. This initiator did not ignite when fired at 22 amps.

An analysis revealed that the bridgewire ignition was normal and should have supplied the energy necessary to reliably ignite the SOS-200 initiation charge.

Theoretical studies of the mechanism of bridgewire ignition and related heat transfer have showed that when the firing current is higher than normal, there is a tendency for the bridgewire to burn out adiabatically before significant heat transfer is accomplished into the mix in immediate contact with the bridgewire.

Analytical experiments were then performed to verify heat transfer from the bridgewires to the ignition mix at high current levels.

These tests prove it was possible to burn out the bridge with high current and not ignite the mix, furthermore this analysis revealed that the present non-conductive Apollo Standard Initiator could be reliably fired at room ambient temperature, any current, 3.5 to 22.0 amps. and at low temperature (-260°F) 10-amp maximum applied current.

INTRODUCTION

This document presents the results of evaluation tests performed by Space Ordnance Systems, Inc., on a non-conductive pyrotechnic compound utilized in a dual bridge 1 watt/1 amp initiator system. The purpose of this compound is to provide immunity to RF and electrostatic environments by controlling the electrical characteristics of the pyrotechnic compound in addition to the normal 1 watt/1 amp capability which simply provides thermal control of heating due to low currents circulating in the bridgewire.

RF evaluation tests have shown that the material does indeed provide a high degree of immunity from such electromagnetic environments. It was necessary, however, to perform further tests to show that the initiator utilizing this compound was capable of meeting other rigorous requirements associated with such electroexplosive devices.

Evaluation testing was performed on 80 Space Ordnance Systems, Inc., Part Number S01-266-21, initiators to demonstrate their functional reliability during and after exposure to conditions of standard and severe environmental stresses. Tests were equal to or more severe than those imposed on the Apollo Standard Initiator (ASI), SOS Part Number S01-266-7. Direct comparisons were made as a result of this report to Qualification Test Report No. 1055 (Reference Appendix 2) to show that the two initiators performed equivalently.

There is great significance to the fact that the non-conductive mix which has been tested to show its immunity to electromagnetic environments can also be incorporated into a state-of-the-art electroexplosive device thereby giving us a significant improvement in the total overall capability of such initiators.

MAIN TEXT

HARDWARE DESCRIPTION AND PURPOSE

The Non-Conductive propellant is used in the form of an insulating layer, slurried over the standard bridgewires of the ASI, after which an additional amount is compacted on top of the slurry. The standard SOS-108 compound is then put on top, and the initiator is completed in the normal manner. The binder used for the new mix is the same as that used in the SOS-108 propellant. Also, the flexibility and adherence properties of the slurry are equal to the SOS-108 propellant.

The use of a new non-conductive mix will provide the four-pin ASI with the required interbridge electrical characteristics and simultaneously reduce the RF sensitivity of the unit.

REQUIREMENTS

Test Conditions

Where tests were performed with atmospheric conditions substantially different from the specified values, proper allowance for any changes in instrument readings was made to compensate for the deviation from the specified conditions.

Test Equipment and Instrumentation

Test equipment and instrumentation utilized for this Test Program is listed in Appendix I.

The identification of equipment used by the outside testing laboratories is available upon request to Space Ordnance Systems, Inc. The accuracies of the test equipment and instrumentation used conformed to acceptable standards and are appropriate for the parameters measured and environmental conditions monitored.

All tools, gauges, instrumentation, etc., that were used as a means of assurance and/or calibration are in accordance with SOS Quality Control Instruction QCI 5.1-1 and 5.1-2.

All equipment was in calibration at the time of use and calibration records were examined to verify that the equipment was within the required tolerance in accordance with the manufacturers specification. In the event that specific equipment was not available at the time of testing, an equivalent substitute was used.

Non-Destructive Testing

A total of one hundred (100) ASI's containing non-conductive propellant SOS-200 were subjected to Non-Destructive Test.

A unit failing to confirm to any tests was rejected. This, however, did not necessitate the rejection of the entire lot. In case of rework, all deficiencies were corrected prior to resubmitting reworked units for tests.

Documented evidence or rework and corrective actions was maintained.

X-Ray Test - Prior to testing, all the specimens were subjected to the X-Ray Test in accordance with MIL-STD-453. All the specimens were x-rayed once, 90° to the longitudinal axis, and in numerical order, by serial number, for traceability to serialized data.

SOS Acceptance Criteria -- The following criteria governed acceptance by SOS:

1. Determine visually that each increment of the explosive charge is present and properly oriented, and that no evidence of voids, cracks, or discontinuities in the powder charges or details are present.

2. Determine that no details are missing or improperly oriented.

3. Verify the presence of lot serial numbers and identity of each x-ray photo to units.

X-Ray Results -- The radiographs indicated that details in each test specimen were present and properly oriented in accordance with specification and drawing requirements. There was no evidence of voids, cracks, or discontinuities in the powder charges or details. All radiographs were reviewed by SOS Quality Control Representatives.

Disposition -- After satisfactory completion of the x-ray test, the specimens were subjected to the tests as described below.

Product Examination - Prior to and after assembly, each specimen respectively, was visually examined. This examination verified that the material, design, construction, dimensions, marking, identification, and workmanship complied with the requirements of SOS

Engineering drawings and all other applicable specifications. Each test specimen satisfactorily met the specification design requirements without discrepancy.

Disposition -- The specimens were then subjected to the test as specified below.

Leakage Test - Each specimen was subjected to the Leakage Test in accordance with SOS TP 5017, with parameters established by SOS TS-116.

Procedure -- Each specimen was placed in a vacuum chamber and maintained at a minimum vacuum of 1-inch Hg absolute for a period of 25 minutes (minimum) to ensure the removal of air from any leaking specimens. The vacuum was then broken by filling the chamber with helium to 15 psig for 5 minutes (minimum). The specimens were then removed from the vacuum chamber and installed in a leak test fixture mounted on the leak detector. Leak rate measurements were made within twenty (20) minutes subsequent to removal from the helium atmosphere.

Test Results -- All leak rates were within the specified parameters of not more than 1×10^{-6} cc/sec. Leak Test records are contained in Appendix II, pages 1 through 4.

Disposition -- The specimens were then subjected to the test as specified.

Bridgewire Resistance Test - Each specimen was subjected to the Bridgewire Resistance Test in accordance with SOS TP 5017, with parameters established by SOS TS-116.

Procedure -- The resistance of the internal circuit of each specimen was measured and recorded, in accordance with applicable portions of SOS-123. The time of current application did not exceed one (1) minute and the test current did not exceed 0.02 amperes.

Test Results -- The measured resistance of each specimen was within the specified parameters of 0.95 to 1.15 ohms. Bridgewire Resistance recordings are contained in Appendix II, pages 1 through 4.

Disposition -- The specimens were then subjected to the test as specified.

Insulation Resistance Test - Each specimen was subjected to the Insulation Resistance Test in accordance with SOS TP 5017, with parameters established by SOS TS-116.

Procedure -- The resistance between the shorted initiator was measured by applying 1000 VDC for 60 seconds in accordance with applicable portions of SOS-124.

Test Results -- The measured resistance of each specimen was within the specified parameters of not less than 2 megohms. Insulation Resistance recordings are contained in Appendix II.

Electrostatic Sensitivity Test (See Figure 2) - Each specimen was subjected to the Electrostatic Sensitivity Test in accordance with SOS Drawing No. S01-266-21, Note 14.

Procedure -- Each specimen was placed into a protective enclosure and connected to a test circuit as illustrated in Figure 2. Each specimen was then subjected to one (1) pulse of a twenty-five (25) kilovolt discharge from a 500 picofarad capacitor as follows:

1. Through the bridgewires. (5000 ohm resistor in series)

2. All pins shorted to case. (No resistor)

3. Circuit to circuit, pins AB to pins CD. (No resistor)

Test Results -- Visual examination of each specimen revealed no evidence of degradation, nor did the specimens ignite as a result of this test. (Refer to Appendix II, pages 1 through 4.)

Disposition -- The specimens were then subjected to the following test.

Interbridge Resistance and Capacitance Test - Using a Digital Ohmmeter, the Interbridge Resistance of each specimen was measured between pins AB and pins CD. Using a Capacitance Bridge, the capacitance of each specimen was measured between pins AB and pins CD.

Disposition -- The specimens were then subjected to the Electrostatic Sensitivity Test as specified below.

Procedure -- The specimens were subjected to the Electrostatic Sensitivity Test in accordance with the procedure specified with the exception of the following.

1. All pins shorted to case.

2. Pins ab to pins CD.

The specimens were then subjected to the Interbridge Resistance and Capacitance Test.

Test Results -- There was no significant change in the interbridge resistance or capacitance of the specimens as a result of the Electrostatic Sensitivity Test. (Refer to Appendix II, pages 5 through 8.)

<u>Dielectric Strength Test (See Figure 3)</u> - Each specimen was subjected to the Dielectric Strength Test in accordance with SOS TP 5021.

Procedure -- Each specimen, in turn, was placed into a safety enclosure and subjected to a 500 volt rms, 60 cps, test potential applied between all pins shorted together and case for a time duration of one (1) minute.

Test Results -- The specimens performed well within the specified parameters in that the leakage current did not exceed 500 microamperes, nor did the pyrotechnic mix ignite as a result of this test. (Refer to Appendix II, pages 5 through 8.)

<u>Environmental Tests</u>

A total of eighty (80) specimens (sixty Group A and twenty Group B) were subjected to the Environmental Test portion of the Evaluation Test Program. Those tests involving Humidity, and High and Low Temperature Vibration were performed by Approved Engineering Test Laboratories. All remaining test (Temperature Cycle and Functional Testing) were performed at the SOS Test Facility in El Segundo, California. The procedures and results of these tests are presented in subsequent paragraphs.

<u>Humidity Test</u> - Twenty (20) specimens from Group B were subjected to the Humidity Test in accordance with Test Procedure 5021 for a period of ten (10) days.

Procedure -- The specimens were subjected to the Humidity Test as defined in Appendix I, Paragraph 8.1.

Test Results -- Visual examination of each specimen revealed no evidence of corrosion or deterioration as a result of this test. (Refer to Appendix I, Paragraph 8.1.3.1.)

Disposition -- Upon completion of the aforementioned test, the specimens were subjected to the Insulation Resistance Test.

Test Results (Insulation Resistance) -- The specimens performed well within the specified parameters in that the measured resistance was not less than 2 megohms. (Refer to Appendix II, Page 36.)

Disposition -- The Twenty (20) specimens were then subjected to the test as specified.

Vibration Test, High Temperature (See Figure 4) - Twenty (20) specimens from Group B were subjected to the Vibration Test High Temperature in accordance with SOS Test Procedure 5021.

Procedure -- The specimens, with shorting devices installed, were mounted in a test fixture simulating service installation. The vibration fixture consisted of a magnesium cube with provisions for mounting the specimens on each of three surfaces of the cubes. Heli-coil inserts were fitted to accept the threaded portion of the specimens. The fixture was designed so no significant resonances in the fixture would occur within the specified frequency spectrum. The fixture was positioned on the shaker head for vibration in each of three axes, by successively remounting the fixture on each of three mutually perpendicular axes. The magnitude of the applied vibration was monitored on the test fixture near an initiator. Vibration was monitored on three mutually perpendicular axes, one of which was the axial centerline (X-axis). The specimens were mounted on the fixture and torqued from 100 to 150 inch pounds. The test was performed with the specimens temperature stabilized at +300°F. During stabilization, the chamber temperature did not exceed +350°F. Representative specimen temperature and chamber temperature were continuously recorded throughout the test. Subsequent to a temperature stabilization of +300°F, and within a 1-hour period, the specimens were subjected to random vibration in each of the three mutually perpendicular axes for a period of 7½ minutes per axis at the following levels:

Frequency (cps)	Test Level (G^2/cps)
10-100	0.0 to 0.8 (6db/octane increase)
100-400	0.8 (constant)
400-2000	0.8 to 0.16 (3db/octane rolloff)

At the conclusion of the Vibration Test, the specimens were removed from the vibration exciter, returned to room ambient conditions, and visually examined for evidence of damage. (Refer to Appendix I.)

Test Results -- Visual examination of each specimen revealed no evidence of damage as a result of this test. (Refer to Appendix I.)

Disposition -- All the specimens were then subjected to the test as specified.

<u>Vibration Test, Low Temperature</u> - Twenty (20) specimens from Group B were subjected to the Vibration Test, Low Temperature in accordance with SOS Test Procedure 5021.

Procedure -- The specimens were subjected to the Vibration Test as described in paragraph, Vibration Test, High Temperature - Procedure, except that the specimens' temperature was stabilized at -260°F nominal (range -255 to -285°F) during this test. (Refer to Appendix I.)

Disposition -- The specimens were then subjected to the test as specified.

<u>Temperature Cycling Test (See Figure 5)</u> - The twenty (20) specimens from Group B were subjected to the Temperature Cycling Test in accordance with SOS Test Procedure 5021.

Procedure -- Two (2) test chambers were utilized for this test, one of which a temperature of -255 to -285°F was maintained. The remaining chamber temperature was maintained at a temperature of +295 to +315°F. The specimens, with shorting connectors installed, were then exposed to twenty (20) temperature cycles as described below. The specimens were installed in the first chamber and exposed to a temperature of -255 to -285°F for a period of one hour. The specimens were then transferred to the second chamber and exposed to a temperature of _295 to +315°F for a period of one-half hour. Transfer time was limited to within five minutes. At the conclusion of the cycling period, the specimens (shorting connectors included) were removed from the chamber, and air dried. Subsequent to drying, the shorting connector was removed and the output end of the specimens were subjected to the Leakage Test as defined. The connector end of the specimens were subjected to the test as specified. Actual leak rates were recorded.

Test Results -- The specimens performed well within the specified parameters, in that the output end of the specimens revealed no leakage in excess of 1×10^{-6} ccHe/sec, and the connector end of the specimens revealed no evidence of dimensional or "out-of-tolerance" conditions. (Refer to Appendix II.)

Disposition -- The specimens were allocated in accordance with Figure 1.

Environmental Seal Test - Each specimen was placed in a chamber maintaining approximately 100% helium atmosphere. While in the helium atmosphere, a connector seal plug was installed on each specimen. The initiators were then removed and placed on the VEECO Leak Detector and a leakage test was performed on the connector seal end. If a specimen revealed a leak in excess of 1×10^{-4} ccHe/sec, the O-ring seal was removed, replaced, and retested. If a specimen demonstrated a second failure, the specimen was re-examined and retested. Leakage rates were recorded. (Refer to Appendix II, page 38.)

Functional Firing Tests

Upon completion of the aforementioned tests, the specimens were subjected to the following functional tests.

High Temperature, No-Fire Bruceton - Thirty (30) specimens from Group A were subjected to the High Temperature, No-Fire Bruceton Test in accordance with SOS Test Procedure 5021.

Procedure -- The specimens were installed in suitable test fixtures, placed in temperature chamber, and subjected to a temperature of +295°F (plus 5°, minus 25°). The specimens were allowed to stabilize at this temperature for a period of not more than two hours, after which the specimens were installed in a test circuit. A current level of 1.8 amperes (current level K) was then applied to the A-B bridgewire circuit of one-half of the specimens for five minutes. The same current level was then applied to the C-D circuit of the remaining specimens for a period of five minutes. In the event ignition occurred on the first specimen when tested at current level K, the second specimen was tested at K minus d, where d was a preassigned increment of current (.1 ± .01 amperes). In the event ignition did not occur on the first specimen, the second specimen was tested at a current level of K plus d. Each succeeding specimen was tested at a current level dependent upon the firing behavior of the previous specimen. Thus, the test results were a sequence of fires (X) and no-fires (O) centered about the 50% firing current level X_R. Data was tabulated by recording the number of X's and the number of O's for each test current level.

Test Results -- The resulting data from the High Temperature No-Fire Tests was analyzed in accordance with the Bruceton Statistical Analysis Method outlined in Appendix A of the NAVORD Report Number 2101, entitled "Statistical Methods Appropriate for Evaluation of Fuze Explosive - Train Safety and Reliability," dated 13 October 1953. The analysis showed that at +300°F the initiator complies with the following requirement.

1. At the 90% confidence level 99.9% of all initiators had a most pessimistic no-fire current of greater than 1.0 amperes when applied to a single bridgewire for five minutes minimum.

Test data from one temperature level was evaluated independently of test data from the other temperature level. A current-time record was made of each initiator which ignited. Primary and back-up recorders were used for all Bruceton testing. Recorders were started at or prior to time of current application. Primary recorders were oscilloscope and polaroid camera, or equivalent. The horizontal sweep was set at 5 milliseconds per centimeter. Backup recorders were of the counter-photocell or oscillograph type with a frequency response of 2400 cps or more, and a paper speed of 1.0 inch. (Refer to Appendix II, pages 9 through 15.)

Disposition -- The specimens were consigned to Bonded Stores for customer disposition.

Low Temperature, All-Fire Bruceton - Thirty (30) specimens from Group A were subjected to the Low Temperature, All-Fire Bruceton Test in accordance with SOS Test Procedure 5021.

Procedure -- The procedure for performing the Low Temperature, All-Fire Bruceton Test was performed as specified except for the following deviations.

1. The stabilized temperature was -260°F (plus 5°, minus 25°).

2. A current level of 2.3 amperes was applied to the A-B and C-D bridgewire circuits for a period of ten milliseconds.

Test Results -- The results of this test are as specified except for the following deviations. The analysis showed that at -260°F the initiator complies with the following requirement.

1. At the 90% confidence level 99.9% of all initiators had a most pessimistic all-fire current equal to or less than

3.5 amperes when applied to a single bridgewire for five minutes (minimum). (Refer to Appendix II, pages 16 through 22.)

Firing Test, Ambient Temperature - Thirty (30) specimens that did not ignite during the No-Fire and All-Fire Bruceton Tests were subjected to the Ambient Temperature Firing Test in accordance with SOS Test Procedure 5021.

Procedure -- Each specimen, in turn, was installed in a test fixture with a free volume of 10 $\pm$ 0.2 cc, and connected to a test circuit similar to that illustrated in Figure 6. A test current of 3.5 to 3.6 amperes dc was then applied to the firing circuits of each specimen. The bridgewire current and pressure versus time was recorded and is documented in Appendix II, pages 23 and 24.

Test Results -- Twenty-six (26) specimens performed well within the Function Time parameters in that the peak pressure after application of current did not exceed ten (10) ms when ignited with 3.5 amperes dc. Four (4) specimens (S/N's 0262, 0255, 0273, and 0280) exceeded the Function Time parameters. (Refer to Appendix II, pages 23 and 24.) Twenty-four (24) specimens performed well within the peak pressure parameters in that the peak pressure produced was within 525 to 775 psig. Six (6) specimens (S/N's 0262, 0285, 0299, 0267, 0287, and 0273) exceeded the peak pressure parameters.

Discussion -- It should be noted that these apparent anomalies are allowable by the Apollo Standard Initiator Specification MC 453-0009. Paragraph 4.2.3 of the specification states that "initiators subjected to Bruceton testing shall be fired for informational data only." Bruceton tests are known to be degrading tests to the bridgewire and propellant in close proximity to it in that the application of a current which is below that sufficient to fire the unit heats the pyrotechnic compound to such a high level that some degradation is likely and therefore the variations reported are to be expected.

Disposition -- The specimens were consigned to bonded stores for customer disposition.

Firing Test, High Temperature - Ten (10) specimens from Group B were subjected to the High Temperature Firing Test in accordance with SOS Test Procedure 5021.

Procedure -- The specimens were subjected to the High Temperature Test as specified except for the following deviations:

1. The initiator test fixture and pressure transducer were placed in a temperature chamber and stabilized at a temperature of +295 to +315°F prior to firing.

2. Thermocouples were utilized in conjunction with a precision temperature bridge to measure chamber, test fixture, and initiator temperature.

3. Two (2) initiators were fired with a test current of 22 to 23 amperes and the remainder at 3.5 to 3.6 amperes.

Test Results -- All the specimens performed well within the specified parameters in that peak time to pressure after current application did not exceed ten (10) ms when ignited with 3.5 and 22 amperes, and the peak pressure produced was within 525 to 775 psig. (Refer to Appendix II, pages 39 through 48.)

Disposition -- The specimens were consigned to bonded stores for customer disposition.

<u>Firing Test, Low Temperature</u> - Ten (10) specimens from Group B were subjected to the Low Temperature Firing Test in accordance with SOS Test Procedure 5021.

Procedure -- The specimens were subjected to the Low Temperature Firing Test as specified except for the following deviations:

1. The initiator, test fixture, and pressure transducer were placed in a temperature chamber and stabilized at a temperature of -255 to -285°F prior to firing.

2. Thermocouples were utilized in conjunction with a precision temperature bridge to measure chamber, test fixture, and initiator temperature.

3. Two (2) initiators were fired with a test potential of 22 to 23 amperes, and the remainder at 3.5 to 3.6 amperes.

Test Results -- All the specimens performed well within the specified parameters, except for one (1) specimen, S/N 0338. This specimen failed to fire upon application of 22 amperes.

Discussion -- Manufacturing records were researched in an effort to locate anomalies which would contribute to the failure. No rejections were recorded against initiator S/N 0338 during the manufacturing sequence.

The production operators responsible for the loading operations were trained and certified for the operations they performed.

The SOS-200 initiation charge used for slurry and initiation charge loading was from powder lot control record (PLCR #192). The lot was acceptance tested and accepted by Quality Control in May of 1967.

Non-Destructive Lot Acceptance Test Records

The following data was recorded during testing:

a) Helium Leakage: Better than 1×10^{-6}
b) Bridgewire Resistance: A-B 1.00, C-D 1.00
c) Insulation Resistance: 20K megohms

Evaluation Testing

The initiator which was a part of Group B was stabilized at -265°F and did not ignite when energized with a current of 22 amps.

Determination of Failure Mode

The 1-596-6 was machined off below the crimped portion of the initiator. The 1-286.11 and SOS-108 main charge was removed. The SOS-200 initiation charge was removed remaining relatively intact.

Color photos identified as Figure 1 and Figure 2 depict the condition of the SOS-200 initiation charge increment and the energized bridgewire.

Photos identified as Figure 1 shows metal particles (bridgewire materials) impregnated into the SOS-200 initiation mix. A color gradation is distinctly discernable in the initiation mix adjacent to the bridgewire extending the entire length of the bridgewire.

NOTE: The color gradation is an apparent difference of homogeneity in the SOS-200 initiation charge. During manufacturing, the SOS-200 initiation charge is mixed with a solvent and slurried or painted onto the 110733 bridgewires to ensure intimate contact (bridgewires to SOS-200 initiation charge). The remaining SOS-200 initiation charge is pressed over the bridgewires in a dry state.

Observed results of the pressed SOS-200 initiation mix Ref: Figure 1. White specks of the oxidizer material can be observed throughout the surface of the mix. The entire mix is a light gray color.

Observed results of the slurried or painted initiation mix adjacent to bridgewires Ref: Figure 1. The mix appears to be considerably darker and finer in texture than the pressed SOS-200 initiation mix. The white specks of oxidizers are not distinguishable in this mix. The entire mix is a darket gray than the pressed SOS-200 initiation mix.

Summary of SOS-200 Initiation Charge

The average particle size of the fuel is approximately 20% the average size of the oxidizer. The fuel is a dark brown color while the oxidizer is white.

Particles of oxidizer and fuel in a total homogeneous mix would not be distinguishable to the extent observed.

The SOS-200 Initiation powder is blended with a solvent prior to the slurry or paint of the bridgewire. A small quantity of the material is picked up by a 000 brush and deposited on and around each bridgewire. The solvent is then driven off and the remaining SOS-200 initiation charge is pressed into place. Heavy particles would tend to precipitate out of the slurry solution leaving a fuel rich mixture at the top.

Conclusions, S/N 0338

The bridgewire ignition was normal and should have supplied the energy necessary to reliably ignite the SOS-200 initiation charge.

The SOS-200 initiation charge slurried or painted on and around the bridgewires is fuel rich and therefore not stoichiometric. Best ignition occurs when the mix is stoichiometric or very slightly fuel rich. Both ignition and burning characteristics drop off rapidly as the mix varies from stoichiometry. It is therefore concluded that the failure mode is attributed to this increment of the SOS-200 charge.

The SOS-200 initiation charge pressed into the 1-656-4 Header Assembly did not exhibit total homogeneity. This however was not the cause for failure because the white specks are uniform and fairly evenly distributed. This condition would adequately supply the necessary oxygen for complete burning once the mix was ignited. This was demonstrated on the remaining units in the lots which were fired and which exhibited normal characteristics.

MODIFIED S01-266-21

Six (6) additional S01-266-21 initiators were manufactured. This was done to prove that a modified slurry application technique would provide a positive corrective action. The initiators were identical to those utilized in Evaluation Test Report 6330 with the exception of bridgewire slurry mixing and application.

Non-Destructive Lot Acceptance Testing

Non-destructive Lot Acceptance Testing was conducted per Test Procedure (TP) 5025, paragraph 4.0.

Temperature Cycling

Temperature Cycling was performed per TP-5021.

Destructive Firing Tests

Destructive Firing Tests were performed per TP-5021, paragraph 4.3.9. All firings were made with 22 amps, at -260°F.

Summary of Test Results

S/N's 0001, 0004, and 0005 fired when pulsed with 22 amps, S/N 0005 produced a peak pressure of 840 psi which is in excess of specification requirements (775 psi max.).

S/N's 0002, 0003, and 0006 failed to fire when pulsed with 22 amps.

Copies on non-destruct lot acceptance test data and destructive lot acceptance test data (pressure-time traces) are included in this report identified as Figure 3 and 4, respectively.

Analytical Studies

Recurrence of the failures experienced in paragraph, Modified S01-266-21, resulted in the following evaluation. The study compares the Apollo Standard Initiator (ASI) to the Non-Conductive Apollo Standard Initiator or (NCASI) as a basis for heat transfer and ignition sensitivity.

The ASI is characterized by a .002 Nilstain Bridgewire which has approximately a 1-ohm resistance. It is designed for a normal all-fire current of 3.5 amps (minus 65^{o} to plus 300^{o}F) with a recommended firing current of 5.0 amps.

Theoretical studies of the mechanism of bridgewire ignition and related heat transfer have shown: when the firing current is higher than normal, there is a tendency for the bridgewire to burn out adiabatically before significant heat transfer is accomplished into the cool mix in immediate contact with the bridgewire. At low current (3.5 - 5.0 amps), the time lag from applying current to bridgewire burnout is dependent upon the thermal properties of the material in contact with the bridgewire. At low current, heat transfer plays an important role. Conversely, the heat transfer is negligible at high current levels.

Experiment

The following experiment was conducted to prove heat transfer from the bridgewires to the ignition mix at high current levels.

Four different type units were manufactured.

a. SOS-108 slurried bridgewire in ASI headers.
b. Bare bridgewire in ASI headers.
c. Stand-off bridgewire (in air) on SBASI pin headers.
d. Alumina pressed under 10,000 psi in ASI headers.

The units were then tested with applied currents of 3.5 amps, 5 amps, 10 amps, 15 amps, 20 amps, 25 amps, 30 amps, 35 amps and 40 amps. Current traces on the oscilloscope were recorded. The bridgewire burnout times are summarized in the following table.

BRIDGEWIRE BURNOUT TIME

APPLIED CURRENT AMPS	SOS-108 SLURRIED ASI HEADER	BARE BRIDGEWIRE ASI HEADER	STAND-OFF BRIDGEWIRE	ALUMINA COVERED ASI HEADER
3.5	3.0 msec	3.2 msec	3.4 msec	90 msec
5.0	1.1 msec	1.5 msec	1.7 msec	7 msec
10.0	340.0 μsec	470.0 μsec	450.0 μsec	920 μsec
15.0	180.0 μsec	220.0 μsec	240.0 μsec	360 μsec
20.0	160.0 μsec	150.0 μsec	180.0 μsec	200 μsec
25.0	100.0 μsec	130.0 μsec	130.0 μsec	145 μsec
30.0	95.0 μsec	120.0 μsec	110.0 μsec	95 μsec
35.0	95.0 μsec	110.0 μsec	105.0 μsec	85 μsec
40.0	90.0 μsec	100.0 μsec	125.0 μsec	110 μsec

Current traces are included in this report identified as Figure 5.

It can be seen that at lower currents, 3.5 to 5.0 amps, the time is dependent upon the material in contact with the bridgewire; at 10 to 15 amps, the difference is reduced, and at higher current, beyond 20 amps they are about the same within the experimental fluctuations. The fact that slurried bridgewire burned faster than bare bridgewire or stand-off bridgewire is due to the fact that slurry burns at lower temperature (680°F) before the bridgewire could reach its melting point.

This experiment has proven that the adiabatic burnout of the bridgewire occurs at high current. For bridgewire in contact with mixes which have much lower thermal diffusibility than the alumina, the adiabatic burnout could occur at a 15 amp current.

A Calculation to Prove the Adiabatic Burnout at High Current

The burnout time at 15 amps for the slurried bridgewire is about 200 μsec, assuming there is one ohm resistance. The heat generated in the bridgewire is:

$$1 \times 15^2 \times 200 \times 10^{-6} = 450 \times 10^{-4} \text{ joules} = 108 \times 10^{-4} \text{ calories}$$

On the other hand, the heat required to raise the temperature of bridgewire from the ambient (20°C) to its melting point (1400°C) is:

1380°C x heat capacity of bridgewire = 1380 x 0.5 x 10^{-5} = 69 x 10^{-4} calories

The latent heat required to melt the bridgewire is:

Mass of bridgewire x latent heat per gram = 3.8 x 10^{-5}gm x 69 cal/gm = 26 x 10^{-4} calories

The sum of the last two heat energies is:

$$69 \times 10^{-4} + 26 \times 10^{-4} = 95 \times 10^{-4}$$

If we considered the small amount of heat lost to the pin to bridgewire junctions, the heat generated by the bridgewire is equivalent to the heat to melt the bridgewire, and no heat is geing conducted out into the mix.

Failure at Low Temperature

When the bridgewire adiabatic burns out, the current stops. The cool mix can be heated up to the explosion temperature only through drawing heat from the melted bridgewire.

The melting point of nilstain 304 is 1400°C and the cold ambient is about -160°C, which gives a temperature differential of 1560°C.

According to the heat transfer theories ("Conduction of Heat in Solids" by Carslow and Jaeger, pages 54-56), the surface of the bridgewire quickly drops to about 40% of this temperature differential, i.e., the difference of temperature between the wire-mix interface and the ambient is:

$$1560 \times 40\% = 624°C$$

which is enough to set off SOS-108 (explosion temperature 350°C) but too marginal for SOS-200 (explosion temperature 450-460°C), which could result in the failure of ignition.

The following conditions could result in a no-fire at high current levels and low temperature.

Slurry - A non-homogeneous slurry of improper application of the slurry to the bridgewires.

One-amp/one-watt no-fire tests - Tests have shown that initiators exposed to this condition exhibit longer rise times from bridgewire burnout to peak pressure when fired at low temperature and high current levels.

Based on the aforementioned tests and analyses it can be ascertained that:

a. Probability exists that due to the low thermal conductivity of the pyrotechnic compound combined with its relative insensitivity to ignition that the bridgewire can burn out before sufficient heat is transferred into the pyrotechnic compound to cause ignition.

b. That the utilization of higher temperature melted bridgewires or bridgewire configurations which would be more effective in conducting heat into the mix would tend to eliminate this problem area.

c. That increasing thermal reactivity of pyrotechnic compound should also improve the ignition capability of the unit.

Post Fire Resistance Test - All the specimens were subjected to the Post Fire Resistance Test as follows:

Procedure -- The after firing leakage current of the specimens was determined at a test potential of 28 to 29 volts dc when measured between the following test points within 30 seconds to 5 minutes.

1. Pins A to B
2. Pins C to D
3. Pins AB to CD
4. All pins shorted and case

Test Results -- The specimens performed well within the specified parameters, in that the after firing leakage current did not exceed 50 milliamperes. (Equivalent to a resistance of 560 ohms minimum.)

Disposition -- The specimens were consigned to bonded stores for customer disposition.

CONCLUSIONS

It is concluded from the results of the testing performed that the S01-266-21 Initiator containing the non-conductive propellant (SOS-200) meets or exceeds the requirements of the Apollo Standard Initiator, NAA/S&ID Specification MC453-0009 in all areas except high current application at very low temperature (-260°F).

The results of the failure investigation implies that limitations should be imposed on the initiator delivered to NASA/Langley for their in-house test program. Analytical calculations indicate that the maximum firing current at -260°F should be restricted to 10 amps.

RECOMMENDATIONS

Space Ordnance Systems, Inc., recommends that this non-conductive propellant may be utilized in future ASI's and SBASI's to provide a more reliable initiator which may be subjected to repeated applications of electrostatic or RF energy with no inadvertent firing or degradation of the propellant.

1. The use of ribbon bridgewires should be explored for use with the non-conductive mix to provide reliable ignition at temperature and current extremes (-260°F +22 amps).

2. Tungsten bridgewires should be researched which would provide a higher bridgewire heat source during bridgewire ignition.

3. The slurry material could be modified by decreasing the particle size of the tellurium dioxide to provide a larger surface area for improved ignition characteristics.

REFERENCE DATA

This section contains all data required to support the ASI Evaluation Program.

Illustrations

Illustrations are provided in conjunction with the preceding text in support of figure references.

Definitions

Stabilization. Stabilization occurs when the reference thermocouple indicates that successive temperatures, taken five minutes apart, are within specification limits.

Test Data and Analysis

Appendix I

Appendix I contains data resulting from Environmental Tests performed at Approved Engineering Test Laboratories.

Appendix II

Appendix II contains data summaries, general test data, and oscilloscope recordings resulting from functional tests.

Appendix III

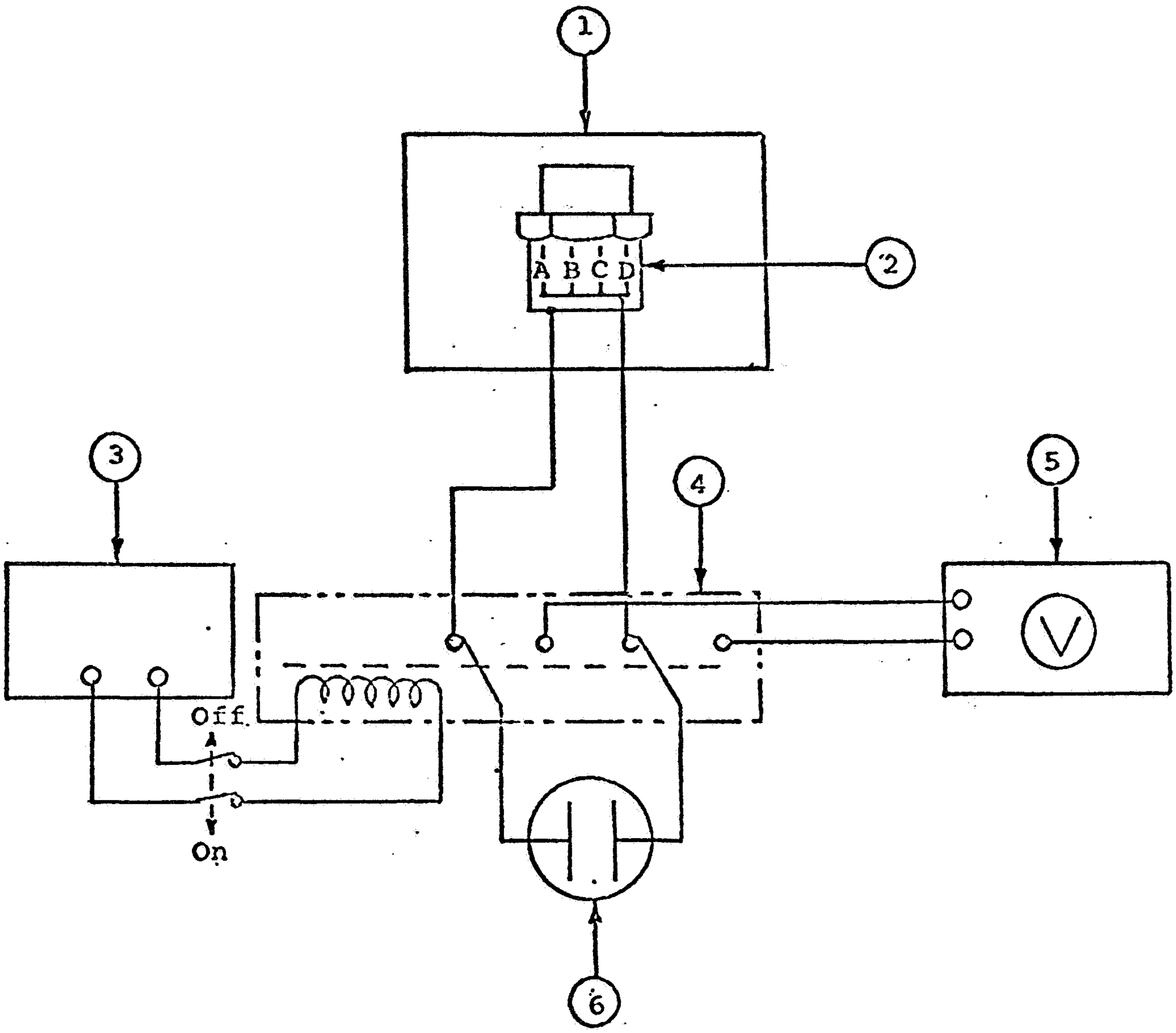
Appendix III contains data summaries, general test data, and oscilloscope recordings resulting from qualification testing of the ASI which shall be used for analysis and comparison.

Appendix IV

Appendix IV contains reports and analysis of all failures resulting from functional malfunctions.

TEST GROUP	A_1	A_2	B	
QUANTITY	30	30	20	
TESTS				REMARKS
Product Examination	X	X	X	
Hermetic Seal Leak Test	X	X	X	
Bridgewire Resistance Test	X	X	X	
Insulation Resistance Test	X	X	X	1000 VDC Applied
Electrostatic Test	X	X	X	25 KV Applied Thru The Bridge-Wires; Shorted Pins to Case And Circuit To Circuit
Interbridge Resistance & Capacitance	X	X	X	
Electrostatic Test	X	X	X	25 KV Applied; Shorted Pins to Case & Circuit to Circuit
Interbridge Resistance & Capacitance	X	X	X	
Dielectric Strength Test	X	X	X	500 V rms Applied
High Temperature No-Fire Bruceton	X			
Low Temperature All-Fire		X		
Ambient 10 c.c. Bomb Firings	*	*		*Fired 30 Units that did not Fire during Bruceton Tests
Humidity Test			X	
Insulation Resistance Test			X	500 VDC Applied
High Temperature Vibration			X	+300°F
Low Temperature Vibration			X	-260°F
Temperature Cycle Test			X	-260 to +300, 20 Cycles
Leakage Test			X	
Environmental Seal Leak Test			X	
High Temperature Firing			X	10 Units
Low Temperature			X	10 Units
Post Fire Resistance Test			X	

Figure 1. Test Sequence and Allocation Chart



1. Protective Enclosure
2. Test Specimen
3. 28 VDC Power Supply
4. High Voltage Relay
5. High Voltage Power Supply
6. High Voltage - Low Leak Capacitor

Figure 2. Electrostatic Sensitivity Test

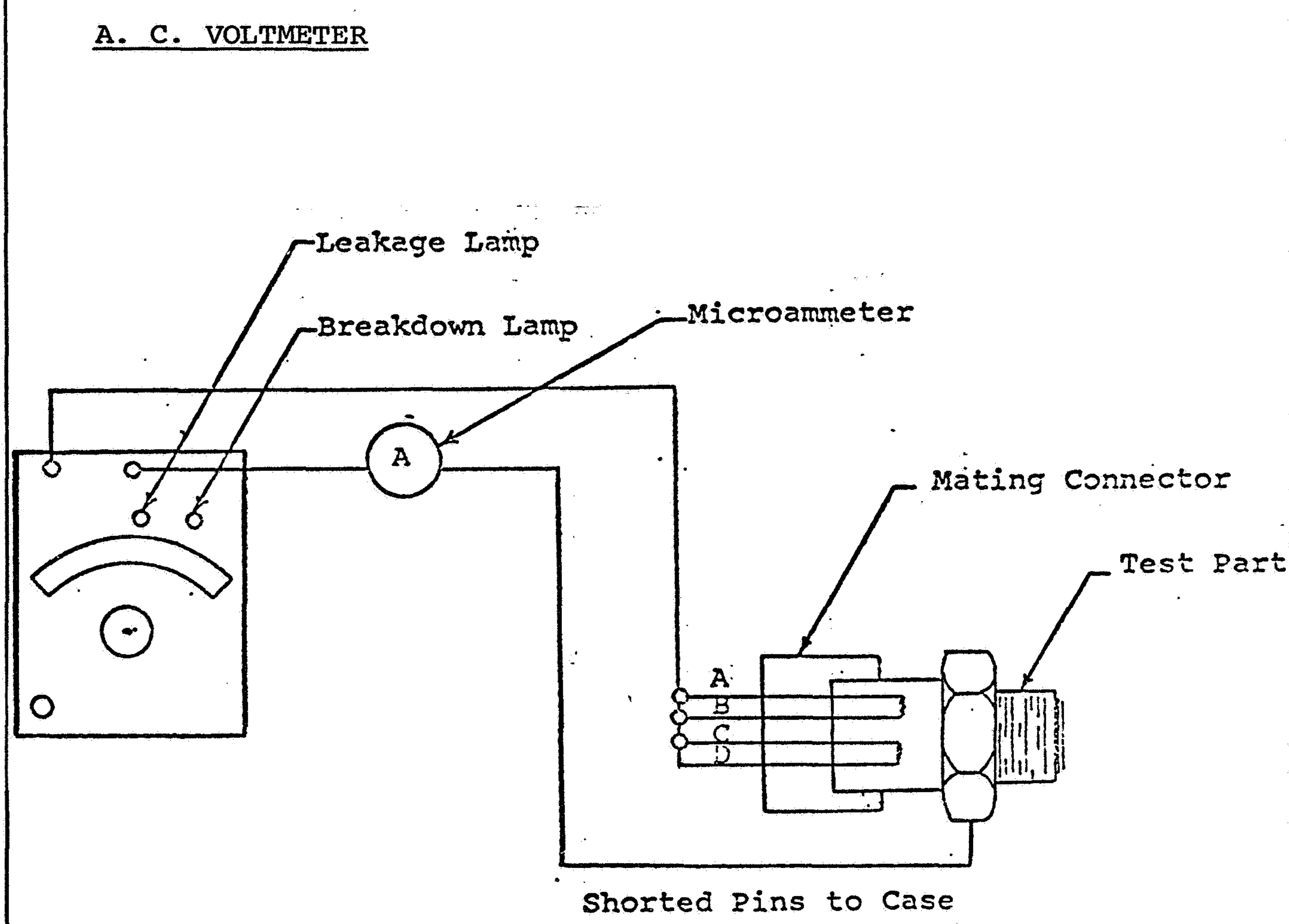


Figure 3, Dielectric Strength Test

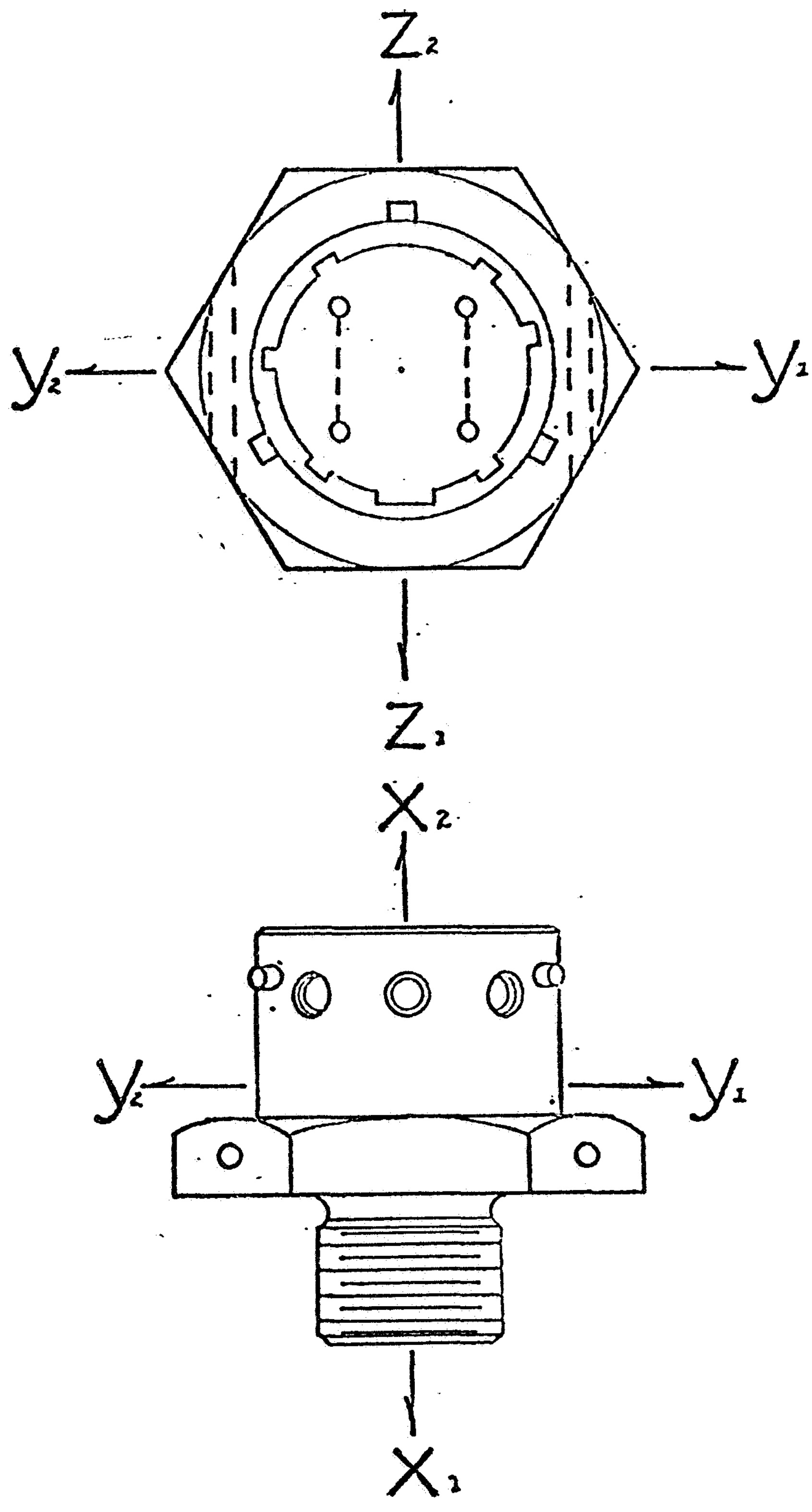
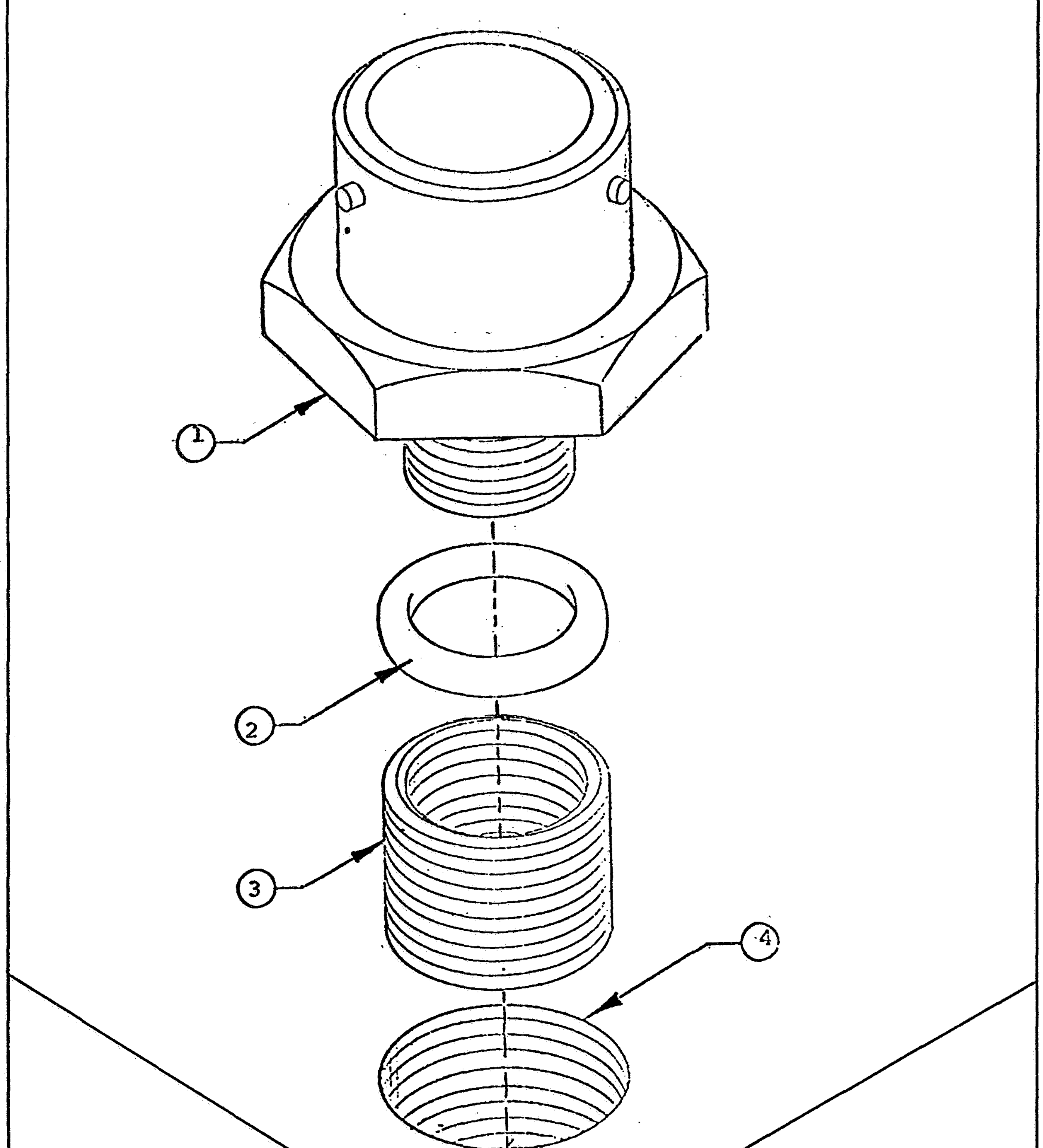
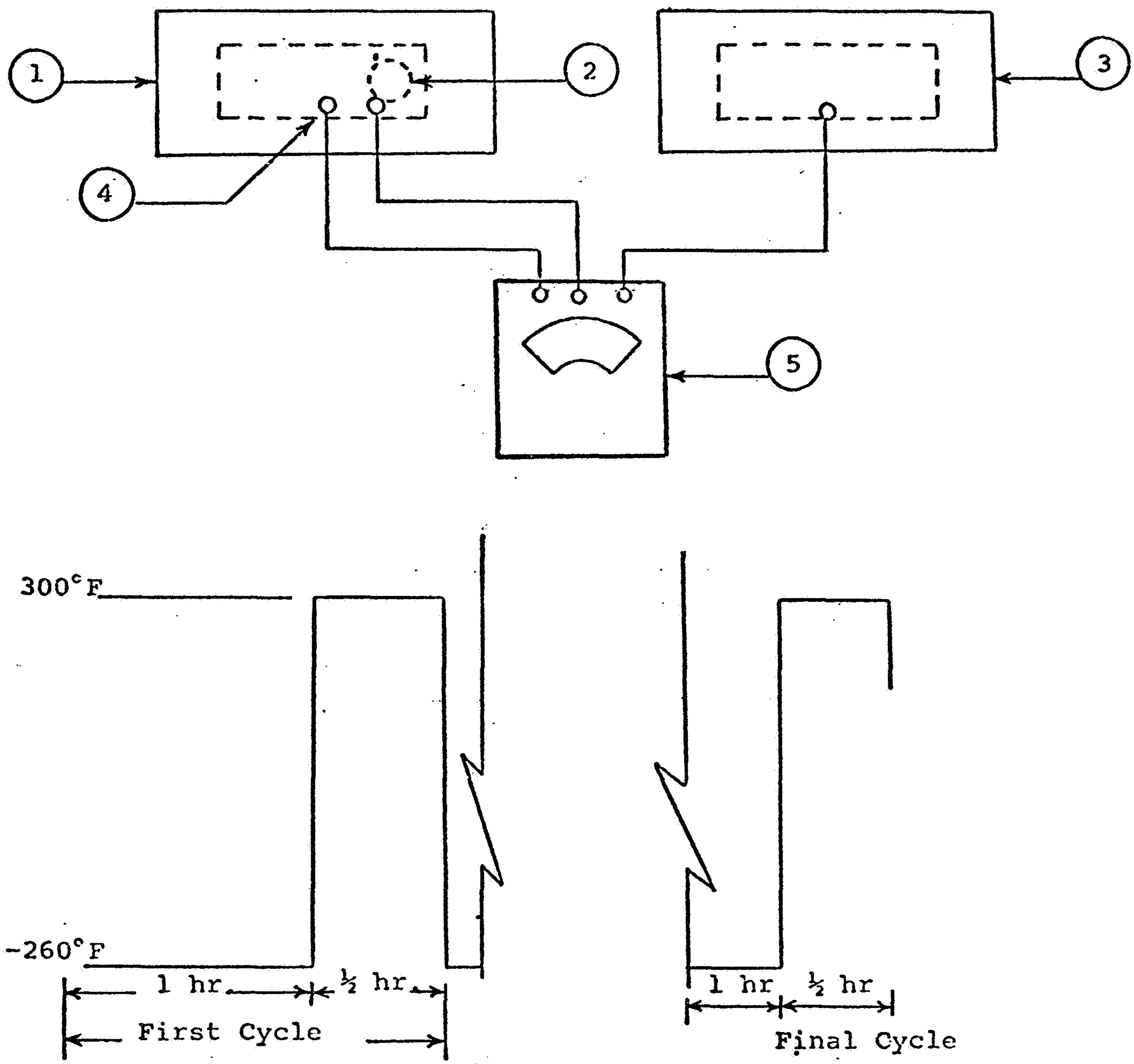


Figure 4. Axis Identification (Sheet 1 of 2)



1. Test Specimen
2. Rubber O-ring
3. Heli Coil Insert
4. Mounting Hole in Magnesium Cube (vents to atmosphere)

Figure 4. Vibration Mounting Configuration (Sheet 2 of 2)



1. Chamber One - Low Temperature
2. Test Specimens
3. Chamber Two - High Temperature
4. Thermocouple (Typical of 3)
5. Thermocouple Bridge

Figure 5. Typical Cycling Test Set-Up

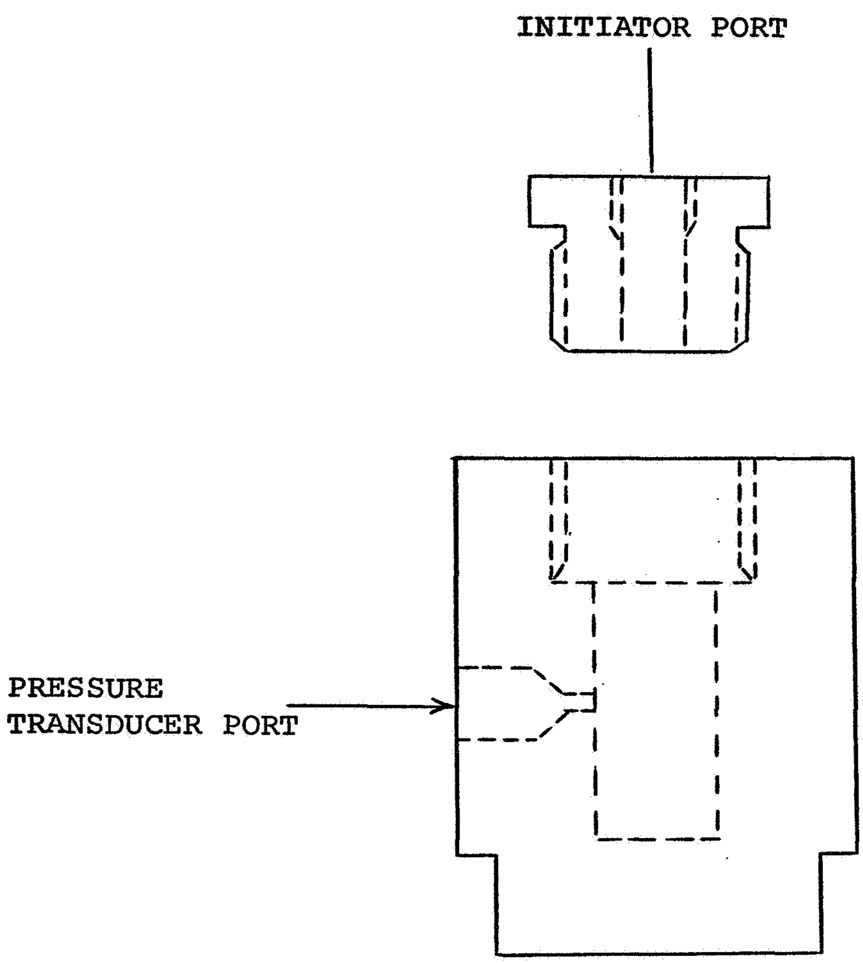
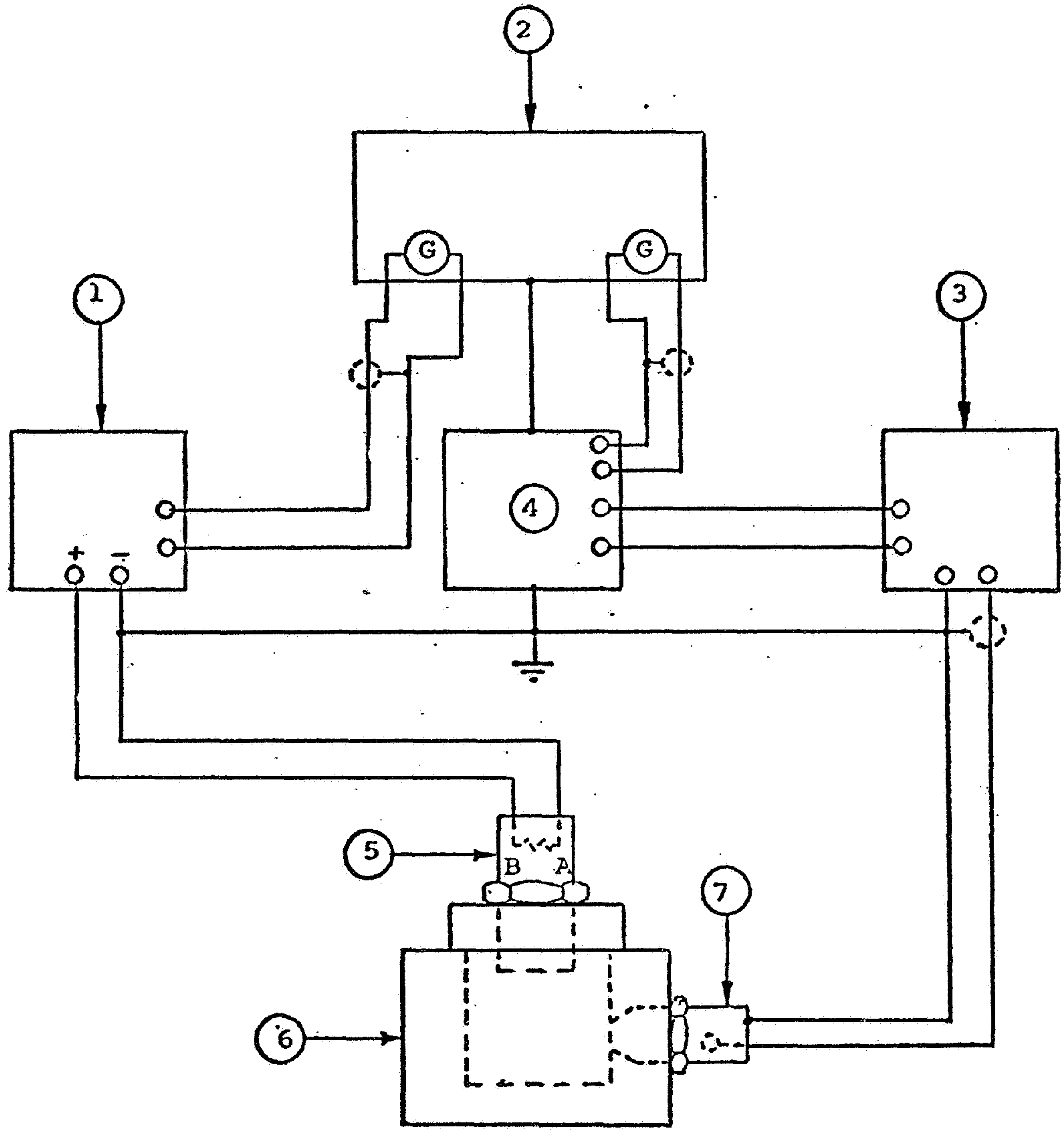


Figure 6. Ten Cubic Centimeter Closed Bomb Fixture (Sheet 1 of 2)



1. Firing Control Panel
2. Recording Oscillograph
3. Charge Amplifier
4. Galvanometer Driver Amplifier
5. Test Specimen
6. 10 cc Closed Bomb Test Fixture
7. Piezoelectric Pressure Transducer

Figure 6. Typical Firing Test Set-Up
(Sheet 2 of 2)

APPENDIX I

Approved Engineering Test Laboratories
Report No. Q 6242-1

Originat 's Report No. Q 6242-1

Revision None

Report of Test on: Twenty (20) Initiators, Electrical, Hotwire, SOS P/N S01-226-21, S/N's SOS-0321-BRR through SOS-0331-BRR, SOS-0333-BRR, SOS-0335-BRR, and SOS-0338-BRR through SOS-0343-BRR

TEST PERFORMED BY
APPROVED ENGINEERING TEST LABORATORIES
5320 West 104th Street
Los Angeles, California

TEST AUTHORIZED BY

SPACE ORDNANCE SYSTEMS
133 Penn Street
El Segundo, California

P.O. No. 12481

	Date	Signature	Stamp
Test Initiated	8/11/67		
Test Completed	8/24/67		
Report Written By	8/30/67		
Test Engineer	8/30/67		
Project Supervisor	8/30/67		
Quality Control	8/30/67		
Lab. Director	8/30/67		
DCASR/LA	8/30/67		
Source Inspection	8/30/67		
Final Release	8/30/67		

NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, of conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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APPROVED ENGINEERING TEST LABORATORIES
5320 W. 104th St., Los Angeles, Calif. 90045
AETL

Report No. Q 6242-1

Date 8/30/67

GENERAL REPORT SUMMARY

1.0 COMPONENT/PART NAME: Initiator, Electrical, Hotwire

1.1 Program or Weapon System: Unknown

1.2 Test Completed: 8/24/67
Report Completed: 8/30/67

1.3 Originator's Report Number: Q 6242-1

1.4 Originator's Report Title: Evironmental Test Report

1.5 Type of Test Performed: Environmental Test

1.6 This test report (supersedes) (supplements) Report No: None

1.7 Summary

1.7.1 The test specimens were subjected to an Environmental Test Program in accordance with Reference 6.1, as required by Reference 6.2 of this test report.

1.7.1.1 The test specimens complied with the specification requirements in all respects. The test results obtained are presented herein for evaluation.

1.8 Description of Test

1.8.1 The test specimens were subjected to the following sequence of testing:

Humidity Test
High Temperature Vibration
Low Temperature Vibration

2.0 REASON FOR TEST

2.1 The reason for this test program was to show compliance of twenty (20) Initiators, Electrical, Hotwire, to the requirements of Reference 6.1, as required by Reference 6.2 of this test report.

2.2 The test specimens are production items manufactured by Space Ordnance Systems, 133 Penn Streel El Segundo, California 90246.

3.0 DESCRIPTION OF TEST SPECIMENS

3.1 The test specimens were twenty (20) Initiators, Electrical, Hotwire, Part Number S01-266-21, S/N's SOS-0321-BRR through SOS-0331-BRR, SOS-0333-BRR, SOS-0335-BRR, and SOS-0338-BRR through SOS-0343-BRR.

4.0 DISPOSITION OF TEST SPECIMENS

4.1 At the conclusion of the test program, the test specimens were returned to Space Ordnance Systems.

5.0 SUMMARY

5.1 The test specimens were subjected to, and complied with, the Environmental Test requirements of Reference 6.1, as required by Reference 6.2, of this test report.

5.2 The test results obtained are presented herein for evaluation.

6.0 REFERENCES

6.1 Space Ordnance Systems, Inc., Test Procedure No. 5021, Revision B, dated 18 February 1965, Paragraphs 4.2.9, 4.3.1, and 4.3.2, titled: " Qualification Testing of Initiator, Electrical, Hotwire".

6.2 Space Ordnance Systems, Inc., Purchase Order No. 12481 dated 8/9/67.

7.0 TEST EQUIPMENT AND INSTRUMENTATION

7.1	Instrument:	Temperature Altitude Chamber
	Manufacturer:	General Thermodynamics, Inc.
	Accessories:	One type G-71-1 Vacuum Gauge, manufactured by High Vacuum Equipment Co.
	Range:	Temperature: -100°F to +400°F
		Altitude: Ambient to 1 x 10^{-7} mm Hg.
7.2	Instrument:	Temperature Potentiometer
	Manufacturer:	Leeds & Northrup
	Model No.:	8693
	Serial No.:	1598231
	Range:	-340 to 2000°F in two scale ranges
	Accuracy:	± 2°F
7.3	Instrument:	Temperature Controller
	Manufacturer:	Bristol Company
	Model No.:	WC-T500FAT22X-1A
	Serial No.:	800630
	Type:	Electronic
	Range:	-150 to +350°F
	Cycle Time:	24 hours
	Accuracy:	± 2°F
7.4	Instrument:	Accelerometer
	Manufacturer:	Endevco Corp.
	Model No.:	2242M4
	Serial No.:	6824
	Type:	Piezoelectric
	Range:	Frequency: 5 to 6000 cps
		Shock: 0 to 2000 g's
		Vibration: 0 to 1000 peak g's (sinusoidal)
	Accuracy:	Frequency Response: ± 5%
		Amplitude Linearity: ± 1%
7.5	Instrument:	Accelerometer Integrator/Amplifier
	Manufacturer:	M. B. Electronics
	Model No.:	N504
	Serial No.:	1044
	Range:	5 to 10,000 cps (Amplify position)
		5 to 3,000 cps (Integrate position)
	Accuracy:	± 1%

7.6	Instrument:	Automatic Control Console
	Manufacturer:	M. B. Electronics
	Model No.:	T388
	Type:	Magnetrostrictive Filters
	Range:	80 Channels, 10 to 2000 cps, 25 cycle bandwidth
	Accuracy:	± 1%
7.7	Instrument:	Vibration Exciter
	Manufacturer:	M. B. Electronics
	Model No.:	C-60
	Serial No.:	119
	Type:	Sine or Random
	Range:	6000 force-pounds; 5 - 5000 cps; 120 g's; 1 inch total displacement
7.8	Instrument:	Amplifier
	Manufacturer:	M. B. Electronics
	Model No.:	T452
	Serial No.:	148
	Range:	17.5 kva
	Accuracy:	± 1.5% (30 to 3000 cps); ± 3% (10 to 30 cps and 3000 to 5000 cps)

8.0 TEST PROCEDURES AND RESULTS

8.1 Humidity Test (Ref. 6.1, Para. 4.2.9)

8.1.1 The test specimens, with all ports capped, were installed in a suitable test chamber on a polyethylene coated rack. The test specimens were suspended by a Nylon cord. Prior to the start of the test, the chamber was between 68 and 100°F with uncontrolled humidity. During the first two (2) hour period, the temperature was gradually raised to 160°F and maintained at this temperature during the following six (6) hour period. During the following sixteen (16) hour period, the chamber temperature was gradually reduced to 68 - 100°F. This constituted one (1) cycle. The test was repeated a sufficient number of times to extend the total time of the test to 240 hours (10 cycles).

8.1.2 The velocity of air throughout the test chamber did not exceed 150 feet per minute. Relative humidity throughout the cycle was 95 ± 5% RH. Distilled water, having a pH value of 6.9 at 77°F was used to obtain the desired humidity.

8.1.3 At the conclusion of the 240 hour period, the test specimens were returned to standard conditions and visually examined for evidence of deterioration, corrosion, or other damage as a result of this test.

8.1.3.1 Visual examinations of the specimens at the conclusion of the test revealed no evidence of corrosion or other damage which might impair proper operation of the specimens. The electrical shorting plugs, which are not part of the specimen, were slightly corroded.

8.2 Vibration (Ref. 6.1, Paras. 4.3.1 and 4.3.2)

8.2.1 The test specimens were simultaneously subjected to random vibration in each of the three mutually perpendicular axes, as shown in Figure 1. The frequencies and vibratory levels were as follows:

Frequency (cps)	Vibratory Level	Total Acceleration g RMS
10 - 100	+6 db/oct	
100 - 400	0.8 g^2/cps	
400 - 2000	-3 db/oct	28 g RMS

8.2.2 During vibration, the specimen temperature was stabilized at -260°F and +300°F for a period of 7.5 minutes in each of the three mutually perpendicular axes, at each temperature. The specimens were torqued to 125 inch pounds in the holding fixture prior to the test. The correct torque was maintained throughout the test. The Power Spectral Density Plots obtained during vibration, are presented as Appendix 1 of this test report.

8.2.3 At the conclusion of vibration in each axis, the specimens were visually examined for evidence of damage or deformation.

8.2.3.1 The test specimens complied with the specification requirements. There was no evidence of damage or deformation noted as a result of this test.

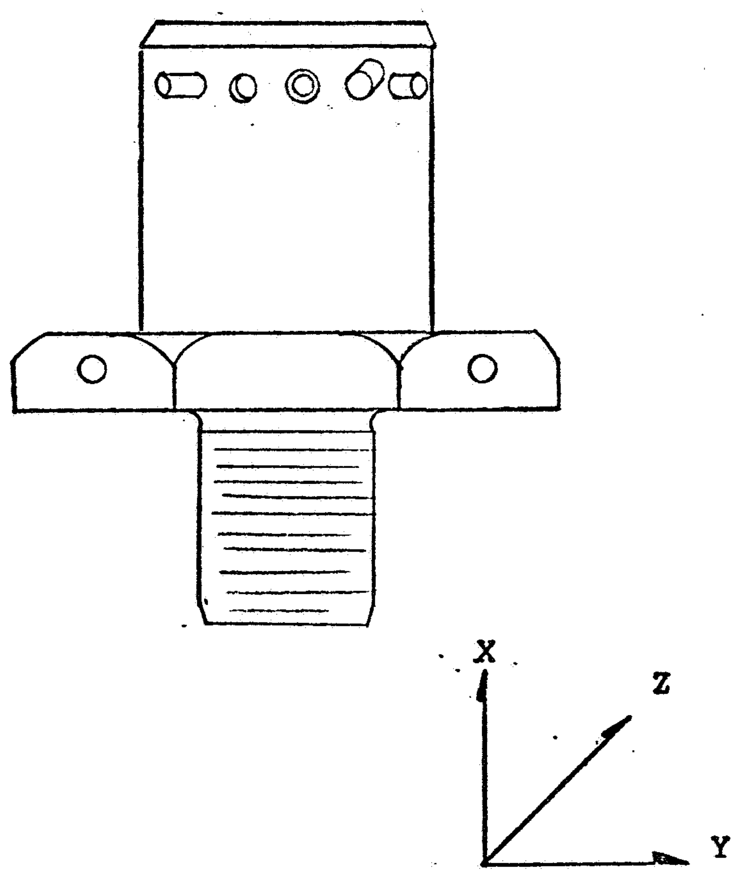
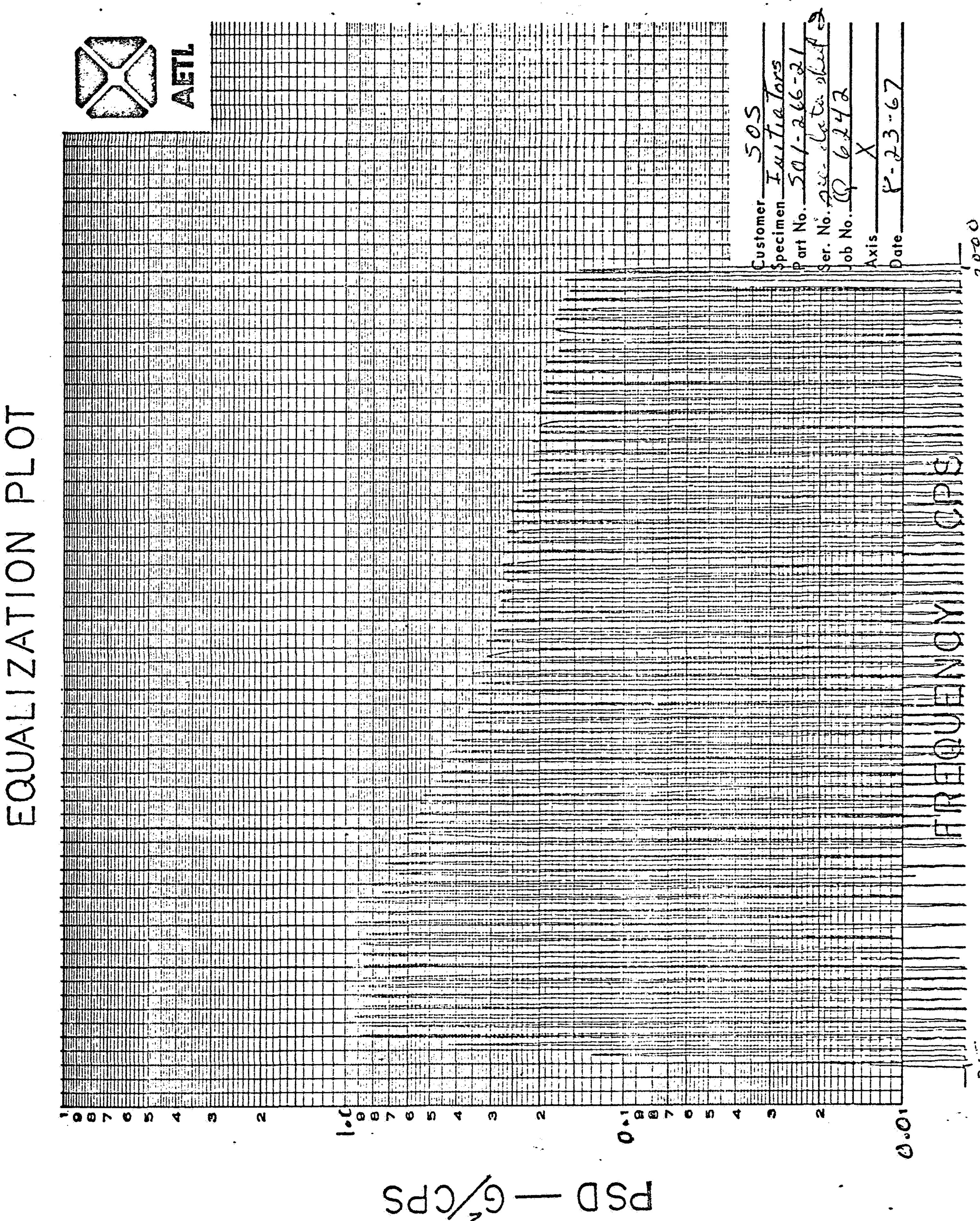


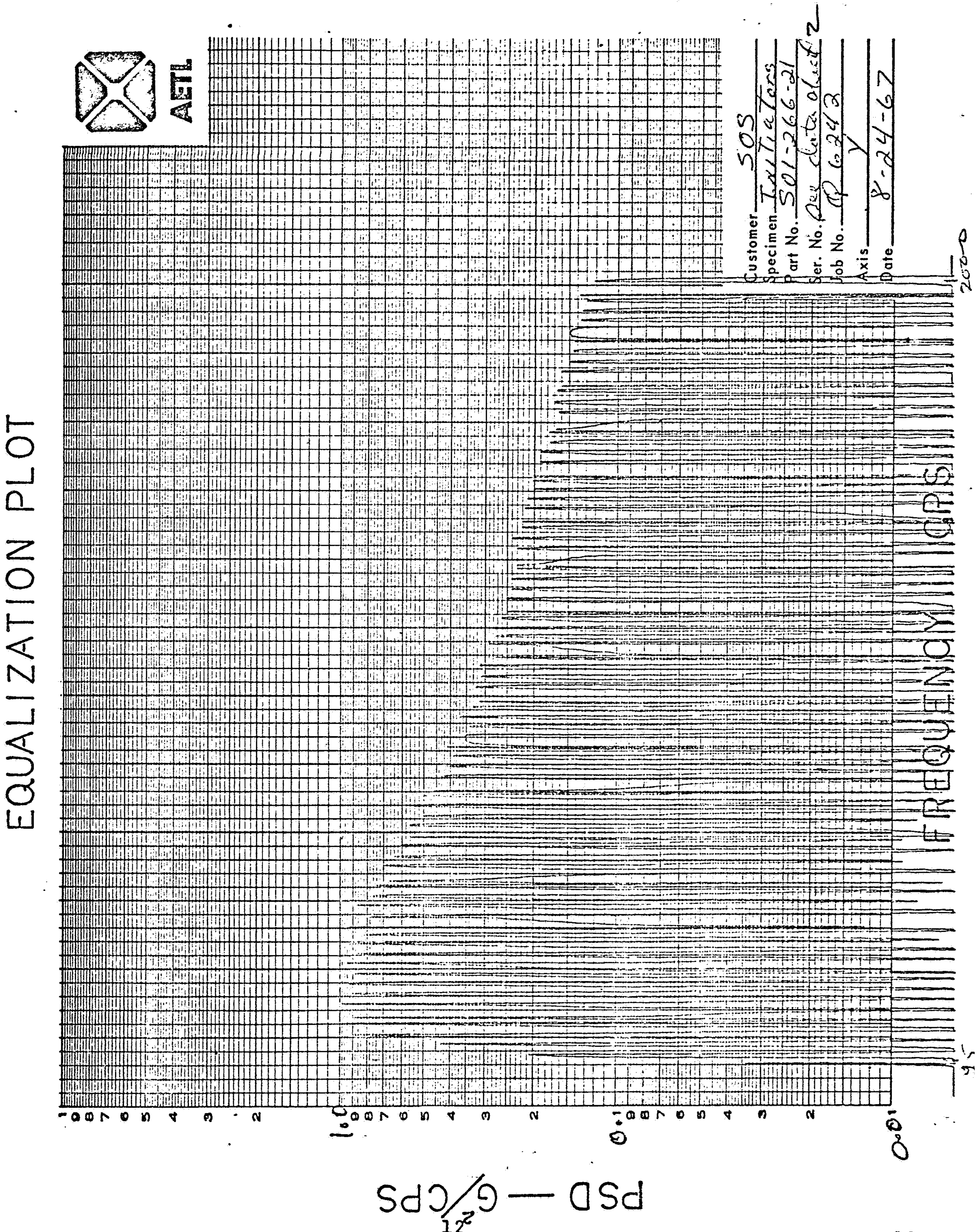
FIGURE 1

TEST SPECIMEN AND AXIS DEFINITIONS

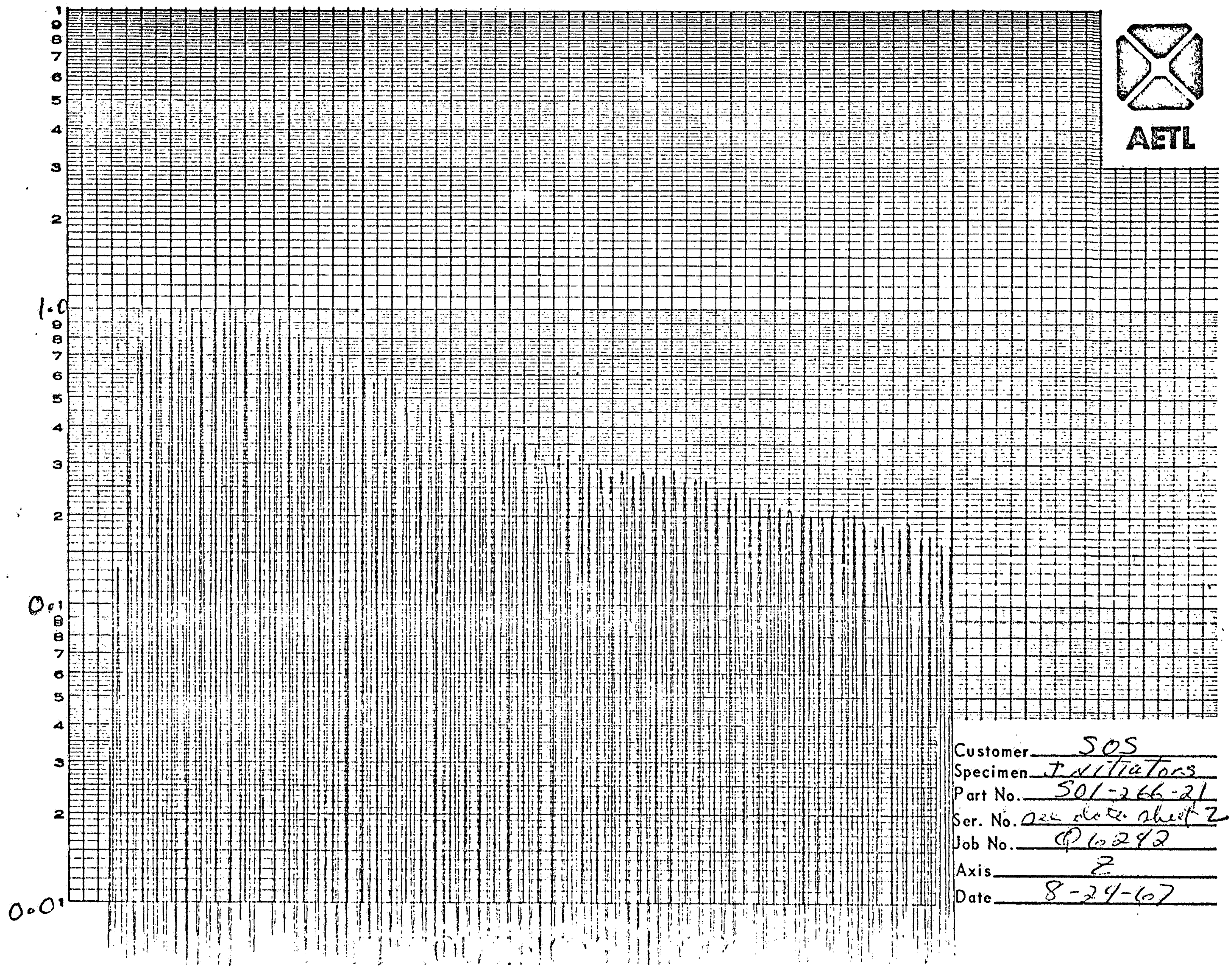
APPENDIX 1

POWER SPECTRAL DENSITY PLOTS


EQUALIZATION PLOT
AETL
Customer 505
Specimen Initiators
Part No. 501-266-21
Job No. Q 6242
Axis X
Date 8-23-67
FREQUENCY CPS
PSD — G²/CPS
1.0
0.1
0.01
2000


EQUALIZATION PLOT
AETL
Customer SOS
Specimen Initiators
Part No. 501-266-21
Ser. No. per data sheet 2
Job No. Q 6243
Axis Y
Date 8-24-67
FREQUENCY CPS
PSD — G²/CPS
1.0
0.1
0.01

EQUALIZATION PLOT



APPENDIX II

PERFORMANCE DATA

ACCEPTANC. TEST DATA SHEET

ITEM: INITIATOR (NON CONDUCTIVE MIX)
SOS P/N: S01-266-21
SOS TEST PROC.: P-1953

CUSTOMER P/N: N/A
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS1-7471

SOS JOB NO. 2835
TOTAL ACCEPT
REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	EXAMINATION OF PRODUCT	RADIOGRAPHIC INSPECTION	HELIUM LEAK TEST: METER DEFLECTION	HELIUM LEAK TEST: SCALE FACTOR PRE CALIB.	HELIUM LEAK TEST: SCALE FACTOR POST CALIB.	HELIUM LEAK TEST: ACTUAL HELIUM LEAK RATE 1 X 10^{-6} CC/SEC MAX.	INSULATION RES. PINS TO CASE 2 MEG. OHMS MIN. RECORD MEGOHMS	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS A–B	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS C–D	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED THROUGH THE BRIDGEWIRE PINS A–B	THROUGH THE BRIDGEWIRE PINS C–D	ALL PINS SHORTED TO CASE.	CIRCUT TO CIRCUT. PINS A–B TO C–D	
1	0250 BRR	[illegible]		TEST 15	TEST 15		TEST 15	11 Meg	1.06	0.99	✓	✓	✓	✓	
2	0251							18 Meg	1.02	1.07	✓	✓	✓	✓	
3	0253							14 Meg	1.02	1.02	✓	✓	✓	✓	
4	0254							20 Meg	1.04	1.06	✓	✓	✓	✓	
5	0255							12 Meg	1.01	1.04	✓	✓	✓	✓	
6	0256							32K	1.06	1.05	✓	✓	✓	✓	
7	0257							34K	1.06	1.10	✓	✓	✓	✓	
8	0258							12 Meg	1.01	1.05	✓	✓	✓	✓	
9	0260							14 Meg	1.05	1.02	✓	✓	✓	✓	
10	0261							66K	1.06	1.08	✓	✓	✓	✓	
11	0262							13 Meg	1.05	1.01	✓	✓	✓	✓	
12	0263							30K	1.03	1.06	✓	✓	✓	✓	
13	0264							14 Meg	1.07	1.06	✓	✓	✓	✓	
14	0265							1.4K	1.05	1.06	✓	✓	✓	✓	
15	0267							56K	1.04	0.99	✓	✓	✓	✓	
16	0268							10 Meg	1.07	1.00	✓	✓	✓	✓	
17	0269							10 Meg	1.06	1.06	✓	✓	✓	✓	
18	0270							10 Meg	1.03	1.02	✓	✓	✓	✓	
19	0273							40K	1.04	1.06	✓	✓	✓	✓	
20	0274							44K	1.05	1.03	✓	✓	✓	✓	
21	0275							12 Meg	1.05	1.03	✓	✓	✓	✓	
22	0276							60K	1.07	1.06	✓	✓	✓	✓	
23	0277							18 Meg	1.08	1.06	✓	✓	✓	✓	
24	0278							56K	1.04	1.05	✓	✓	✓	✓	
25	0279 BRR	[illegible]	5-5-67	TEST 15	TEST 15		TEST 15	44K	1.06	1.03	✓	✓	✓	✓	
TEST TECH (INITIAL)		1-27-67													APPROVAL SIGNATURES
DATE				8/9/67	8/9/67		8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	C.A. Reynolds
STAMPS: WITNESS (SOS)				TEST 15	TEST 15		TEST 15	TEST 9	TEST 9	TEST 9	TEST 15	TEST 15	TEST 15	TEST 15	[signature]
STAMPS: WITNESS (CUSTOMER)															
STAMPS: WITNESS (GOVT.)															

ITEM: INITIATOR (NON CONDUCTIVE MIX) CUSTOMER P/N: N/A SOS JOB NO. 2835

SOS P/N: S01-266-21 CUSTOMER SPEC: N/A TOTAL ACCEPT REJECT

SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS1-7471

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	EXAMINATION OF PRODUCT	RADIOGRAPHIC INSPECTION	HELIUM LEAK TEST: METER DEFLECTION	HELIUM LEAK TEST: SCALE FACTOR PRE CALIB.	HELIUM LEAK TEST: SCALE FACTOR POST CALIB.	HELIUM LEAK TEST: ACTUAL HELIUM LEAK RATE 1 X 10⁻⁶ CC/SEC MAX.	INSULATION RES. PINS TO CASE 2 MEG. OHMS MIN. RECORD MEGOHMS	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS A–B	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS C–D	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: THROUGH THE BRIDGEWIRE PINS A-B	THROUGH THE BRIDGEWIRE PINS C-D	ALL PINS SHORTED TO CASE	CIRCUT TO CIRCUT. PINS A-B TO C-D	
1	0280 BRR	(A-19)		TEST		TEST	TEST	20meg	1.06	1.05	✓	✓	✓	✓	
2	0281							40K	1.05	1.07	✓	✓	✓	✓	
3	0282							64K	1.03	1.06	✓	✓	✓	✓	
4	0283							48K	1.03	1.01	✓	✓	✓	✓	
5	0284							54K	1.00	1.08	✓	✓	✓	✓	
6	0285							22Meg	1.06	1.07	✓	✓	✓	✓	
7	0286							20meg	1.08	1.08	✓	✓	✓	✓	
8	0287							18Meg	1.05	1.00	✓	✓	✓	✓	
9	0288							13meg	1.09	1.08	✓	✓	✓	✓	
10	0289							16meg	1.07	1.06	✓	✓	✓	✓	
11	0290							36K	1.10	1.06	✓	✓	✓	✓	
12	0291							16meg	1.05	1.04	✓	✓	✓	✓	
13	0292							20meg	1.05	1.00	✓	✓	✓	✓	
14	0293							48K	1.03	1.07	✓	✓	✓	✓	
15	0294							24K	1.06	1.05	✓	✓	✓	✓	
16	0295							24meg	1.03	1.05	✓	✓	✓	✓	
17	0296							27meg	1.05	1.09	✓	✓	✓	✓	
18	0297							16meg	1.07	1.07	✓	✓	✓	✓	
19	0298							20meg	1.08	1.07	✓	✓	✓	✓	
20	0299							18meg	1.04	1.06	✓	✓	✓	✓	
21	0300							60K	1.05	1.07	✓	✓	✓	✓	
22	0301							80K	1.05	1.03	✓	✓	✓	✓	
23	0303							80K	1.00	1.02	✓	✓	✓	✓	
24	0305							90K	1.02	1.03	✓	✓	✓	✓	
25	0306 BRR	(A-19)		TEST		TEST	TEST	60K	1.02	1.06	✓	✓	✓	✓	
	TEST TECH (INITIAL)	4-27	75-57												APPROVAL SIGNATURES
	DATE			8/9/7	8/9/7		8/9/7	8/9	8/9	8/9	8/9/67	8/9/67	8/9/67	8/9/67	CA Reynolds
STAMPS	WITNESS (SOS)			TEST	TEST		TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	[signature]
	WITNESS (CUSTOMER)														
	WITNESS (GOVT.)														

ITEM: INITIATOR (NON CONDUCTIVE MIX)
SOS P/N: S01-266-21
SOS TEST PROC.: P-1953

CUSTOMER P/N: N/A
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS1-7471

SOS JOB NO. 2835
TOTAL ACCEPT
REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	EXAMINATION OF PRODUCT	RADIOGRAPHIC INSPECTION	HELIUM LEAK TEST: METER DEFLECTION	HELIUM LEAK TEST: PRE CALIB. SCALE FACTOR	HELIUM LEAK TEST: POST CALIB. SCALE FACTOR	HELIUM LEAK TEST: ACTUAL HELIUM LEAK RATE 1 X 10^{-6} CC/SEC MAX.	INSULATION RES. PINS TO CASE 2 MEG. OHMS MIN. RECORD MEGOHMS	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS A–B	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS C–D	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: THROUGH THE BRIDGEWIRE PINS A–B	THROUGH THE BRIDGEWIRE PINS C–D	ALL PINS SHORTED TO CASE.	CIRCUT TO CIRCUT. PINS A–B TO C–D	
1	0307 BRR			TEST		TEST	TEST	120K	1.07	1.02	✓	✓	✓	✓	
2	0309							140K	1.04	1.01	✓	✓	✓	✓	
3	0311							20meg	1.02	0.99	✓	✓	✓	✓	
4	0313							20meg	1.07	1.04	✓	✓	✓	✓	
5	0314							120K	1.00	1.00	✓	✓	✓	✓	
6	0315							70K	1.05	1.03	✓	✓	✓	✓	
7	0316							100K	0.99	0.99	✓	✓	✓	✓	
8	0318							60K	1.03	1.01	✓	✓	✓	✓	
9	0319							2K	1.00	1.02	✓	✓	✓	✓	
10	0320							20meg	1.00	1.03	✓	✓	✓	✓	
11	0321 -							12meg	1.02	1.02	✓	✓	✓	✓	
12	0322 -							120K	1.02	1.00	✓	✓	✓	✓	
13	0323 -							12meg	1.01	1.02	✓	✓	✓	✓	
14	0324 -							100K	1.02	1.08	✓	✓	✓	✓	
15	0325 -							14meg	1.02	1.02	✓	✓	✓	✓	
16	0326 -							20meg	1.04	1.03	✓	✓	✓	✓	
17	0327 -							60K	0.99	0.99	✓	✓	✓	✓	
18	0328 -							20meg	1.04	1.05	✓	✓	✓	✓	
19	0329 -							14meg	1.04	0.99	✓	✓	✓	✓	
20	0330 -							20meg	1.02	1.01	✓	✓	✓	✓	
21	0331 -							80K	1.04	0.99	✓	✓	✓	✓	
22	0333 -							20meg	1.01	1.00	✓	✓	✓	✓	
23	0335 -							40meg	0.99	1.00	✓	✓	✓	✓	
24	0337 -							100K	1.01	1.05	✓	✓	✓	✓	
25	0338 BRR			TEST		TEST	TEST	20K	1.00	1.00	✓	✓	✓	✓	
	TEST TECH (INITIAL)	4-27	5-57												APPROVAL SIGNATURES
	DATE			8/9/67		8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	8/9/67	[signature]
STAMPS	WITNESS (SOS)			TEST		TEST	TEST	[stamp]	[stamp]	[stamp]	TEST	TEST	TEST	TEST	[signature]
	WITNESS (CUSTOMER)														
	WITNESS (GOVT.)														

ITEM: INITIATOR (NON CONDUCTIVE MIX)
SOS P/N: S01-266-21
SOS TEST PROC.: P-1953

CUSTOMER P/N: N/A
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS1-7471

SOS JOB NO. 2835
TOTAL ACCEPT
REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	EXAMINATION OF PRODUCT	RADIOGRAPHIC INSPECTION	HELIUM LEAK TEST: METER DEFLECTION	HELIUM LEAK TEST: SCALE FACTOR PRE CALIB.	HELIUM LEAK TEST: SCALE FACTOR POST CALIB.	HELIUM LEAK TEST: ACTUAL HELIUM LEAK RATE 1×10^{-6} CC/SEC MAX.	INSULATION RES. PINS TO CASE 2 MEG. OHMS MIN. RECORD MEGOHMS	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS A–B	BRIDGEWIRE RESISTANCE .95–1.15 OHMS PINS C–D	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: THROUGH THE BRIDGEWIRE PINS A-B	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: THROUGH THE BRIDGEWIRE PINS C-D	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: ALL PINS SHORTED TO CASE.	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED: CIRCUT TO CIRCUT. PINS A-B TO C-D
1	0339 BRR							20meg	1.03	1.07	✓	✓	✓	✓
2	0340							20meg	1.04	1.07	✓	✓	✓	✓
3	0341							32meg	1.03	1.00	✓	✓	✓	✓
4	0342							20meg	0.99	1.02	✓	✓	✓	✓
5	0343							32meg	1.01	1.00	✓	✓	✓	✓
6	0344							60K	1.00	1.01	✓	✓	✓	✓
7	0345							32meg	1.02	1.00	✓	✓	✓	✓
8	0346							80K	0.99	1.01	✓	✓	✓	✓
9	0347							40meg	1.01	1.05	✓	✓	✓	✓
10	0348							80K	1.02	1.00	✓	✓	✓	✓
11	0351							100K	1.09	1.01	✓	✓	✓	✓
12	0353							120K	0.99	1.02	✓	✓	✓	✓
13	0354							80K	1.05	1.05	✓	✓	✓	✓
14	0355							80K	1.02	1.09	✓	✓	✓	✓
15	0356							80K	1.06	1.04	✓	✓	✓	✓
16	0357							60K	1.08	1.01	✓	✓	✓	✓
17	0359							100K	1.06	1.08	✓	✓	✓	✓
18	0360							20meg	1.08	1.03	✓	✓	✓	✓
19	0361							100K	1.03	1.07	✓	✓	✓	✓
20	0362							80K	1.05	1.03	✓	✓	✓	✓
21	0365							70K	1.03	1.01	✓	✓	✓	✓
22	0366							20meg	1.04	1.02	✓	✓	✓	✓
23	0367							6K	0.98	1.04	✓	✓	✓	✓
24	0368							100K	1.03	0.99	✓	✓	✓	✓
25	0369 BRR							80K	1.06	1.05	✓	✓	✓	✓
	TEST TECH (INITIAL)	[illegible]												
	DATE			8/9/7	8/9/7		8/9/7	8/9	8/9	8/9	8/9/67	8/9/67	8/9/67	8/9/67
STAMPS	WITNESS (SOS)													
	WITNESS (CUSTOMER)													
	WITNESS (GOVT.)													

APPROVAL SIGNATURES

ACCEPTANCE TEST DATA SHEET

ITEM: INITIATOR (Non-conductive mix) CUSTOMER P/N: N/A SOS JOB NO. 2835
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A TOTAL ACCEPT REJECT
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471

ITEM COUNT	MEMBER NUMBER (CODE SERIAL LOT)	PRE ELECTROSTATIC INTERBRIDGE RES. OHMS	PRE ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PINS TO CASE	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PIN TO PIN	POST ELECTROSTATIC INTERBRIDGE RES. OHMS	POST ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	DIELECTRIC STRENGTH TEST. 500 MICRO AMPERES MAXIMUM:
1	0250 BRR	45Meg	2.6	✓	✓	40Meg	2.7	3 μA
2	0251	70Meg	2.5	✓	✓	55Meg	2.5	1 "
3	0253	90Meg	2.6	✓	✓	90Meg	2.6	1 "
4	0254	110Meg	2.4	✓	✓	105Meg	2.5	.5 "
5	0255	90Meg	2.5	✓	✓	100Meg	2.7	1 "
6	0256	90Meg	2.4	✓	✓	90Meg	2.5	1 "
7	0257	80Meg	2.3	✓	✓	80Meg	2.4	1 "
8	0258	90Meg	2.5	✓	✓	100Meg	2.6	1 "
9	0260	70Meg	1.5	✓	✓	65Meg	2.6	1 "
10	0261	70Meg	2.4	✓	✓	70Meg	2.5	1 "
11	0262	80Meg	2.5	✓	✓	70Meg	2.6	1 "
12	0263	105Meg	2.5	✓	✓	100Meg	2.6	1 "
13	0264	85Meg	2.6	✓	✓	90Meg	2.6	1 "
14	0265	90Meg	2.5	✓	✓	85Meg	2.6	1 "
15	0267	90Meg	2.6	✓	✓	80Meg	2.6	1 "
16	0268	70Meg	2.5	✓	✓	70Meg	2.6	1 "
17	0269	60Meg	2.5	✓	✓	62Meg	2.6	1 "
18	0270	65Meg	2.5	✓	✓	60Meg	2.6	1 "
19	0273	70Meg	2.5	✓	✓	70Meg	2.6	1 "
20	0274	80Meg	2.4	✓	✓	100Meg	2.6	1 "
21	0275	100Meg	2.5	✓	✓	80Meg	2.5	1 "
22	0276	100Meg	2.5	✓	✓	100Meg	2.6	1 "
23	0277	110Meg	2.4	✓	✓	105Meg	2.5	1 "
24	0278	90Meg	2.5	✓	✓	90Meg	2.5	1 "
25	0279 BRR	90Meg	2.5	✓	✓	100Meg	2.7	1 "
	TEST TECH (INITIAL)							
	DATE	8/4/67	8/9/67	8/10/67	8/10/67	8/10/67	8/10/67	8/10/67
STAMPS	WITNESS (SOS)	A TEST IS	A TEST IS	A TEST IS	A TEST IS	A TEST IS	A TEST IS	A TEST IS
	WITNESS (CUSTOMER)							
	WITNESS (GOVT.)							

APPROVAL SIGNATURES

C. A. Reynolds

Richard Powell

ITEM: INITIATOR (Non-conductive mix) CUSTOMER P/N: N/A
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471
SOS JOB NO. 2835
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	PRE ELECTROSTATIC INTERBRIDGE RES. OHMS	PRE ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PINS TO CASE	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PIN TO PIN	POST ELECTROSTATIC INTERBRIDGE RES. OHMS	POST ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	DIELECTRIC STRENGTH TEST. 500 MICRO AMPERES MAXIMUM.
1	0280 BRR	100meg	2.6	✓	✓	100 meg	2.7	1 μA
2	0281	100meg	2.5	✓	✓	90meg	2.7	1 "
3	0282	100meg	2.3	✓	✓	85meg	2.5	1 "
4	0283	90meg	2.4	✓	✓	80meg	2.5	1 "
5	0284	105meg	2.4	✓	✓	105meg	2.7	1 "
6	0285	110meg	2.4	✓	✓	100meg	2.5	1 "
7	0286	115meg	2.4	✓	✓	100meg	2.5	1 "
8	0287	105meg	2.3	✓	✓	95meg	2.5	1 "
9	0288	100meg	2.5	✓	✓	90meg	2.6	1 "
10	0289	100meg	2.5	✓	✓	105meg	2.5	1 "
11	0290	105meg	2.5	✓	✓	95meg	2.6	1 "
12	0291	135meg	2.3	✓	✓	110meg	2.3	1 "
13	0292	90meg	2.3	✓	✓	100meg	2.3	1 "
14	0293	80meg	2.3	✓	✓	95meg	2.5	1 "
15	0294	100meg	2.5	✓	✓	95meg	2.5	1 "
16	0295	100meg	2.5	✓	✓	105meg	2.5	1 "
17	0296	100meg	2.5	✓	✓	110meg	2.7	1 "
18	0297	130meg	2.5	✓	✓	120meg	2.7	1 "
19	0298	120meg	2.4	✓	✓	110meg	2.6	1 "
20	0299	110meg	2.3	✓	✓	100meg	2.6	1 "
21	0300	105meg	2.3	✓	✓	100meg	2.6	1 "
22	0301	118meg	2.5	✓	✓	115meg	2.8	1 "
23	0303	115meg	2.4	✓	✓	110meg	2.6	1 "
24	0305	115meg	2.4	✓	✓	105meg	2.7	1 "
25	0306 BRR	110meg	2.5	✓	✓	110meg	2.7	1 "
	TEST TECH (INITIAL)							
	DATE	8/9/67	8/9/67	8/10/67	8/10/67	8/10/67	8/10/67	8/10/67
STAMPS	WITNESS (SOS)	A TEST 15	A TEST 15	A TEST 15	A TEST 15	A TEST 15	A TEST 15	A TEST 15
	WITNESS (CUSTOMER)							
	WITNESS (GOVT.)							

APPROVAL SIGNATURES
[signature]
[signature]

ITEM: INITIATOR (Non-conductive mix) CUSTOMER P/N: N/A
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471

SOS JOB NO. 2835
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	PRE ELECTROSTATIC INTERBRIDGE RES. OHMS	PRE ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PINS TO CASE	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PIN TO PIN	POST ELECTROSTATIC INTERBRIDGE RES. OHMS	POST ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	DIELECTRIC STRENGTH TEST. 500 MICRO AMPERES MAXIMUM.
1	0307 BAR	120meg	2.5	✓	✓	100 meg	2.7	1 μA
2	0309	120meg	2.3	✓	✓	105meg	2.6	1 "
3	0311	100meg	2.3	✓	✓	95meg	2.6	1 "
4	0313	100meg	2.5	✓	✓	100meg	2.6	1 "
5	0314	110meg	2.4	✓	✓	105meg	2.6	1 "
6	0315	95meg	2.3	✓	✓	100meg	2.6	1 "
7	0316	110meg	2.4	✓	✓	100meg	2.6	1 "
8	0318	65meg	2.4	✓	✓	70meg	2.6	1 "
9	0319	120meg	2.5	✓	✓	110meg	2.7	1 "
10	0320	115meg	2.4	✓	✓	100meg	2.4	1 "
11	0321	115meg	2.2	✓	✓	100meg	2.5	1 "
12	0322	110meg	2.3	✓	✓	100meg	2.5	1 "
13	0323	100meg	2.4	✓	✓	100meg	2.5	1 "
14	0324	105meg	2.3	✓	✓	105meg	2.6	1 "
15	0325	118meg	2.4	✓	✓	115meg	2.6	1 "
16	0326	125meg	2.3	✓	✓	118meg	2.6	1 "
17	0327	170meg	2.3	✓	✓	140meg	2.6	1 "
18	0328	140meg	2.5	✓	✓	118meg	2.6	1 "
19	0329	130meg	2.4	✓	✓	115meg	2.8	1 "
20	0330	130meg	2.5	✓	✓	110meg	2.6	1 "
21	0331	140meg	2.4	✓	✓	125meg	2.6	1 "
22	0333	180meg	2.4	✓	✓	155meg	2.7	1 "
23	0335	200meg	2.5	✓	✓	200meg	2.5	1 "
24	0337	160meg	2.4	✓	✓	150meg	2.5	1 "
25	0338 BAR	160meg	2.5	✓	✓	140meg	2.7	1 "
	TEST TECH (INITIAL)							
	DATE	8/9/67	8/9/67	8/10/67	8/10/67	8/10/67	8/10/67	8/10/67
STAMPS	WITNESS (SOS)	TEST	TEST	TEST	TEST	TEST	TEST	TEST
	WITNESS (CUSTOMER)							
	WITNESS (GOVT.)							

APPROVAL SIGNATURES

[illegible]

Richard Powell

ITEM: INITIATOR (Non-conductive mix) CUSTOMER P/N: N/A
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471
SOS JOB NO. 2835
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	PRE ELECTROSTATIC INTERBRIDGE RES. OHMS	PRE ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PINS TO CASE	ELECTROSTATIC SENSITIVITY 25 KVDC APPLIED PIN TO PIN	POST ELECTROSTATIC INTERBRIDGE RES. OHMS	POST ELECTROSTATIC INTERBRIDGE CAPACITANCE PICO FARADS	DIELECTRIC STRENGTH TEST. 500 MICRO AMPERES MAXIMUM.
1	0339 BRR	150Meg	2.4	✓	✓	130Meg	2.6	1 µA
2	0340	165Meg	2.5	✓	✓	142Meg	2.6	1 "
3	0341	180Meg	2.4	✓	✓	165Meg	2.6	1 "
4	0342	180Meg	2.4	✓	✓	150Meg	2.6	1 "
5	0343	160Meg	2.3	✓	✓	135Meg	2.4	1 "
6	0344	190Meg	2.3	✓	✓	190Meg	2.5	1 "
7	0345	170Meg	2.3	✓	✓	155Meg	2.5	1 "
8	0346	210Meg	2.3	✓	✓	185Meg	2.5	1 "
9	0347	170Meg	2.5	✓	✓	145Meg	2.5	1 "
10	0348	220Meg	2.4	✓	✓	200Meg	2.5	1 "
11	0351	140Meg	2.4	✓	✓	150Meg	2.5	1 "
12	0353	140Meg	2.4	✓	✓	141Meg	2.5	1 "
13	0354	170Meg	2.4	✓	✓	150Meg	2.5	1 "
14	0355	380Meg	2.4	✓	✓	330Meg	2.5	1 "
15	0356	130Meg	2.4	✓	✓	110Meg	2.5	1 "
16	0357	150Meg	2.4	✓	✓	125Meg	2.5	1 "
17	0359	145Meg	2.4	✓	✓	135Meg	2.5	1 "
18	0360	144Meg	2.4	✓	✓	115Meg	2.6	1 "
19	0361	100Meg	2.4	✓	✓	100Meg	2.6	1 "
20	0362	110Meg	2.4	✓	✓	100Meg	2.6	1 "
21	0365	140Meg	2.4	✓	✓	124Meg	2.6	1 "
22	0366	105Meg	2.5	✓	✓	100Meg	2.8	1 "
23	0367	75Meg	2.6	✓	✓	80Meg	2.7	1 "
24	0368	130Meg	2.5	✓	✓	115Meg	2.6	1 "
25	0369 BRR	130Meg	2.4	✓	✓	110Meg	2.6	1 "
	TEST TECH (INITIAL)							
	DATE	8/4/67	8/4/67	8/10/67	8/10/67	8/10/67	8/10/67	8/10/67
STAMPS	WITNESS (SOS)	TEST	TEST	TEST	TEST	TEST	TEST	TEST
	WITNESS (CUSTOMER)							
	WITNESS (GOVT.)							

APPROVAL SIGNATURES
C. A. Reynolds [signature]
Richard Powell [signature]

Bruceton Test Per Navord 2101

GROUP A-1

Item: INITIATOR (NON COND MIX) Pulse Time: 5 MIN Job No: 2835

Date: 8-16-67 Test Temp. +295-325 °F No. Bridges: 2

S/N

AMP	0251 A-B	0256	0262	0267	0261	0254	0250	0263	0257	0255	0265	0264	0253	0258	0260 A-B	0264 C-D	0268 C-D	0269	0270	0273	0274	0275	0276	0277	0278	0279	0280	0281	0282	0283 C-D	i	n	in	i^2n
1.6			O				O									?	O														0	3	0	0
1.7		X		O		X		O		O		O		O		X		O		O		O		O		O			?	O	1	11	11	11
1.8	X				X				X		X		X		X				X		X		X		X		O		X		2	1	2	4
1.9																												X						
																															TOTALS	15	13	15
																																N	A	B

$\bar{X} = c + d\,(A/N \pm \tfrac{1}{2}) =$ 1.737

$M = (NB - A^2) / N^2 =$ 0.249

$S =$ 0.450 ---- (Graph 1, 2)

$G =$ 1.20 ---- (Graph 3, 5)

$H =$ 1.20 ---- (Graph 4, 5)

$\sigma_R = sd =$ 0.045

$\sigma_{\bar{X}} = \sigma_R\, G / \sqrt{N} =$ 0.0139

$\sigma_\sigma = \sigma_R\, H / \sqrt{N} =$ 0.0139

$t_1 =$ 3.09 ---- (Table, P.4)

$t_2 =$ 1.76 ---- (Table 2)

$N.F. = \bar{X}_R - t_1\sigma_R - t_2\,(\sigma_{\bar{X}}^2 + t_1^2\sigma_\sigma^2)^{1/2} =$ 1.519

$A.F. = \bar{X}_R + t_1\sigma_R + t_2\,(\sigma_{\bar{X}}^2 + t_1^2\sigma_\sigma^2)^{1/2} =$ N/A

No-Fire and All-Fire Current Values at 99.9 %

Reliability and 90 % Confidence Level.

1. Let the zero increment level correspond to the lowest current level of the symbol occurring less frequently.
2. "c" is lowest level of symbol occurring less frequently.
3. In equation for $\bar{X}$, use + if calculations based on symbol at smallest current value and - if based on symbol at largest current value.

8/16-67

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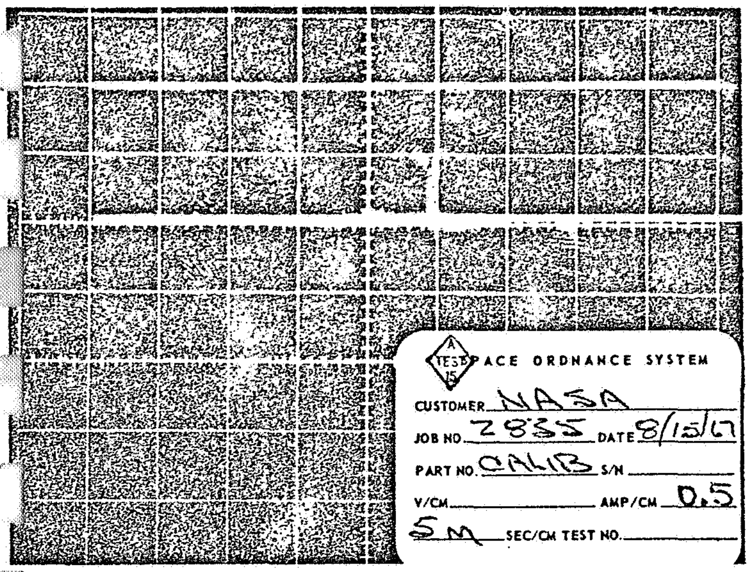

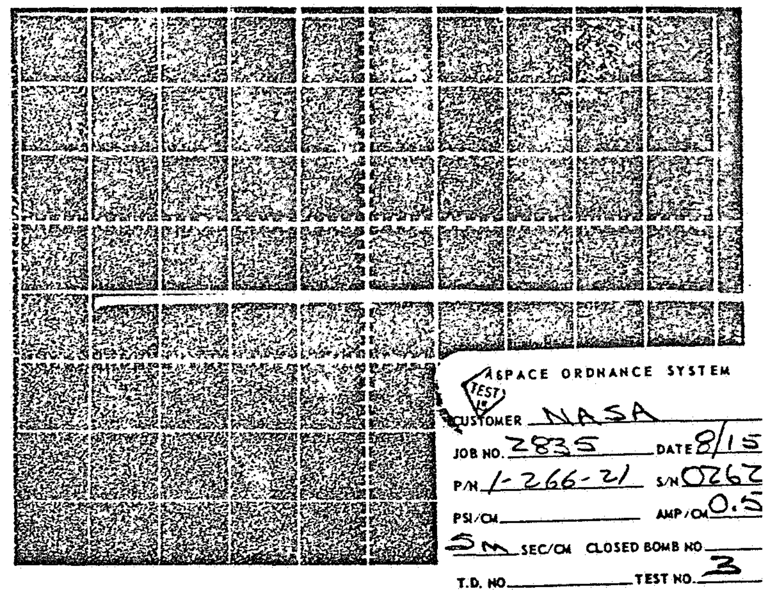

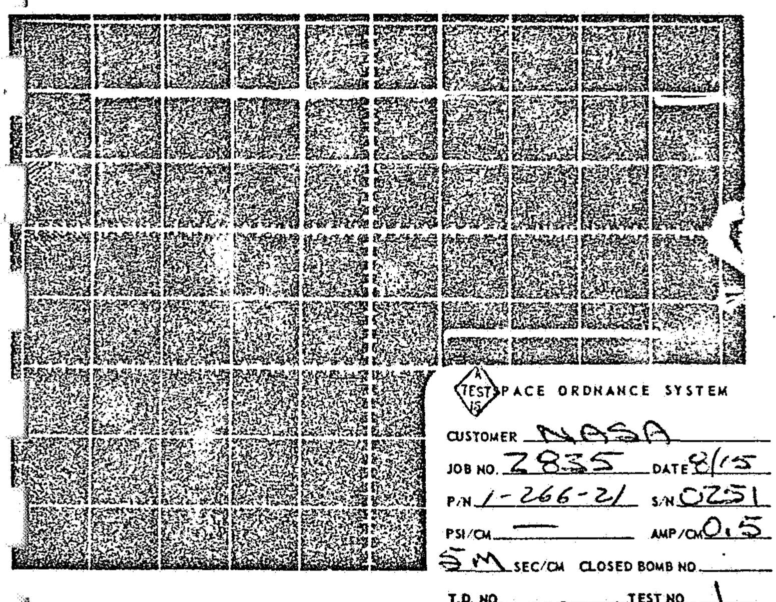

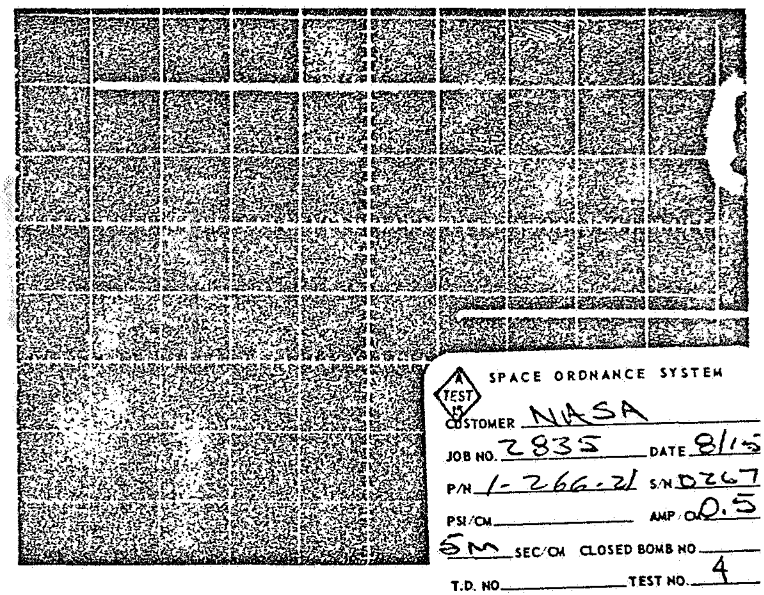

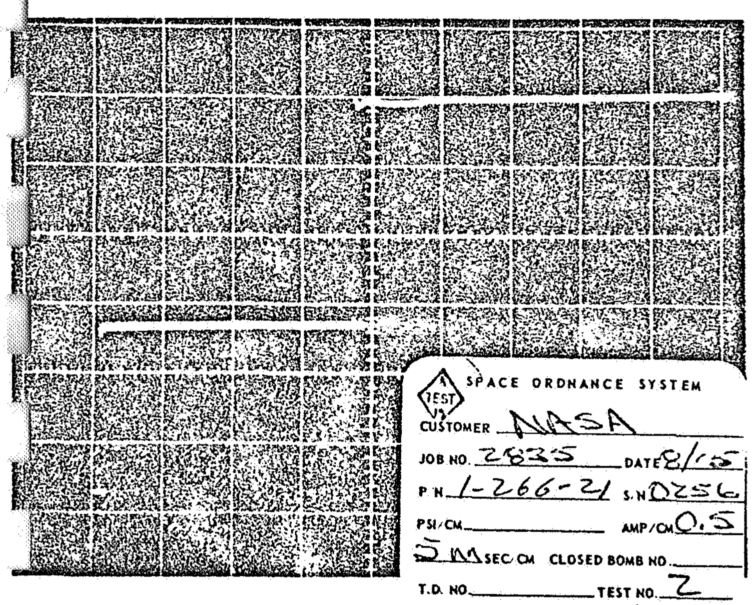

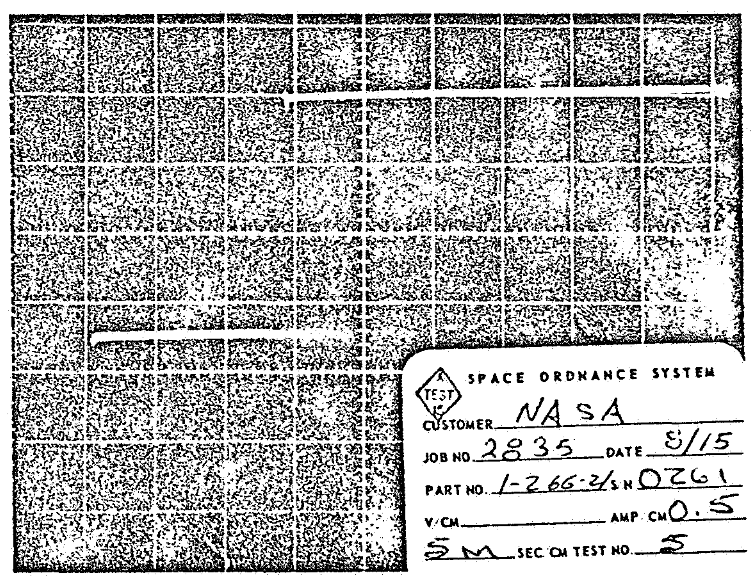

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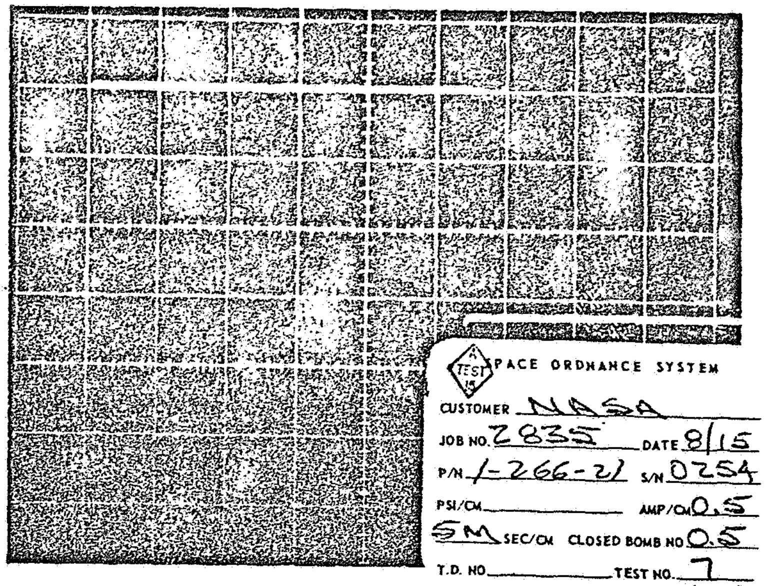
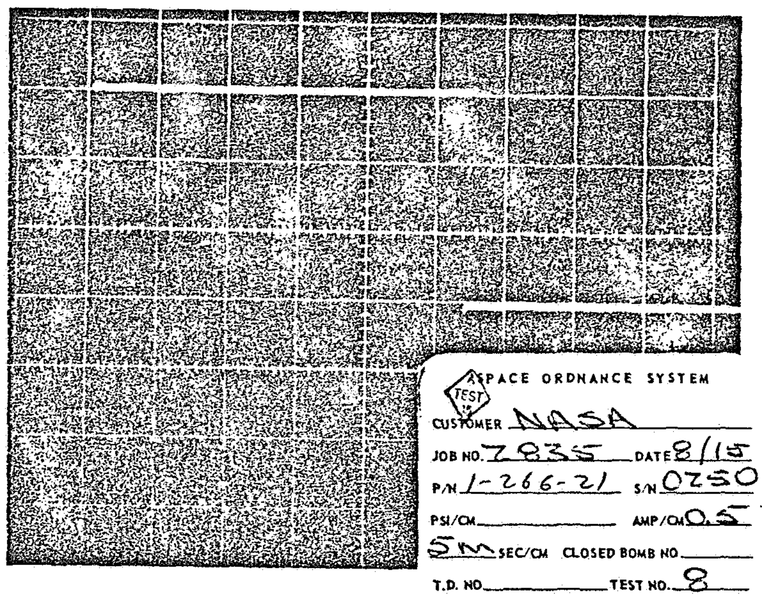
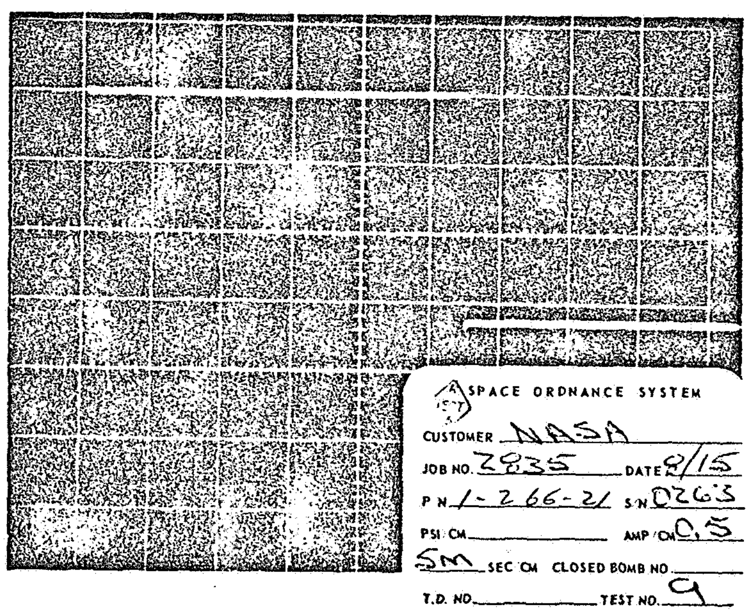
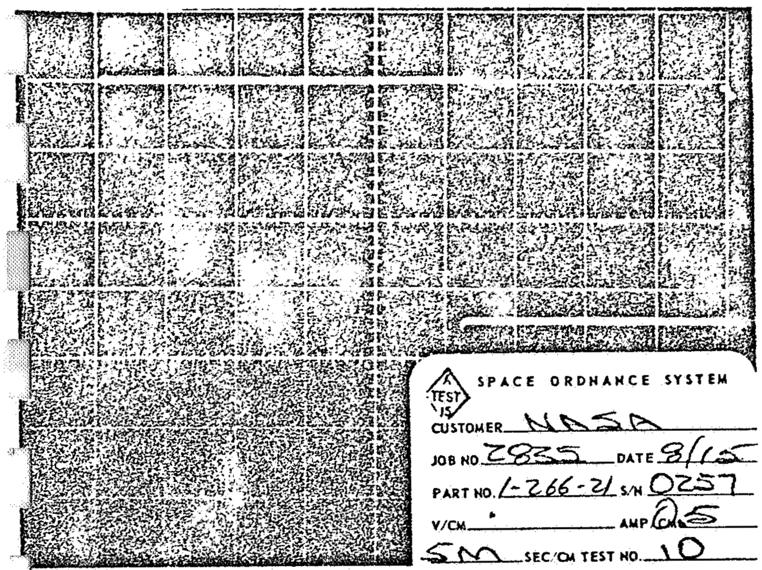
26 July 1968





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JOB NO. 2835 DATE 8/15
PART NO. 1-266-21 S/N 0257
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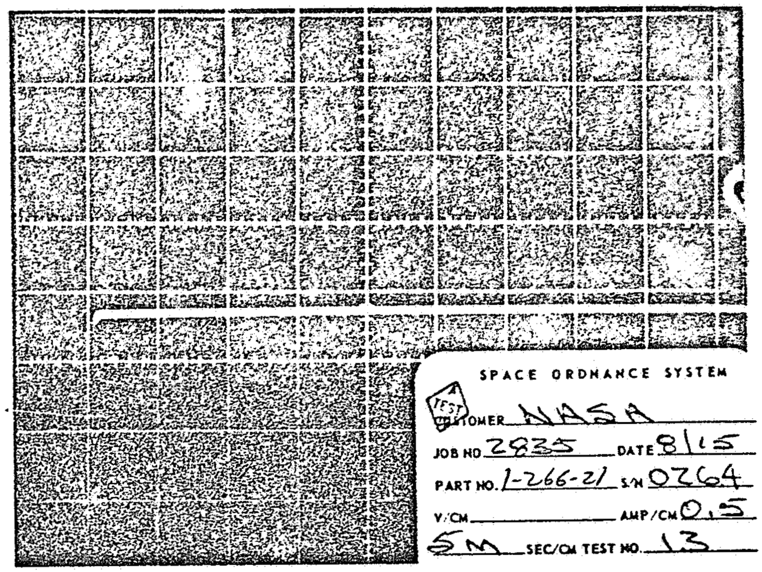
5M SEC/CM TEST NO. 10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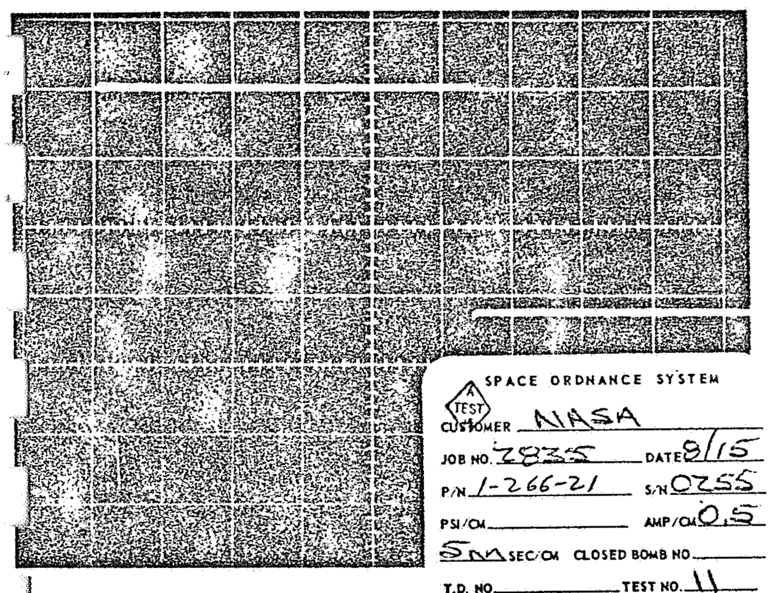
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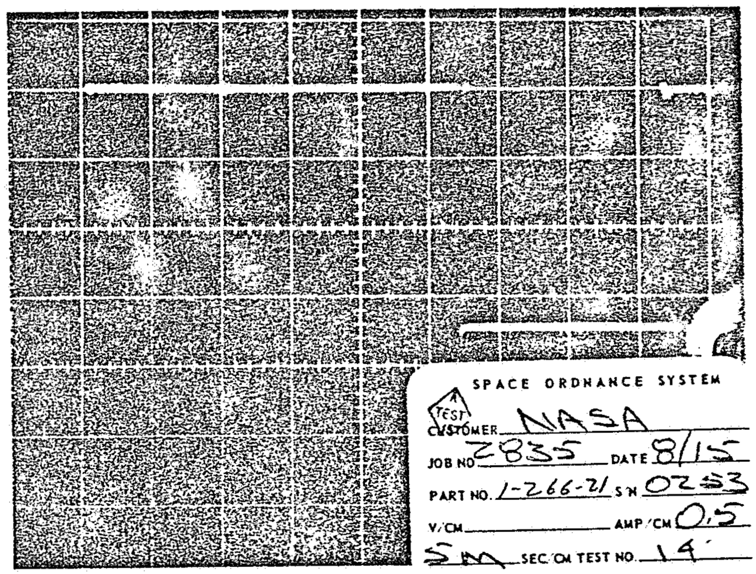
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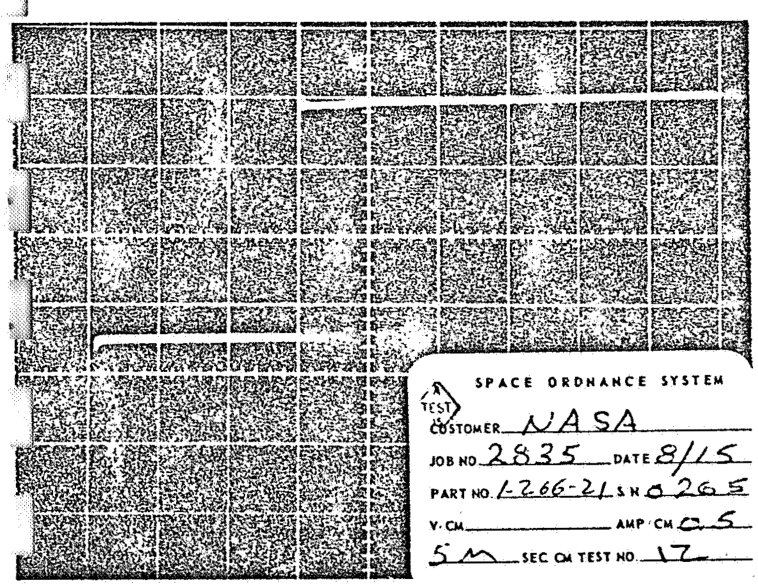
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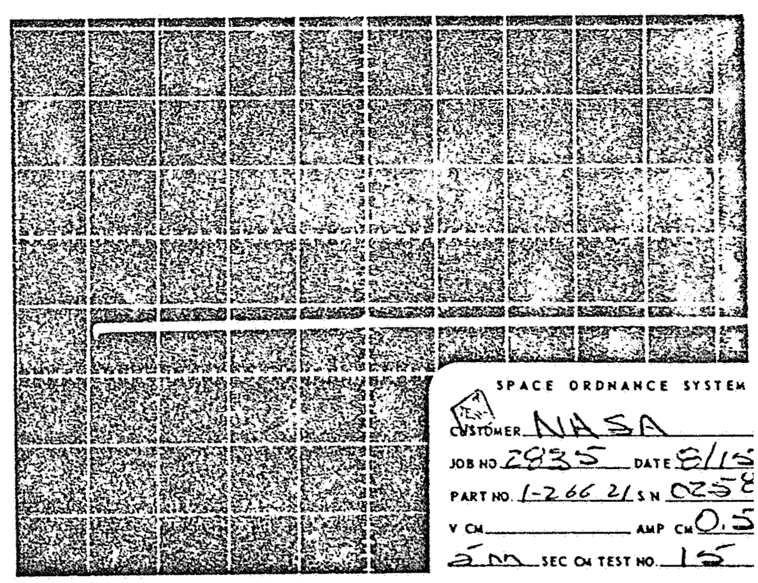
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JOB NO. 2835 DATE 8/15
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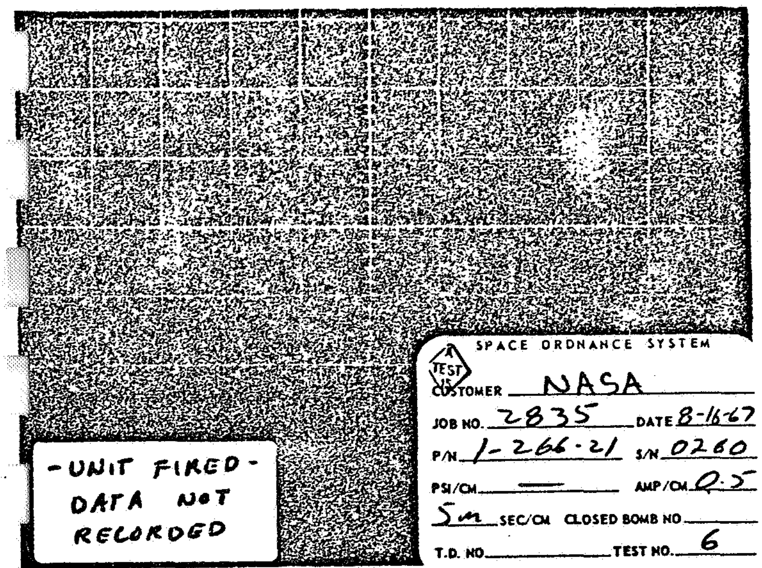
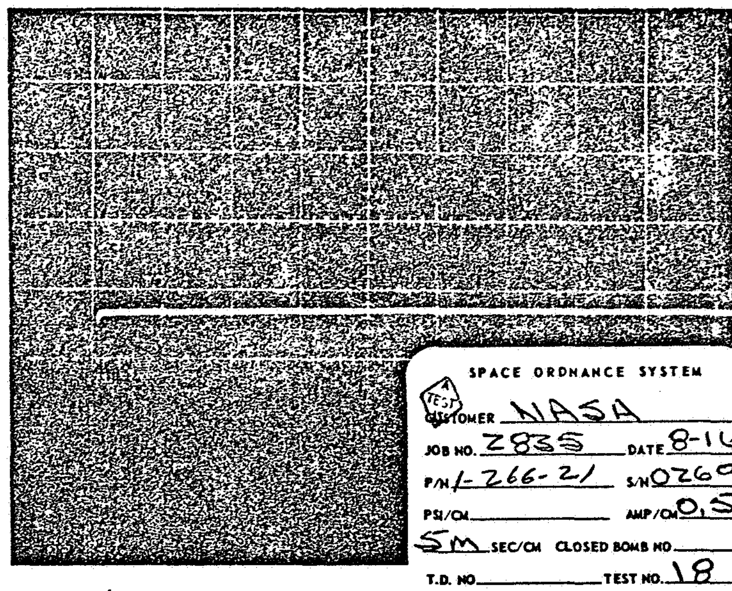
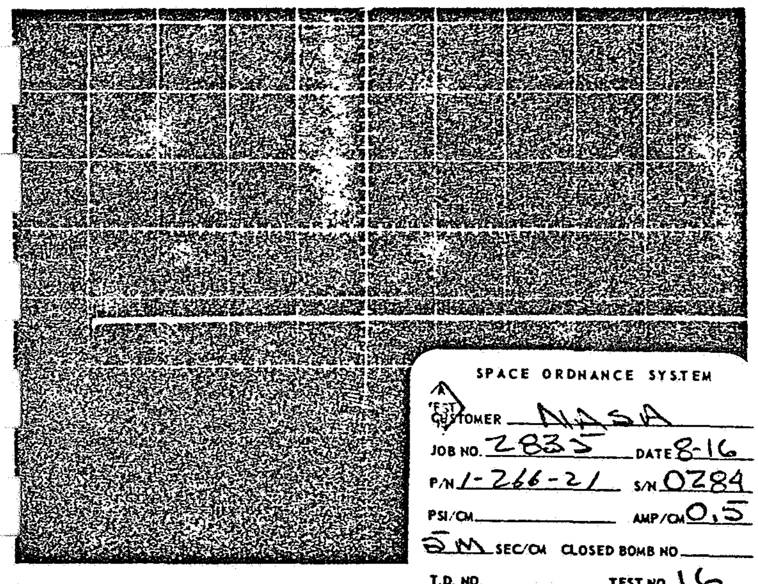
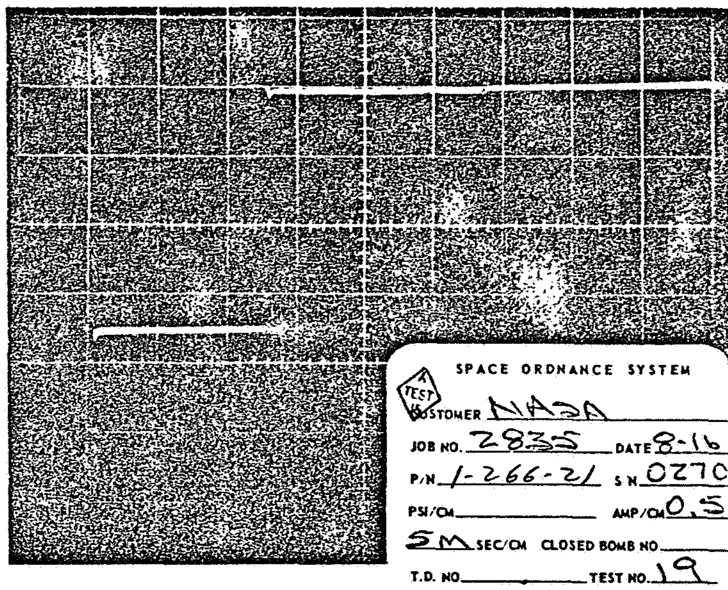
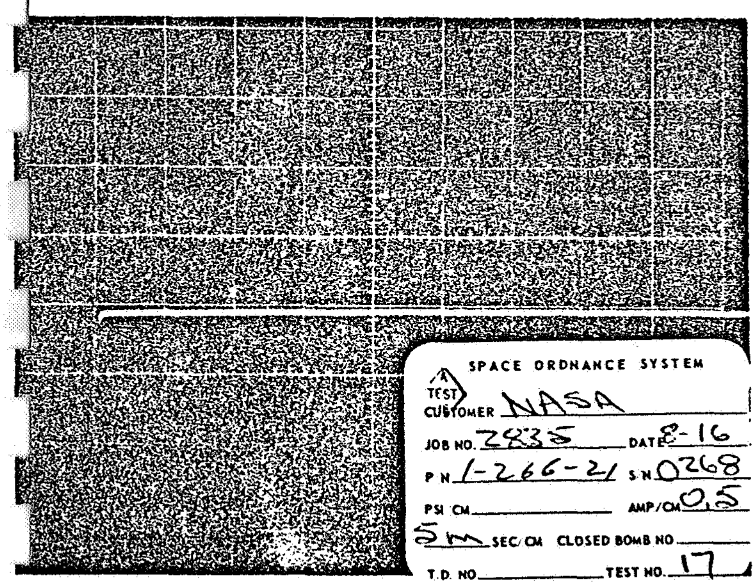
26 July 1968

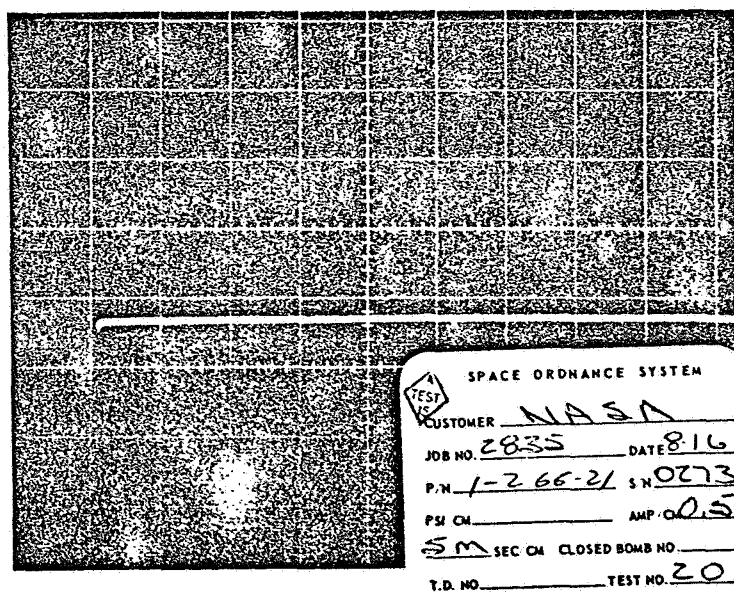












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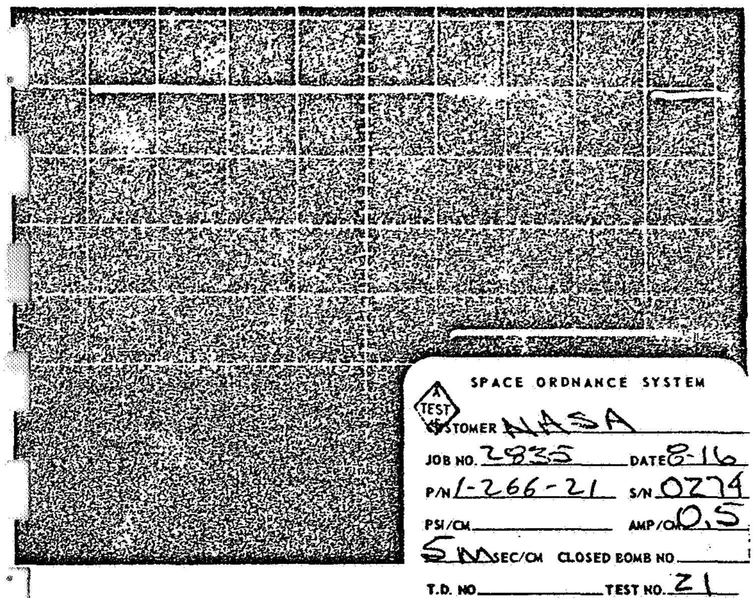

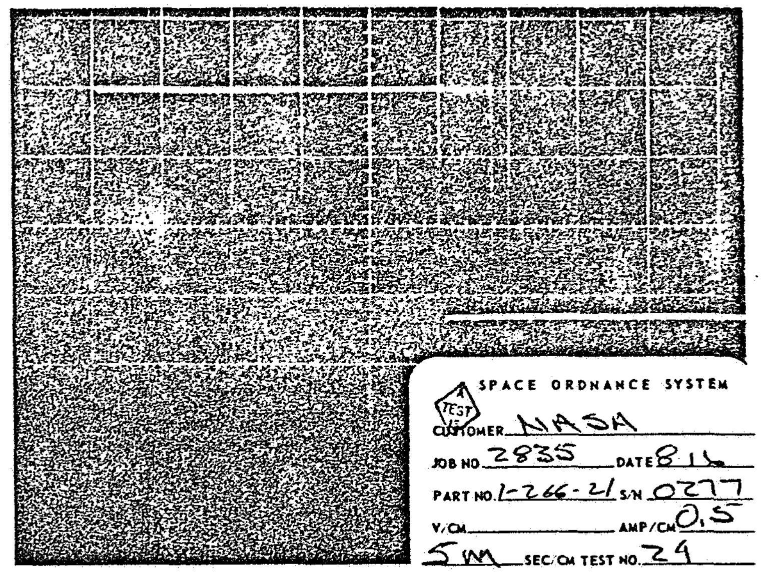

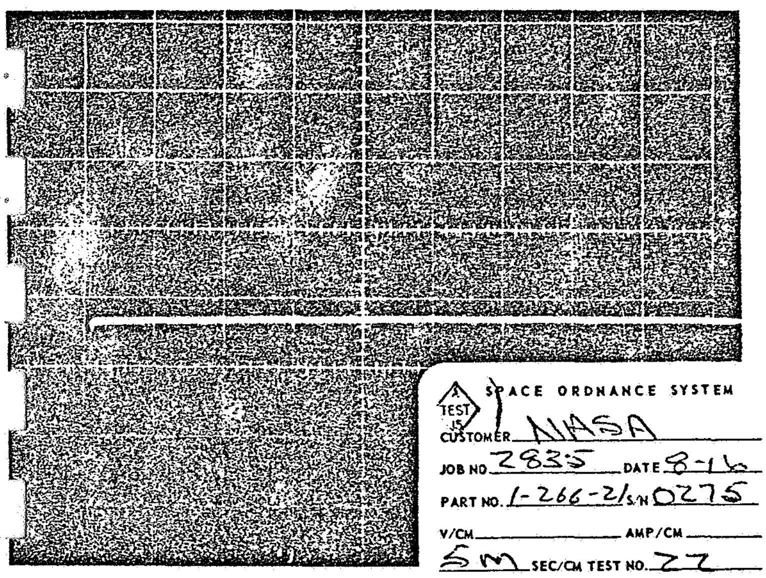

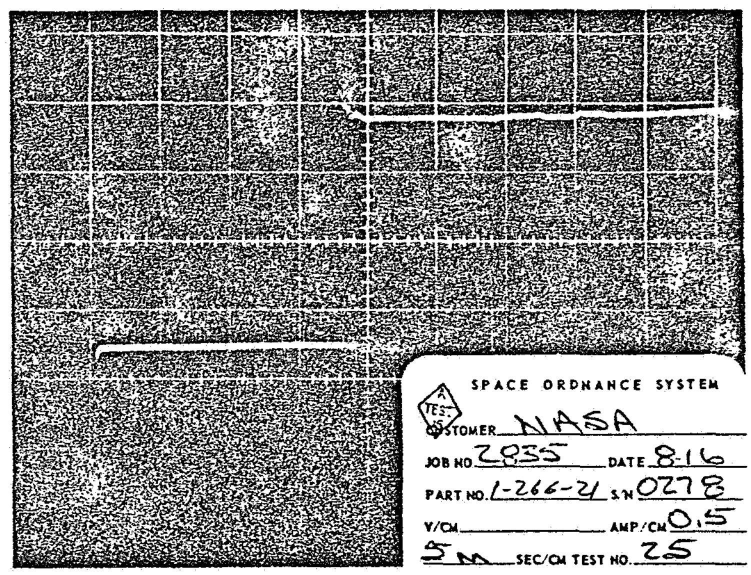

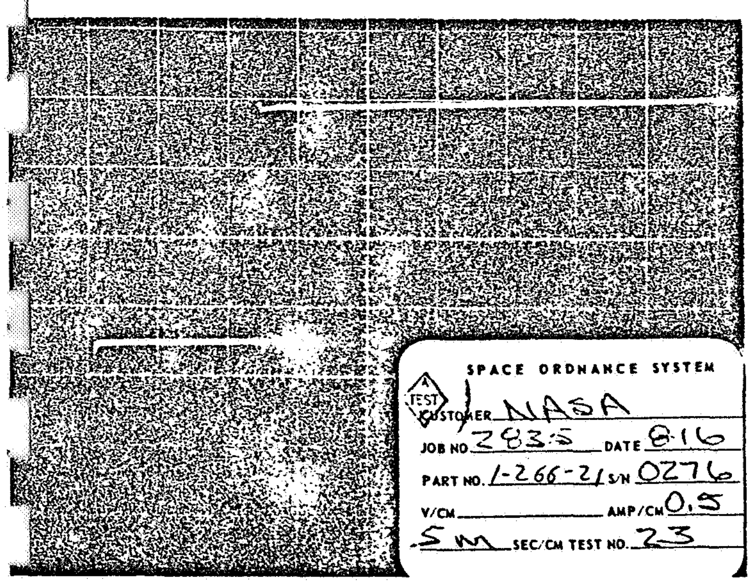

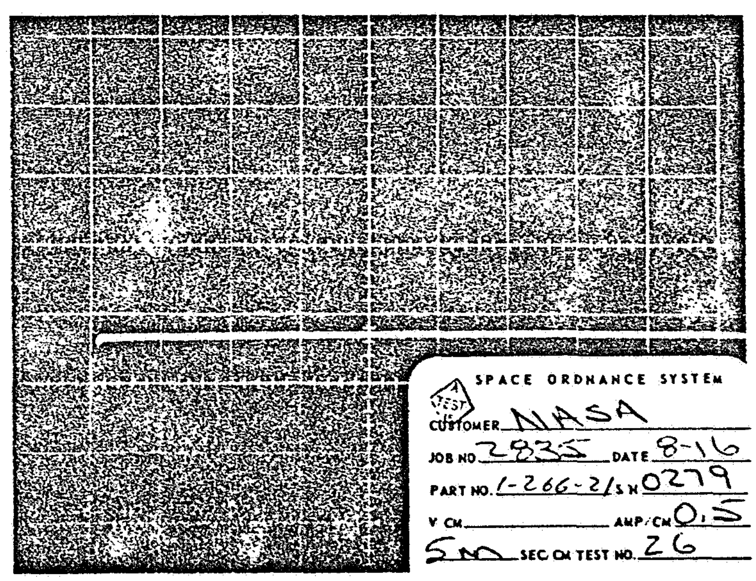

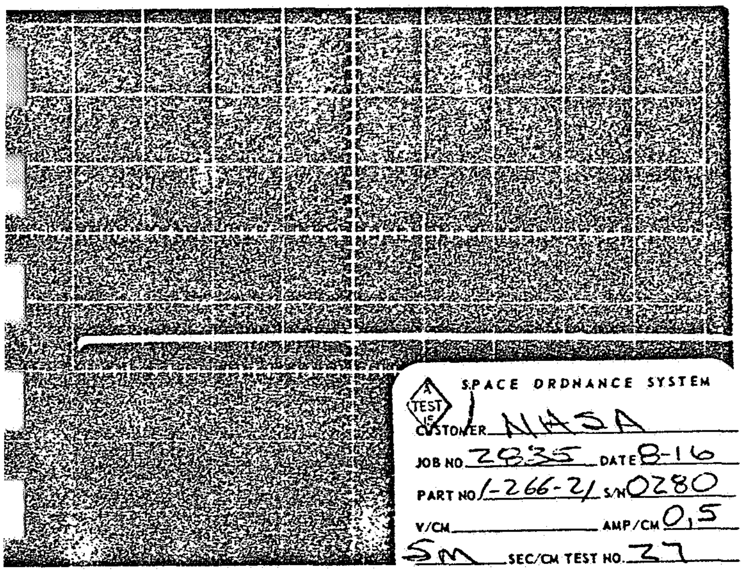
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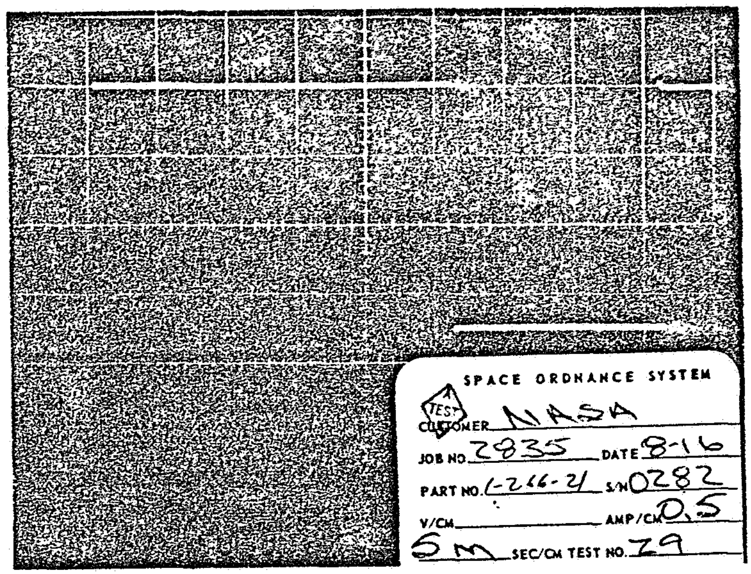
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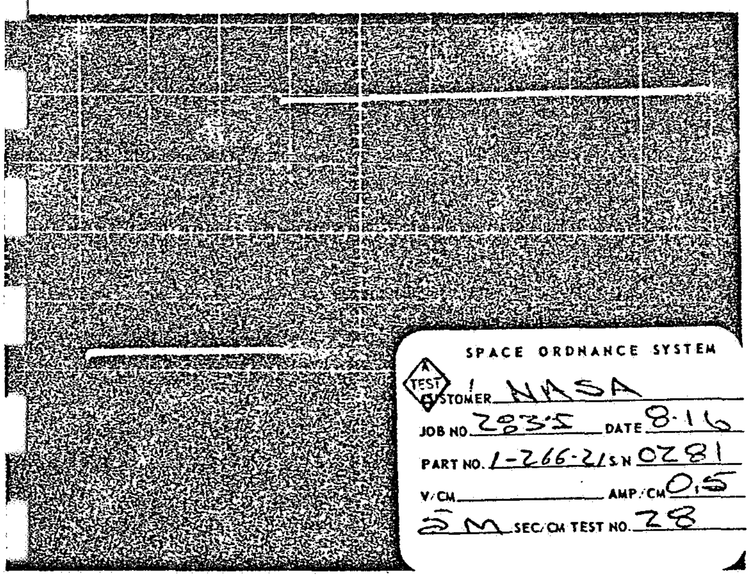
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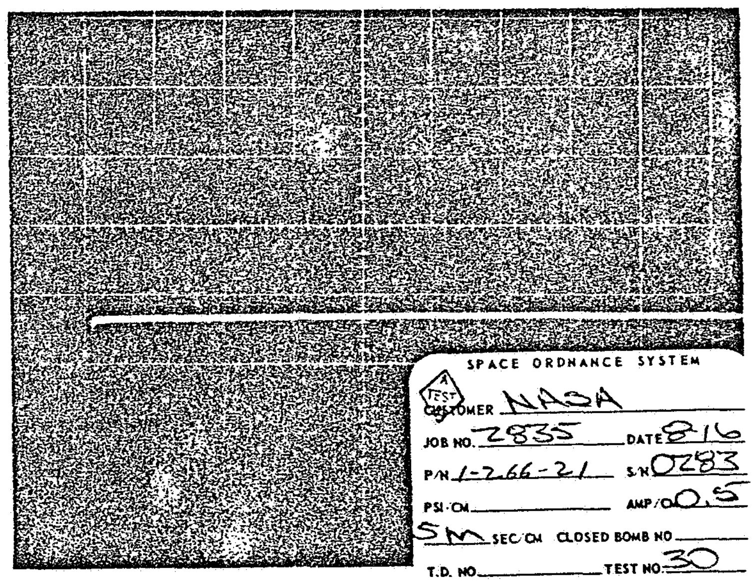
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P/N 1-266-21 S/N 0283
PSI/CM AMP/CM 0.5
5M SEC/CM CLOSED BOMB NO.
T.D. NO. TEST NO. 30

Bruceton Test Per Navord 2101

GROUP A-2

Item: *INITIATOR - NON COND. MIX* Pulse Time: *10 MILLISECONDS* Job No: *2835*

Date: *8-17-67* Test Temp: -260^{+5}_{-25} °F No. Bridges: *2*

S/N *A-B ←→ A-B C-D ←→ C-D*

AMP	0285	0286	0287	0288	0289	0290	0291	0292	0293	0294	0295	0296	0297	0298	0299	0300	0301	0303	0305	0306	0307	0309	0311	0313	0314	0315	0316	0318	0319	0320	i	n	in	i^2n
2.1															O																			
2.2						O		O				O		X		O		O				O									0	1	0	0
2.3	O		O		X		X		O		X		X				X		O		X		O		O		O		O		1	6	6	6
2.4		X		X						X										X				X		X		X		X	2	8	16	32
																															TOTALS	15	22	38
																																N	A	B

$\bar{X} = c + d\ (A/N \pm \frac{1}{2}) = 2.297$

$S = 0.663$ - - - - (Graph 1, 2)

$H = 2.07$ - - - - (Graph 4, 5)

$\sigma_{\bar{x}} = \sigma_R\ G\ /\sqrt{N} = 0.0158$

$t_1 = 3.09$ - - - - (Table, P.4)

$N.F. = \bar{X}_R - t_1\sigma_R - t_2\ (\sigma_{\bar{X}}^2 + t_1^2\sigma_\sigma^2)^{1/2} =$ N/A

$A.F. = \bar{X}_R + t_1\sigma_R + t_2\ (\sigma_{\bar{X}}^2 + t_1^2\sigma_\sigma^2)^{1/2} = 2.695$

$M = (NB - A^2)\ /\ N^2 = 0.382$

$G = 0.925$ - - - - (Graph 3, 5)

$\sigma_R = sd = 0.0663$

$\sigma_\sigma = \sigma_R\ H\ /\sqrt{N} = 0.0354$

$t_2 = 1.76$ - - - - (Table 2)

No-Fire and All-Fire Current Values at *99.9%*

Reliability and *90* % Confidence Level.

1. Let the zero increment level correspond to the lowest current level of the symbol occurring less frequently.
2. "c" is lowest level of symbol occurring less frequently.
3. In equation for $\bar{X}$, use + if calculations based on symbol at smallest current value and - if based on symbol at largest current value.

8/17/67

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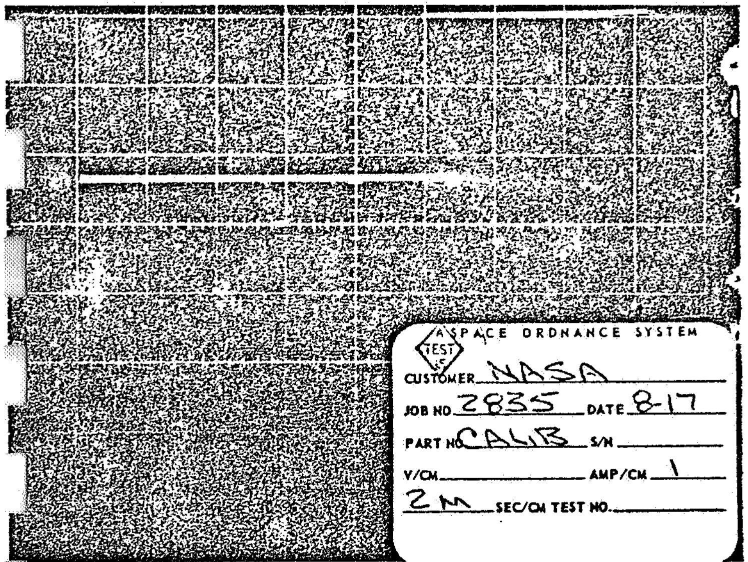

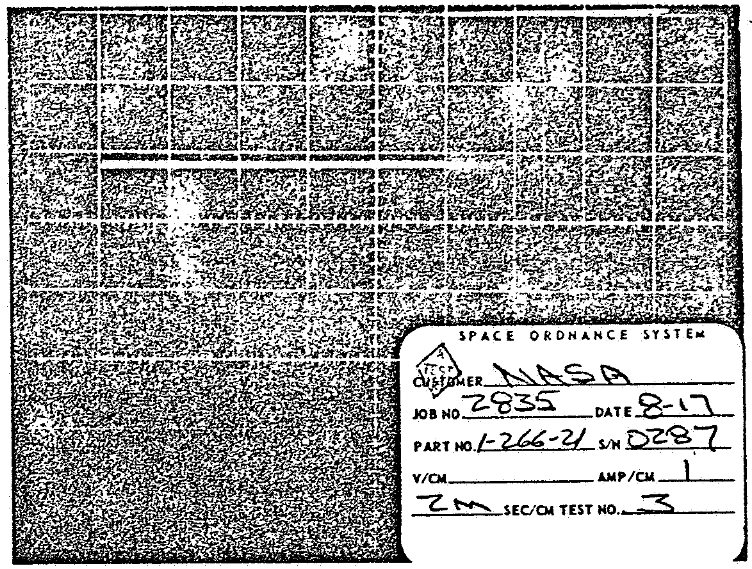

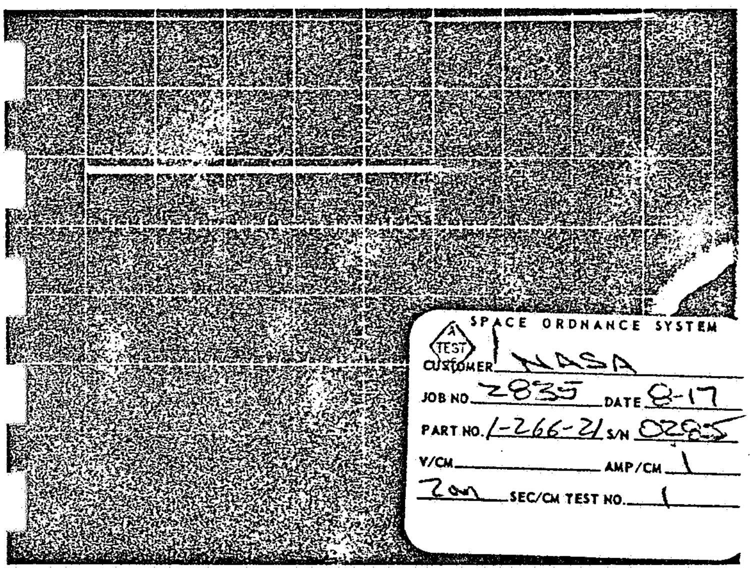

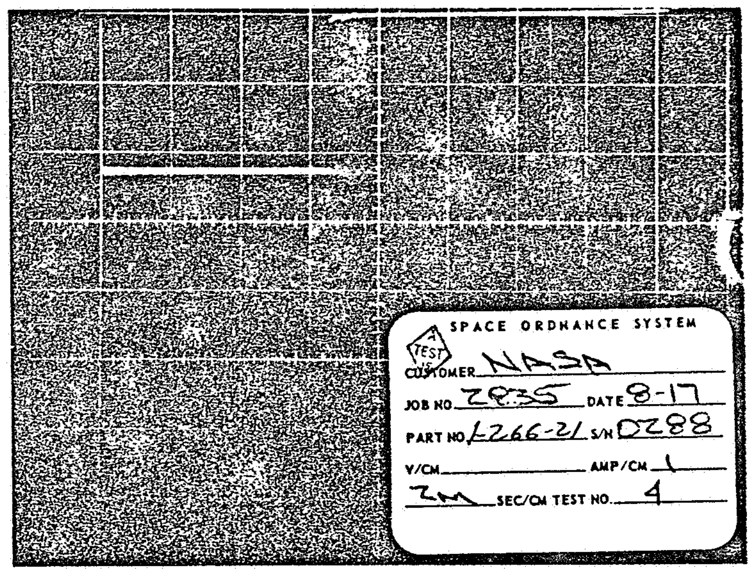

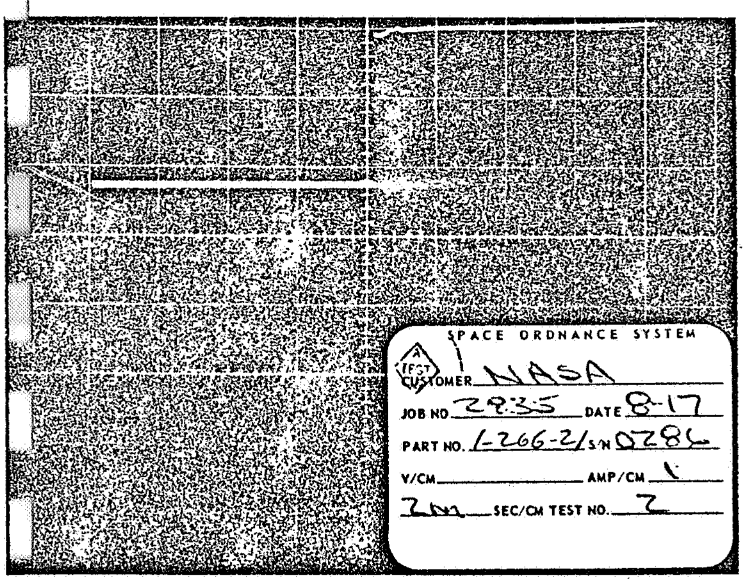

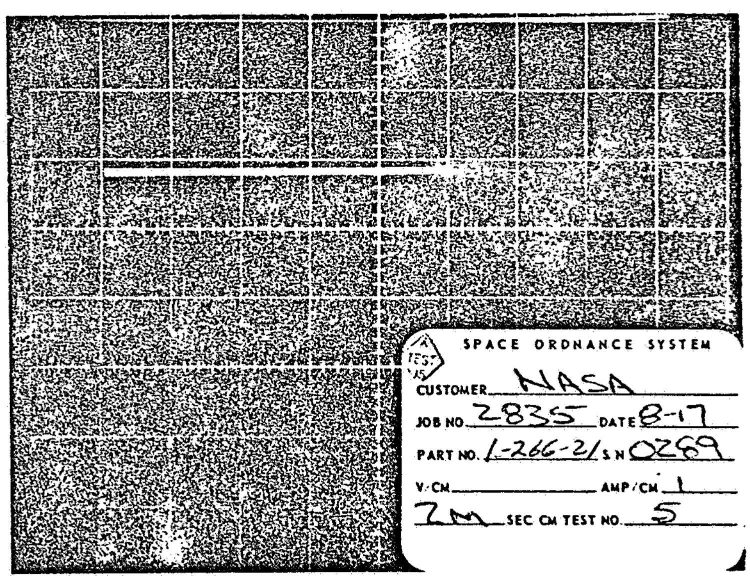

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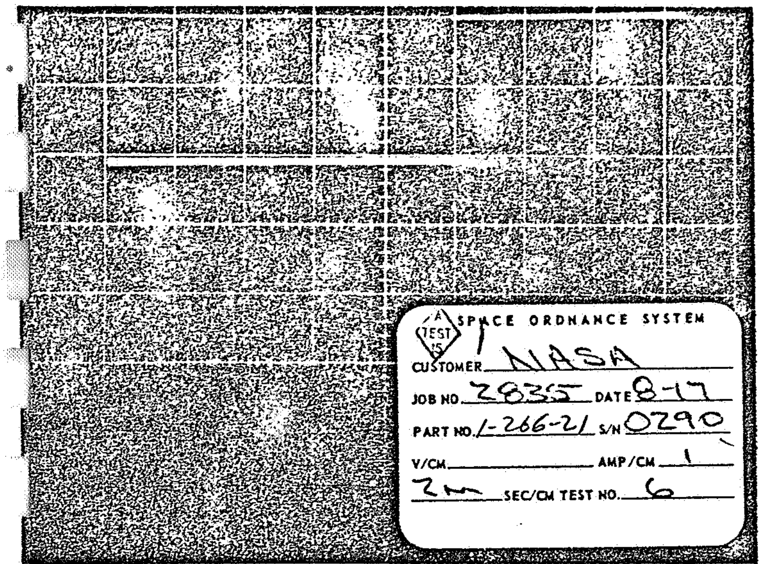

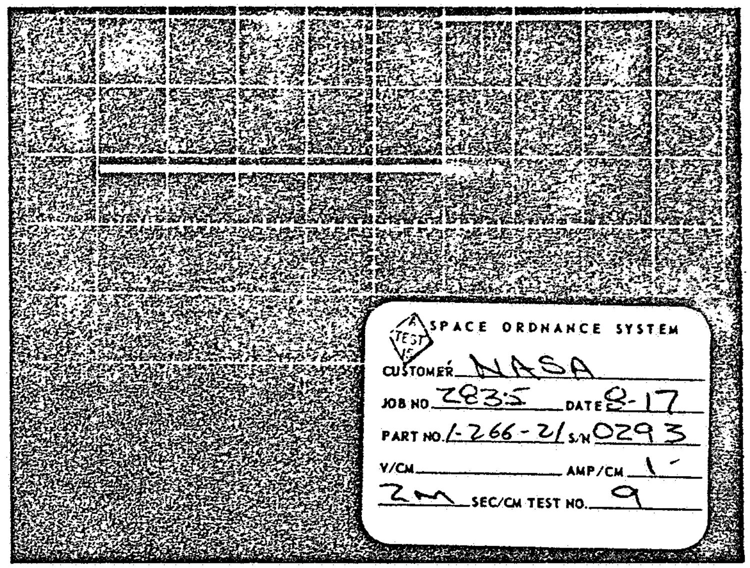

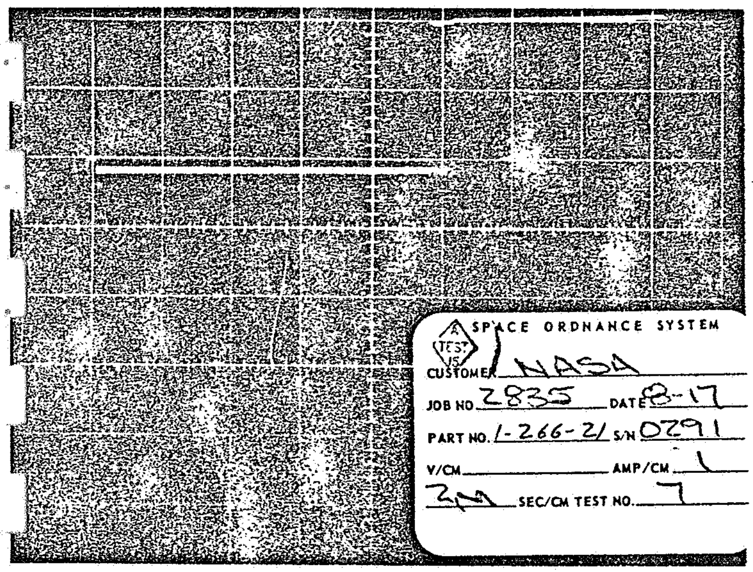

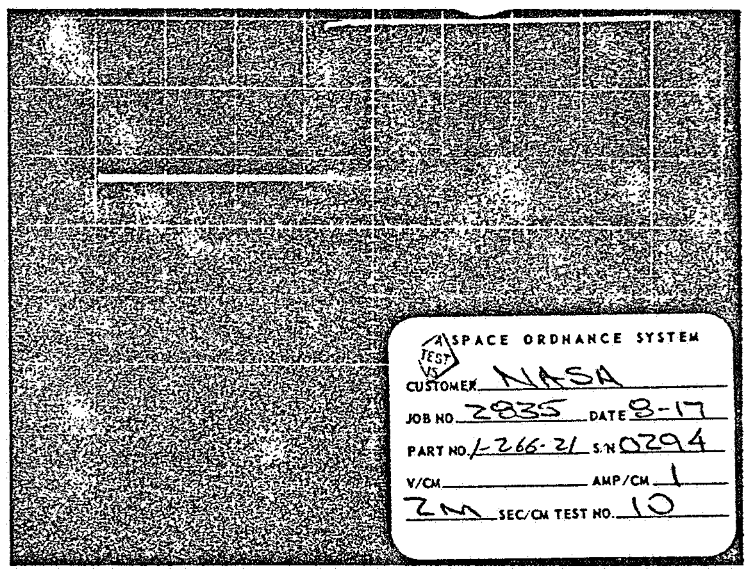

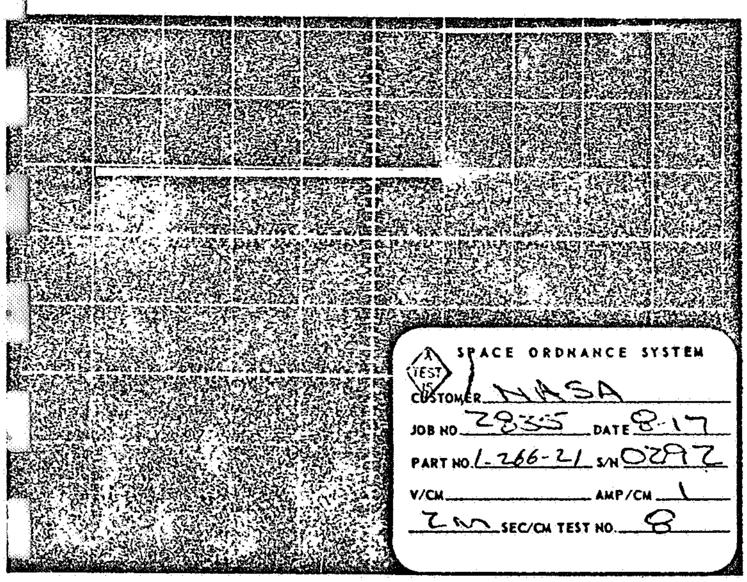

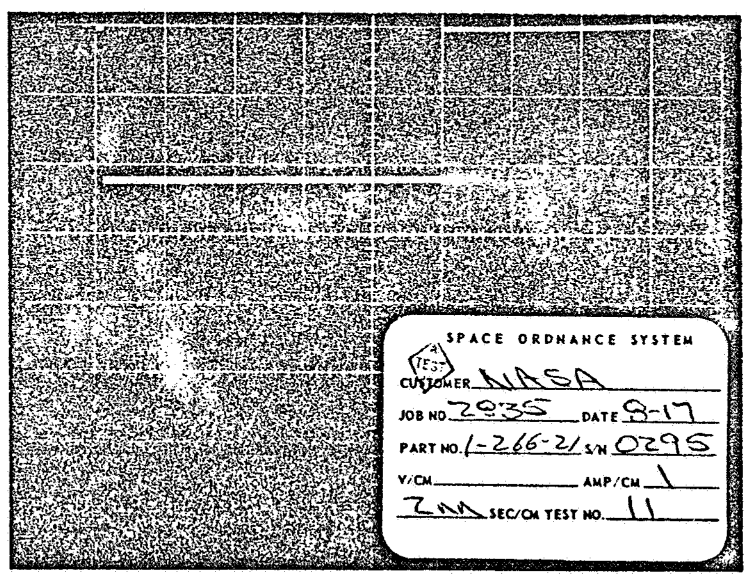

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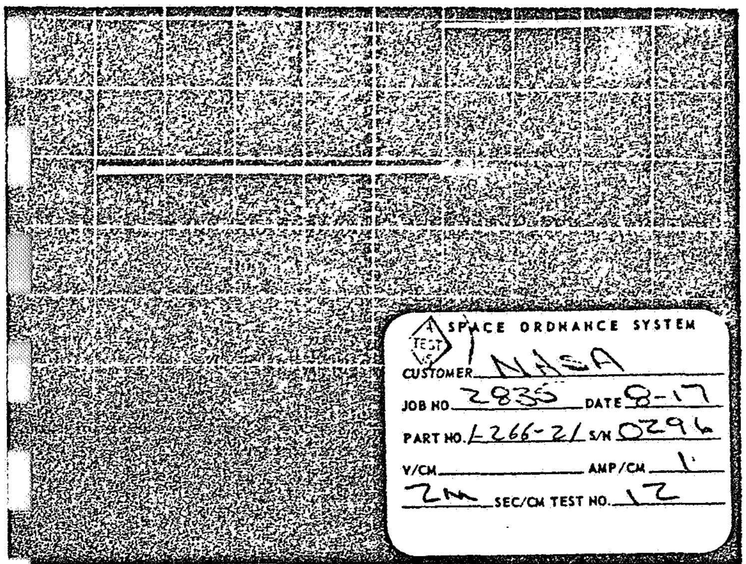

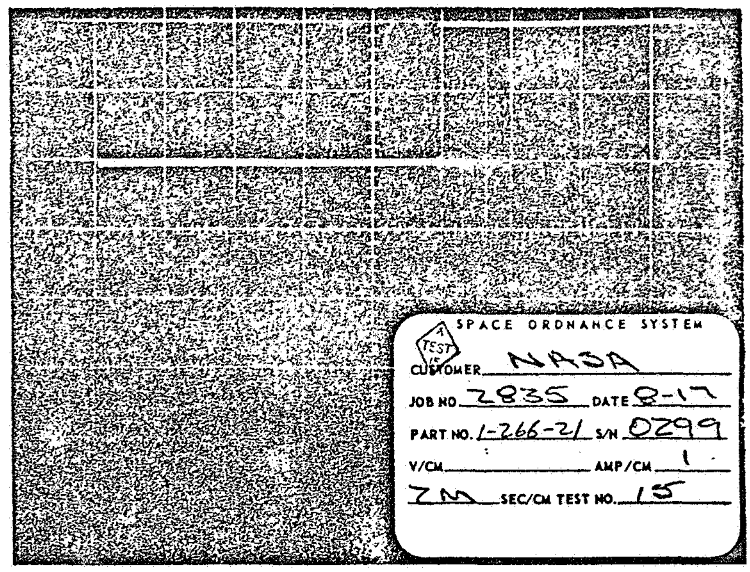

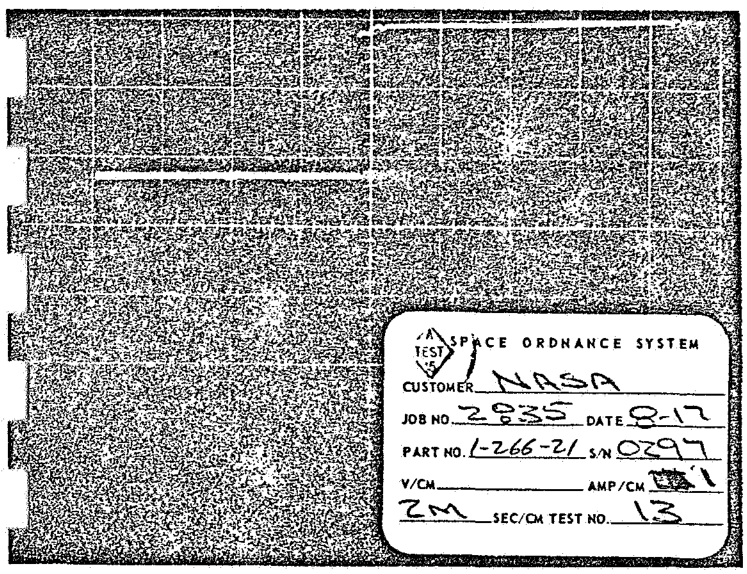

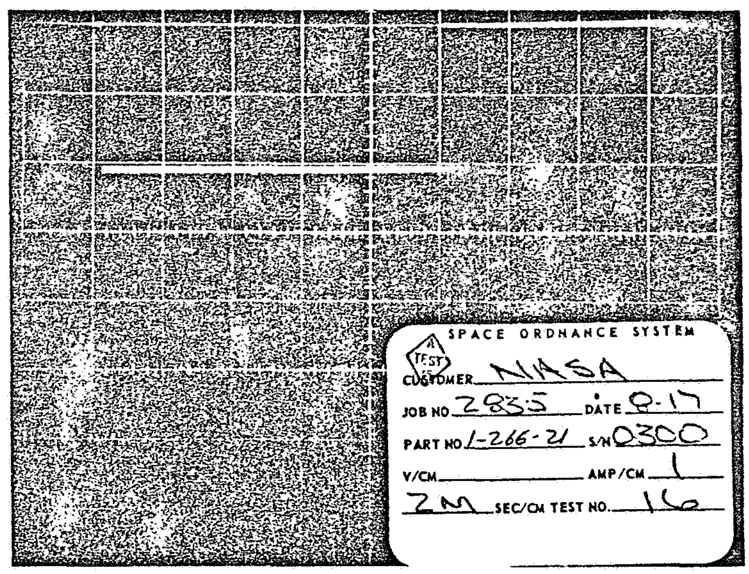

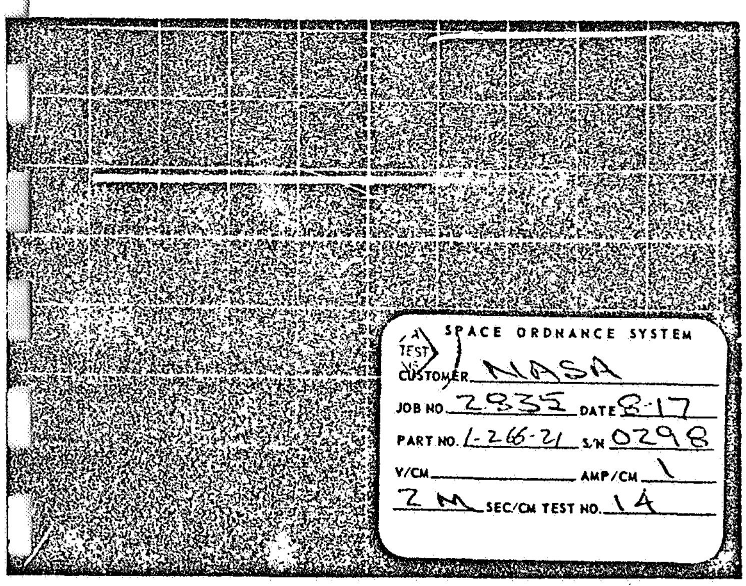

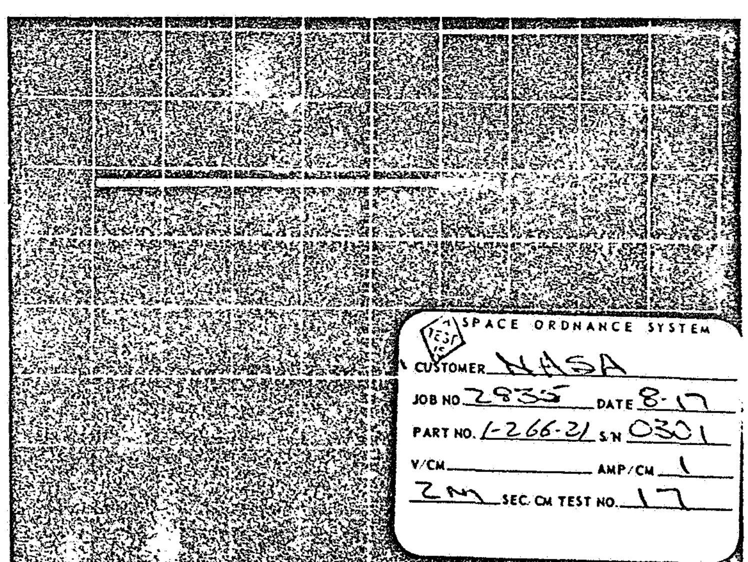

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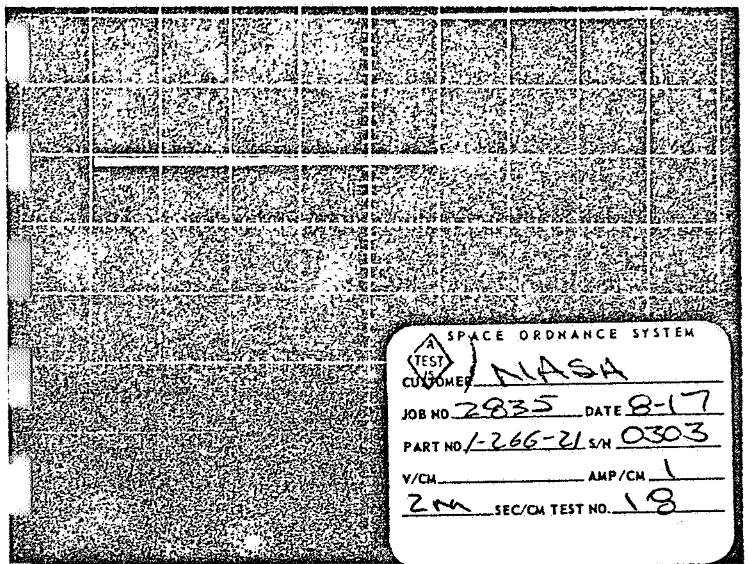

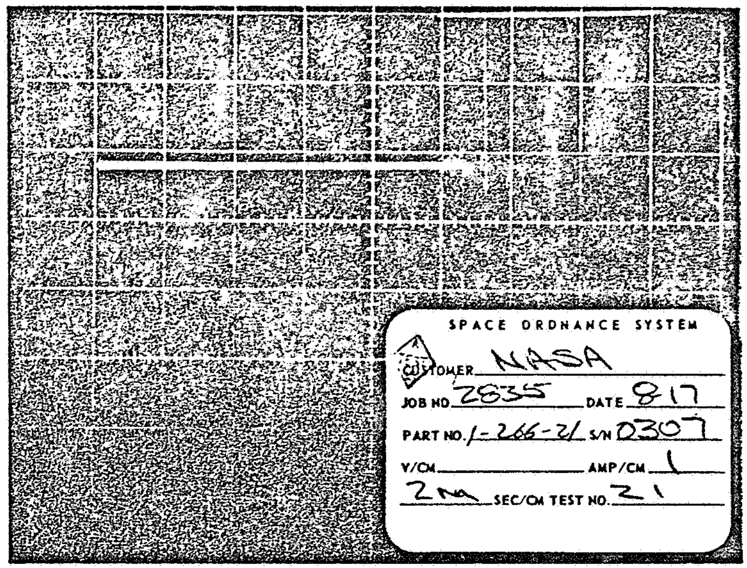

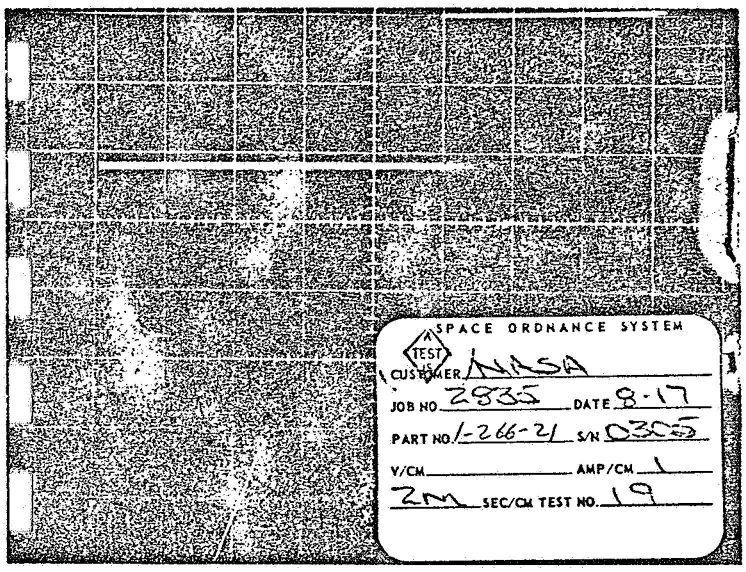

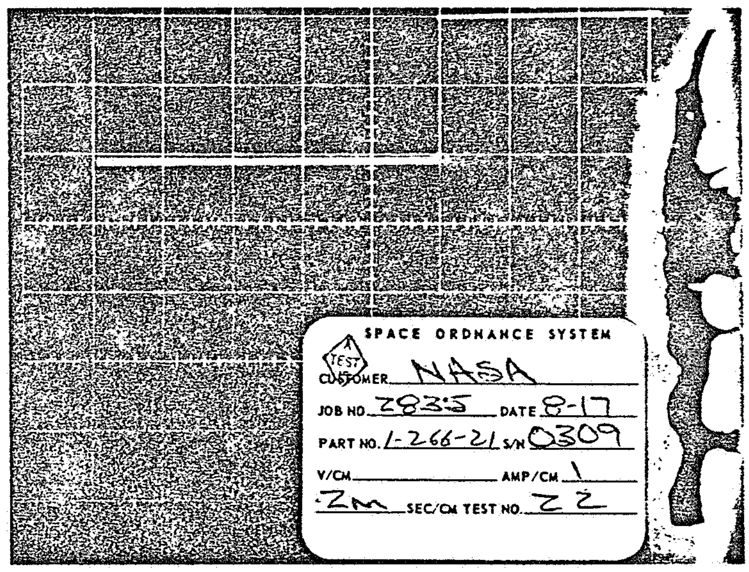

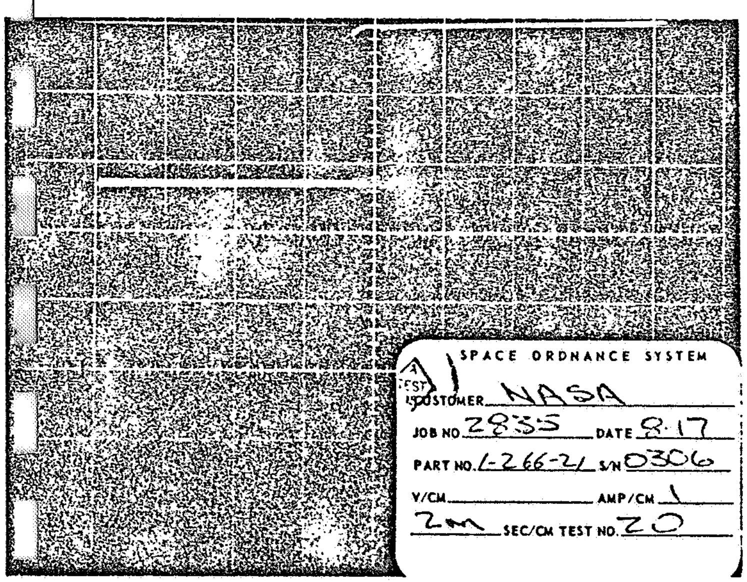

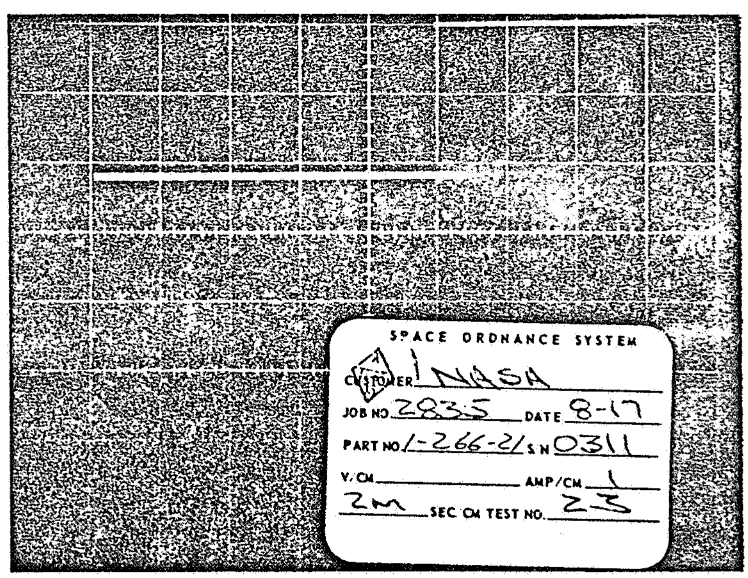

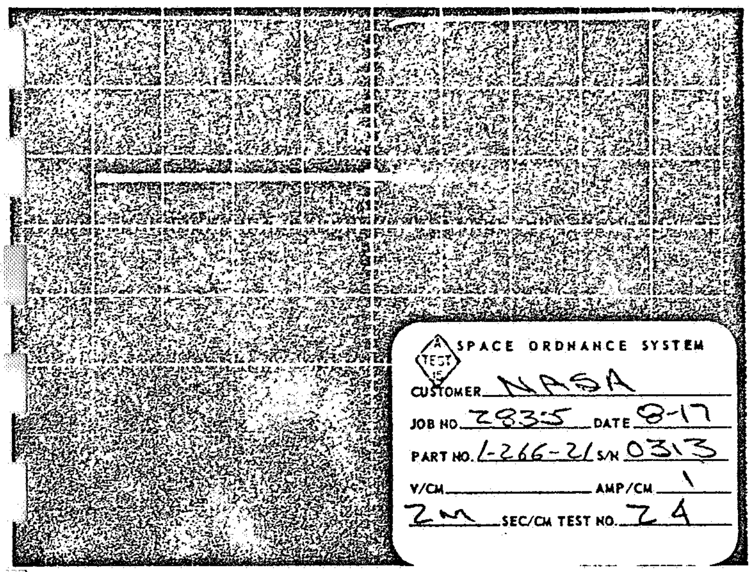
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JOB NO. 2835 DATE 8-17
PART NO. 1-266-21 S/N 0313
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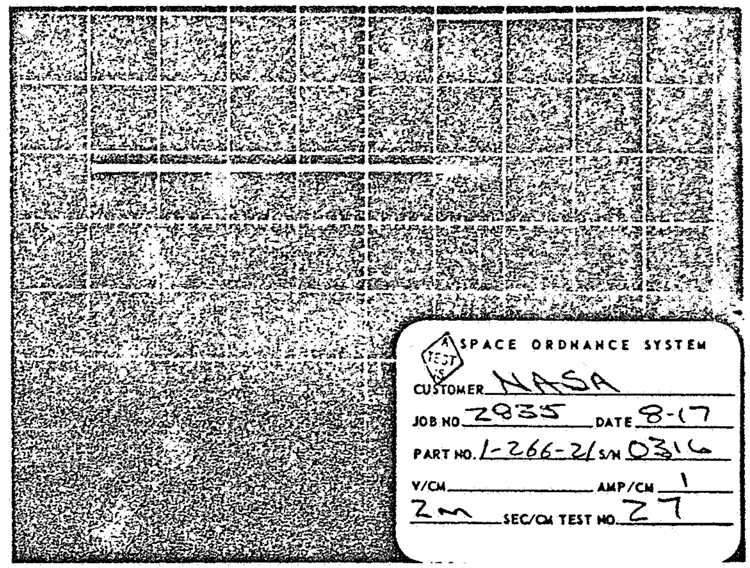
2m SEC/CM TEST NO. 24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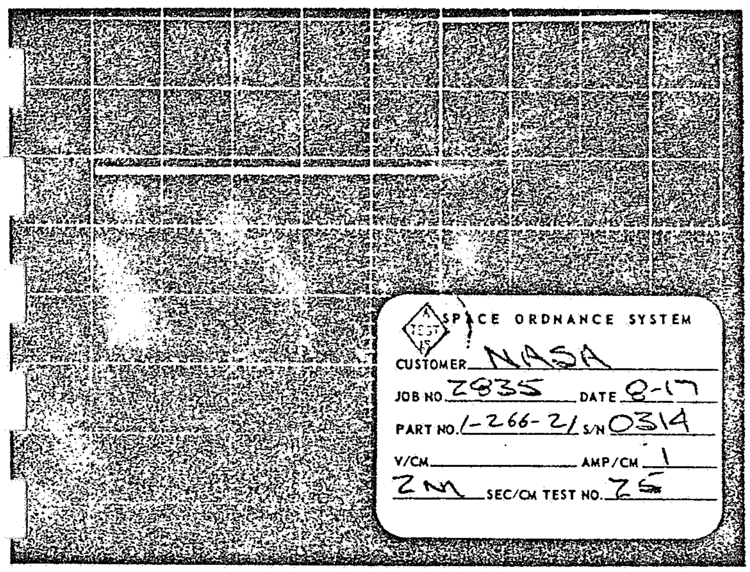
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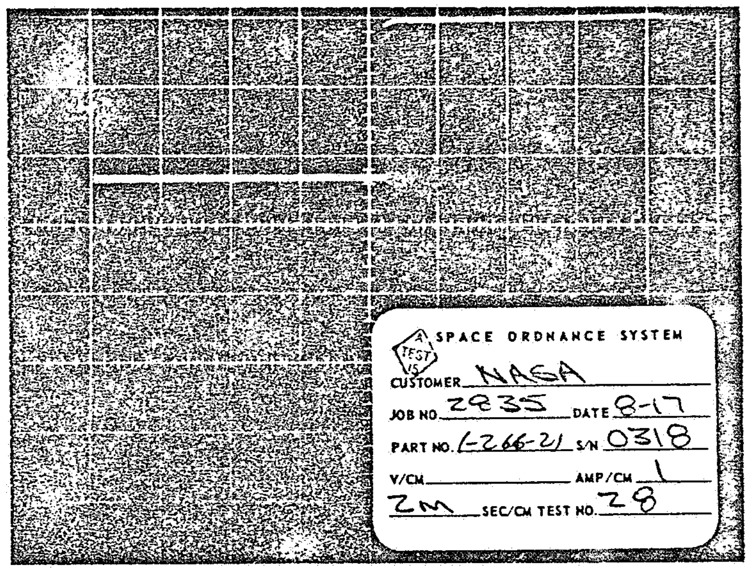
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JOB NO. 2835 DATE 8-17
PART NO. 1-266-21 S/N 0318
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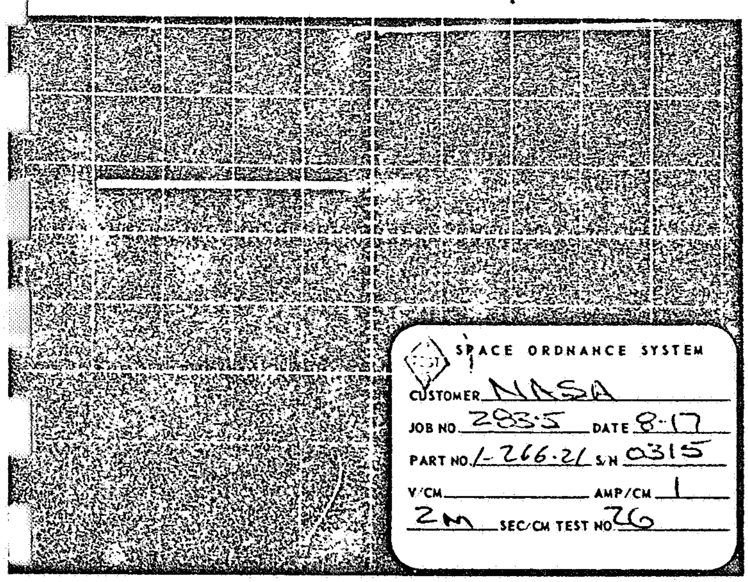
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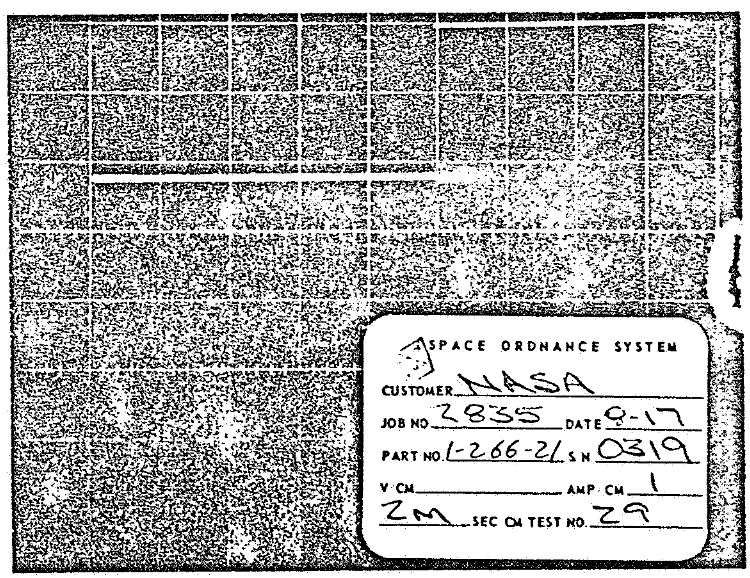
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JOB NO. 2835 DATE 8-17
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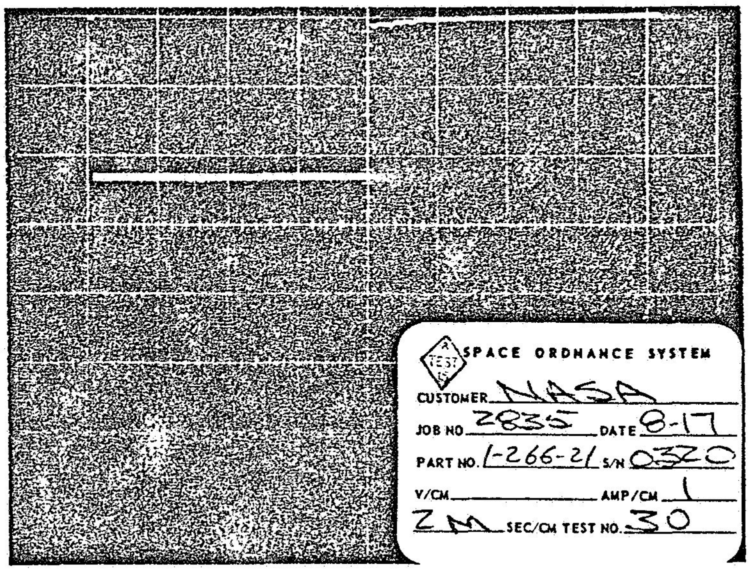
SPACE ORDNANCE SYSTEMS, INC.

26 July 1968



ACCEPTANCE TEST DATA SHEET

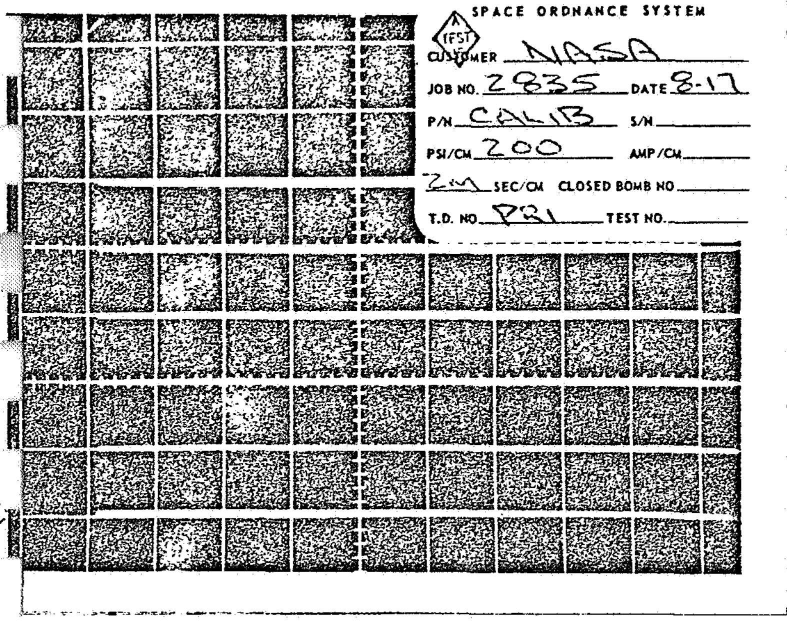
ITEM: INITIATOR (Non conductive mix) CUSTOMER P/N: N/A
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471
SOS JOB NO. 2835
TOTAL ACCEPT REJECT

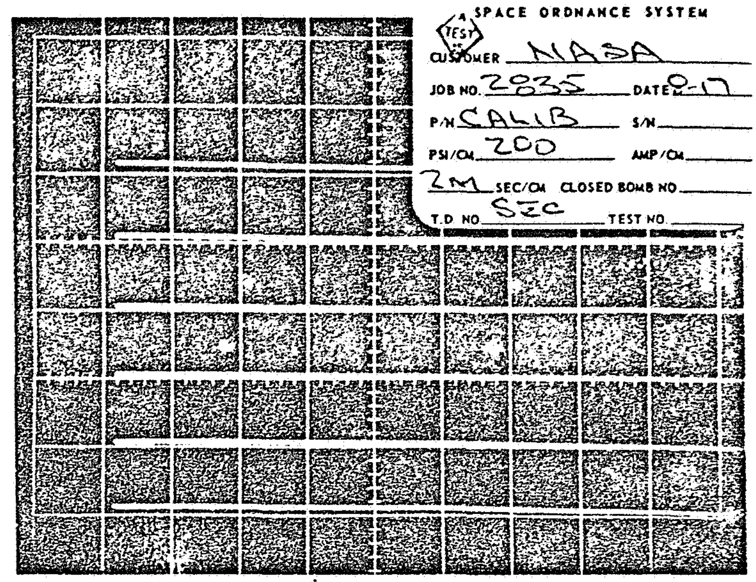
ITEM COUNT	MEMBER NUMBER (CODE SERIAL LOT)	Bridgewire to be fired. A-B or C-D	Circuit Resistance. Ohms	Firing Curent. Amps.	Post-Fire Current Leakage. 50 ma Max. Pin A to B	Pin C to D	Pins AB to CD	All Pins shorted to Case	Function Time 10 ms Max. Current application to peak press.	Peak Press. 525 to 775 psig.	Conditioned Temperature Degs. F.	
1	0290 BRR	A-B	1.15	3.5	<1	<1	<1	<1	3.3	760	AMB	
2	0262	A-B	1.09	3.5	<1	.06	<1	<1	10.1	800		
3	0285	A-B	1.14	3.5	<1	<1	<1	<1	3.3	800		
4	0299	A-B	1.10	3.5	<1	<1	<1	<1	3.1	780		
5	0296	A-B	1.11	3.5	<1	<1	.15	<1	2.8	710		
6	0267	A-B	1.18	3.5	<1	<1	<1	<1	8.0	790		
7	292 0282	A-B	1.14	3.5	<1	<1	<1	<1	3.3	740		Idenity Misread
8	0287	A-B	1.12	3.5	<1	<1	<1	<1	3.0	810		
9	0250	A-B	1.10	3.5	<1	<1	<1	<1	8.0	770		
10	0283	A-B	1.08	3.5	<1	<1	<1	<1	3.1	710		
11	0263	A-B	1.19	3.5	<1	<1	<1	<1	7.7	730		
12	0255	A-B	1.10	3.5	<1	<1	<1	<1	10.7*	670		* Re-Read @ 10.2 MS.
13	0264	A-B	1.18	3.5	<1	1.5	1	1.5	8.7	710		
14	0258 BRR	A-B	1.11	3.5	<1	<1	<1	<1	8.7	710	AMB	
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
	TEST TECH (INITIAL)											APPROVAL SIGNATURES
	DATE	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	8/18/67	
STAMPS	WITNESS (SOS)	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	TEST 15	Richard Powell
	WITNESS (CUSTOMER)											
	WITNESS (GOVT.)											

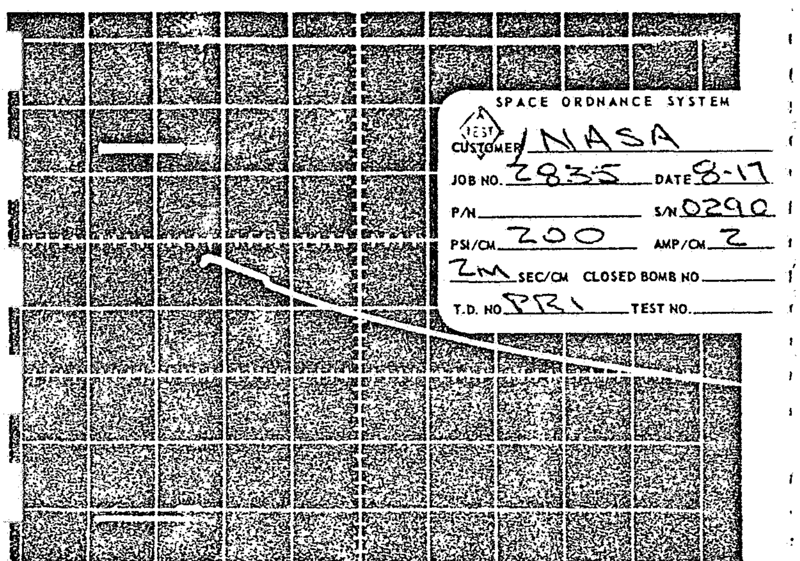
ITEM: INITIATOR (Non conductive mix) CUSTOMER P/N: N/A SOS JOB NO. 2835
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A TOTAL ACCEPT REJECT
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471

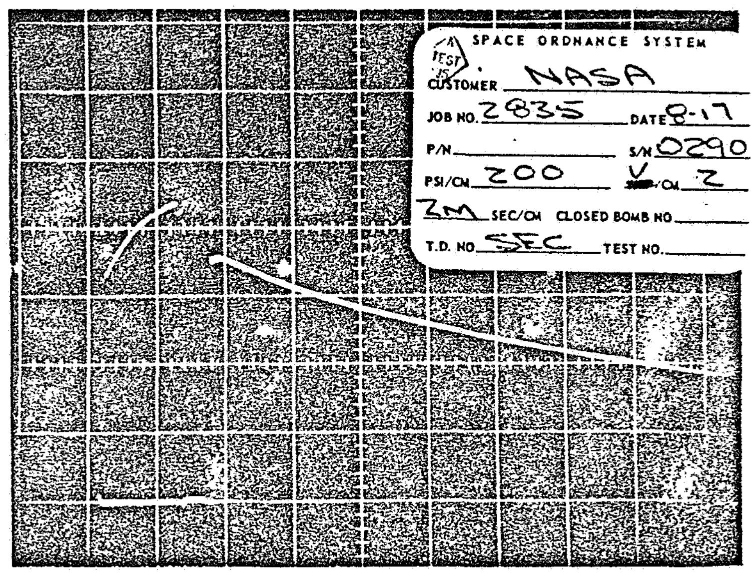
ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	Bridgewire to be fired. A-B or C-D	Circuit Resistance. Ohms	Firing Curent. Amps	Post-Fire Current Leakage. 50 ma Max. Pin A to B	Pin C to D	Pins AB to CD	All Pins shorted to Case	Function Time 10 ms Max. Current application to peak press.	Peak Press. 525 to 775 psig.	Conditioned Temperature Degs. F.	
1	0314 BRR	C-D	1.07	3.5	<1	<1	<1	<1	3.2	710	AMB	
2	0273		1.14		<1	<1	<1	<1	10.5	790		
3	0303		1.04		<1	<1	<1	<1	2.8	720		
4	0305		1.11		<1	<1	<1	<1	2.6	690		
5	269 ~~0289~~		1.17		<1	<1	<1	<1	8.6	660		Identity Mis Read
6	0311		1.08		1.5	<1	3	<1	3.2	720		
7	0277		1.24		<1	<1	<1	<1	9.7	670		
8	0268		1.08		<1	<1	<1	<1	8.1	680		
9	0263		1.12		<1	<1	<1	<1	8.7	680		
10	316 ~~0315~~		1.08		<1	<1	<1	<1	2.9	710		Identity Mis Read.
11	0280		1.18		<1	<1	<1	<1	11.1	660		
12	0275		1.16		<1	<1	<1	<1	7.9	680		
13	0279		1.14		<1	<1	<1	<1	9.6	700		
14	0309		1.09		<1	<1	<1	<1	2.6	690		
15	0300	C-D	1.16	3.5	<1	<1	<1	<1	3.1	710		
16	0319 BRR	C-D	1.10	3.5	<1	<1	<1	<1	2.5	700	AMB	
17												
18												
19												
20												
21												
22												
23												
24												
25												
	TEST TECH (INITIAL)											APPROVAL SIGNATURES
	DATE	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	9/18/67	
STAMPS	WITNESS (SOS)	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	Richard Powell
	WITNESS (CUSTOMER)											
	WITNESS (GOVT.)											

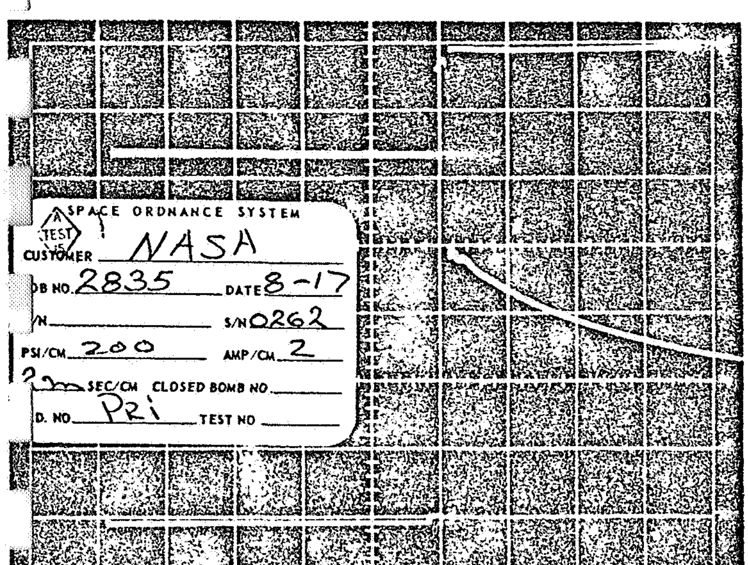
SPACE ORDNANCE SYSTEMS, INC.

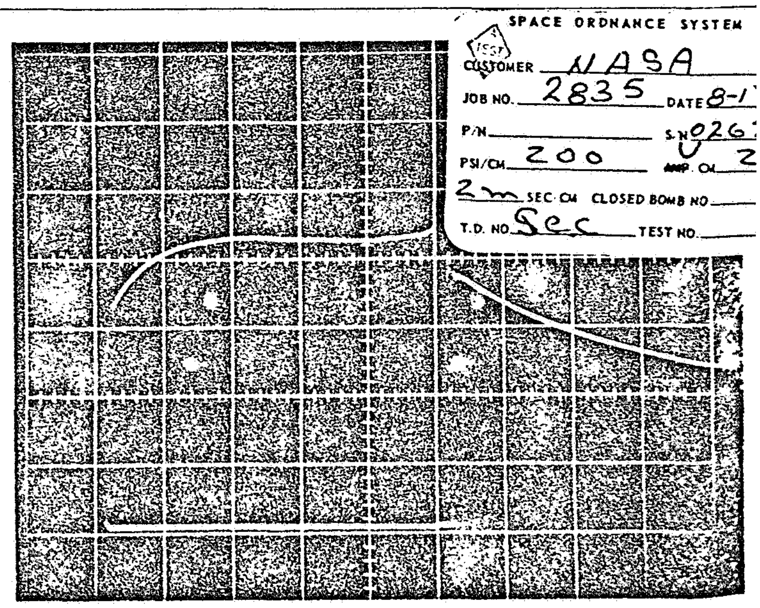






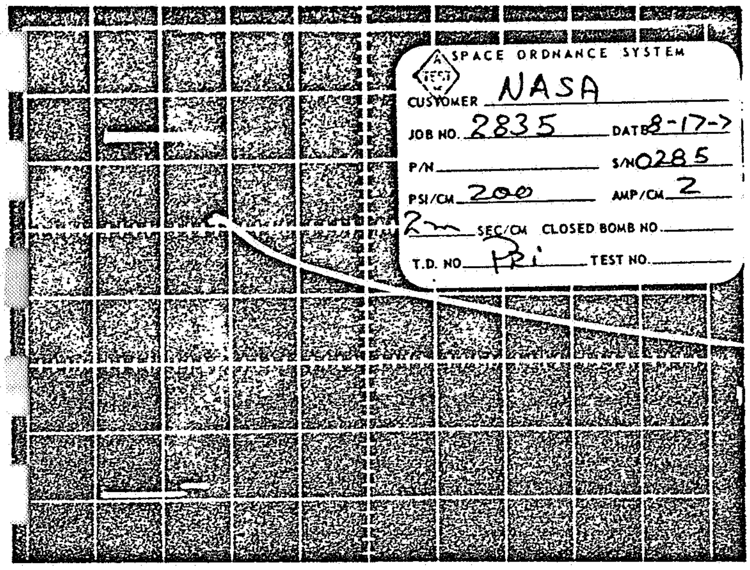


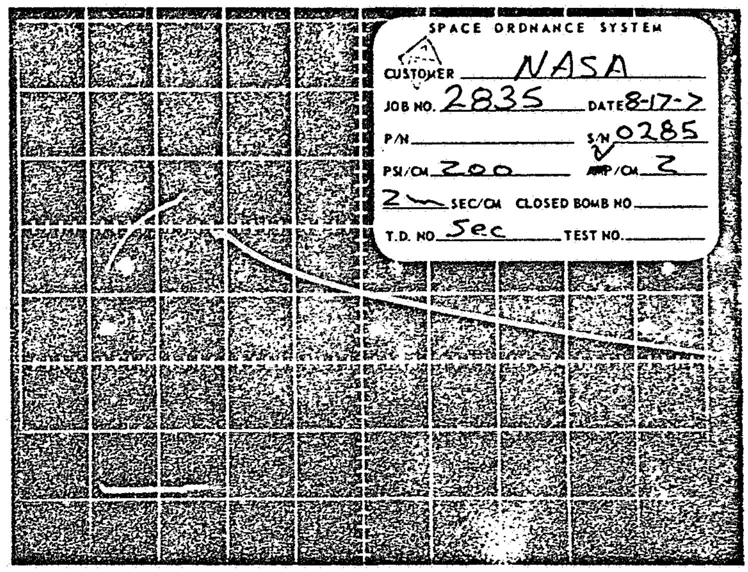


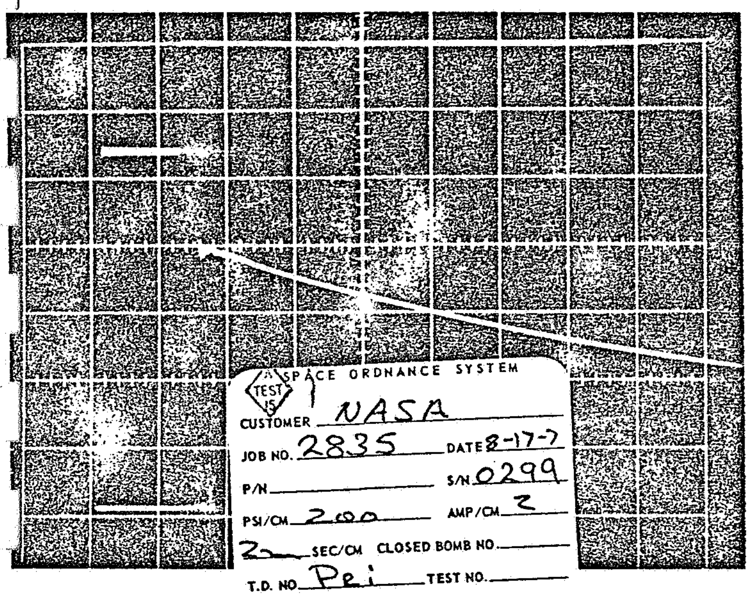


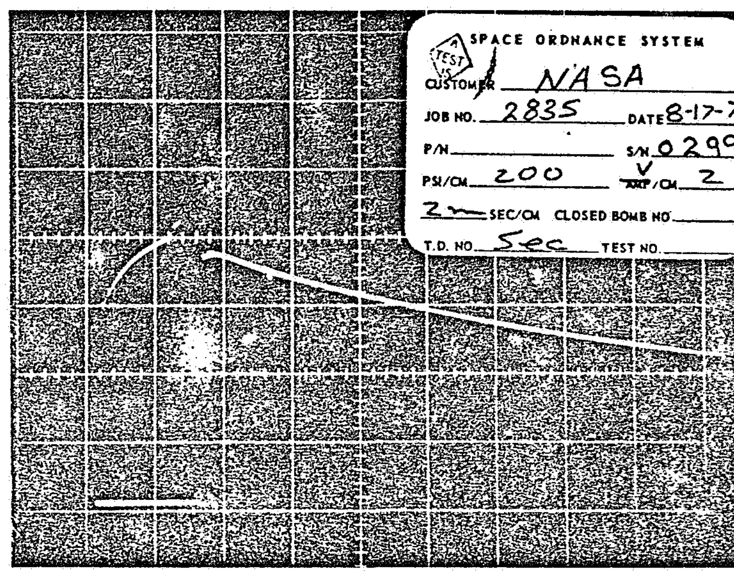
SPACE ORDNANCE SYSTEMS, INC.

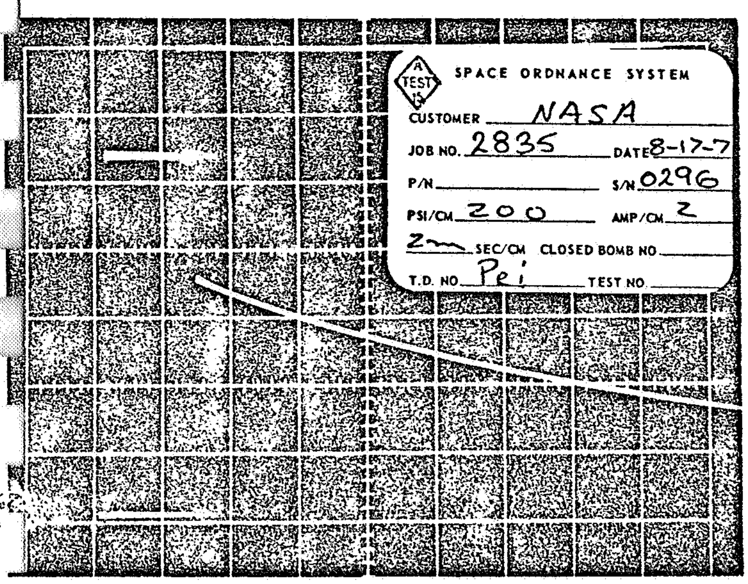
26 July 1968

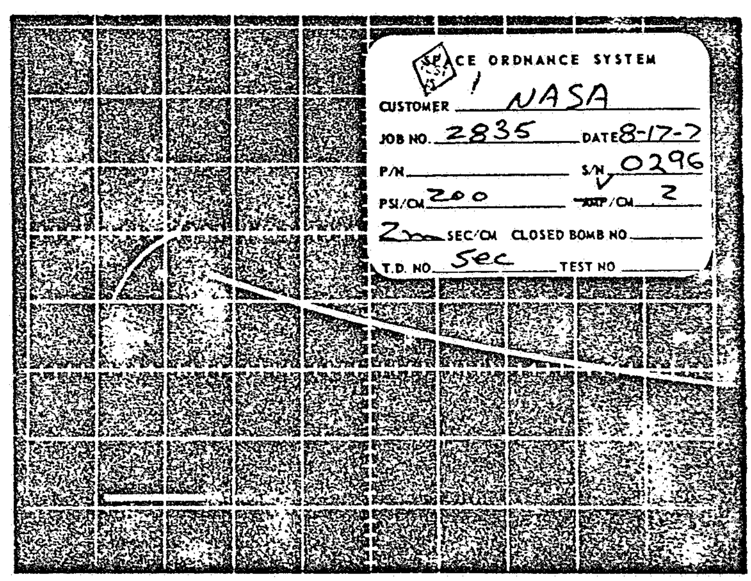












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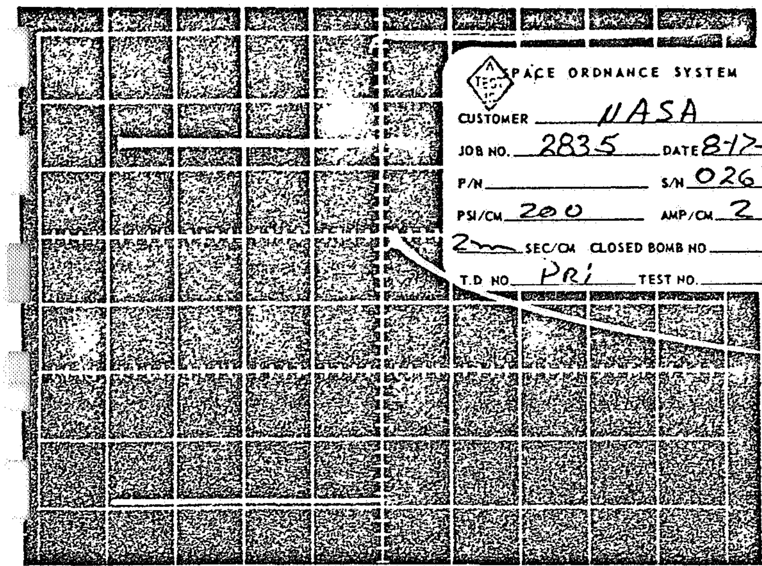

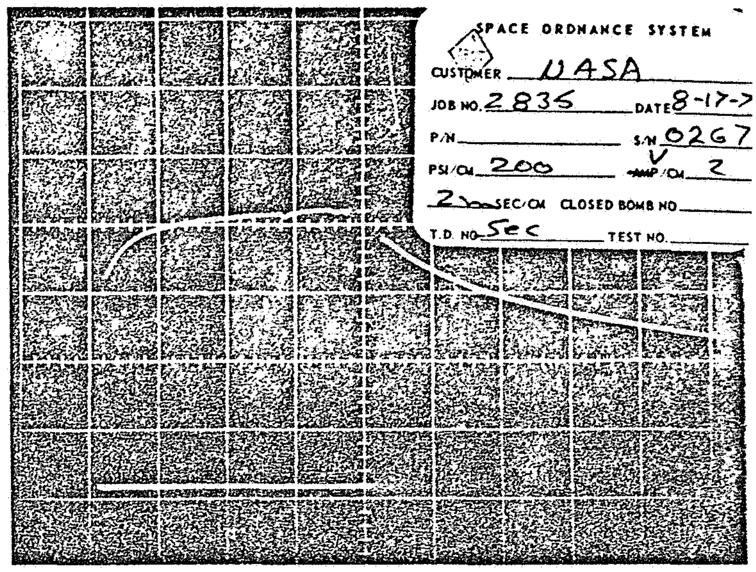

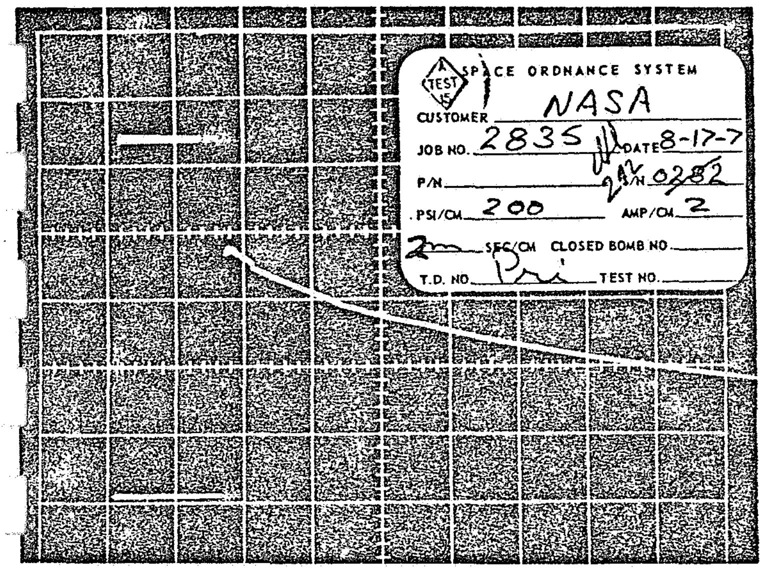

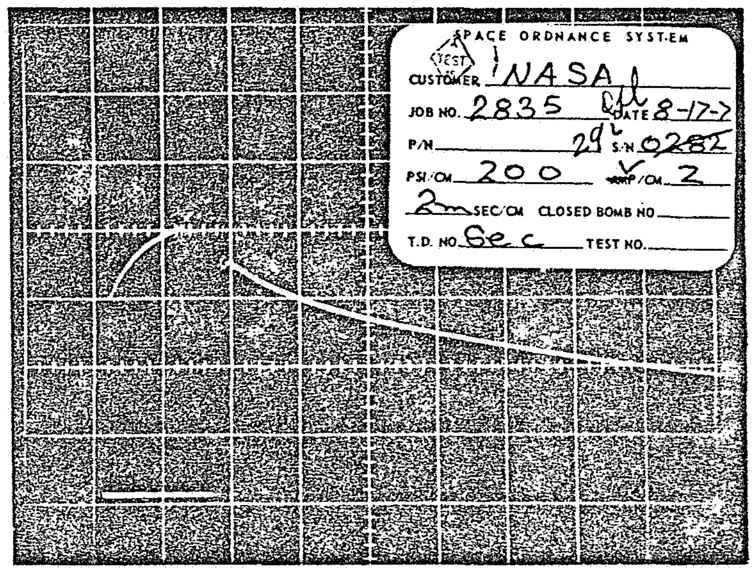

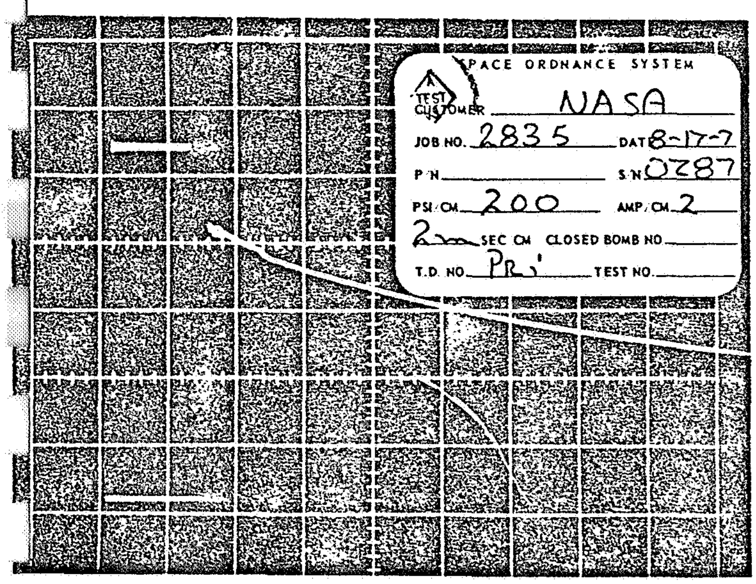

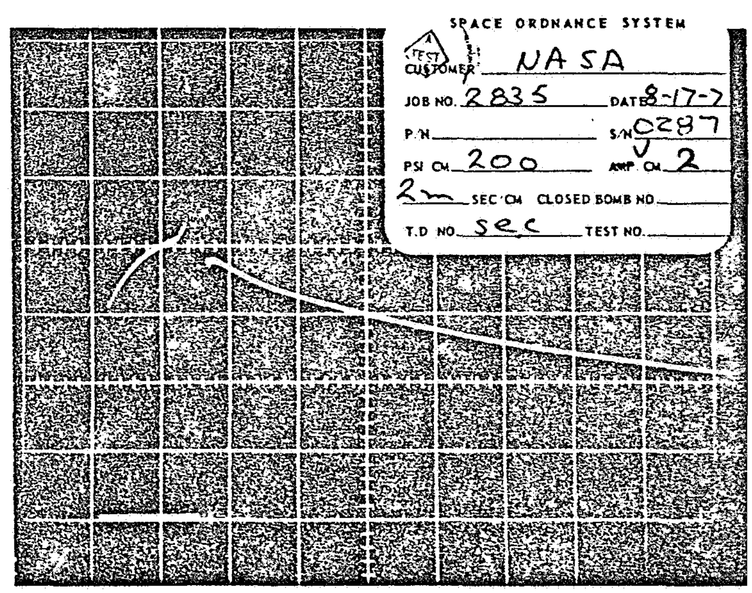

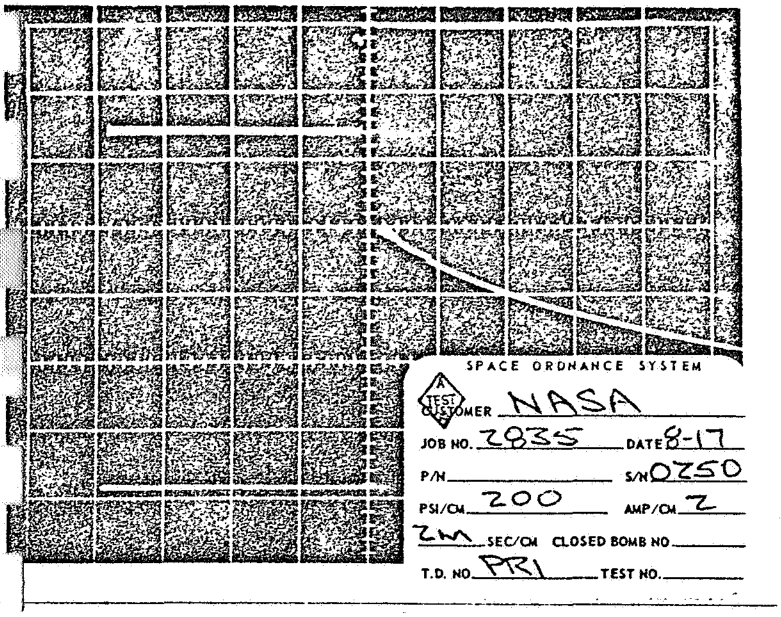
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JOB NO. 2835 DATE 8-17
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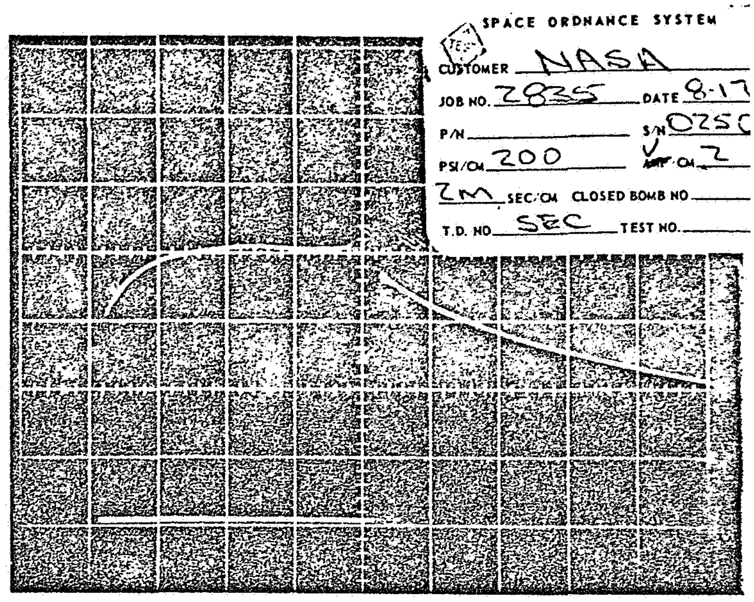
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CUSTOMER NASA
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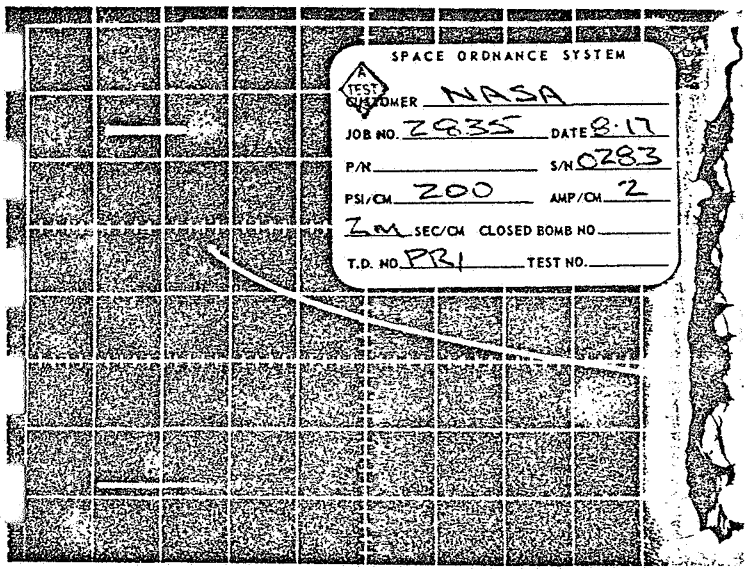
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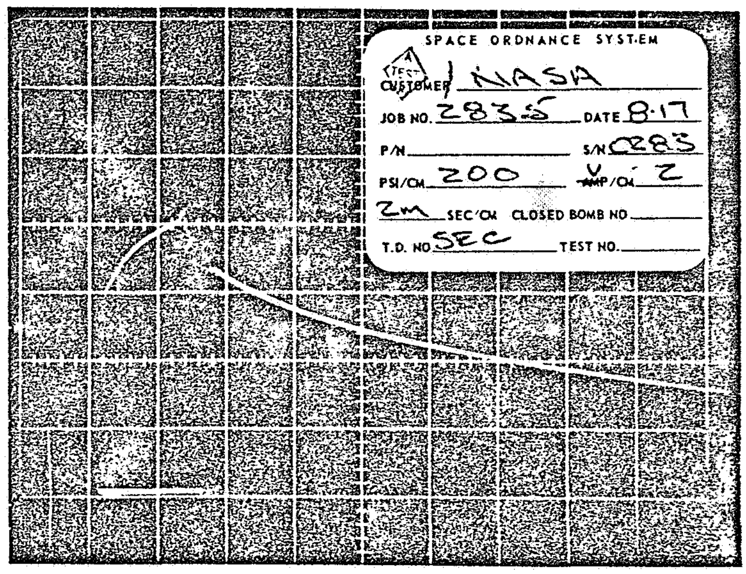
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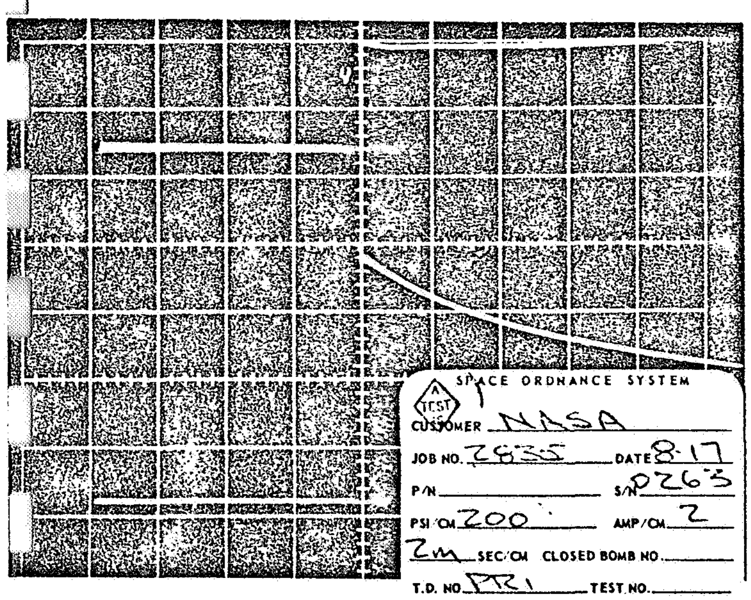
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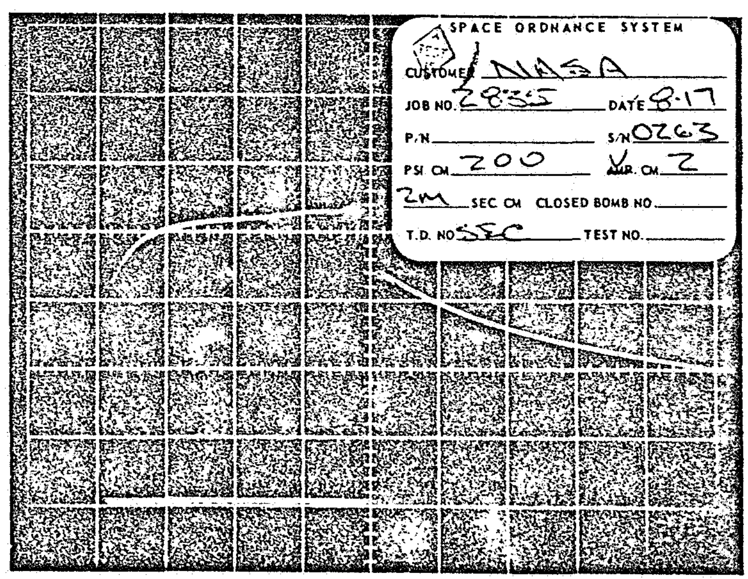
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JOB NO. 2835 DATE 8-17
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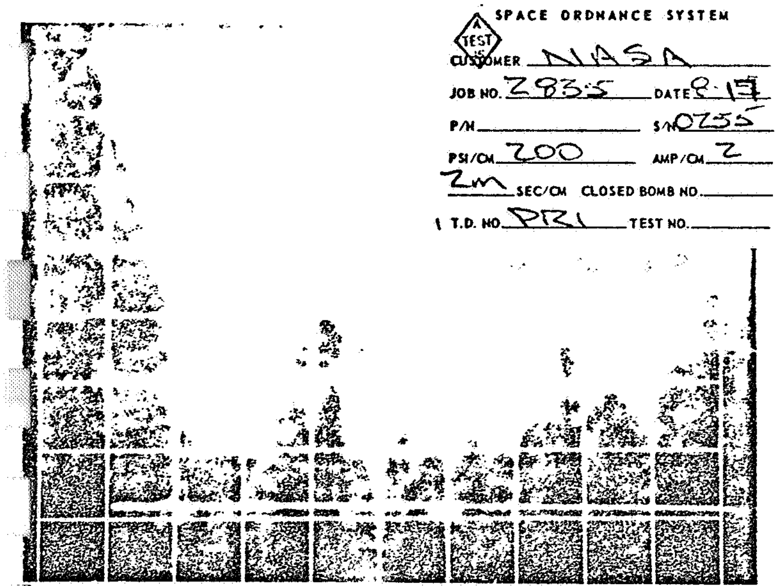

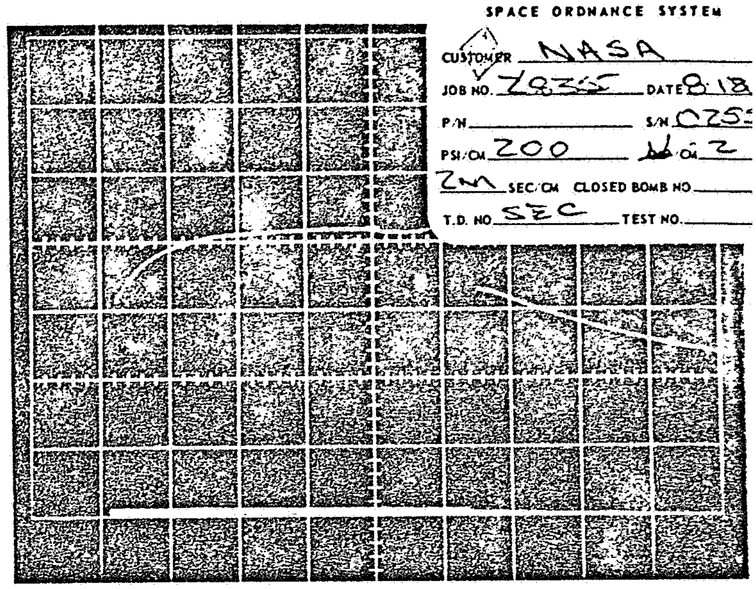

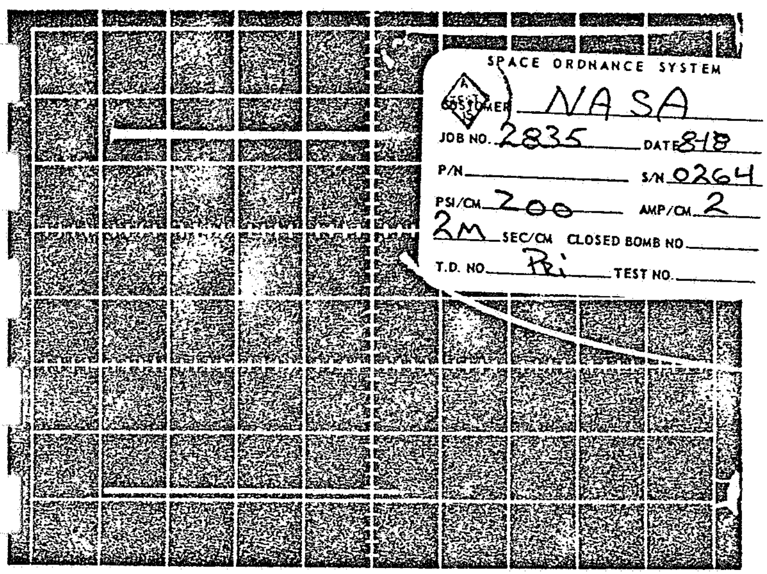

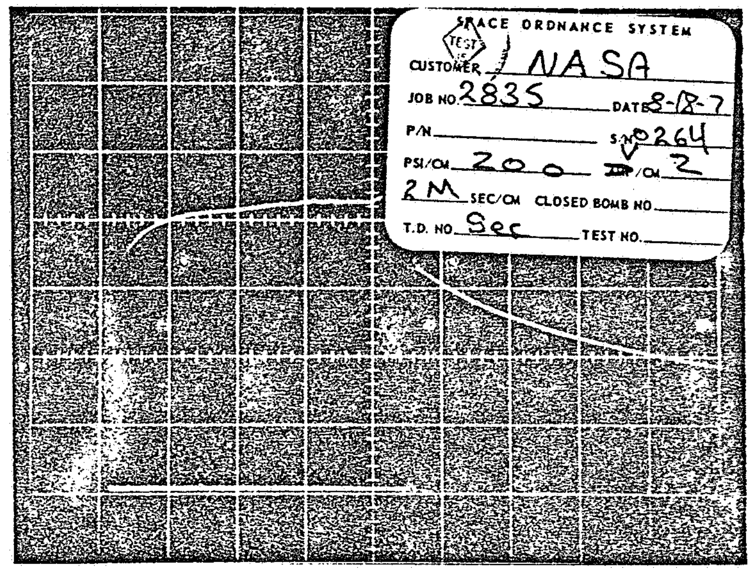

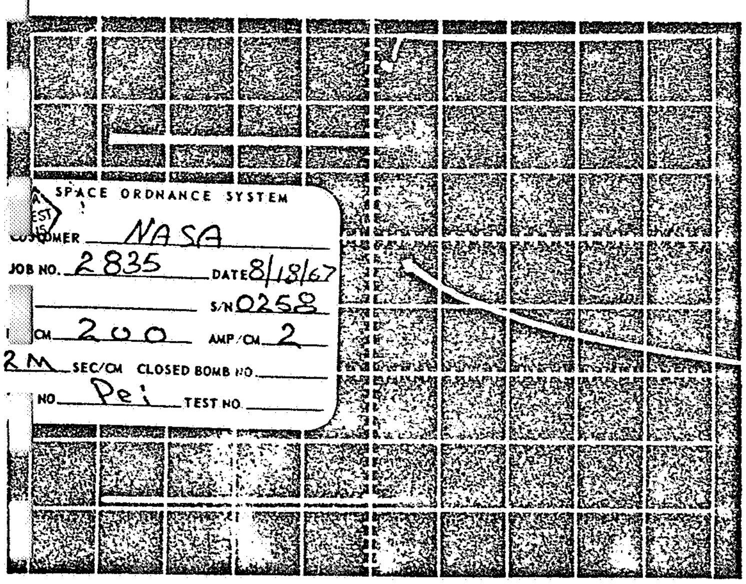

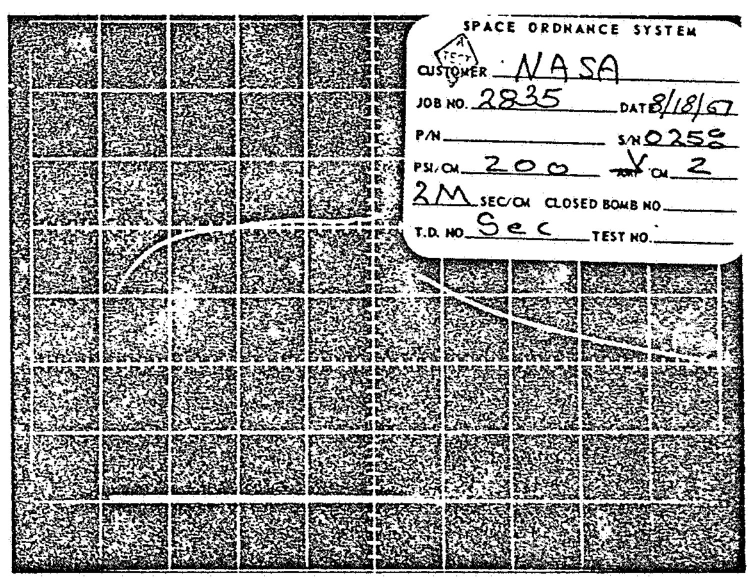

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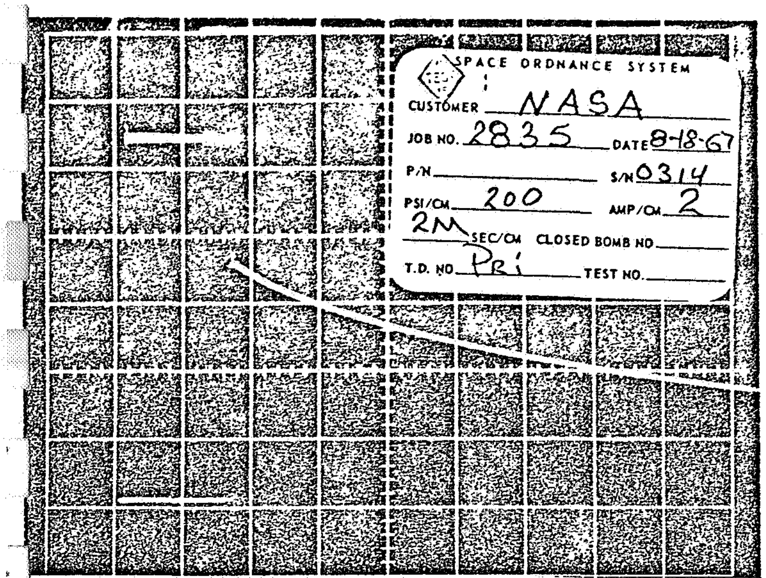

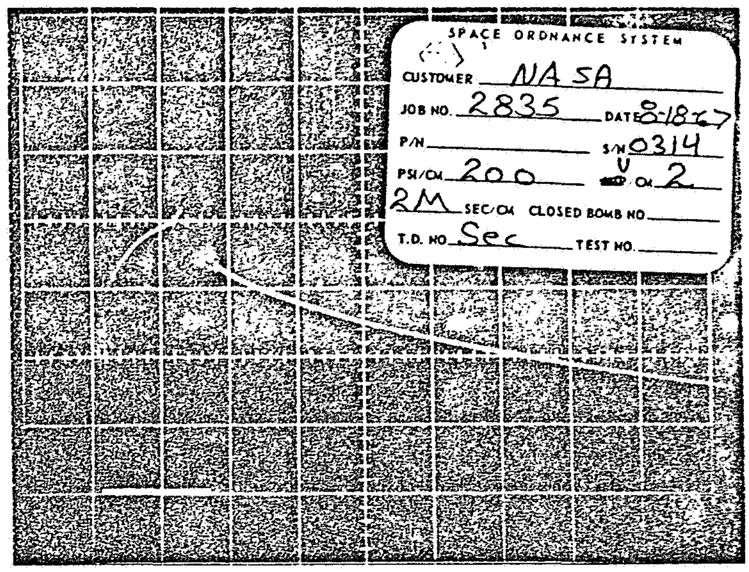

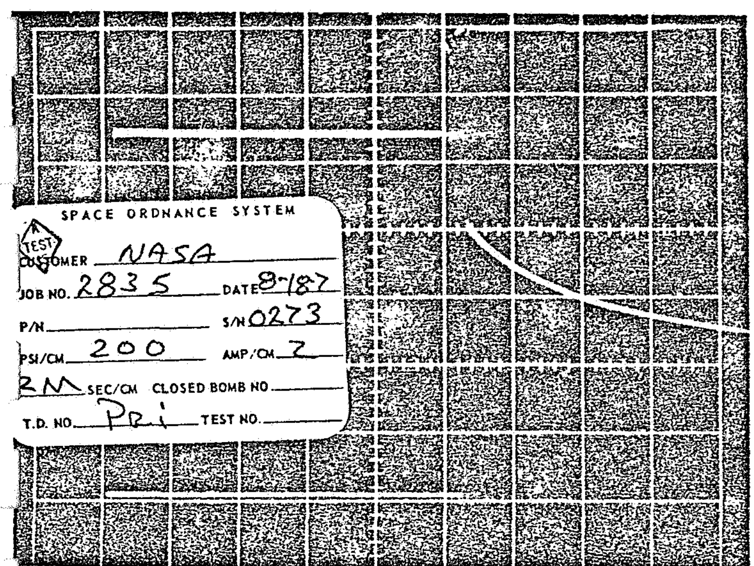

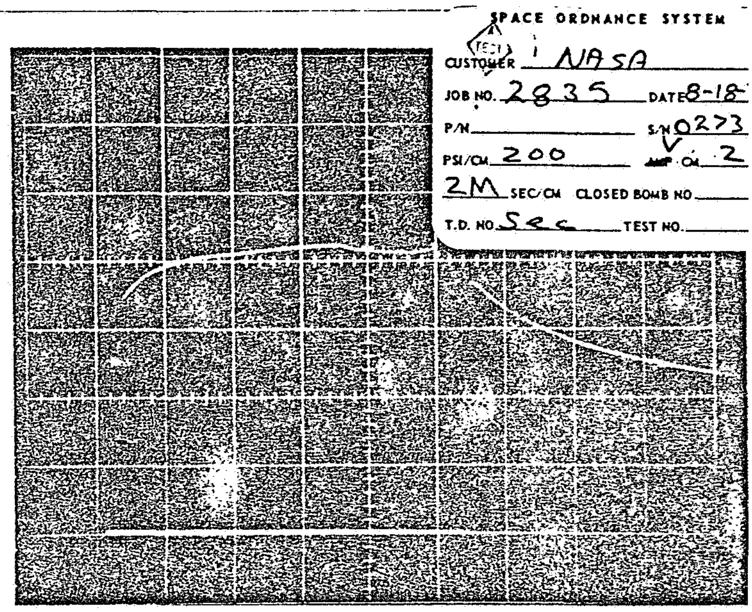

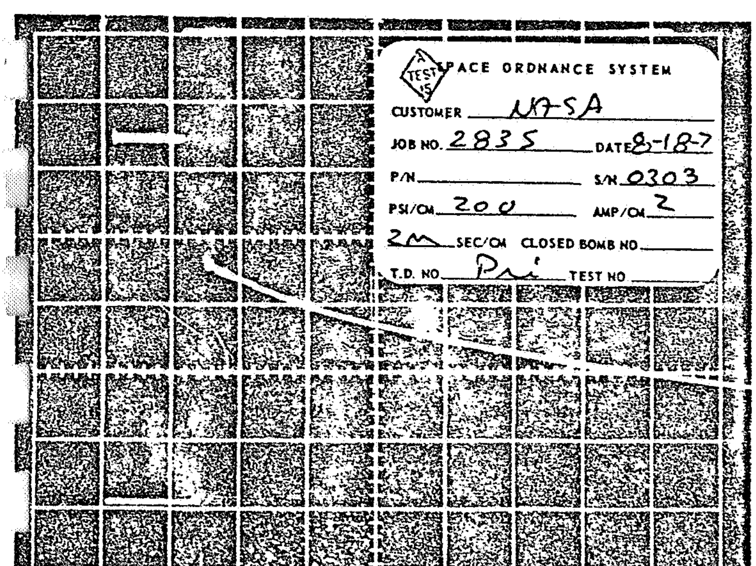

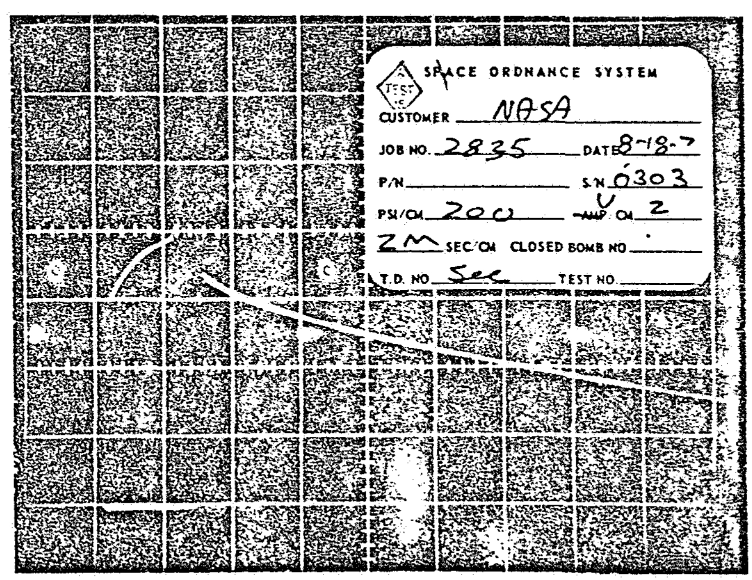

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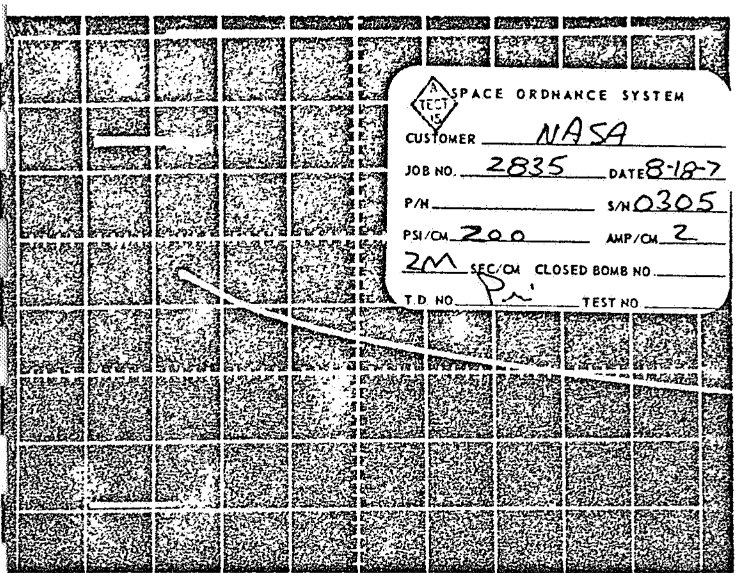
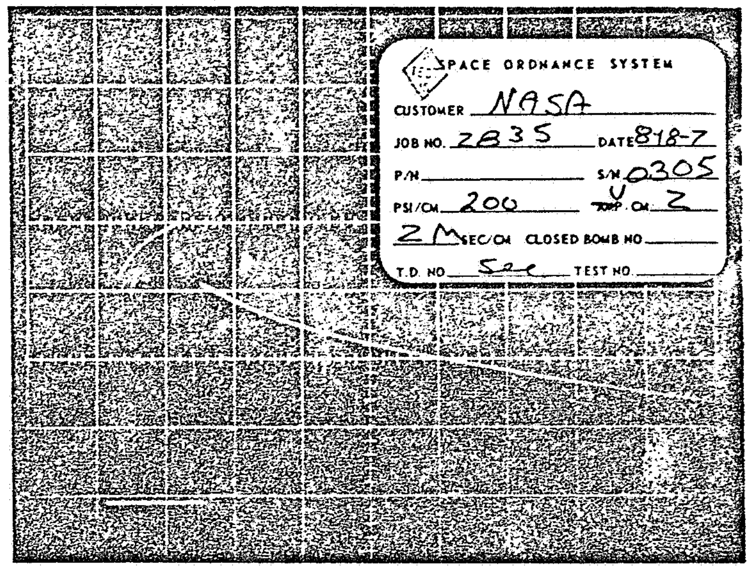
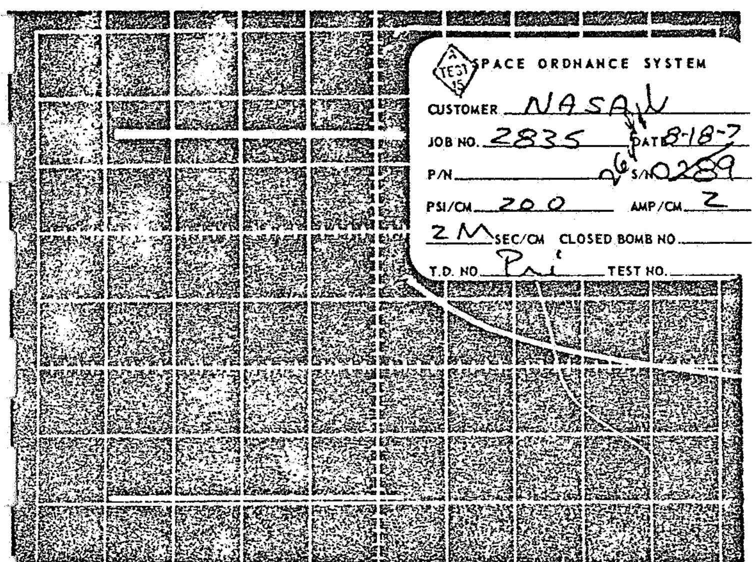
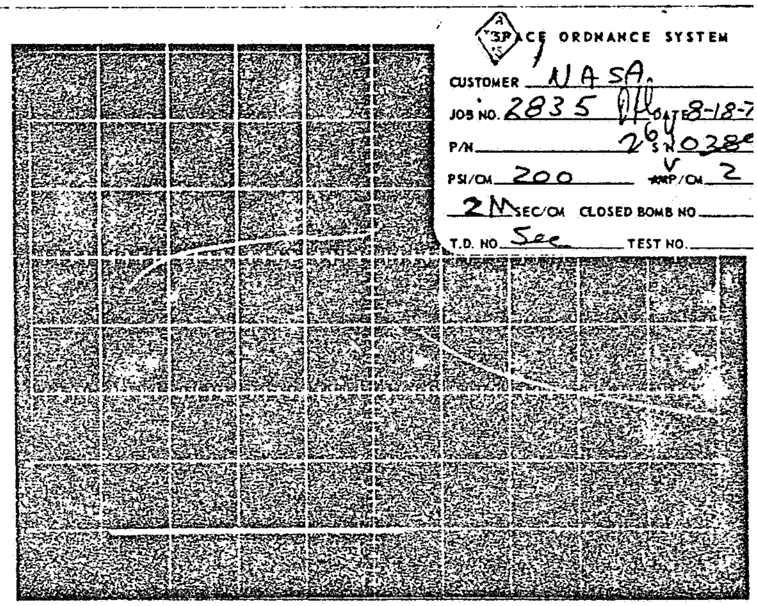
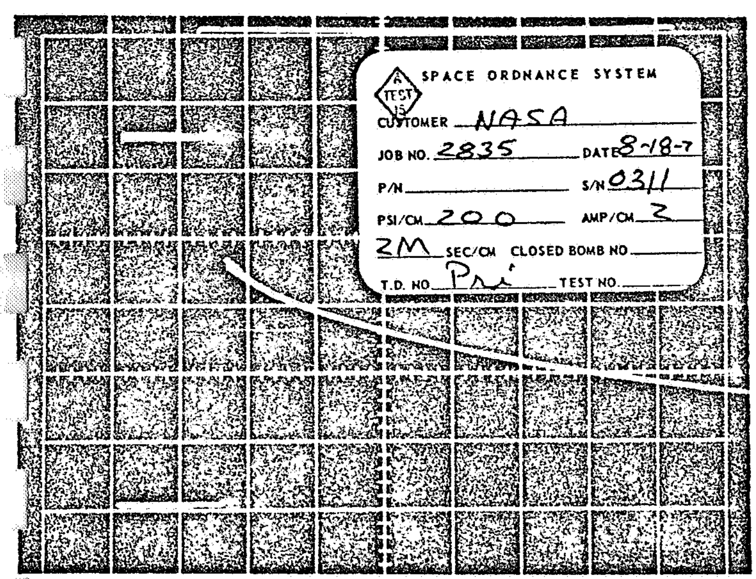
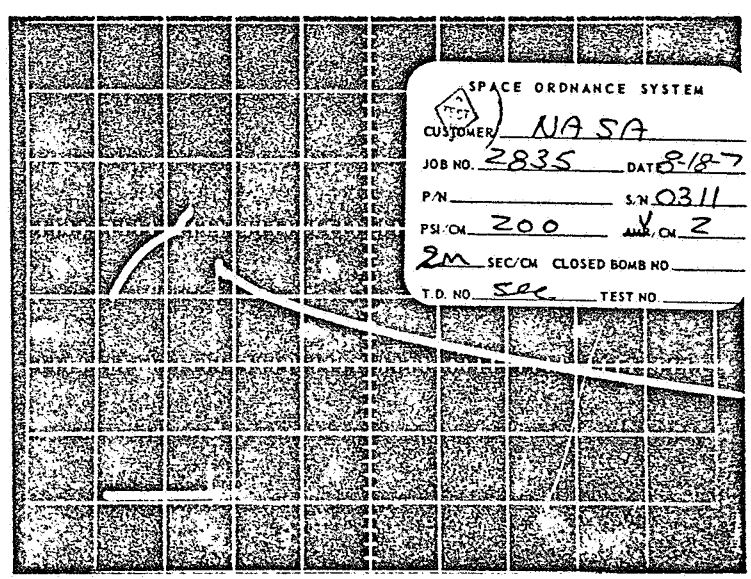




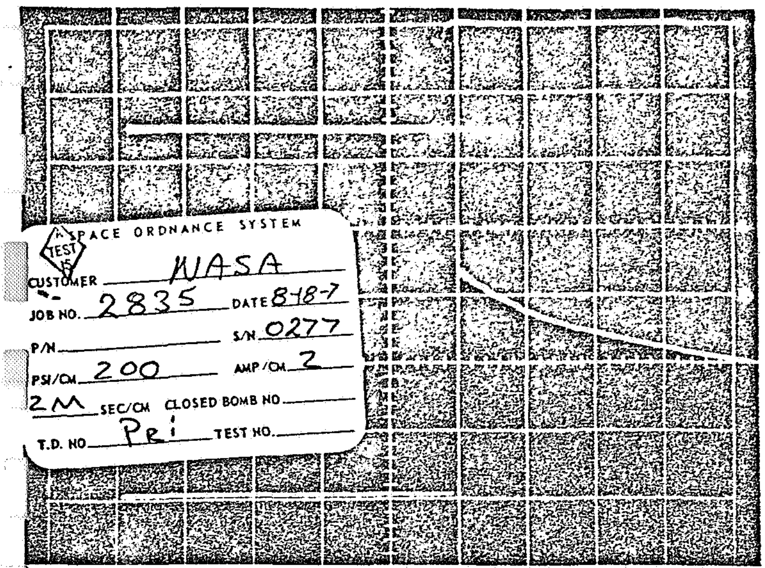


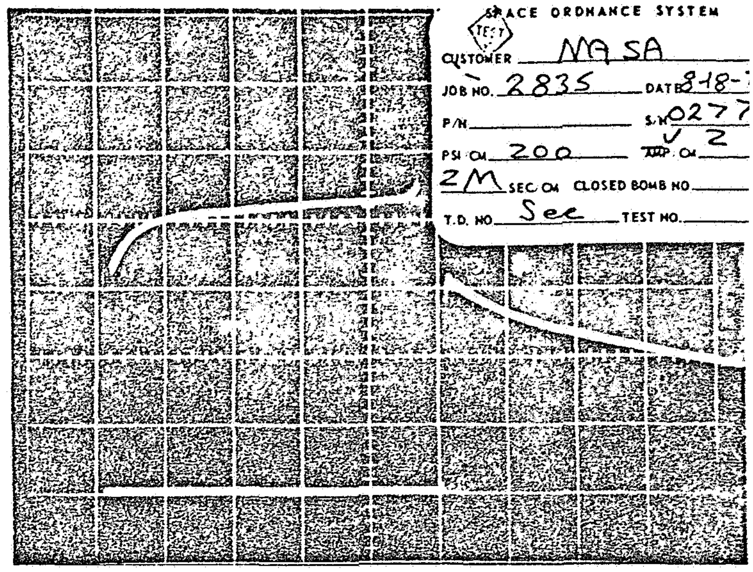


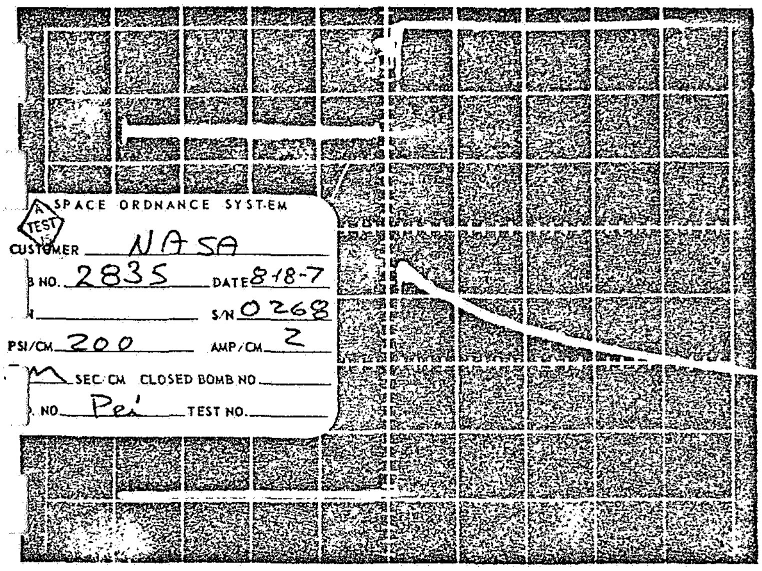


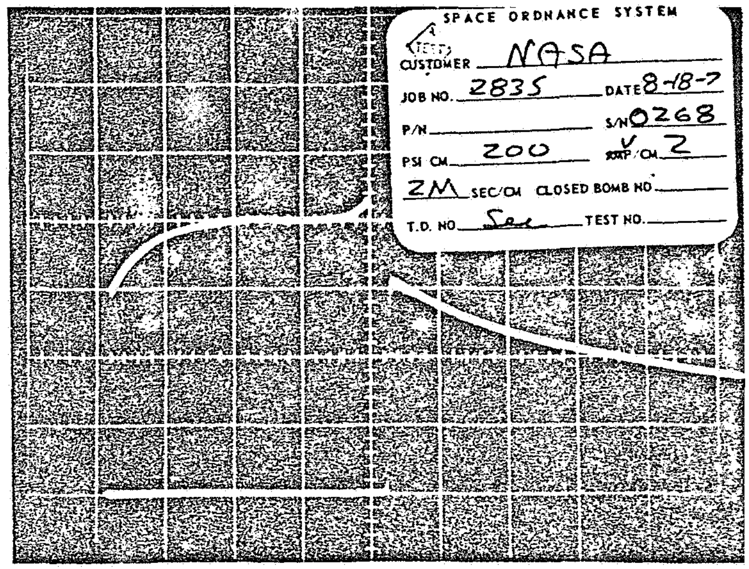


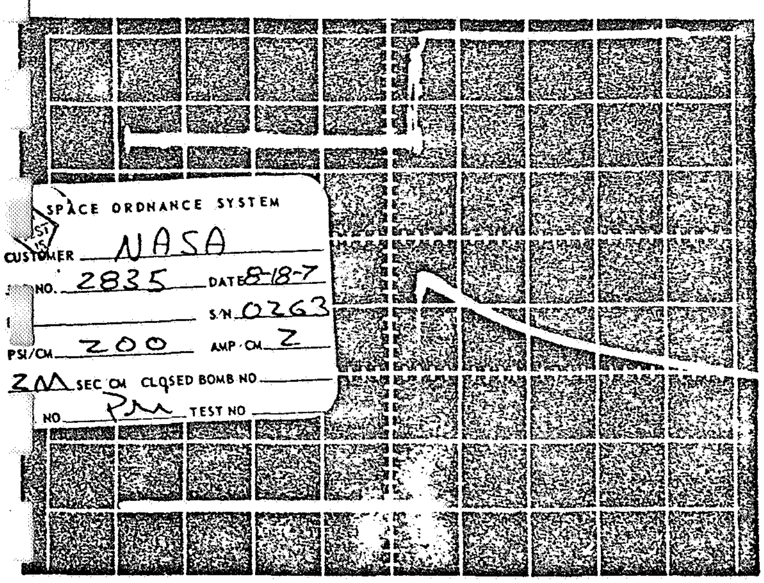
SPACE ORDNANCE SYSTEMS, INC.

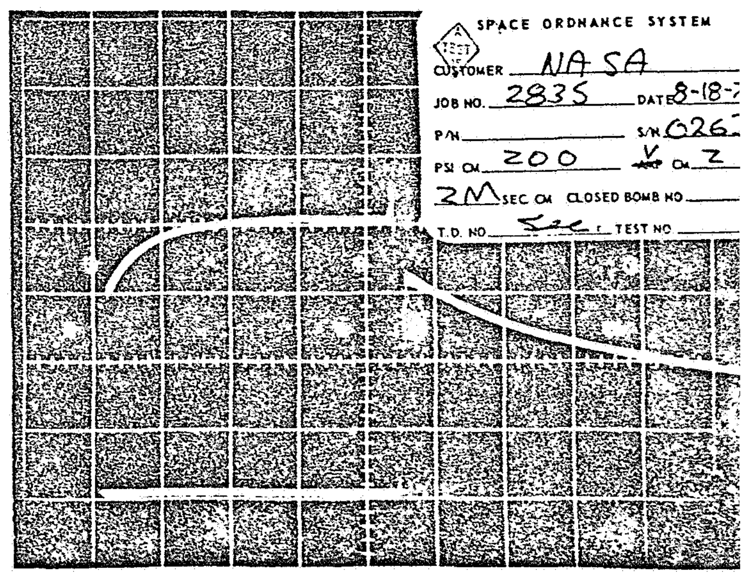




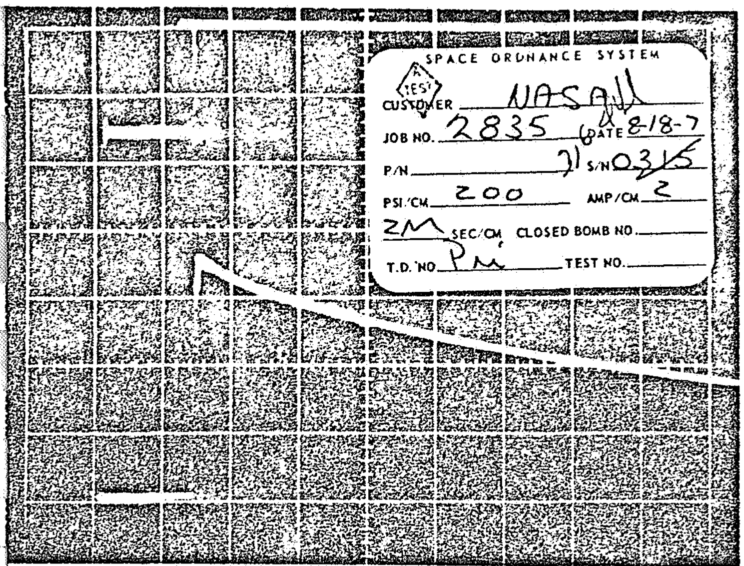


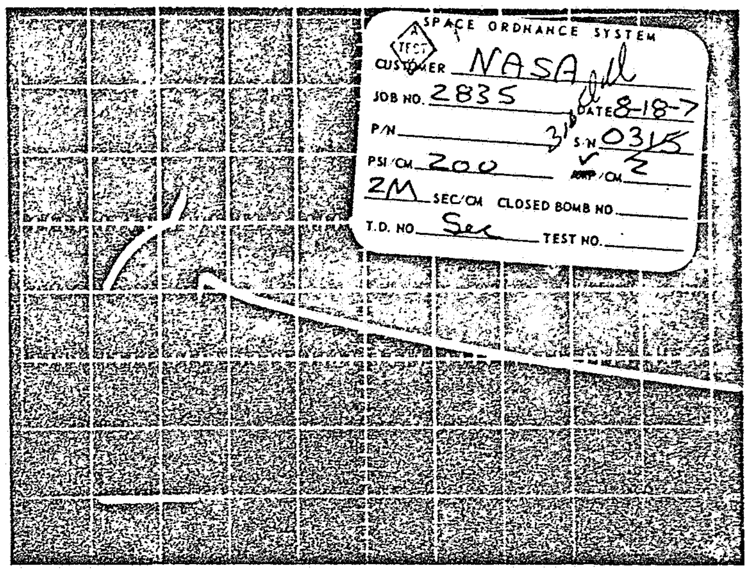


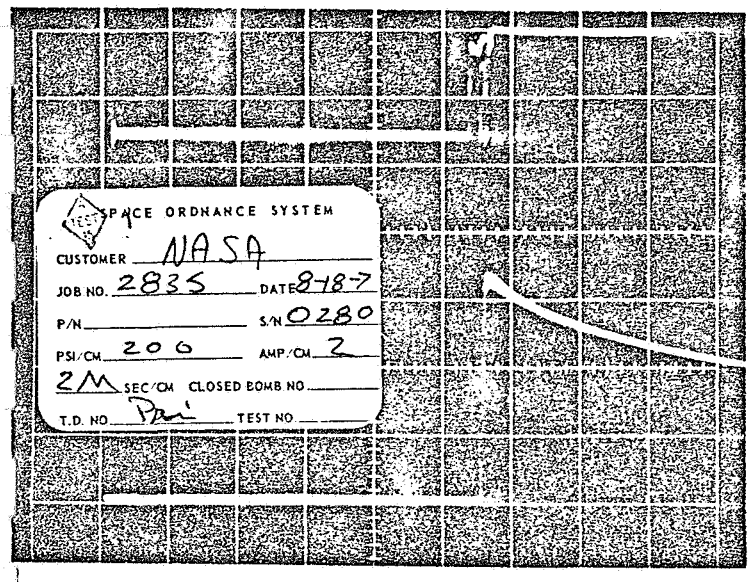


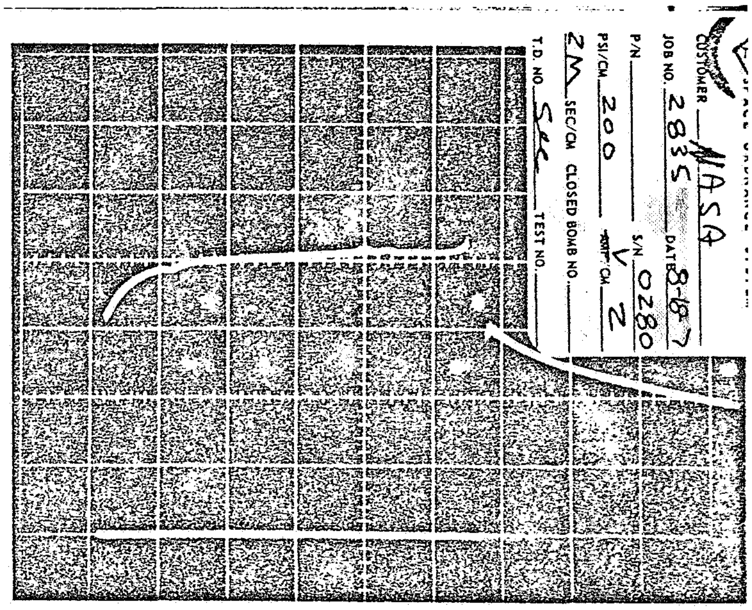


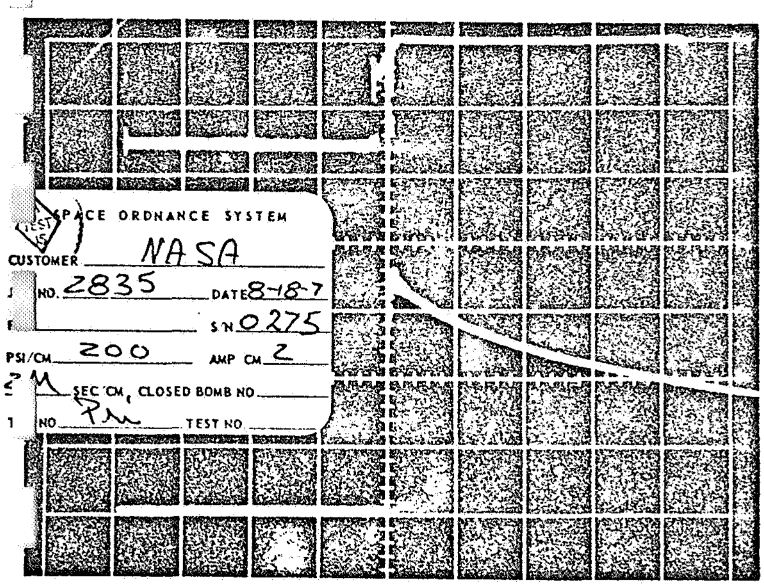
SPACE ORDNANCE SYSTEMS, INC.

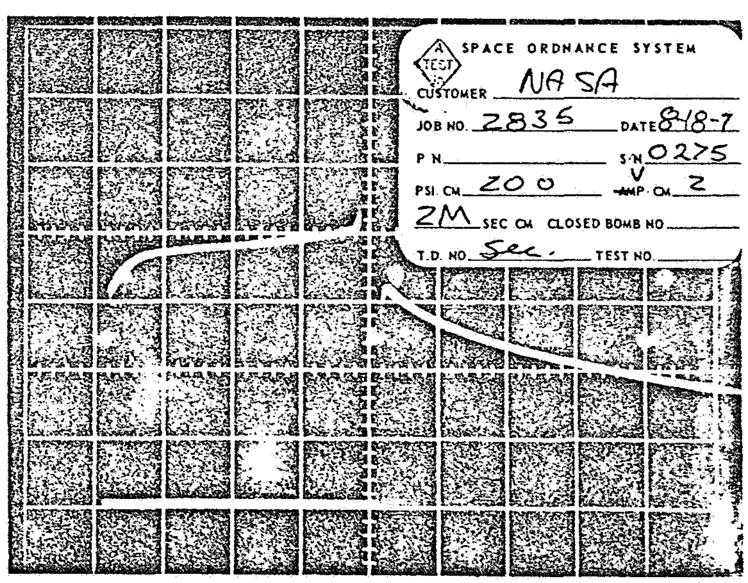












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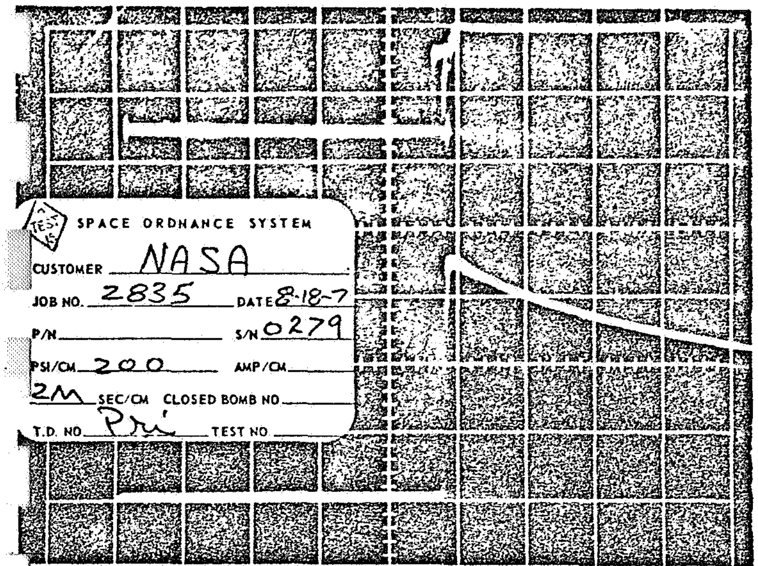
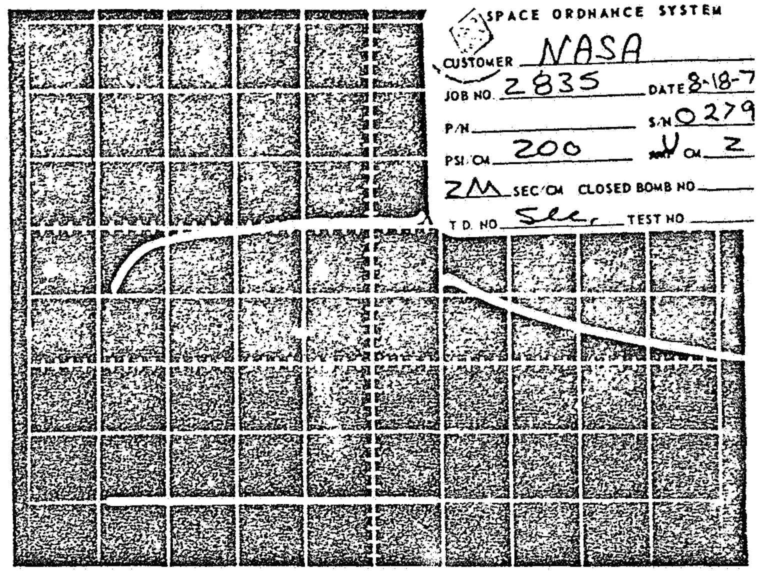
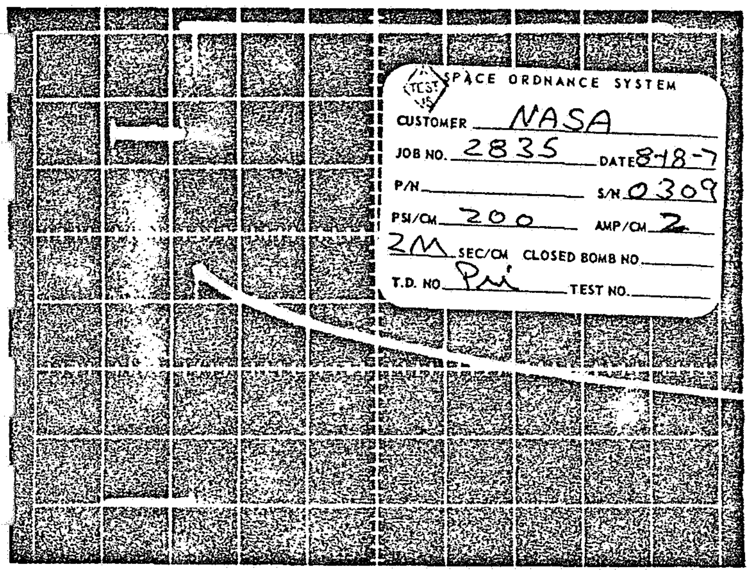
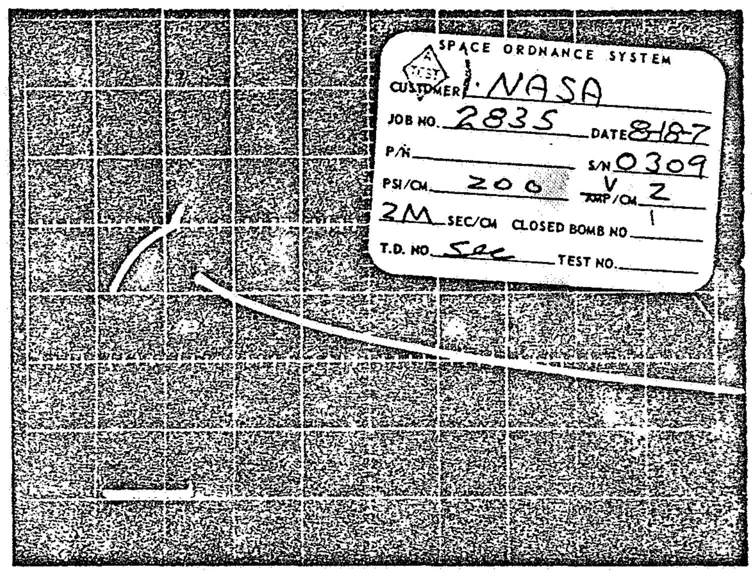
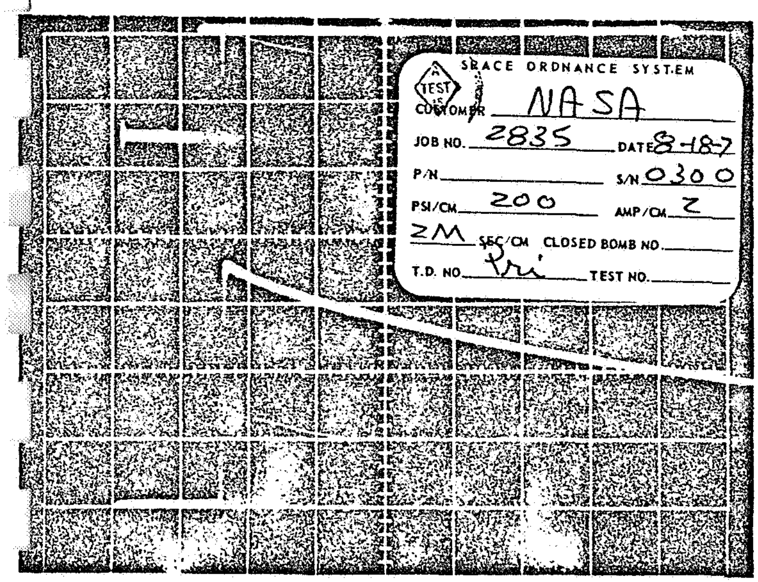
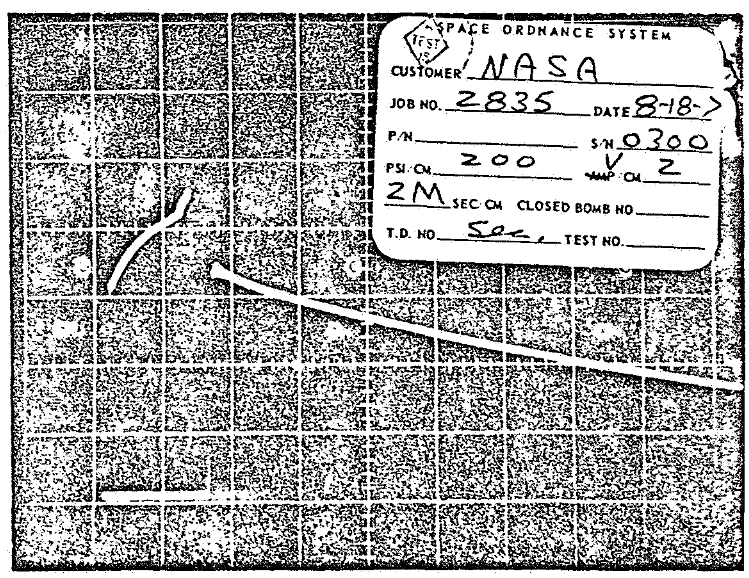




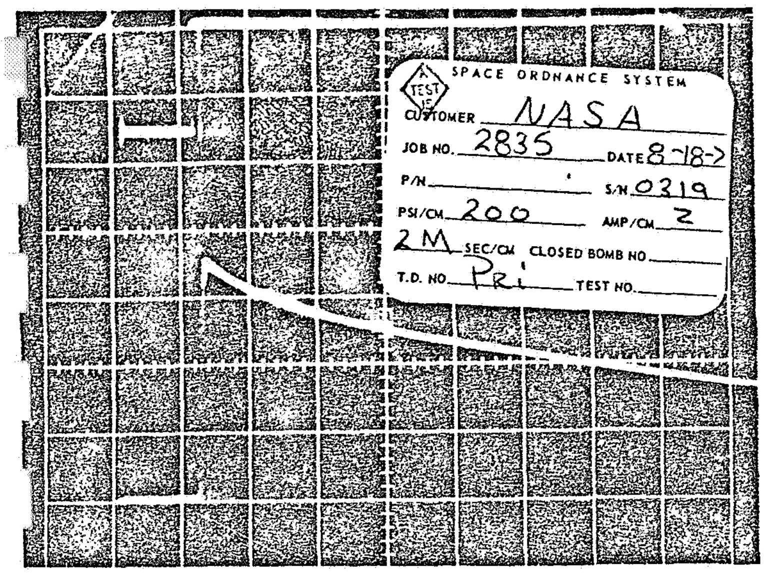


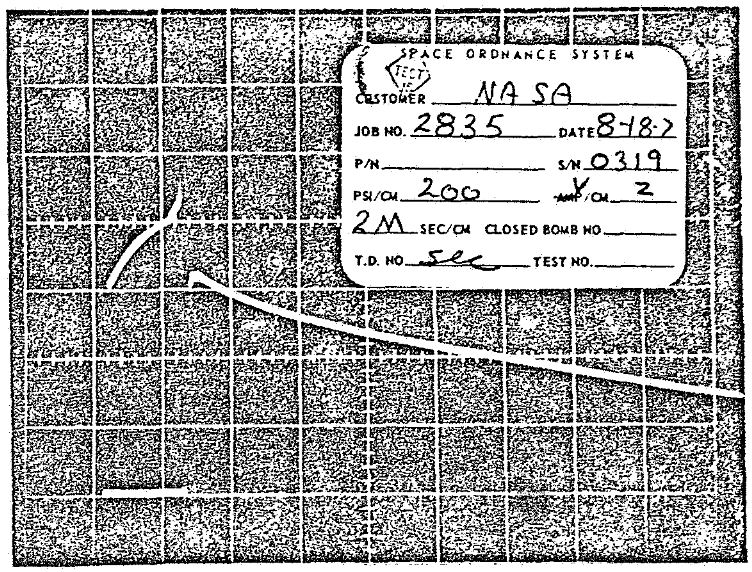


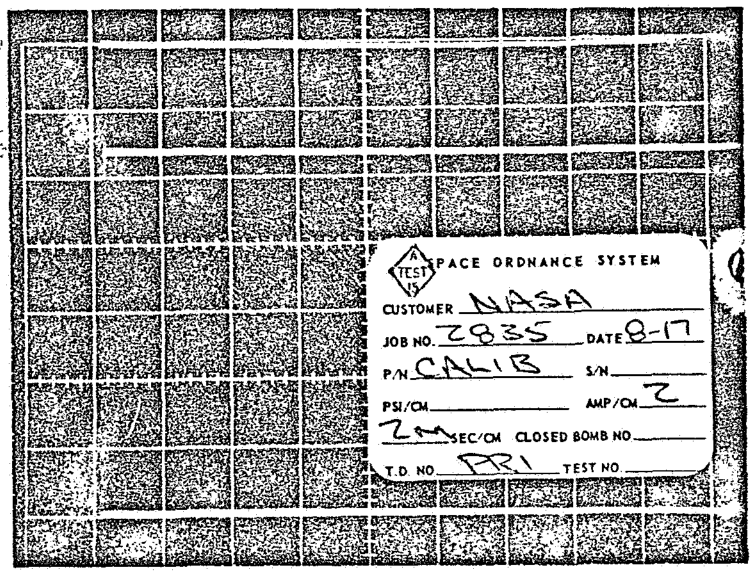




SPACE ORDNANCE SYSTEMS, INC.







ACCEPTANCE TEST DATA SHEET

ITEM: INITIATOR (Non conductive mix) CUSTOMER P/N: N/A
SOS P/N: S01-266-21 CUSTOMER SPEC: N/A
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471
SOS JOB NO. 2835
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER (CODE SERIAL LOT)	Ten day Humidity Test		Insulation Res. Pins to Case. 2 meg ohms min. Record meg ohms. (MEGOHMS)	Random vibration +300 Degs. F.		Random vibration -260 Degs. F		
		Accept.	Rej.		Accept.	Rej.	Accept.	Rej.	
1	0321 BRR	↑		30	↑		↑		
2	0337			60					
3	0331			34					
4	0329			31					
5	0333			33					
6	0330			34					
7	0342			37					
8	0335			90					
9	0339			36					
10	0327			67					
11	0326			45					
12	0343			26					
13	0324			48					
14	0338			27					
15	0325			40					
16	0328			41					
17	0323			25					
18	0322			34					
19	0341			45					
20	0340 BRR			35					
21									
22									
23									
24									
25		↓			↓		↓		
	TEST TECH (INITIAL)			T.W.					APPROVAL SIGNATURES
	DATE	8/27/67		8-22-67	8/25/67		8/25/67		C.A. Reynolds
STAMPS	WITNESS (SOS)	TEST 4		TEST 4	TEST 4		TEST 4		Richard Powell
	WITNESS (CUSTOMER)								
	WITNESS (GOVT.)								

P.O. NO. NAS 1-7471

SPACE ORDNANCE SYSTEMS, INC.
FINAL ACCEPTANCE TEST DATA SHEET

CNTR. NO. PRIME

JOB NO. 7835

SPEC. ______ ITEM Initiator (NON COND. MIX) DWG. NO S01-266-21 TOTAL ACCEPT ____ REJECT ____

TEST SPEC. T.P. 5021 TEST TECH. J Richardson APPROVED E A Reynolds DATE ____

DATE	-255 to -285° F CHAMBER: TIME IN	CHAMBER TEMP. DegreeF	TIME OUT (1 hr)	+295 to +315° F CHAMBER: TIME IN	CHAMB TEMP. DegreesF	TIME OUT (30 min)	REMARKS Cycle #	Temp. Cycling Reference Para. 5.5.4	
8-28-67	0930	-270°	1030	1035	+312°	1105	1 STARTING TEMP		-280°
11	1110	-272°	1210	1215	+306	1245	2		+310°
	1250	-260°	1350	1355	+308°	1425	3		
	1430	-280°	1530	1535	+312°	1605	4		
	1610	-275°	1710	1715	+311°	1745	5		
	1750	-275°	1850	1855	+310	1925	6		
	1930	-260°	2030	2035	+311	2105	7		
	2110	-262°	2210	2215	+311	2245	8		
	1250	-270°	2350	2355	+310	2425	9		
8-29-67	2430	-270°	0130	0135	+311	0205	10		
	0210	-268	0310	0315	+310	0345	11		
	0350	-268	0450	0455	+310	0525	12		
	0530	-271	0630	0635	+310	0705	13		
	0710	-271	0810	0815	+310	0845	14		
	0850	-271	0950	0955	+312	1025	15		
	1030	-282	1130	1135	+312	1205	16		
	1210	-280	1310	1315	+310	1345	17		
	1350	-270	1450	1455	+306	1525	18		
	1530	-280	1630	1635	+307	1705	19		
	1710	-274	1810	1815	+308	1845	20		
	8-30-67	8-30-67	8-30-67	8-30-67	8-30-67	8-30-67	8-30-67		

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

Test Report 6330

26 July 1968

ITEM: INITIATOR (NON-CONDUCTIVE MIX)
SOS P/N: SO1-266-21
SOS TEST PROC.: P-1953

CUSTOMER P/N: N/A
CUSTOMER SPEC: N/A
CONT/P.O. NO: NAS 1-7471

SOS JOB NO. 2835
TOTAL ACCEPT
REJECT

ITEM COUNT	MEMBER NUMBER — CODE SERIAL LOT	TEMP. CYCLE TEST, -260 TO +300 DEGS. F. 20 CYCLES — ACCEPT	REJ.	HERMETIC SEAL HELIUM LEAK TEST — METER DEFLECTION	SCALE FACTOR (PRE CAL. .13 X10, POST CAL .13 X10)	ACTUAL LEAK RATE 1X10⁻⁶ C.C./SEC. MAX.	ENVIRONMENTAL SEAL HELIUM LEAK TEST — METER DEFLECTION	SCALE FACTOR (PRE CAL. .14 X10, POST CAL .13 X10)	ACTUAL LEAK RATE 1X10⁻⁴ C.C./SEC. MAX.		
1	0321 BRR	↓		.46	10	2.4×10^{-7}	.83	100	4.1×10^{-6}		
2	0322			.67	10	3.5×10^{-7}	.32	100	1.6×10^{-6}		
3	0323			.63	10	3.2×10^{-7}	.71	100	3.5×10^{-6}		
4	0324			.64	10	3.3×10^{-7}	.67	100	3.3×10^{-6}		
5	0325			.25	10	1.3×10^{-7}	.11	1000	5.5×10^{-6}		
6	0326			.15	10	7.7×10^{-8}	.35	100	1.7×10^{-6}		
7	0327			.12	10	6.2×10^{-8}	.35	100	1.7×10^{-6}		
8	0328			x .46	100	2.1×10^{-6}	—	—	—	X	LEAKS THRU PIN HEADER
9	0329			.54	10	2.8×10^{-7}	.72	100	3.6×10^{-6}		
10	0330			.73	10	3.8×10^{-7}	.45	100	2.2×10^{-6}		
11	0331			.84	10	4.3×10^{-7}	.22	100	1.1×10^{-6}		
12	0332			.39	10	2.0×10^{-7}	.10	1000	5.0×10^{-6}		
13	0335			.72	10	3.7×10^{-7}	.38	100	1.9×10^{-6}		
14	0337			.55	10	2.8×10^{-7}	.10	1000	5.0×10^{-6}		
15	0338			.68	10	3.5×10^{-7}	.80	100	4.0×10^{-6}		
16	0339			.55	10	2.8×10^{-7}	.38	100	1.9×10^{-6}		
17	0340			.66	10	3.4×10^{-7}	.91	100	4.5×10^{-6}		
18	0341			.73	10	3.8×10^{-7}	.44	100	2.2×10^{-6}		
19	0342			.36	10	1.9×10^{-7}	.26	100	1.3×10^{-6}		
20	0343 BRR			.58	10	3.0×10^{-7}	.40	100	2.0×10^{-6}		
21											
22											
23											
24											
25											
	TEST TECH (INITIAL)	[signature]		[initials]	[initials]	RM	[initials]	[initials]	RM		APPROVAL SIGNATURES
	DATE	8/30/67		8/30/67	8/30/67	8-30-67	8/30/67	8/30/67	8-30-67		[signature]
STAMPS	WITNESS (SOS)	TEST 15		TEST	TEST	TEST 15	TEST	TEST	TEST		[signature]
	WITNESS (CUSTOMER)										
	WITNESS (GOVT.)										

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

Test Report 6330

26 July 1968

ITEM: INITIATOR (Non conductive mix) CUSTOMER P/N: N/A

SOS P/N: S01-266-21 CUSTOMER SPEC: N/A

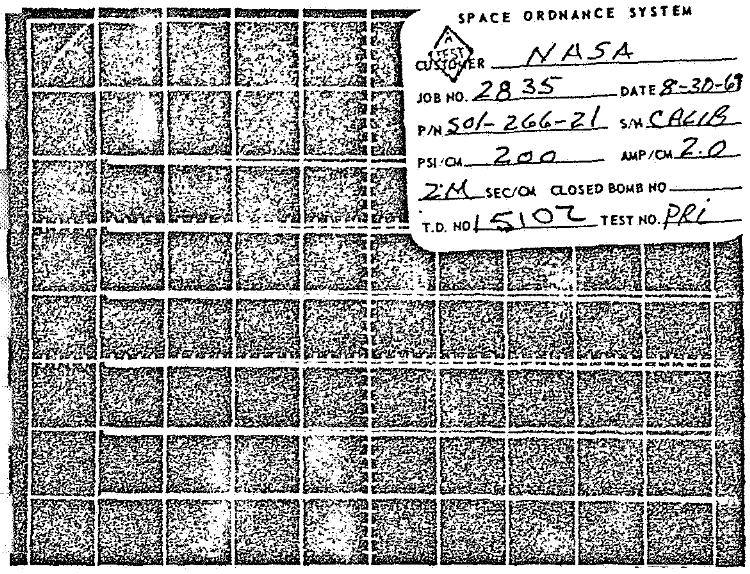
SOS TEST PROC.: P-1953 CONT/P.O. NO: NAS 1-7471

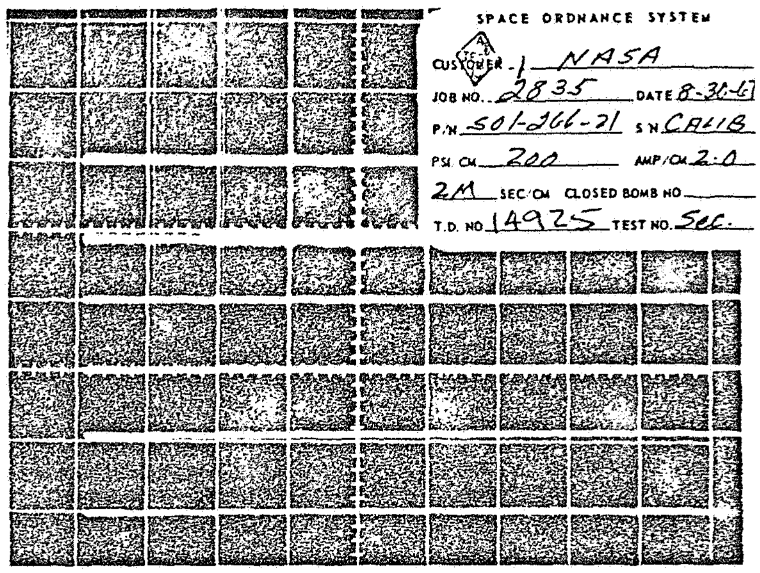
SOS JOB NO. 2835

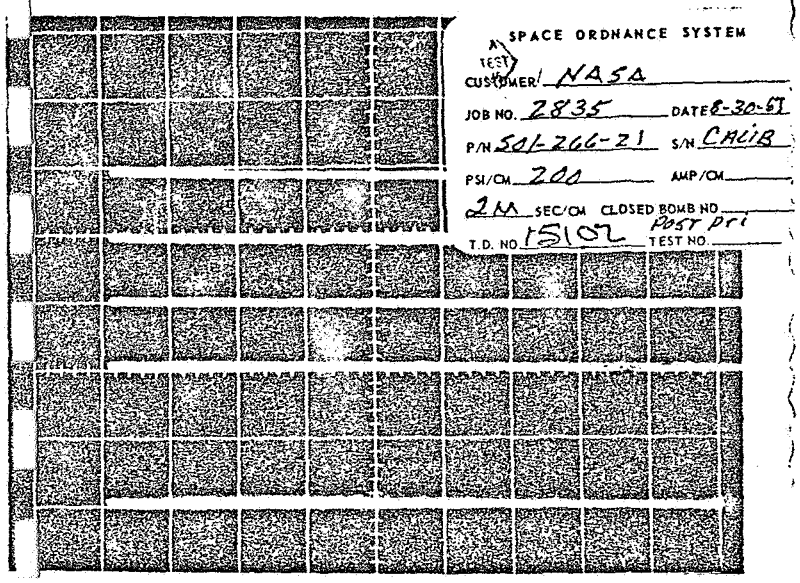
TOTAL ACCEPT REJECT

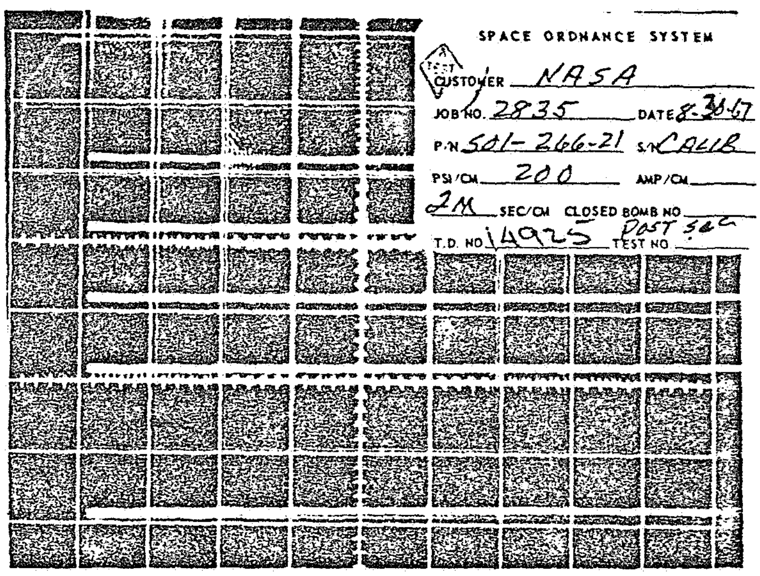
ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	Bridgewire to be fired. A-B or C-D	Circuit Resistance. Ohms	Firing Curent. Amps	Post-Fire Current Leakage. 50 ma Max. Pin A to B	Pin C to D	Pins AB to CD	All Pins shorted to Case	Function Time 10 ms Max. Current application to peak press.	Peak Press. 525 to 775 psig.	Conditioned Temperature Degs. F.	
1	0330 BRR	A-B	1.26	3.5	.01	.07	.02	.01	4.8	760	+300	
2	0324	A-B	1.25	3.5	.01	.01	.01	.01	5.3	660		
3	0329	A-B	1.26	3.5	.01	.01	.01	.01	3.9	670		
4	0323	A-B	1.24	3.5	.01	.01	.01	.01	4.3	650		
5	0325	C-D	1.22	3.5	.01	.01	.01	.01	5.0	670		
6	0328	C-D	1.24	3.5	.05	.03	.71	.01	4.7	650		
7	0327	C-D	1.23	3.5	.01	.01	.01	.01	4.2	610		
8	0322	C-D	1.22	3.5	.01	.01	.01	.01	4.4	600		
9	0326	A-B	1.23	22	.01	.01	.01	.01	2.8	600		
10	0321 BRR	C-D	1.16	22	.01	.01	.01	.01	2.2	670	+300	
11												
12	0331 BRR	A-B	0.88	3.5	.01	.01	.01	.01	8.1	800	-270	
13	0339	A-B	0.83	3.5	.01	.01	.01	.01	6.1	750		
14	0340	A-B	0.93	3.5	.01	.01	.01	.01	6.7	820		
15	0333	A-B	0.80	3.5	.01	.01	.01	.01	5.1	750		
16	0341	C-D	0.91	3.5	.01	.01	.01	.01	6.0	780		
17	0335	C-D	0.94	3.5	.01	.01	.01	.01	6.5	830		
18	0342	C-D	0.83	3.5	.01	.01	.01	.01	6.3	860		
19	0337	C-D	0.90	3.5	.01	.01	.01	.01	5.4	880		
20	0343	A-B	0.81	22	.01	.01	.01	.01	4.8	880		
21	0338 BRR	C-D	0.79	22	—	—	—	—	—	—	-270	UNIT DID NOT FIRE; INVEST.
22												INDICATED BRIDGEWIRE DESTROYED
23												DURING CURRENT APPLICATION.
24												
25												
	TEST TECH (INITIAL)	GGA						GGA	RM	RM	CJ	APPROVAL SIGNATURES
	DATE	8-30-67						8-30-67	8-30-67	8-30-67	8-30-67	
STAMPS	WITNESS (SOS)	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	TEST	
	WITNESS (CUSTOMER)											
	WITNESS (GOVT.)											

SPACE ORDNANCE SYSTEMS, INC.

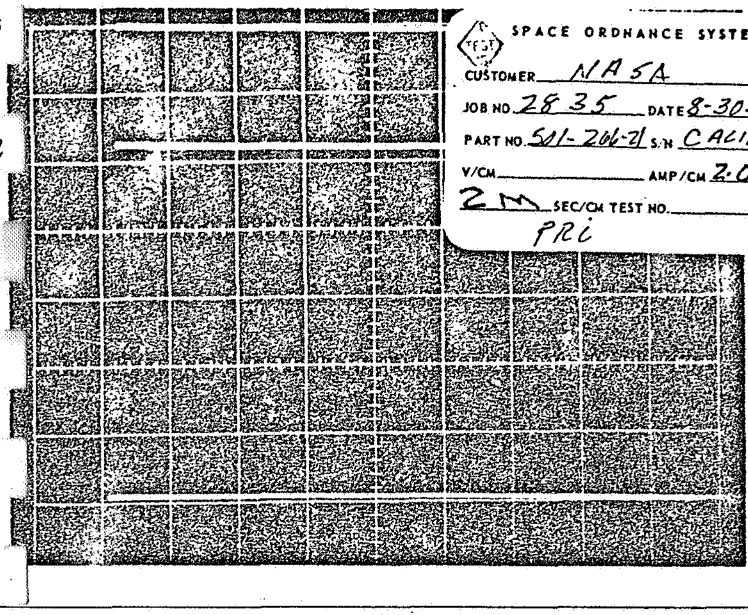


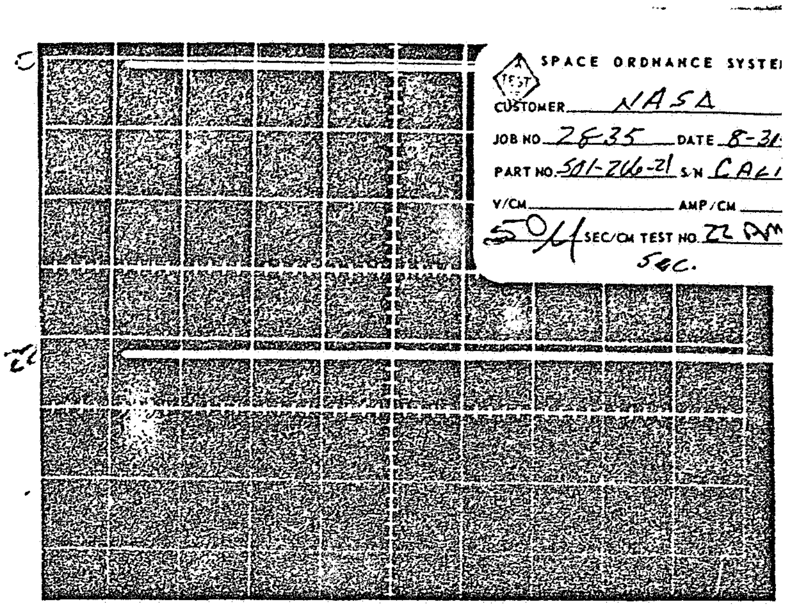


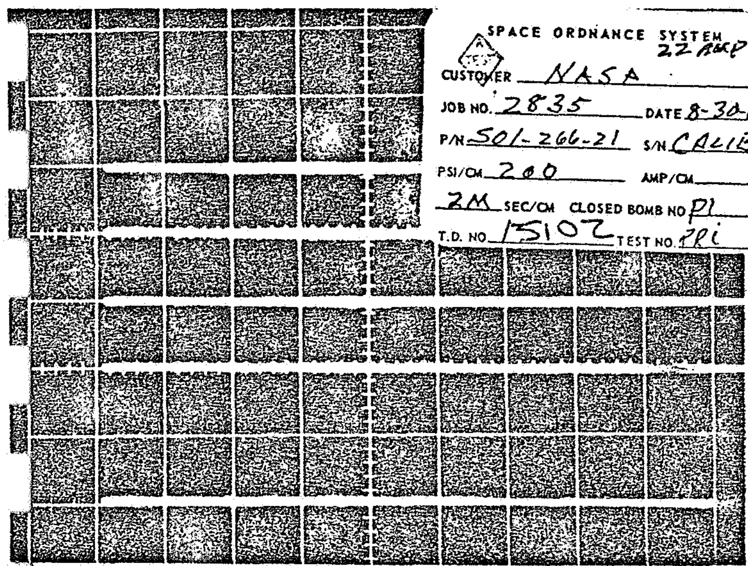


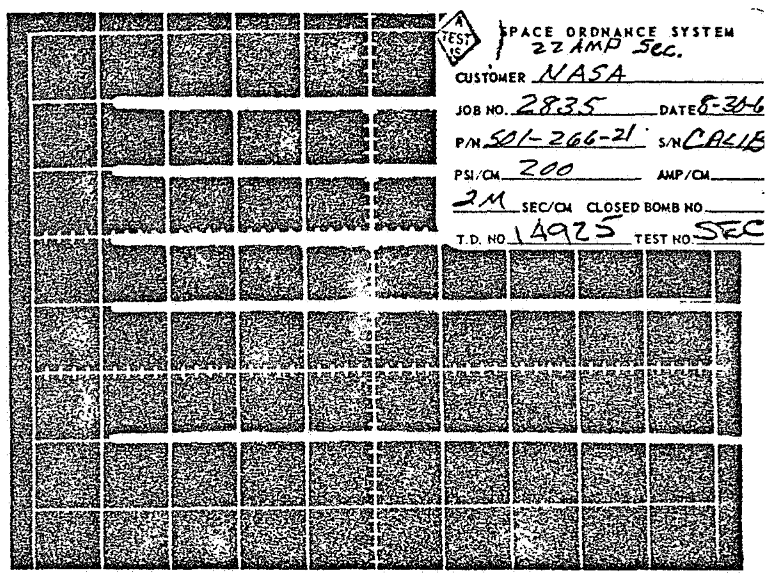


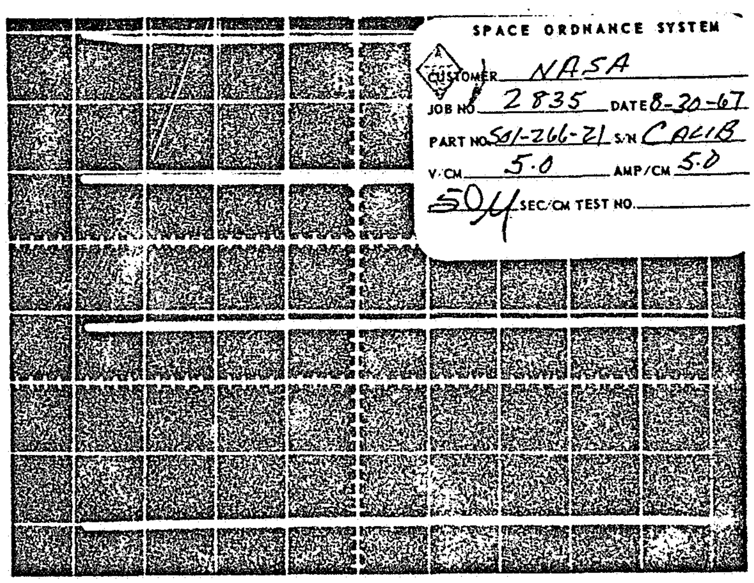
SPACE ORDNANCE SYSTEMS, INC.











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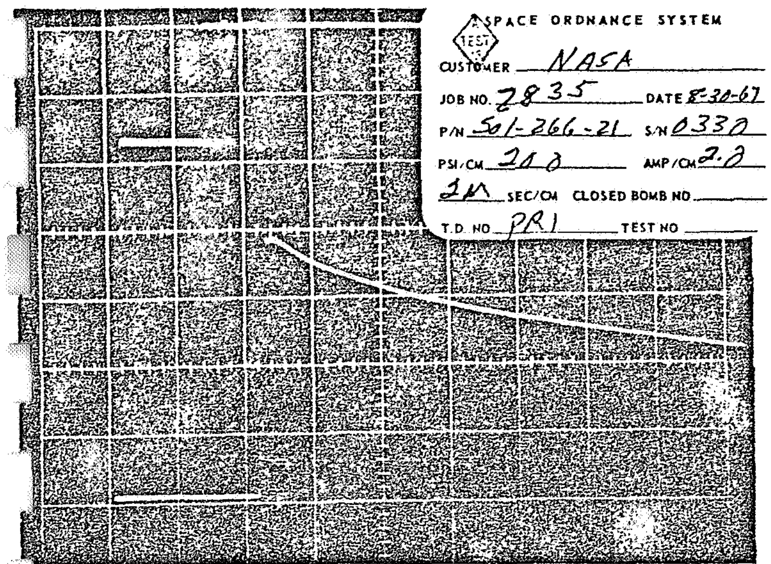
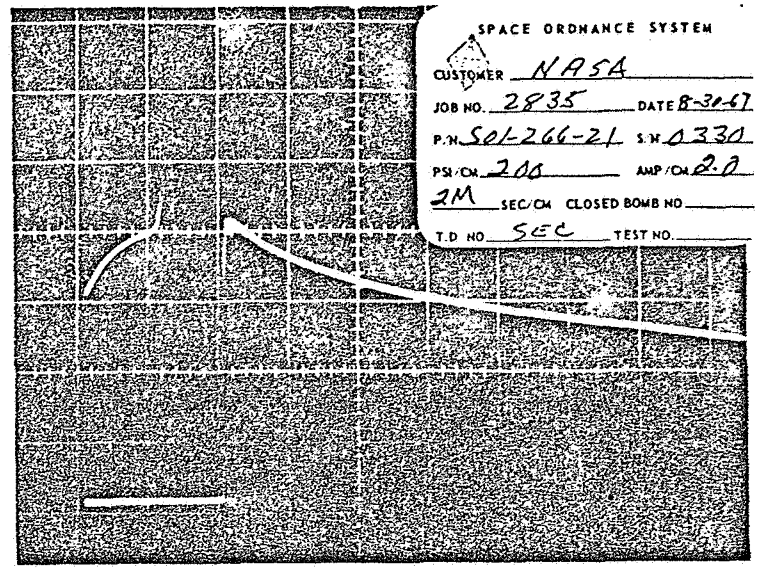
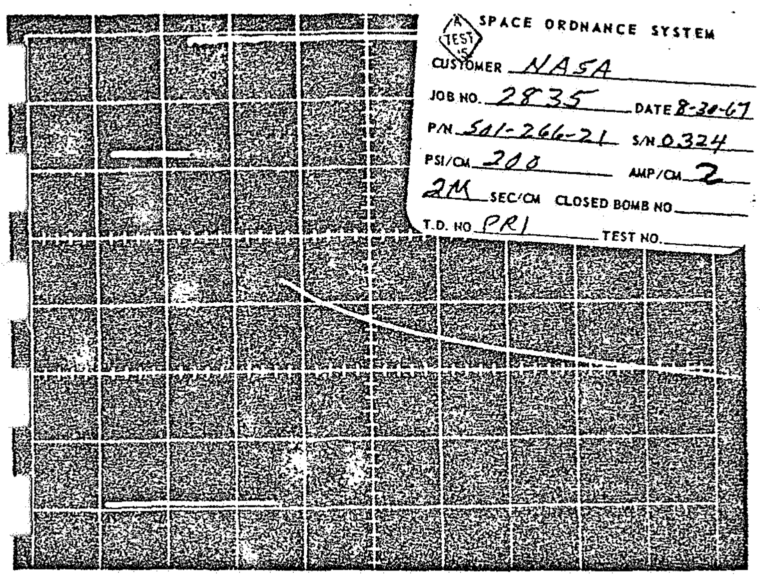
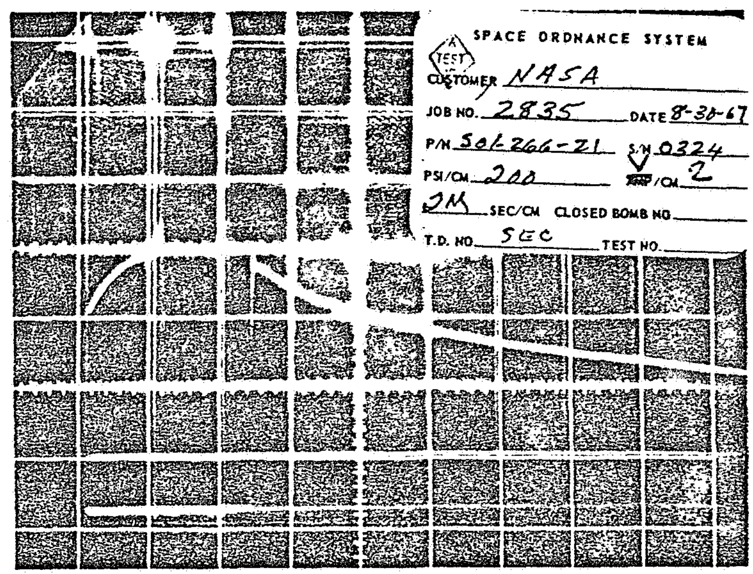
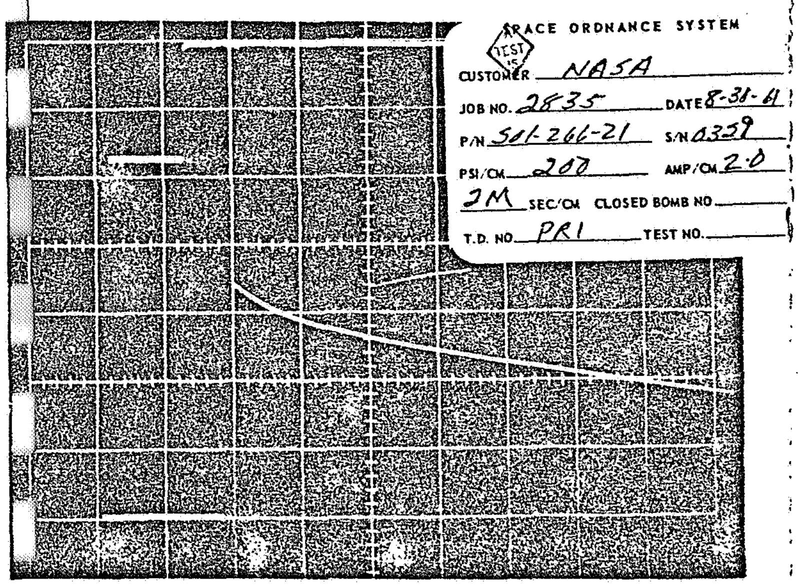
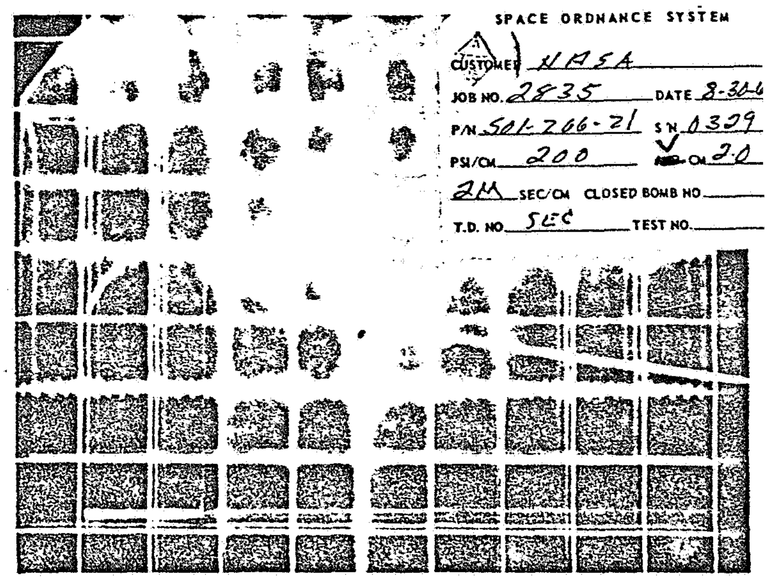






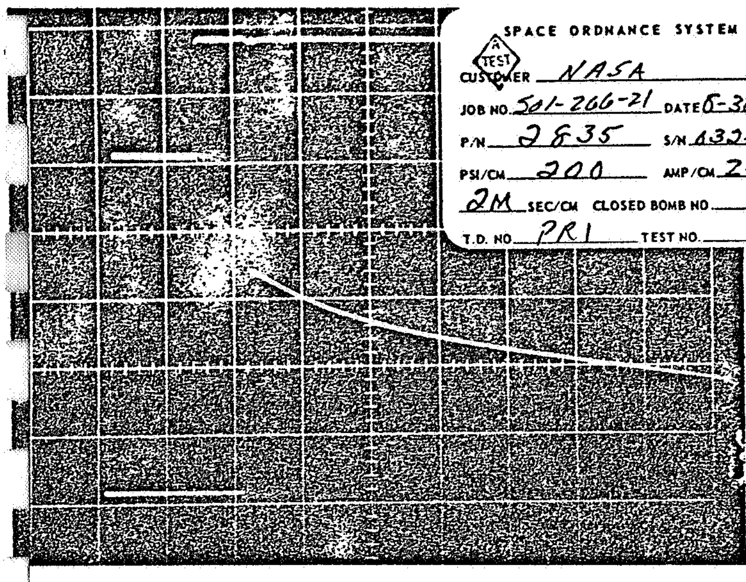


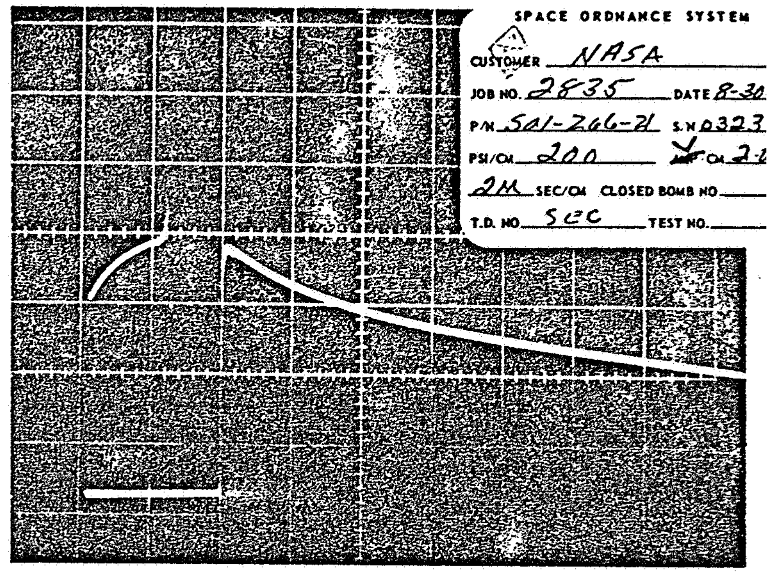


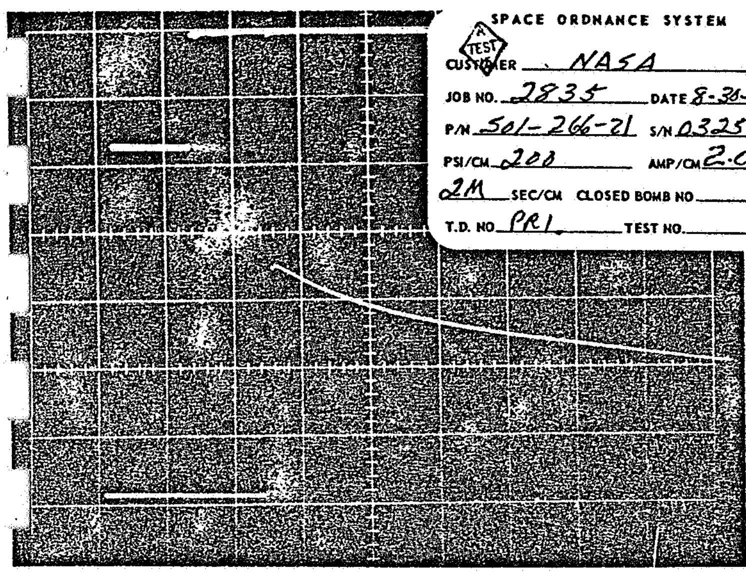


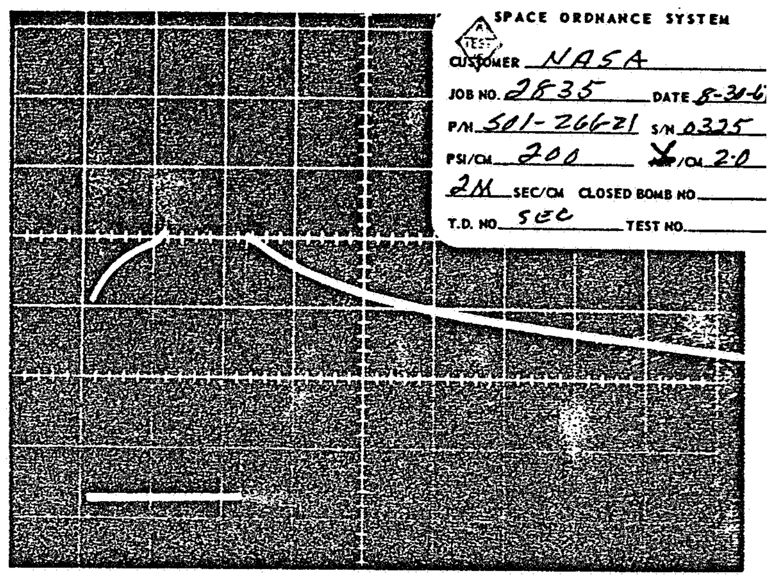
SPACE ORDNANCE SYSTEMS, INC.

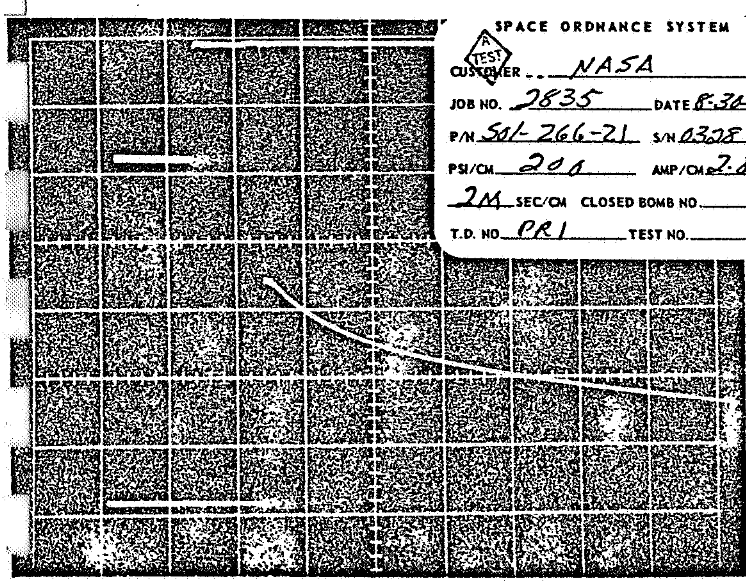
26 July 1968

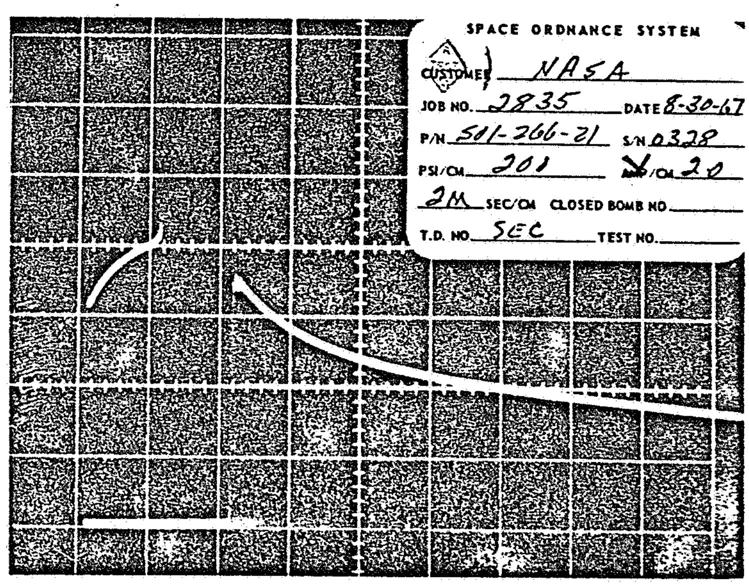






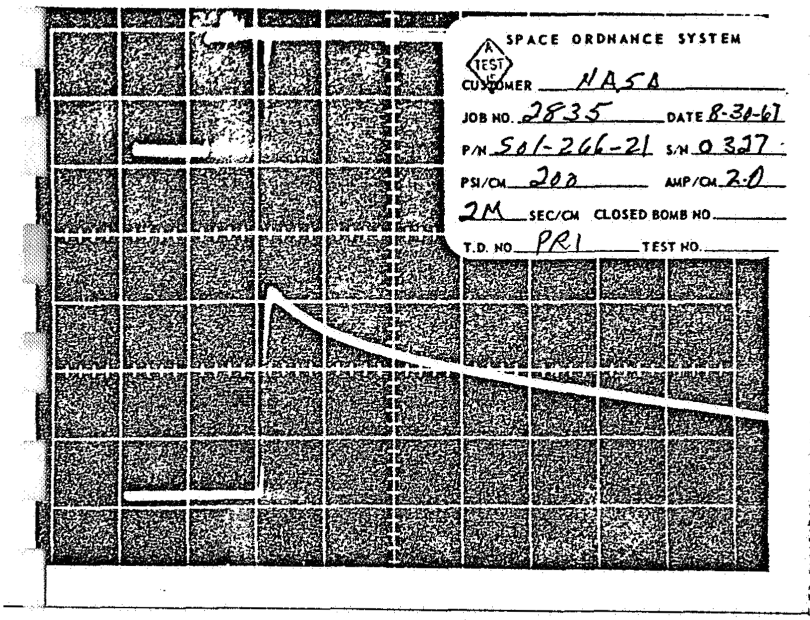


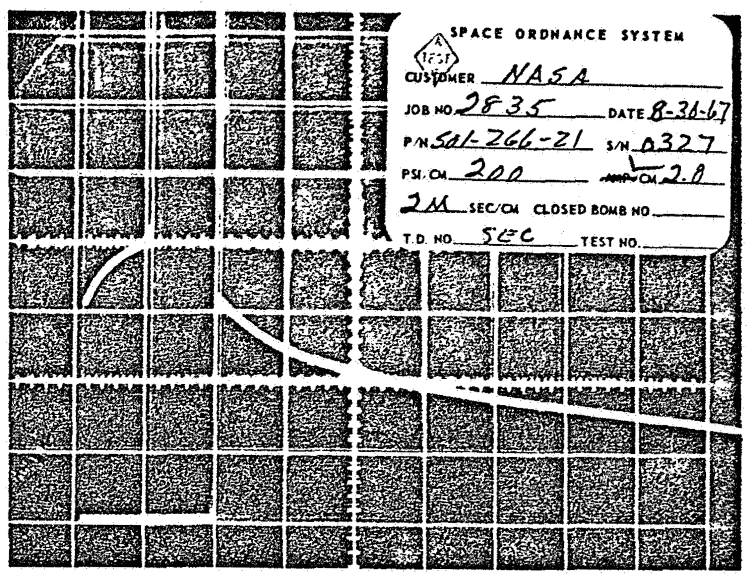


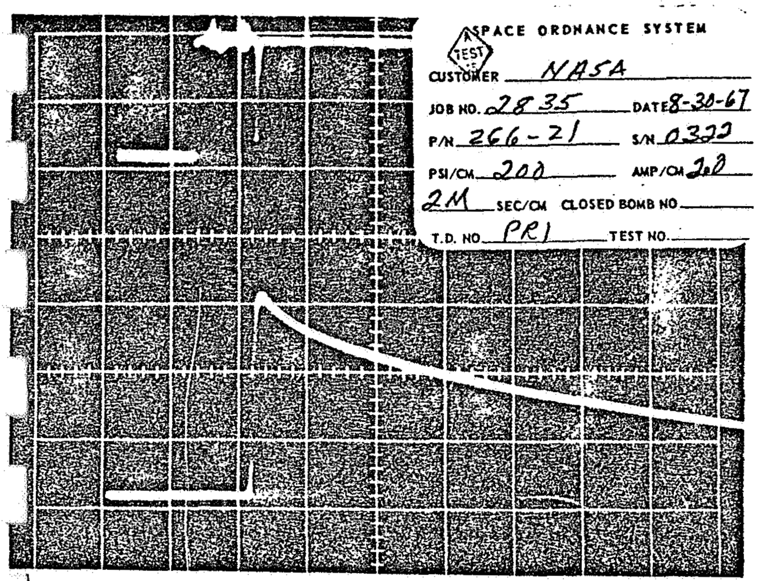


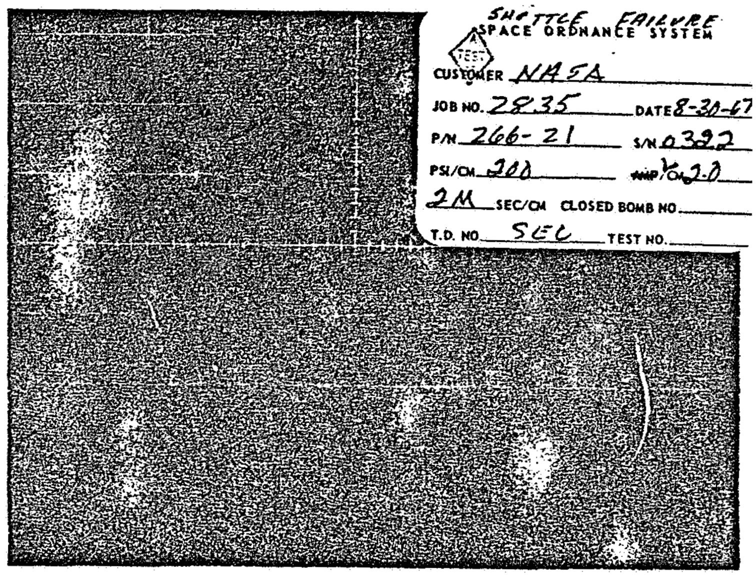
SPACE ORDNANCE SYSTEMS, INC.

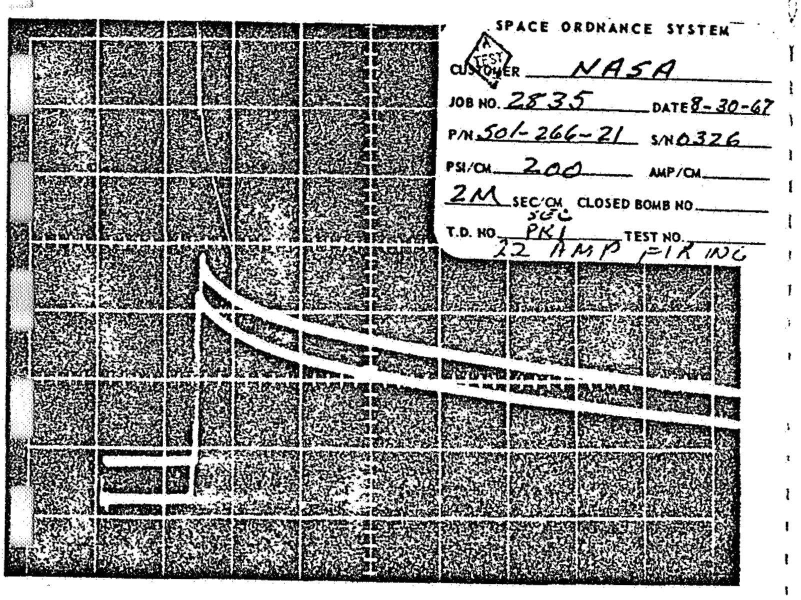
26 July 1968

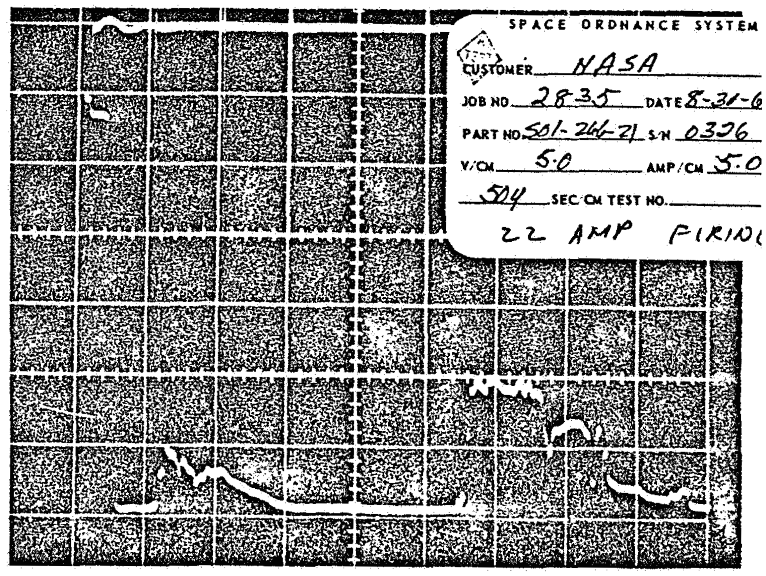






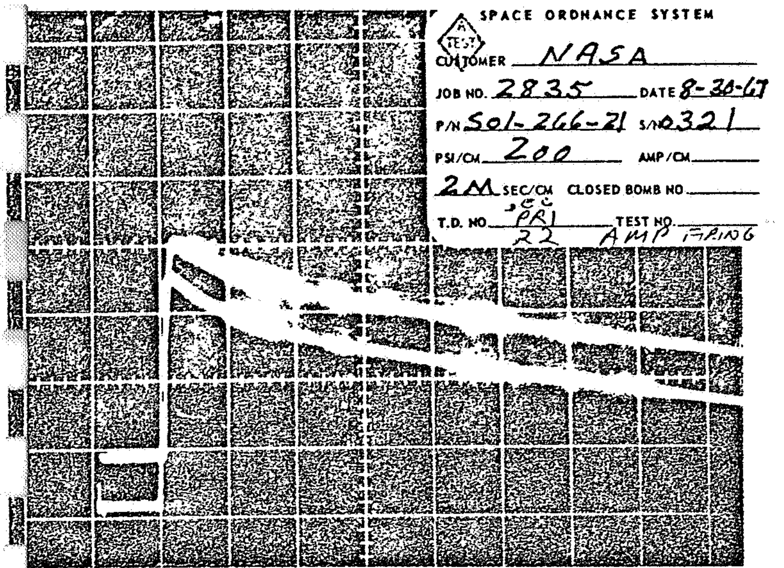


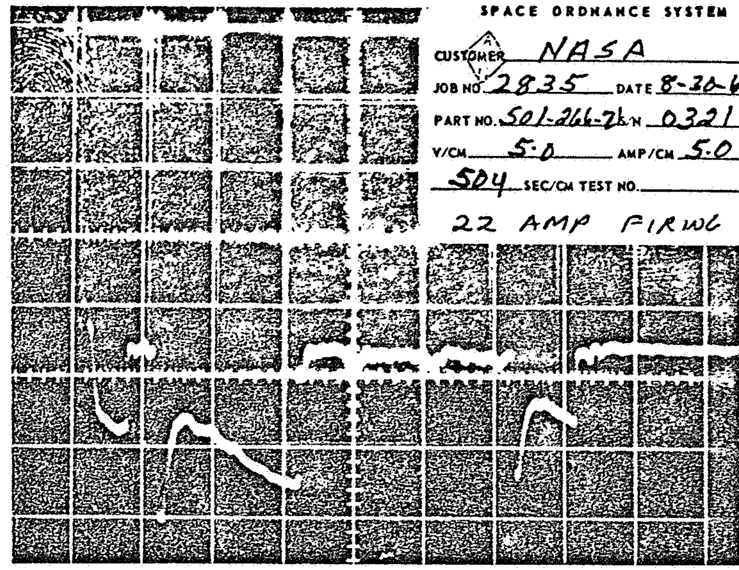


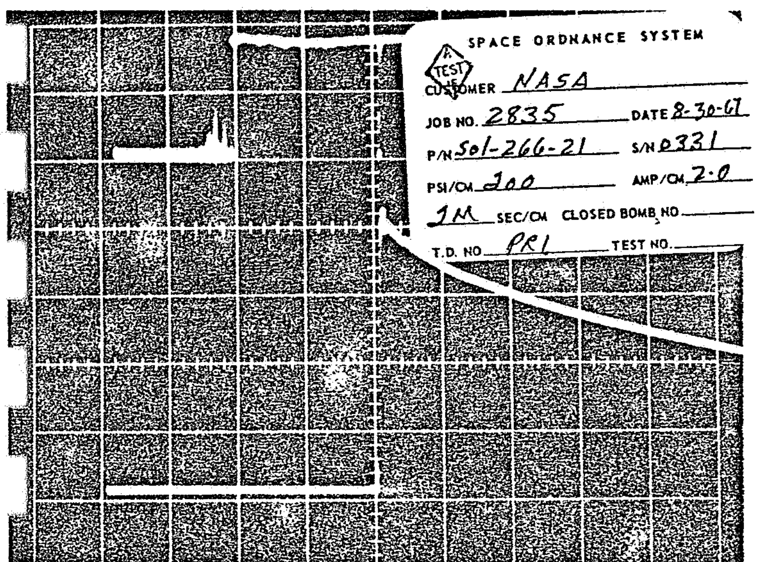


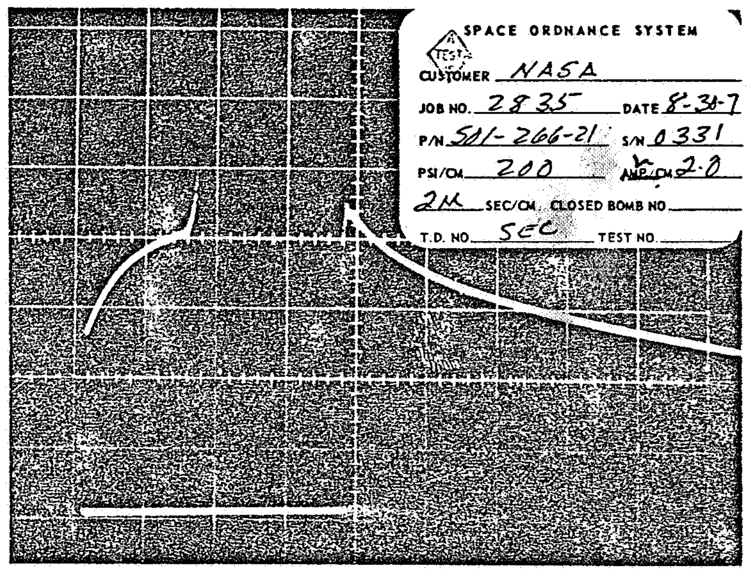
SPACE ORDNANCE SYSTEMS, INC.

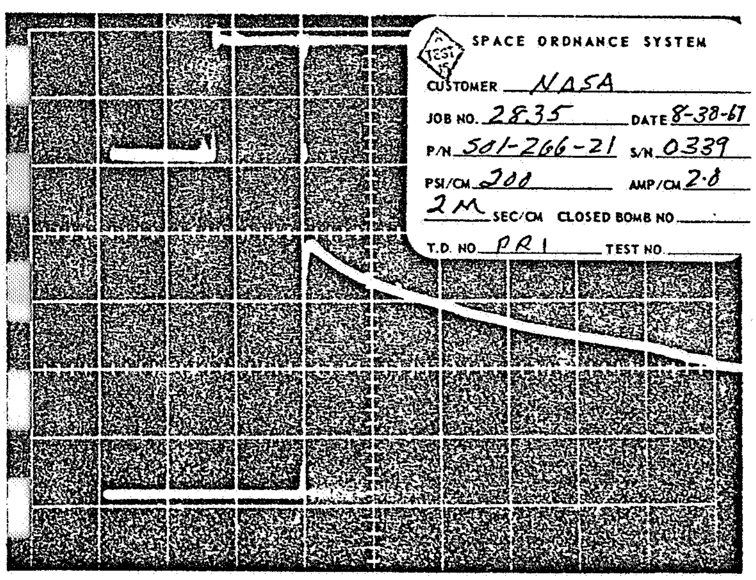
26 July 1968

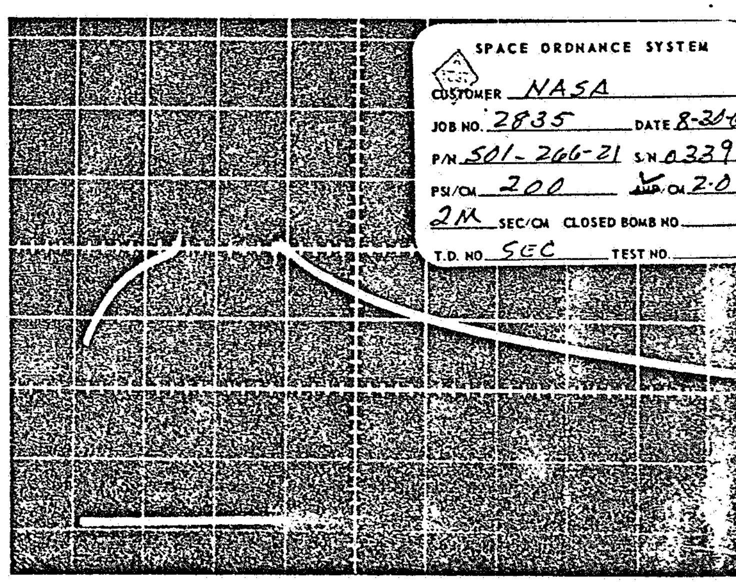


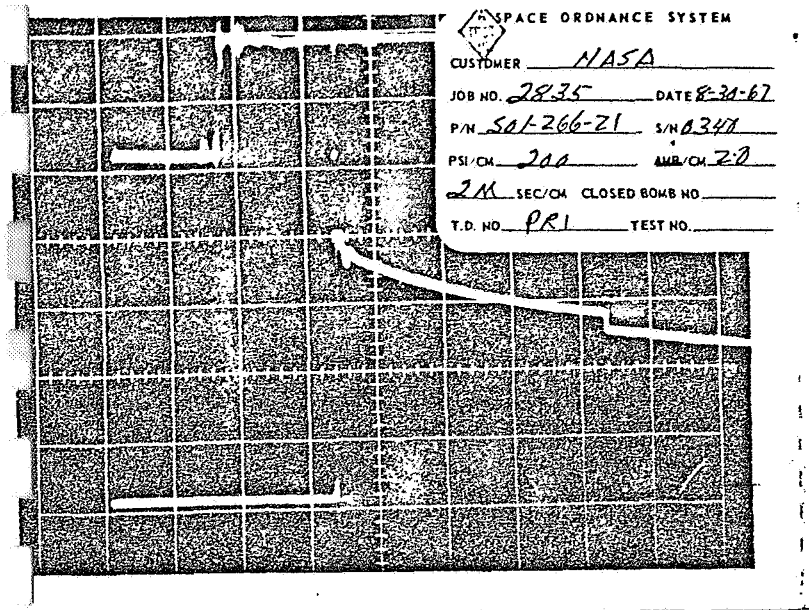


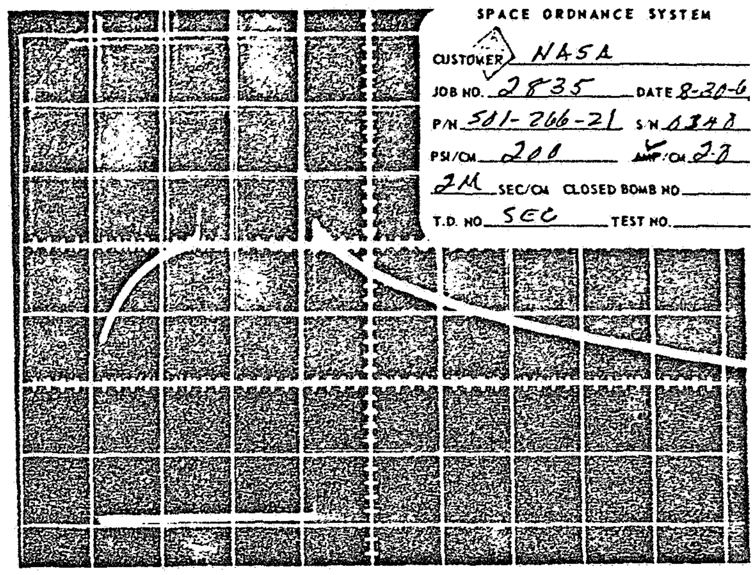









SPACE ORDNANCE SYSTEM
CUSTOMER NASA
JOB NO. 2835 DATE 8-30-67
P/N 501-266-21 S/N 0340
PSI/CM 200 AMP/CM 2.0
2M SEC/CM CLOSED BOMB NO.
T.D. NO. PR1 TEST NO.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CUSTOMER NASA
JOB NO. 2835 DATE 8-30-6
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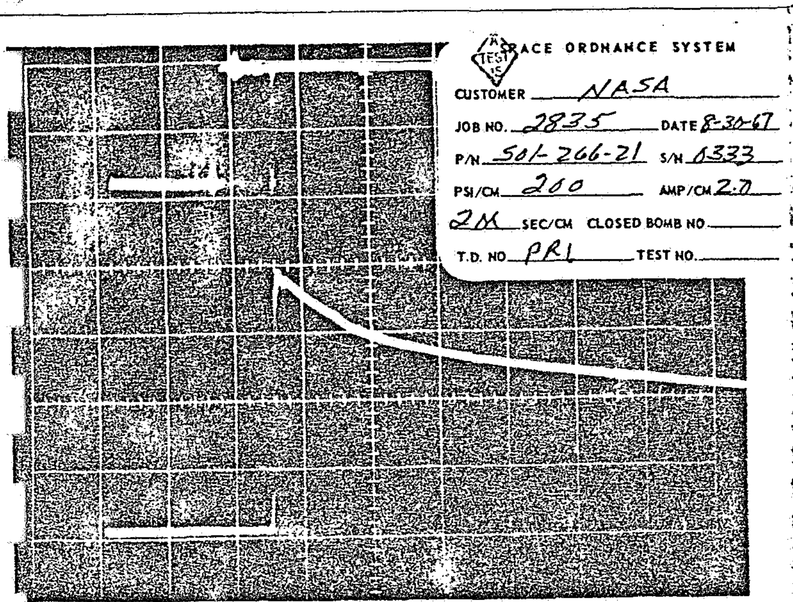
PSI/CM 200 AMP/CM 2.0
2M SEC/CM CLOSED BOMB NO.
T.D. NO. SEC TEST NO.


SPACE ORDNANCE SYSTEM
CUSTOMER NASA
JOB NO. 2835 DATE 8-30-67
P/N 501-266-21 S/N 0333
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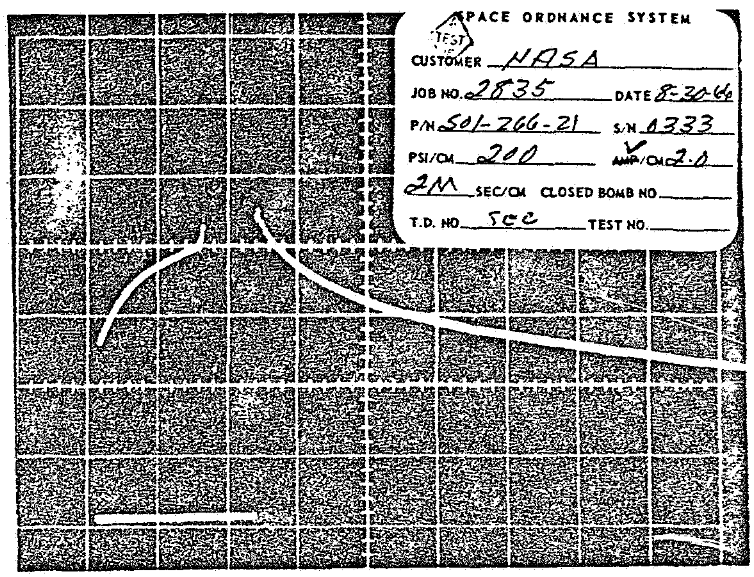
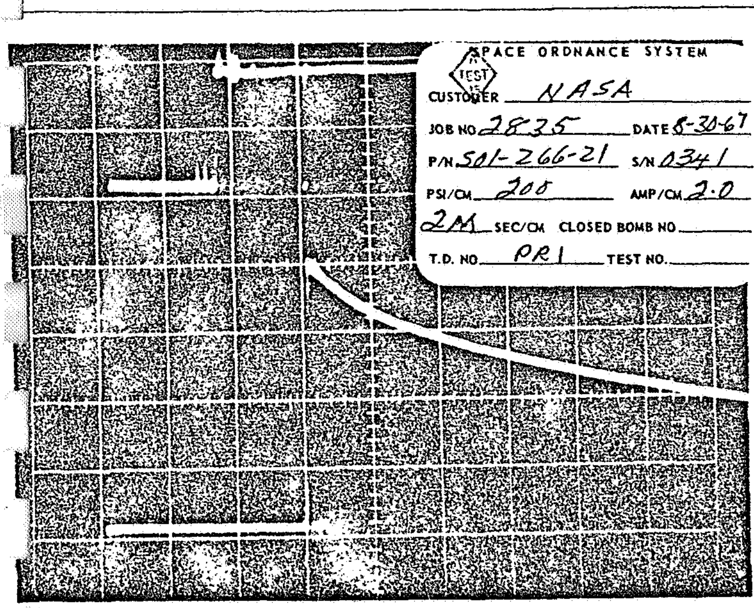
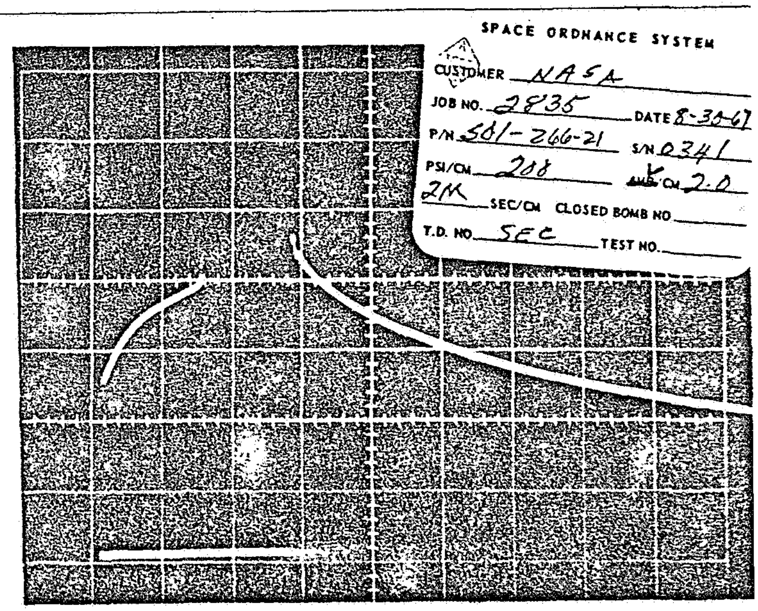
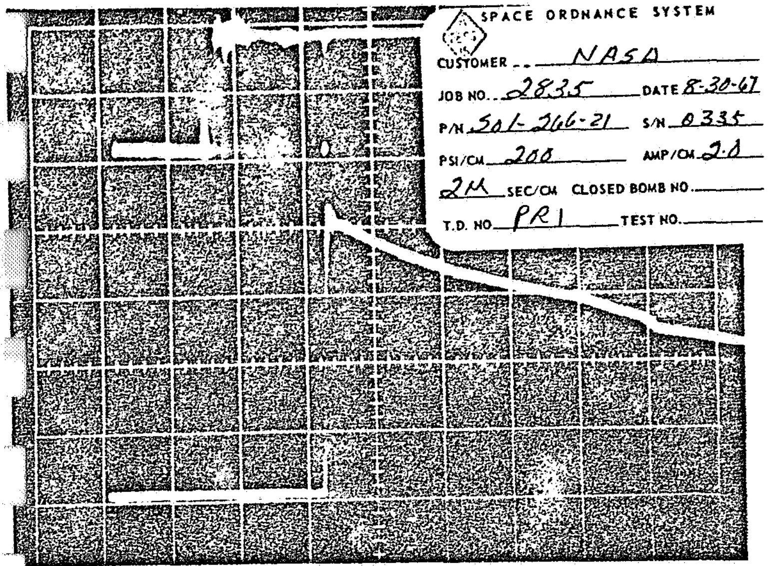
2M SEC/CM CLOSED BOMB NO.
T.D. NO. PR1 TEST NO.

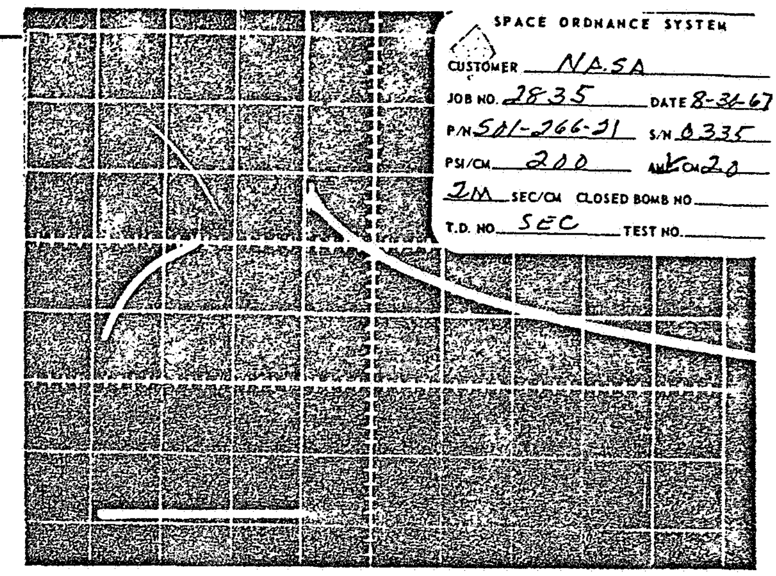

SPACE ORDNANCE SYSTEM
CUSTOMER NASA
JOB NO. 2835 DATE 8-30-66
P/N 501-266-21 S/N 0333
PSI/CM 200 AMP/CM 2.0
2M SEC/CM CLOSED BOMB NO.
T.D. NO. SEC TEST NO.

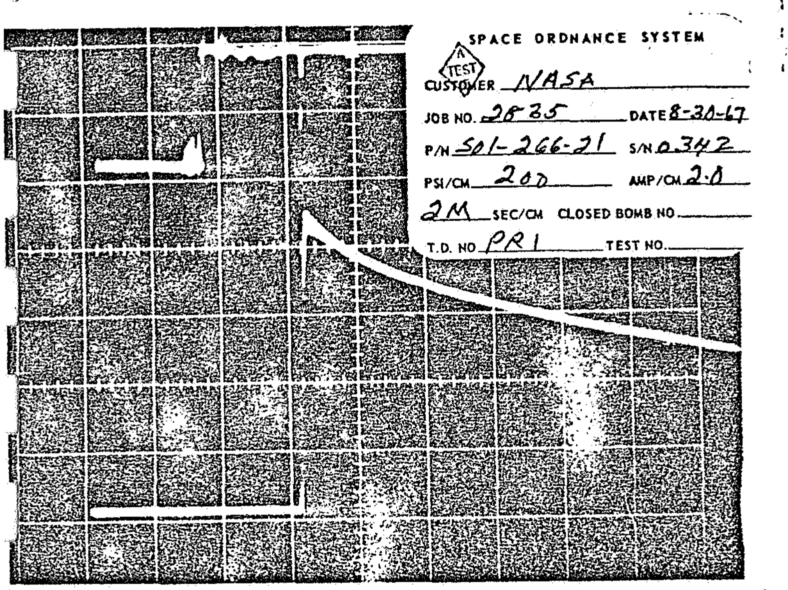

SPACE ORDNANCE SYSTEM
CUSTOMER NASA
JOB NO 2835 DATE 8-30-67
P/N 501-266-21 S/N 0341
PSI/CM 200 AMP/CM 2.0
2M SEC/CM CLOSED BOMB NO.
T.D. NO. PR1 TEST NO.

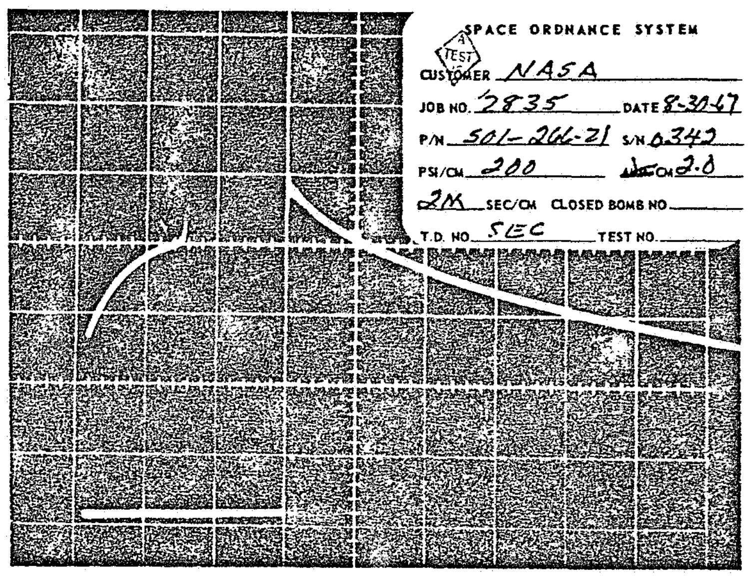

SPACE ORDNANCE SYSTEM
CUSTOMER NASA
JOB NO. 2835 DATE 8-30-67
P/N 501-266-21 S/N 0341
PSI/CM 200 CM 2.0
2M SEC/CM CLOSED BOMB NO.
T.D. NO. SEC TEST NO.

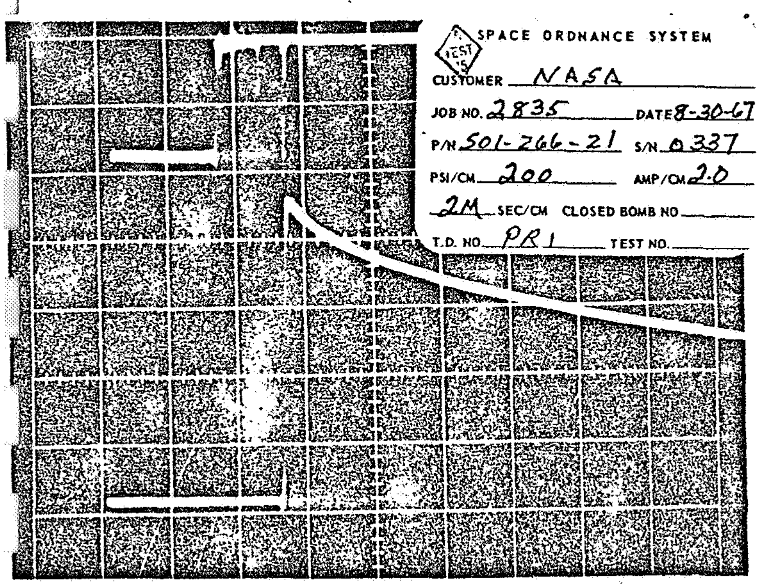
SPACE ORDNANCE SYSTEMS, INC.

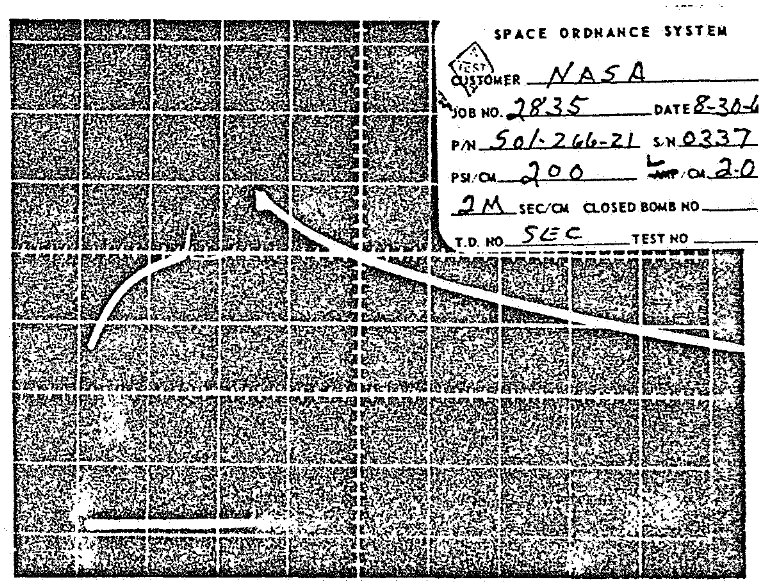




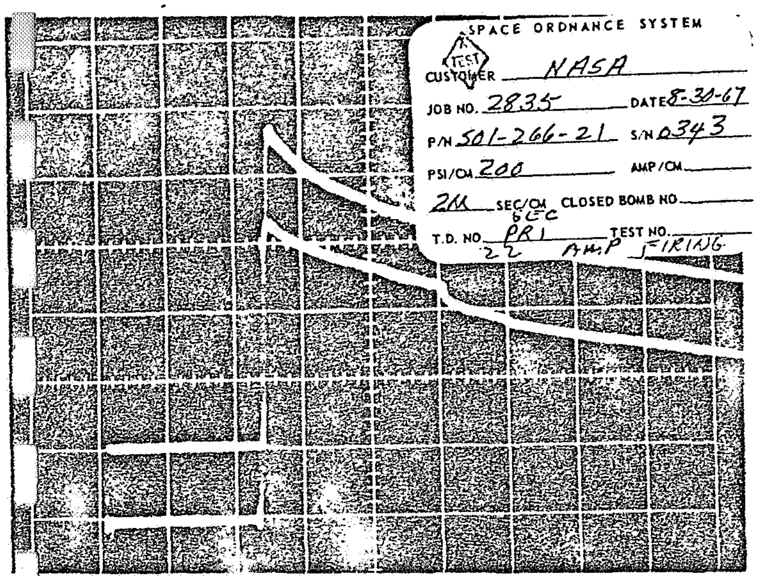


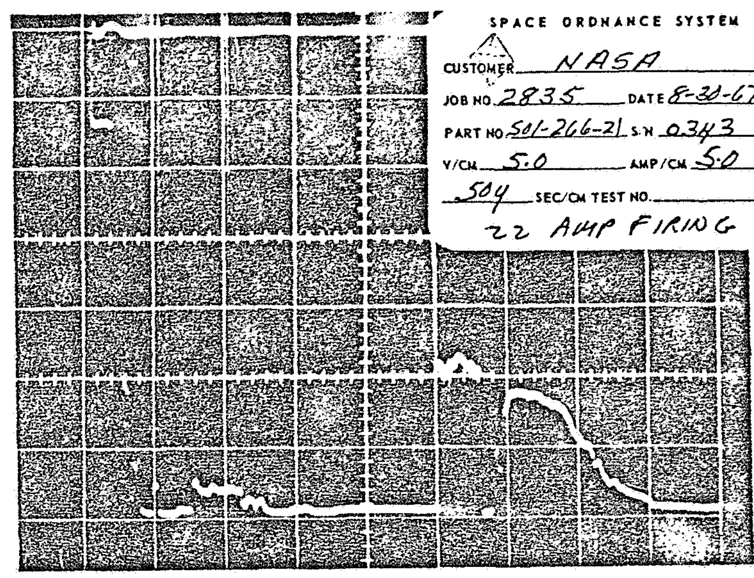


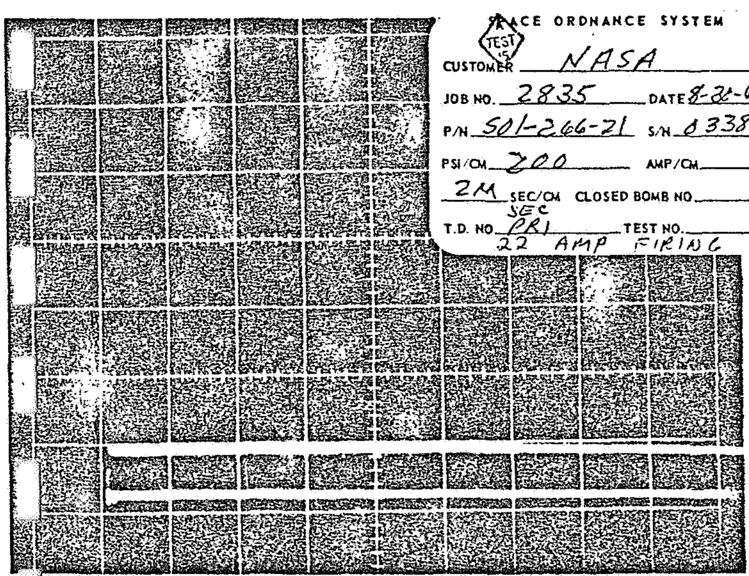


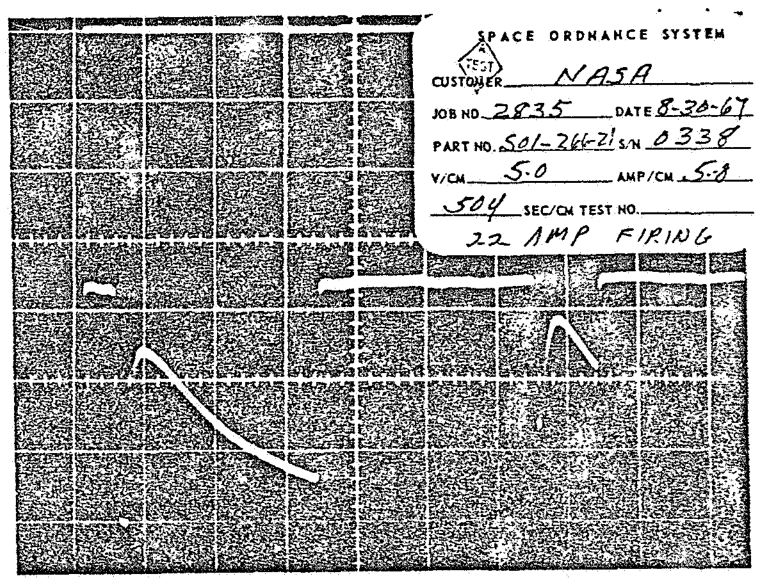


SPACE ORDNANCE SYSTEMS, INC.









All equipment was in calibration at the time of use and calibration records were examined to verify that the equipment was within the required tolerance in accordance with the manufacturer's specification. In the event that specific equipment was not available at the time of testing, an equivalent substitute was used.

TEST EQUIPMENT LIST

The equipment, or its equivalent, listed subsequently was used to perform the tests as applicable.

X-RAY

- Daly Industrial X-Ray, Inc.
  Model No. MT300

LEAKAGE TEST

Helium Leak Detector
Vacuum Electronics Corporation
Model No. MS9-AB
Maximum Sensitivity: 1×10^{-10}cc/sec/He

Vacuum Pump
Welsh Scientific Company
Model No. 1-117-1
Range: 1.0 micron

Pressure/Vacuum Chamber
Prest-o-Lite Company, Inc.
Model No. U-69
Range: 1 psia to 124 psia

Helium Leak Standard
VEECO
Model No. SC-4
Leak Rate: 6.7×10^{-8}cc/sec/He

INSULATION RESISTANCE

Megohmmeter
Freed
Model No. 1620C
Range: 500,000 ohms to 10,000,000 megohms
Accuracy: ±5%

Megohmmeter
General Radio
Model No. 1862B
Range: .5 to 2,000,000 megohms @ 500 VDC
Accuracy: ±3%

BRIDGEWIRE RESISTANCE

Digital Ohmmeter
Cubic Corporation
Model No. 0-41
Range: 0.01 ohms to 9.999 megohms
Accuracy: ±1%

ELECTROSTATIC DISCHARGE

High Voltage D.C. Supply
Del Electronics Corporation
Model No. 20 HPT1-1
Range: 0-30 K Volts

High Voltage Low Leak Capacitor
Plastic Capacitor Corporation
Tolerance: 500 pf ±10%
Type: 300-501 Glass Capacitor

High Voltage Relay
Jennings
Model No. VS-8
Range: 0-50 K Volts

High Voltage Probe
Tektronix
Type: P60115
Range: 0-25 K VDC, 1000x attenuation

Oscilloscope
Tektronix
Type: 545B
Sensitivity: 100 microvolts to 29 v per centimeter
Accuracy: ±3% 5 millivolts

DIELECTRIC STRENGTH

Davenport Manufacturing Company
Model VA100C120
Range: 0-10 KVAC

FIRING TESTS

Constant Current Power Supply
E & R Development Company
Model No. PS-6R
Range: 0-5 minutes
0-5 amperes

Temperature Potentiometer
Leeds and Northrop Company
Model No. 8693
Range: -340 to +650^{o}F.

Dead Weight Tester
Ashcroft
Model No. 130513-100
Range: 0-10,000 psig
Accuracy: 0.1% of indicated pressure

High Current Pulse Generator
Space Ordnance Systems, Inc.
Model No. SWG-1
Range: 0-100 ms pulse width
0-10 amperes
Accuracy: ±2% amplitude
±1% pulse width

Pressure Transducer
Kistler Instrument Company
Model No. 601A
Range: 0-4,000 psig

Charge Amplifier
Kistler Instrument Company
Model No. 568 or equivalent
Range: Variable

High Temperature Chamber
Blue M Electric Company
Model No. POM 206C
Range: 150 to 650^{o}F.

Temperature Recorder/Controller
Minneapolis-Honeywell
Model No. 152x13
Range: -350 to +350^{o}F.

Capacitance Bridge
General Radio Company
Type 716-081

Digital Ohmmeter
Cubic Corporation
Model 0-41 Ohmmeter
Model C-2 Control Unit

APPENDIX III

Selected ASI Performance Data

P.O.No.: M5H3XA-650005
Contr. : NAS9-150

SPACE ORDNANCE SYSTEMS, INC.

DATA SHEET

CUSTOMER NAA/S&ID
Initiator, Electrical, Hotwire
PART NO. SO1-266-7, ME453-0009-0007
SPEC. SOS TP 5021, MC453-0009B, Amendments 3 & 4a
PARA. 4.4.1.1 Low Temperature No Fire Bruceton
S/N Noted Group A

JOB NO. 2047
REPORT NO. 1055
DATE: 2-25-65
AMBIENT TEMP. 65 ± °F
PHOTO.
TEST MEDIUM
TEMP. -260°F

MANUFACTURER	
INSTRUMENTATION	
S/N	
RANGE	
RATED	
ACCURACY	

BRUCETON TEST

S/N	Record No.	Current amps	Bridgewire	Applied: Current Duration sec.
10002 {0078 AAF	{26794			
0078 AAF	26795	2.5	A-B	20
10002 0011 AAF	26796	2.4		230.8
10002 0071 AAF	26797	2.3		22.2
10002 0079 AAF	26798	2.2		NF
10002 0080 AAF	26799	2.3		84
10002 0082 AAF	26800	2.2		NF
10002 0073 AAF	26801	2.3		NF
10002 0083 AAF	26802	2.4		199
10002 0086 AAF	26803	2.3		NF
10002 0087 AAF	26805	2.4		196.6
10002 0089 AAF	26806	2.3		NF
10002 0090 AAF	26809	2.4		238.8
10002 0091 AAF	26808	2.3		NF
10002 0013 AAF	26809	2.4		141.2
10002 0063 AAF	26810	2.3	A-B	NF
10002 0058 AAF	26812	2.4	C-D	26
10002 0050 AAF	26813	2.3		261.8
10002 0045 AAF	26814	2.2		NF
10002 0032 AAF	26815	2.3		NF
10002 0038 AAF	26819	2.4		12.1
10002 0025 AAF	26820	2.3		NF
10002 0046 AAF	26821	2.4		NF
10002 0018 AAF	26822	2.5		— 10 msec.
10002 0033 AAF	26823	2.4		— 8 msec.
10002 0020 AAF	26824	2.3		NF
10002 0044 AAF	26825	2.4		23.9
10002 0074 AAF	26826	2.3		58.2
10002 0076 AAF	26827	2.2		NF
10002 0064 AAF	26828	2.3		NF
10002 0059 AAF	26829	2.4	C-D	13.5

NOTE: NF = 5 MINUTE DURATION OF APPLIED CURRENT To a single BRIDGEWIRE CIRCUIT

SPECIMEN FAILED
SPECIMEN PASSED ✓
F.R. WRITTEN

TESTED BY ENGINEERING TEST DEPT.
WITNESS [signature]
SHEET NO. 1 OF 19

Bruceton Test Per Navord 2101

Item: INITIATOR P-N SOI-266-7 ME 453-0009-0007 Pulse Time: 5 MINUTES Job No: 2047

Date: 2-25-65 Test Temp. -260 °F No. Bridges: 1

S/N

AMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	i	n	in	i^2n
2.60																																		
2.50	X																						X											
2.40		X						X		X		X		X		X				X		O		X		X				X	2	1	2	4
2.30			X		X		O		O		O		O		O		X		O		O				O		X		O		1	9	9	9
2.20				O		O												O										O			0	4	0	0
2.10																																		
2.00																																		
																																14 (N)	11 (A)	13 (B)

$\overline{X} = c + d\ (A/N \pm \frac{1}{2}) = 2.33$

$S = .5417$ ---- (Graph 1, 2)

$H = 1.26$ ---- (Graph 4, 5)

$\sigma_x = \sigma_R\ G\ /\sqrt{N} = .0163$

$t_1 = 3.090$ ---- Table, P.4)

N.F. $= \overline{X} - t_2\ \sigma_x - t_1\ (\sigma_R + t_2\ \sigma_\sigma) = 2.032$

A.F. $= \overline{X} + t_2\ \sigma_x + t_1\ (\sigma_R + t_2\ \sigma_\sigma) = 2.628$

$M = (NB \cdot A^2) / N^2 = .315$

$G = 1.13$ ---- (Graph 3, 5)

$\sigma_R = sd \div .0542$

$\sigma_\sigma = \sigma_R\ H\ /\sqrt{N} = .0185$

$t_2 = 1.77$ ---- (Table 2)

No-Fire and All-Fire Current Values at 99.9 %

Reliability and 90.0 % Confidence Level.

1. Let the zero increment level correspond to the lowest current level of the symbol occurring less frequently.
2. "c" is lowest level of symbol occurring less frequently.
3. In equation for $\overline{X}$, use + if calculations based on symbol at smallest current value and - if based on symbol at largest current value.

SPACE ORDNANCE SYSTEMS, INC.

.O.No.: M5H3XA-650005
Contr. : NAS9-150

SPACE ORDNANCE SYSTEMS INC.

DATA SHEET

CUSTOMER NAA/S&ID

Initiator, Electrical, Hotwire

PART NO. S01-266-7, ME453-0009-0007

SPEC. SOS TP 5021, MC453-0009B, Amendments 3 & 4a

PARA. 4.4.1.2 High Temperature No Fire Bruceton

S/N Noted Group A

JOB NO. 2047

REPORT NO. 1055

DATE: 2-25-65

AMBIENT TEMP. 65 ± 10°F

PHOTO.

TEST MEDIUM

TEMP. +300°F

MANUFACTURER	
INSTRUMENTATION	
S/N	
RANGE	
RATED	
ACCURACY	

BRUCETON TEST

S/N	Record No.	Current amps	Bridgewire APPLIED	Applied Current Duration sec.
10002 0039 AAF	26831	1.8	A-B	NF
10002 0026 AAF	26832	1.9		— 5 msec
10002 0077 AAF	26833	1.8		30
10002 0051 AAF	26834	1.7		NF
10002 0066 AAF	26835	1.8		0.3
10002 0069 AAF	26836	1.7		NF
10002 0060 AAF	26837	1.8		5
10002 0061 AAF	26838	1.7		NF
10002 0062 AAF	26839	1.8		NF
10002 0052 AAF	26840	1.9		67
10002 0054 AAF	26841	1.8		NF
10002 0056 AAF	26842	1.9		1.3
10002 0047 AAF	26843	1.8		NF
10002 0048 AAF	26844	1.9		47.8
10002 0049 AAF	26846	1.8	A-B	13.3
10002 0040 AAF	26847	1.7	C-D	NF
10002 0042 AAF	26848	1.8		NF
10002 0043 AAF	26849	1.9		11.2
10002 0035 AAF	26850	1.8		NF
10002 0036 AAF	26851	1.9		NF
10002 0037 AAF	26852	2.0		7.7
10002 0028 AAF	26853	1.9		46.5
10002 0030 AAF	26854	1.8		NF
10002 0031 AAF	26855	1.9		— 11 msec.
10002 0021 AAF	26856	1.8		6.3
10002 0022 AAF	26857	1.7		NF
10002 0023 AAF	26858	1.8		NF
10002 0014 AAF	26861	1.9		7.7
10002 0015 AAF	26862	1.8		NF
10002 0016 AAF	26863	1.9	C-D	5.5

NOTE: NF = 5 MINUTE DURATION OF APPLIED CURRENT

SPECIMEN FAILED

SPECIMEN PASSED

F.R. WRITTEN

TESTED BY Eng Test [illegible]

WITNESS [illegible]

SHEET NO. 3 OF 19

INITIATOR
Item: P/N 501-266-7 ME453-0009-0007   Bruceton Test Per Navord 2101

Pulse Time: 5 MINUTES   Job No: 2047

Date: 2-25-65   Test Temp: +300 °F   No. Bridges: 1

AMP \ S/N →	0039	0026	0077	0051	0066	0065	0060	0061	0062	0052	0054	0056	0047	0048	0049	0040	0042	0043	0035	0036	0037	0028	0030	0031	0021	0022	0023	0014	0015	0016	i	n	in	i^2n
2.0																					X													
1.9		X								X		X		X				X		O		X		X				X		X	2	1	2	4
1.8	O		X		X		X		O		O		O		X		O		O				O		X		O		O		1	9	9	9
1.7				O		O		O								O										O					0	5	0	0
																																15	11	13
																																N	A	B

$\overline{X} = c + d_1 (A/N \pm \frac{1}{2}) = 1.823$

$S = .565$ ------------ (Graph 1, 2)

$H = 1.30$ ------------ (Graph 4, 5)

$\sigma x = \sigma_R\, G / \sqrt{N} = .0161$

$t_1 = 3.090$ ------------ (Table, P.4)

$N.F. = \overline{X} - t_2\, \sigma x - t_1\, (\sigma_R + t_2\, \sigma\sigma) = 1.514$

$A.F. = \overline{X} + t_2\, \sigma x + t_1\, (\sigma_R + t_2\, \sigma\sigma) = 2.132$

$M = (NB - A^2) / N^2 = .328$

$G = 1.123$ ------------ (Graph 3, 5)

$\sigma_R = sd = .0565$

$\sigma\sigma = \sigma_R\, H / \sqrt{N} = .0195$

$t_2 = 1.76$ ------------ (Table 2)

No-Fire and All-Fire Current Values at 99.9%

Reliability and 90 % Confidence Level.

1. Let the zero increment level correspond to the lowest current level of the symbol occurring less frequently.
2. "c" is lowest level of symbol occurring less frequently.
3. In equation for $\overline{X}$, use + if calculations based on symbol at smallest current value and - if based on symbol at largest current value.

P.O. NO. M5H3XA-650005
CONTR. NO. NAS9-150
CUSTOMER NAA/S&ID

SPACE ORDNANCE SYSTEMS, INC.
DATA SHEET

JOB NO. 2047 LOT NO. ABF
REPORT NO. 1055
DATE 2-27-28-65
AMBIENT TEMP. 70 ± 10°F
PHOTO.
TEST MEDIUM
TEMP. AMBIENT

Initiator, Electrical Hotwire

PART NO. SO1-266-7, ME453-0009-0007
SPEC. TP 5021, MC453-0009B Amendments 3 & 4a
PARA. 4.4.1, 4.3.7 ALL FIRE CURRENT TEST ROOM TEMP.
S/N Noted Group "A"

MANUFACTURER	Kistler Sensitivity Setting
INSTRUMENTATION	
S/N	Amplifier 2.04 X 10 TRANSDUCER 10972 PRIMARY
RANGE	Amplifier 2.26 X 10 TRANSDUCER 12295 SECONDARY
RATED	

MEMBER NUMBER CODE	SERIAL	LOT	Circuit RESISTANCE OHMS Leads	B.W.	INITIATION TIME MILLISECONDS		START PRESSURE RISE TO PEAK MILLISECONDS		PEAK PRESSURE PSI 10972	PEAK PRESSURE PSI 12295	app. amps	peak amps	peak volts
10002	0047	AAF	.09 AB	1.09	2.4	2.3	.6	.7	715	725	3.5		6.2
10002	0030	AAF	.09 AB	1.04	2.6	2.5	.6	.8	675	690			5.9
10002	0042	AAF	.09 AB	1.12	2.4	2.3	.6	.7	640	675			6.3
10002	0046	AAF	.09 AB	1.02	2.4	2.3	.6	.9	630	620			5.8
10002	0069	AAF	.09 AB	1.10	5.8	5.6	.7	.6	670	690			7.2
10002	0039	AAF	.09 AB	1.15	—	—	—	—	—	—			7.3
…002	0089	AAF	.09 AB	1.15	5.1	4.9	.7	.9	700	710			6.9
…002	0035	AAF	.09 AB	1.03	2.5	2.4	.7	1.1	720	630			6.0
…002	0036	AAF	.09 AB	.99	2.7	2.5	.6	.9	675	660			5.8
…002	0059	AAF	.09 AB	1.05	—	—	—	—	—	—			7.2
10002	0086	AAF	.09 AB	1.03	5.8	5.4	.6	1.0	700	690			6.6
10002	0023	AAF	.09 AB	1.05	2.3	2.2	.6	.9	640	665			6.2
10002	0063	AAF	.09 AB	.97	5.6	5.8	1.0	.8	555*	635			5.8
10002	0076	AAF	.09 AB	.76	2.8	2.7	.7	.7	680	685			5.9
10002	0091	AAF	.07 CD	1.05	2.4	2.4	.7	.9	685	690			6.1
10002	0015	AAF	.07 CD	1.02	8.4	8.0	.7	1.0	665	650			6.8
10002	0032	AAF	.07 CD	1.02	7.5	7.0	.3	1.0	665	680			—
10002	0025	AAF	.07 CD	1.05	2.4	2.4	.7	.9	665	665			6.0
10002	0061	AAF	.07 CD	1.05	6.8	6.2	.6	1.1	665	675			6.2
10002	0062	AAF	.07 CD	.97	2.8	2.8	.6	.8	640	680			5.6
10002	0073	AAF	.07 CD	1.01	2.6	2.5	.6	.9	630	660			5.8
10002	0022	AAF	.07 CD	1.05	8.2	7.6	.5	1.0	690	705			7.2
10002	0045	AAF	.07 CD	1.09	6.0	5.6	.6	.9	660	675			6.5
10002	0064	AAF	.07 CD	.99	5.8	5.5	.7	.7	620	630			6.1
10002	0020	AAF	.07 CD	1.09	4.8	4.6	.7	.9	650	640			6.6
10002	0051	AAF	.07 CD	1.06	2.6	2.5	.6	.8	665	640			6.1
10002	0040	AAF	.07 CD	1.07	6.8	6.4	.8	.9	655	630			6.8
10002	0079	AAF	.07 CD	1.07	2.6	3.2	.6	.1	645	555**			6.2
10002	0082	AAF	.07 CD	1.06	2.6	3.2	.6	.2	640	620	3.5		6.4

NOTE: BRIDGE WIRE RESISTANCE DOES NOT INCLUDE LEADS

10002

NOTES: * TRANSDUCER S/N 10972 HAS LOOSE CONNECTION
** TRANSDUCER S/N 12295 " " "

SPECIMEN FAILED
SPECIMEN PASSED ✓
F.R. WRITTEN

TESTED BY ENGINEERING TEST DEPT.
WITNESS
APPROVED BY D. Dorsey
SHEET NO. 3 OF 19

ENG. BK. FORM G

P.O.No.: M5H3XA-650005
Contr.No: NAS9-150

SPACE ORDNANCE SYSTEMS, INC.

DATA SHEET

CUSTOMER NAA/S&ID
Initiator

JOB NO. 2047
REPORT NO. 1055
DATE: 2-28-65
AMBIENT TEMP. 65±10°F
PHOTO.
TEST MEDIUM
TEMP. AMBIENT

PART NO. SO1-266-7 ME453-0009-0007
SPEC. TP 5021B
PARA. 4.4.1, 4.3.7 ALL FIRE CURRENT TEST ROOM TEMP
S/N Noted Group A

MANUFACTURER
INSTRUMENTATION
S/N
RANGE
RATED
ACCURACY

28 VDC Applied — Record Milliamperes

POST FIRE CURRENT TEST

MEMBER NO. Code	Serial	Lot	A-B	C-D	AB-CD	Pins to Case
10002	0097	AAF	2.20	0.69	2.00	0.61
10002	0030	AAF	2.60	3.10	1.90	0.23
10002	0047	AAF	2.00	0.015	2.90	0.66
10002	0046	AAF	0.90	0.001	0.90	0.86
10002	0069	AAF	0.88	0.002	1.38	0.43
10002	0039	AAF	Bridgewire Burnout - No Fire			
10002	0089	AAF	0.004	0.006	0.008	0.009
10002	0035	AAF	22.0	1.00	18.0	1.30
10002	0036	AAF	0.001	3.20	46.0	0.11
10002	0054	AAF	Bridgewire Burnout - No Fire			
10002	0086	AAF	0.002	0.002	0.015	0.028
10002	0023	AAF	1.40	1.00	18.0	0.68
10002	0063	AAF	0.002	0.002	0.006	0.02
10002	0076	AAF	2.50	0.002	0.006	0.044
10002	0091	AAF	0.004	0.009	0.008	5.10
10002	0015	AAF	5.50	3.00	2.90	3.50
10002	0032	AAF	5.20	0.46	2.00	1.00
10002	0025	AAF	4.00	0.026	0.24	0.012
10002	0061	AAF	0.001	0.002	0.002	0.019
10002	0067	AAF	0.47	0.006	2.00	0.46
10002	0073	AAF	0.004	0.005	0.12	0.17
10002	0022	AAF	24.0	7.80	18.0	8.00
10002	0045	AAF	6.20	32.0	28.0	18.0
10002	0064	AAF	0.001	0.001	0.001	0.002
10002	0020	AAF	0.004	2.00	0.006	2.50
10002	0051	AAF	0.001	5.20	0.001	0.006
10002	0040	AAF	3.20	0.008	0.26	0.16
10002	0079	AAF	~~0.055~~ 0.05	0.001	0.012	0.003
10002	0082	AAF	1.20	1.80	4.20	2.00

SPECIMEN FAILED
SPECIMEN PASSED
F.E. WRITTEN

TESTED BY ENGINEERING TEST DEPT. [illegible]
WITNESS [illegible]
SHEET NO. 6 OF 19

APPENDIX IV

Failure Reports and Analysis

FAILURE ANALYSIS REPORT

FOR

NASA/LANGLEY

Non-Conductive Mix 200
Apollo Standard Initiator

FAR #156

16 November 1967

Engineering Report Number ER-6356

FAILURE ANALYSIS REPORT
SPACE ORDNANCE SYSTEMS, INC.

REPORT # FAR #156
DATE 11/16/67
ER 6356

USTOMER NASA/Langley	P.O. NAS1-7471	DATE 8/30/67	R.R. 10066	NOD --
O PART NAME Non-Conductive ASI	SOS PART NUMBER SO1-266-21		L/N BRR	JOB NO. 2835
USTOMER PART NAME N A	CUSTOMER PART NUMBER N/A		S/N He Leaker 0328 0338 Dudded	
YPE OF TEST AT TIME OF FAILURE 0328 Helium Leakage, 0338 Destructive Lot Acceptance			PERFORMED BY: Eng. Test	
E T PROCEDURE:	REV. NO.:		PARA. NO.:	
AILURE REPORTED TO: N SA/Langley			DATE:	

ODE OF FAILURE:
See Attached

AUSE OF FAILURE:
See Attached

AILURE ANALYSIS:

See Attached

O CLUSIONS AND RECOMMENDATIONS:

See Attached

OI RECTIVE ACTION:

See Attached

AILURE ANALYSIS PREPARED BY:
V. Klever

EFFECTIVITY:

IS TRIBUTION:

gr. Eng. Analysis
ng Availability
RE Coordinator
gr. Eng. Design & Dev.
ng neer
ua ity Control Mgr.

APPROVED

Engineer	[signature]	Date 11-21-
Mgr. Eng. Design & Development		Date
Mgr. Eng. Analysis	[signature]	Date 11-21-
V.P. Engineering	[signature]	Date 12/
Mgr. Q. C:	[signature]	Date 12-7-

ustomer, (Yes) No
overnment QAR, Yes (No)

Page IV-2

GENERAL

Two (2) failures occurred during evaluation testing of the Non-Conductive Apollo Standard Initiator.

S/N 0328 exhibited excessive leakage after temperature cycling at +300°F. The phenomenon will be evaluated under Section "A" of the following report.

S/N 0338 misfired upon application of a 22 amp firing pulse after being conditioned at -265°F. The failure will be evaluated under Section "B" of the following report.

The report describes the inspections and tests performed to establish the respective failure modes.

Copies of Drawings, 1-266-21 Initiator Assembly and 1-656 Pin Header Assembly are attached as cross reference material. These will also acquaint NASA/Langley personnel with the details of construction of the Non-Conductive Apollo Standard Initiator.

SECTION "A"
S/N 0328, Helium Leaker

FAILURE ANALYSIS

Manufacturing Records

Manufacturing records were researched in an effort to locate anomalies which would contribute to a subsequent helium leak failure.

The initiator successfully completed helium testing at operation #16 of the process traveler. This test is performed after soldering the 1-656-4 pin header into the 1-717 body.

The initiator successfully completed helium leak testing at operation #46 of the process traveler. This test is performed after pressing of the SOS-200 initiation charge.

The initiator was again helium leak tested at operation #61 of the process traveler. This test is performed after welding of the 1-596-6 cup.

Non-Destructive Lot Acceptance Test Records

Test records indicate S/N 0328 passed the 1×10^{-6} helium leak test requirement during non-destructive testing.

Evaluation Testing

The initiator which was a part of Group B was subjected to humidity, vibration and temperature cycling. Following these tests the initiator exhibited a helium leakage in excess of specification requirements.

A preliminary analysis was conducted which isolated the leakage to the connector end, the initiator was released for test firing. The suspected reason for failure to pass helium leak test was a separation of SOS-100 epocast from the connector pins in the connector end of the initiator. This condition allows helium to become entrapped in the plenum between the potting compound and the pin header assembly. Helium can also be entrapped between the pin header and the initiator body in sufficient quantities to exhibit a false indication of leakage.

It was shown that the only true indication of helium leakage integrity was a through leak test. It was agreed between project engineering and reliability that the initiator could be fired and subsequently be subjected to a through leak test without clouding the results of the failure analysis. This constitutes a more severe test than removal of the 1-596-6 cup, removal of the explosive charges and conducting a through leak test. Additionally the heat generated by firing is insufficient to generate temperature in the pin seal and to melt the solder seal and thereby either cause or repair a leak

The initiator was fired and subsequently exhibited a helium leak integrity in excess of specification requirements.

The initiator was glass beaded to remove firing residue which could conceivably seal a leakage path from pins to ceramic in the charge area of the pin header assembly.

This also removes residue on the outer circumference of the pin header assembly above the ceramic to body solder seal. Helium leak testing performed at this time shows the initiator exceeds the 1×10^{-6} requirement. Actual reading is 1.1×10^{-8}.

CONCLUSIONS

The helium leakage exhibited during evaluation testing was an erroneous indication. The solder seal (1-656-4 Header Assembly to the 1-717 body) and the silver solder seal (-101 Pins to -100 Header) is intact and demonstrates a capability to pass a through helium leakage requirement.

A review of the 1-266-21 initiator assembly and 1-656 pin header assembly drawings reveal that a plenum exists between the two assemblies, migration of helium can occur into this area if a satisfactory seal is not achieved between the SOS-100 epocast and the connector pins. Since this is a false indication of leakage, it is not considered a failure.

The initiator will be maintained in its present status pending acceptance of this failure analysis.

SECTION "B"
S/N 0338, Misfired at 22 Amps

FAILURE ANALYSIS

Manufacturing Records

Manufacturing records were researched in an effort to locate anomalies which would contribute to the failure. No rejections were recorded against initiator S/N 0338 during the manufacturing sequence.

The production operators responsible for the loading operations were trained and certified for the operations they performed.

The SOS-200 initiation charge used for slurry and initiation charge loading was from powder lot control record (PLCR #192). The lot was acceptance tested and accepted by Quality Control in May of 1967.

Non-Destructive Lot Acceptance Test Records

The following data was recorded during testing:

a) Helium Leakage: Better than 1×10^{-6}
b) Bridgewire Resistance: A-B 1.00, C-D 1.00
c) Insulation Resistance: 20K megohms

Evaluation Testing

The initiator which was a part of Group B was stabilized at -265°F and did not ignite when energized with a current of 22 amps.

Determination of Failure Mode

The 1-596-6 was machined off below the crimped portion of the initiator. The 1-286.11 and SOS-108 main charge was removed. The SOS-200 initiation charge was removed remaining relatively intact.

Color photos identified as Figure 1 and Figure 2 depict the condition of the SOS-200 initiation charge increment and the energized bridgewire.

Photos identified as Figure 1 shows metal particles (bridgewire materials) impregnated into the SOS-200 initiation mix. A color gradation is distinctly discernable in the initiation mix adjacent to the bridgewire extending the entire length of the bridgewire.

NOTE: The color gradation is an apparent difference of homogeneity in the SOS-200 initiation charge. During manufacturing, the SOS-200 initiation charge is mixed with a solvent and slurried or painted onto the 110733 bridgewires to ensure intimate contact (bridgewires to SOS-200 initiation charge). The remaining SOS-200 initiation charge is pressed over the bridgewires in a dry state.

Observed results of the pressed SOS-200 initiation mix Ref: Figure 1. White specks of the oxidizer material can be observed throughout the surface of the mix. The entire mix is a light gray color.

Observed results of the slurried or painted initiation mix adjacent to bridgewires Ref: Figure 1. The mix appears to be considerably darker and finer in texture than the pressed SOS-200 initiation mix. The white specks of oxidizers are not distinguishable in this mix. The entire mix is a darket gray than the pressed SOS-200 initiation mix.

Summary of SOS-200 Initiation Charge

The average particle size of the fuel is approximately 20% the average size of the oxidizer. The fuel is a dark brown color while the oxidizer is white.

Particles of oxidizer and fuel in a total homogeneous mix would not be distinguishable to the extent observed.

The SOS-200 Initiation powder is blended with a solvent prior to the slurry or paint of the bridgewire. A small quantity of the material is picked up by a 000 brush and deposited on and around each bridgewire. The solvent is then driven off and the remaining SOS-200 initiation charge is pressed into place. Heavy particles would tend to precipitate out of the slurry solution leaving a fuel rich mixture at the top.

Conclusions, S/N 0338

The bridgewire ignition was normal and should have supplied the energy necessary to reliably ignite the SOS-200 initiation charge.

The SOS-200 initiation charge slurried or painted on and around the bridgewires is fuel rich and therefore not stoichiometric. Best ignition occurs when the mix is stoichiometric or very slightly fuel rich. Both ignition and burning characteristics drop off rapidly as the mix varies from stoichiometry. It is therefore concluded that the failure mode is attributed to this increment of the SOS-200 charge.

The SOS-200 initiation charge pressed into the 1-656-4 Header Assembly did not exhibit total homogeneity. This however was not the cause for failure because the white specks are uniform and fairly evenly distributed. This condition would adequately supply the necessary oxygen for complete burning once the mix was ignited. This was demonstrated on the remaining units in the lots which were fired and which exhibited normal characteristics.

MODIFIED S01-266-21

Six (6) additional S01-266-21 initiators were manufactured. This was done to prove that a modified slurry application technique would provide a positive corrective action. The initiators were identical to those utilized in Evaluation Test Report 6330 with the exception of bridgewire slurry mixing and application.

Non-Destructive Lot Acceptance Testing

Non-destructive Lot Acceptance Testing was conducted per Test Procedure (TP) 5025, paragraph 4.0.

Temperature Cycling

Temperature Cycling was performed per TP-5021.

Destructive Firing Tests

Destructive Firing Tests were performed per TP-5021, paragraph 4.3.9. All firings were made with 22 amps, at -260°F.

Summary of Test Results

S/N's 0001, 0004, and 0005 fired when pulsed with 22 amps, S/N 0005 produced a peak pressure of 840 psi which is in excess of specification requirements (775 psi max.).

S/N's 0002, 0003, and 0006 failed to fire when pulsed with 22 amps.

Copies on non-destruct lot acceptance test data and destructive lot acceptance test data (pressure-time traces) are included in this report identified as Figure 3 and 4, respectively.

ANALYTICAL STUDIES

Recurrence of the failures experienced in paragraph, Modified S01-266-21, resulted in the following evaluation. The study compares the Apollo Standard Initiator (ASI) to the Non-Conductive Apollo Standard Initiator or (NCASI) as a basis for heat transfer and ignition sensitivity.

The ASI is characterized by a .002 Nilstain Bridgewire which has approximately a 1-ohm resistance. It is designed for a normal all-fire current of 3.5 amps (minus 65^{o} to plus 300^{o}F) with a recommended firing current of 5.0 amps.

Theoretical studies of the mechanism of bridgewire ignition and related heat transfer have shown: when the firing current is higher than normal, there is a tendency for the bridgewire to burn out adiabatically before significant heat transfer is accomplished into the cool mix in immediate contact with the bridgewire. At low current (3.5 - 5.0 amps), the time lag from applying current to bridgewire burnout is dependent upon the thermal properties of the material in contact with the bridgewire. At low current, heat transfer plays an important role. Conversely, the heat transfer is negligible at high current levels.

Experiment

The following experiment was conducted to prove heat transfer from the bridgewires to the ignition mix at high current levels.

Four different type units were manufactured.

a. SOS-108 slurried bridgewire in ASI headers.
b. Bare bridgewire in ASI headers.
c. Stand-off bridgewire (in air) on SBASI pin headers.
d. Alumina pressed under 10,000 psi in ASI headers.

The units were then tested with applied currents of 3.5 amps, 5 amps, 10 amps, 15 amps, 20 amps, 25 amps, 30 amps, 35 amps and 40 amps. Current traces on the oscilloscope were recorded. The bridgewire burnout times are summarized in the following table.

BRIDGEWIRE BURNOUT TIME

APPLIED CURRENT AMPS	SOS-108 SLURRIED ASI HEADER	BARE BRIDGEWIRE ASI HEADER	STAND-OFF BRIDGEWIRE	ALUMINA COVERED ASI HEADER
3.5	3.0 msec	3.2 msec	3.4 msec	90 msec
5.0	1.1 msec	1.5 msec	1.7 msec	7 msec
10.0	340.0 μsec	470.0 μsec	450.0 μsec	920 μsec
15.0	180.0 μsec	220.0 μsec	240.0 μsec	360 μsec
20.0	160.0 μsec	150.0 μsec	180.0 μsec	200 μsec
25.0	100.0 μsec	130.0 μsec	130.0 μsec	145 μsec
30.0	95.0 μsec	120.0 μsec	110.0 μsec	95 μsec
35.0	95.0 μsec	110.0 μsec	105.0 μsec	85 μsec
40.0	90.0 μsec	100.0 μsec	125.0 μsec	110 μsec

Current traces are included in this report identified as Figure 5.

It can be seen that at lower currents, 3.5 to 5.0 amps, the time is dependent upon the material in contact with the bridgewire; at 10 to 15 amps, the difference is reduced, and at higher current, beyond 20 amps they are about the same within the experimental fluctuations. The fact that slurried bridgewire burned faster than bare bridgewire or stand-off bridgewire is due to the fact that slurry burns at lower temperature (680°F) before the bridgewire could reach its melting point.

This experiment has proven that the adiabatic burnout of the bridgewire occurs at high current. For bridgewire in contact with mixes which have much lower thermal diffusibility than the alumina, the adiabatic burnout could occur at a 15 amp current.

A Calculation to Prove the Adiabatic Burnout at High Current

The burnout time at 15 amps for the slurried bridgewire is about 200 μsec, assuming there is one ohm resistance. The heat generated in the bridgewire is:

$$1 \times 15^2 \times 200 \times 10^{-6} = 450 \times 10^{-4} \text{ joules} = 108 \times 10^{-4} \text{ calories}$$

On the other hand, the heat required to raise the temperature of bridgewire from the ambient (20°C) to its melting point (1400°C) is:

$$1380^\circ C \times \text{heat capacity of bridgewire} = 1380 \times 0.5 \times 10^{-5} = 69 \times 10^{-4} \text{ calories}$$

The latent heat required to melt the bridgewire is:

$$\text{Mass of bridgewire} \times \text{latent heat per gram} = 3.8 \times 10^{-5}\text{gm} \times 69 \text{ cal/gm} = 26 \times 10^{-4} \text{ calories}$$

The sum of the last two heat energies is:

$$69 \times 10^{-4} + 26 \times 10^{-4} = 95 \times 10^{-4}$$

If we considered the small amount of heat lost to the pin to bridgewire junctions, the heat generated by the bridgewire is equivalent to the heat to melt the bridgewire, and no heat is geing conducted out into the mix.

Failure at Low Temperature

When the bridgewire adiabatic burns out, the current stops. The cool mix can be heated up to the explosion temperature only through drawing heat from the melted bridgewire.

The melting point of nilstain 304 is 1400°C and the cold ambient is about -160°C, which gives a temperature differential of 1560°C.

According to the heat transfer theories ("Conduction of Heat in Solids" by Carslow and Jaeger, pages 54-56), the surface of the bridgewire quickly drops to about 40% of this temperature differential, i.e., the difference of temperature between the wire-mix interface and the ambient is:

$$1560 \times 40\% = 624^\circ C$$

which is enough to set off SOS-108 (explosion temperature 350°C) but too marginal for SOS-200 (explosion temperature 450-460°C), which could result in the failure of ignition.

The following conditions could result in a no-fire at high current levels and low temperature.

Slurry - A non-homogeneous slurry of improper application of the slurry to the bridgewires.

One-amp/one-watt no-fire tests - Tests have shown that initiators exposed to this condition exhibit longer rise times from bridgewire burnout to peak pressure when fired at low temperature and high current levels.

CONCLUSIONS

Based on the aforementioned tests and analyses it can be ascertained that:

a. Probability exists that due to the low thermal conductivity of the pyrotechnic compound combined with its relative insensitivity to ignition that the bridgewire can burn out before sufficient heat is transferred into the pyrotechnic compound to cause ignition.

b. That the utilization of higher temperature melted bridgewires or bridgewire configurations which would be more effective in conducting heat into the mix would tend to eliminate this problem area.

c. That increasing thermal reactivity of pyrotechnic compound should also improve the ignition capability of the unit.

1-266-21 INITIATOR: SERIAL NO. 0338, SOS 200 Pellet

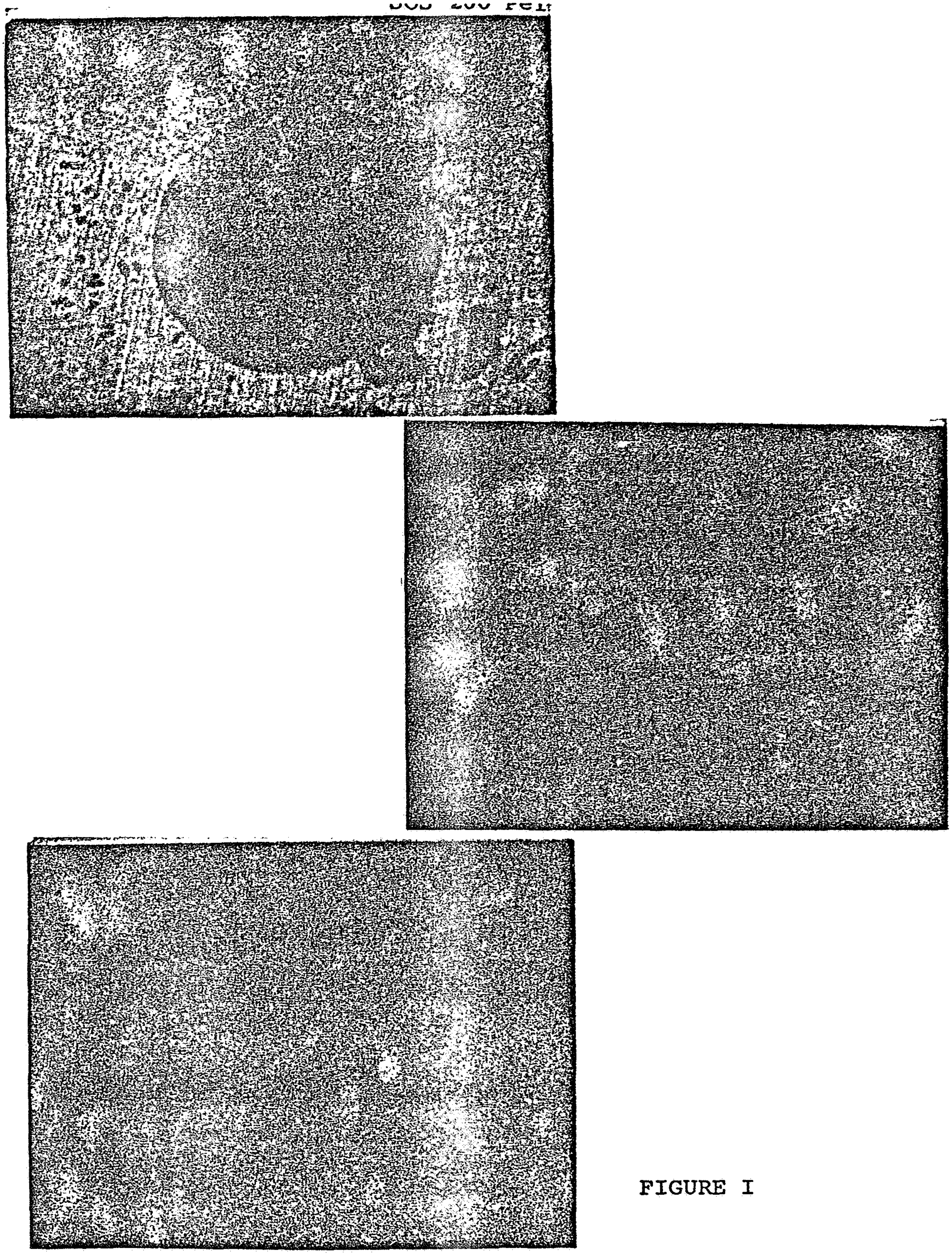


FIGURE I

1-266-21 INITIATOR: SERIAL NO. 0338 Pin-Header Assembly Bridge Area

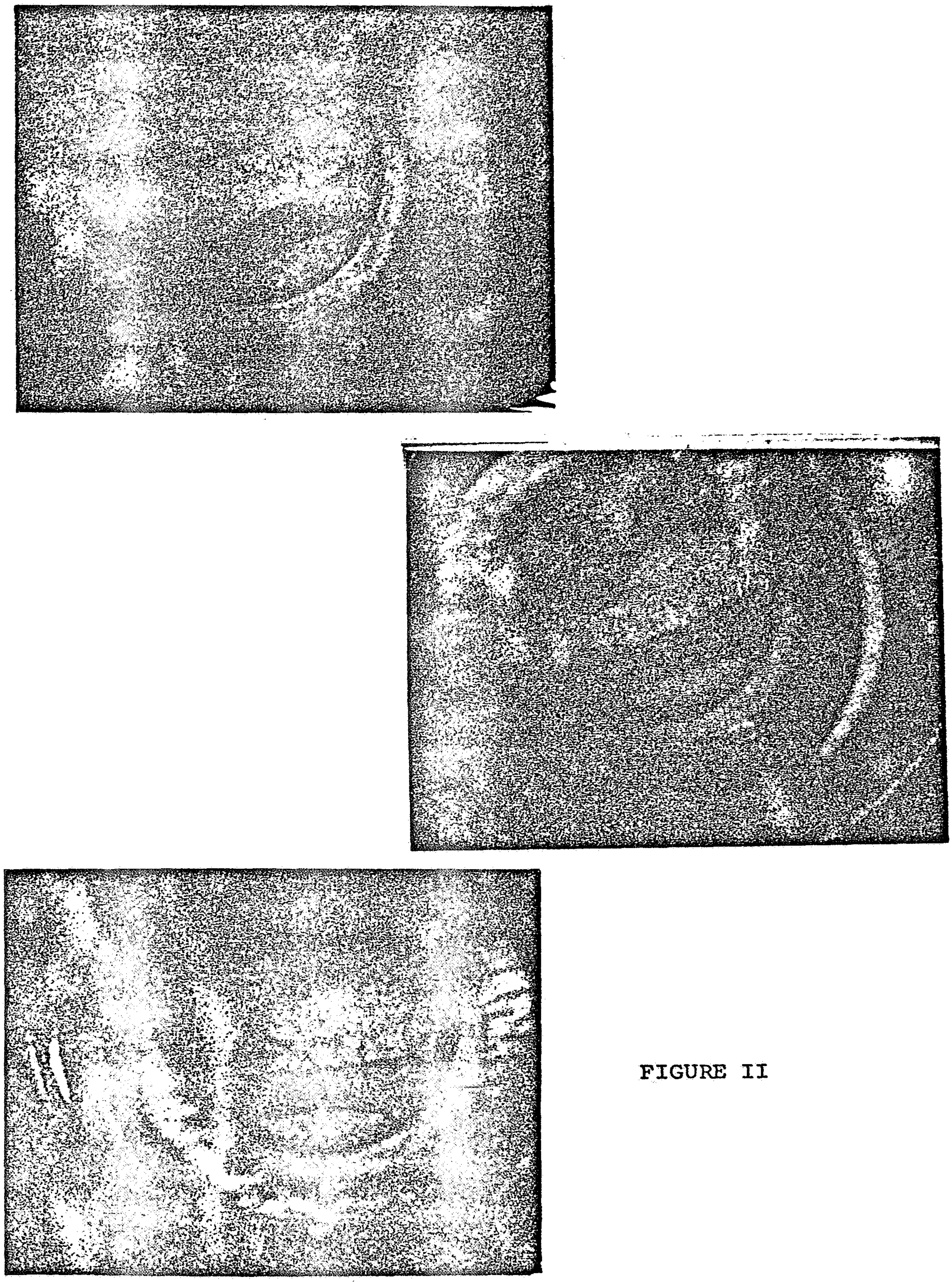


FIGURE II

SPACE ORDNANCE SYSTEMS, INC.

FAR #156
16 November 1967
(ER-6356)

ACCEPTANCE TEST DATA SHEET (POST TEMPERATURE CYCLING TEST)

ITEM: Initiator (Non Cond. Mix.) CUSTOMER P/N:
SOS P/N: S01-266-21 CUSTOMER SPEC:
SOS TEST PROC.: 5021-B CONT/P.O. NO.: NAS 1-74711

SOS JOB NO: 2835
TOTAL ACCEPT REJECT

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	EXAMINATION OF PRODUCT	BRIDGEWIRE RESISTANCE OHMS PINS A-B	INSULATION RES. PINS TO CASE OHMS MIN RECORD MEGOHMS	* BOMB: METER DEFLECTION	BOMB: SCALE FACTOR (PRE-CALIB. .16X10 / POST-CALIB. .16X10)	BOMB: ACTUAL HELIUM LEAK RATE 1 X 10-6 CC/SEC MAXIMUM	* ENVIRONMENTAL SEAL: METER DEFLECTION	ENVIRONMENTAL SEAL: SCALE FACTOR (PRE-CALIB. .16X10 / POST-CALIB. .16X10)	ENVIRONMENTAL SEAL: ACTUAL HELIUM LEAK RATE 1 X 10-4 CC/SEC MAX.	* HELIUM LEAK TEST REMARKS
1	0001	N/A	N/A	N/A	.58	10	2.4×10^{-7}	.47	100	2.0×10^{-6}	
2	0002				.45	10	1.9×10^{-7}	.64	100	2.7×10^{-6}	
3	0003				.42	10	1.8×10^{-7}	.46	100	1.9×10^{-6}	
4	0004				.40	10	1.7×10^{-7}	.68	100	2.9×10^{-6}	
5	0005				.42	10	1.8×10^{-7}	.64	100	2.7×10^{-6}	
6	0006				.34	10	1.4×10^{-7}	.59	100	2.5×10^{-6}	
7											
8											
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24											
25											
	TEST TECH (INITIAL)				[illegible]	[illegible]		[illegible]	[illegible]	RM	APPROVAL SIGNATURES
	DATE				11-2-67	11-2-67		11-2-67	11-2-67	11-2-67	
STAMPS	WITNESS (SOS)										
	WITNESS (CUSTOMER)										
	WITNESS (GOVT.)										

SPACE ORDNANCE SYSTEMS, INC.

ACCEPTANCE TEST DATA SHEET

FAR #156
16 November 1967
(ER-6356)

ITEM: Initiator (Non Cond. Mix.) CUSTOMER P/N: SOS JOB NO. 2835
SOS P/N: S01-266-21 CUSTOMER SPEC: TOTAL ACCEPT REJECT
SOS TEST PROC.: 5021-B CONT/P.O. NO:

ITEM COUNT	MEMBER NUMBER CODE SERIAL LOT	CIRCUIT RESISTANCE OHMS	POST FIRE CURRENT LEAKAGE ____ MILLIAMPERES MAXIMUM: PIN A TO B	PIN C TO D	PINS AB–CD	PINS TO CASE	CURRENT APPLICATION TO PEAK PRESS. ____ MILLI-SECONDS MAX.	PEAK PRESSURE ____ TO ____ PSIG	Firing Current (Amps)	
1	0001	.93	0.1	0.1	750	.01	3.2	790	22.0	
2	0002	.78	—	—	—	—	—	—		DID NOT FIRE
3	0003	.90	—	—	—	—	—	—		DID NOT FIRE
4	0004	.88	.01	.01	.01	.01	5.3	780		
5	0005	.84	.01	.01	.01	.01	5.9	840		
6	0006	.82	—	—	—	—	—	—	22.0	DID NOT FIRE
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
/	TEST TECH (INITIAL)						RM	RM		APPROVAL SIGNATURES
/	DATE						11/2/67	11/2/67		
STAMPS	WITNESS (SOS)									
	WITNESS (CUSTOMER)									
	WITNESS (GOVT.)									

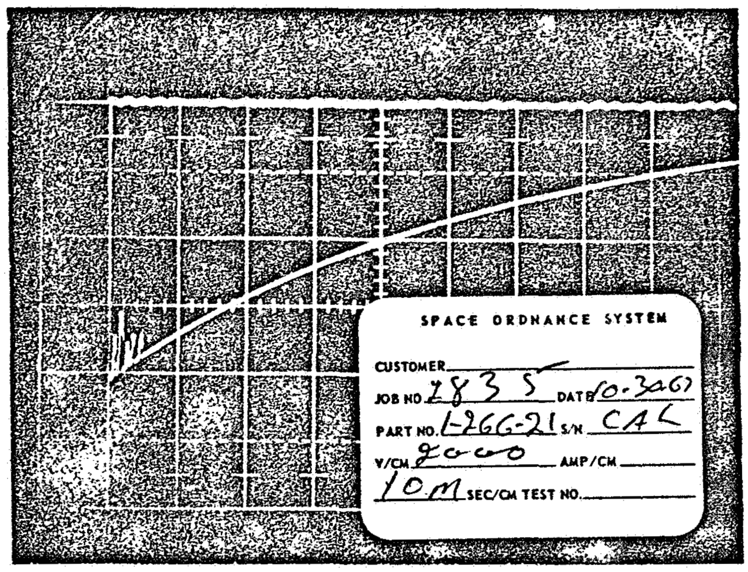
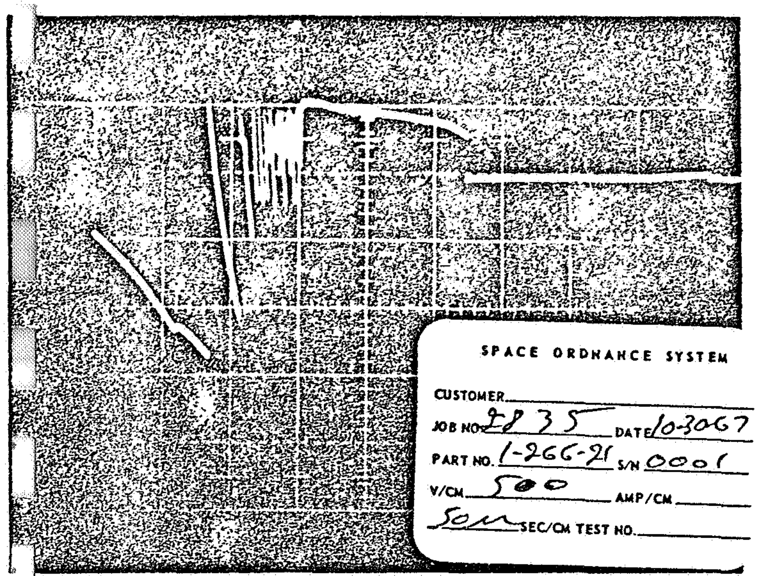
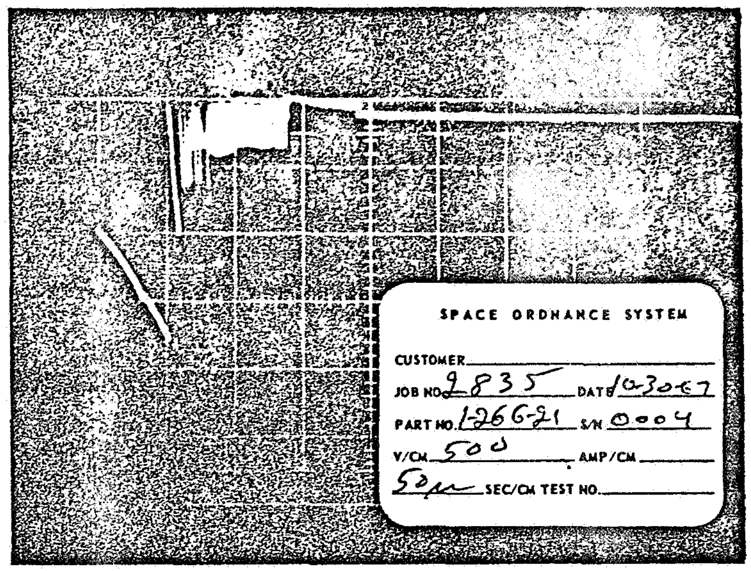
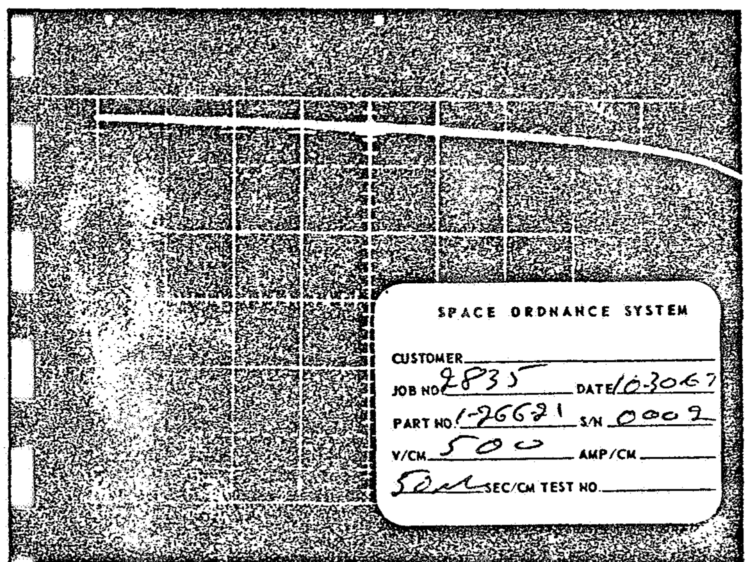

SPACE ORDNANCE SYSTEM
CUSTOMER
JOB NO 2835 DATE 10-30-67
PART NO. 1-266-21 S/N CAL
V/CM 2000 AMP/CM
10 M SEC/CM TEST NO.

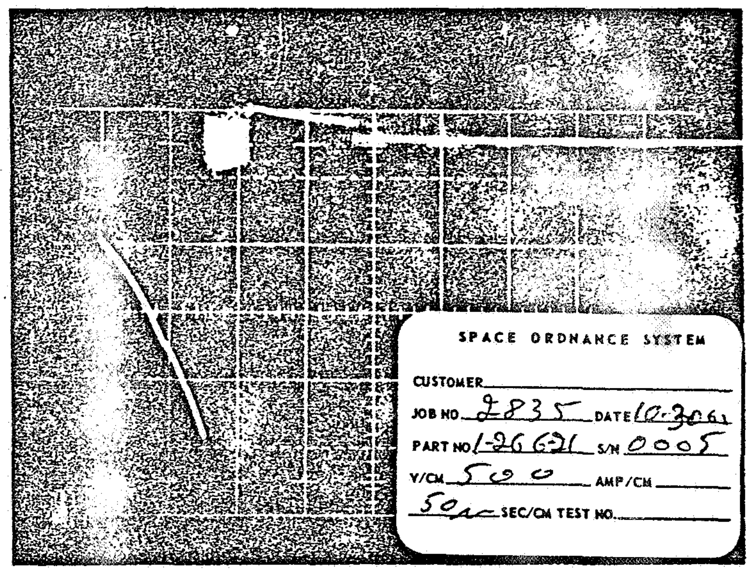
Figure 4

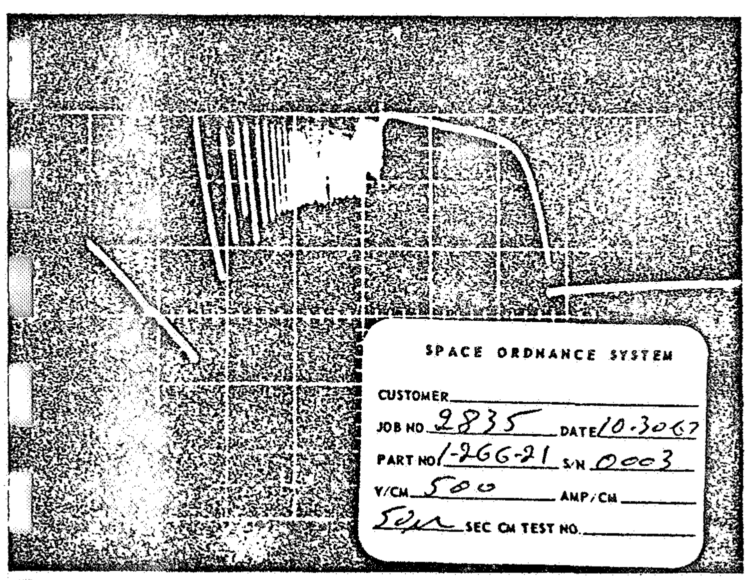
SPACE ORDNANCE SYSTEMS, INC.











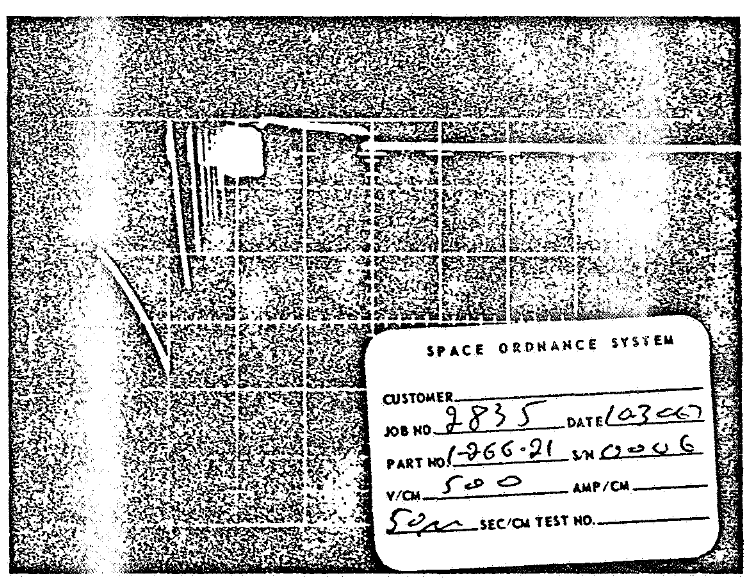
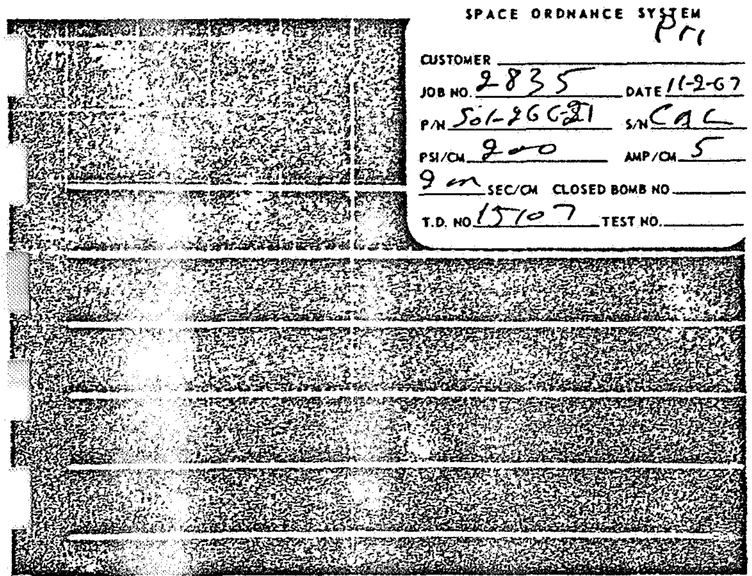
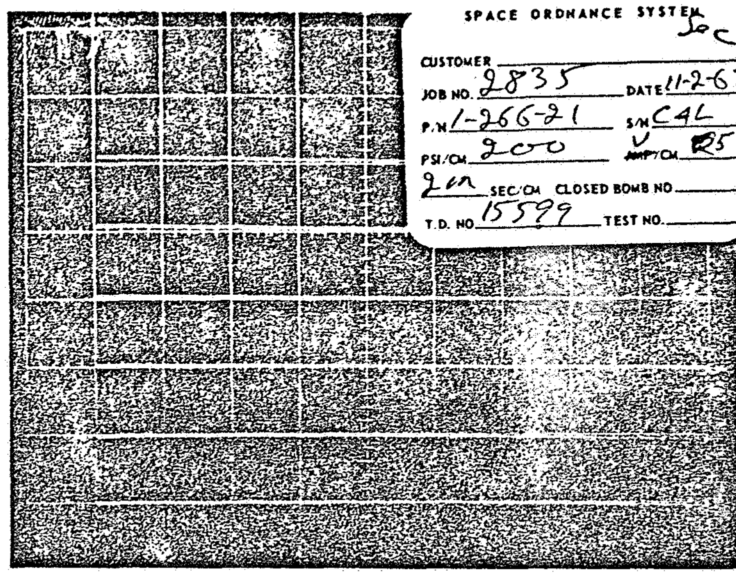
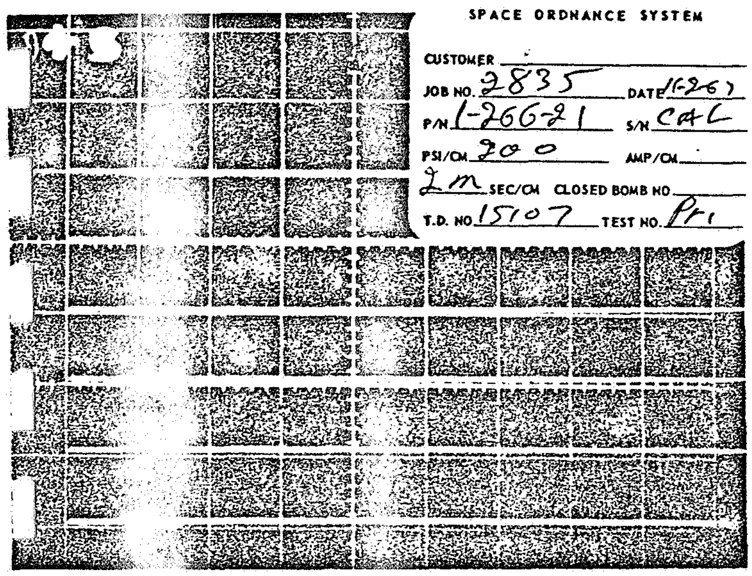


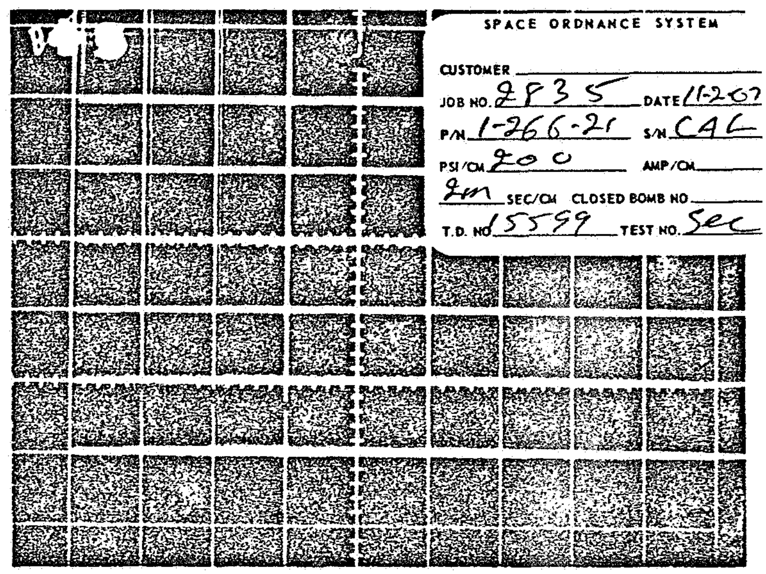
Figure 4

SPACE ORDNANCE SYSTEMS, INC.









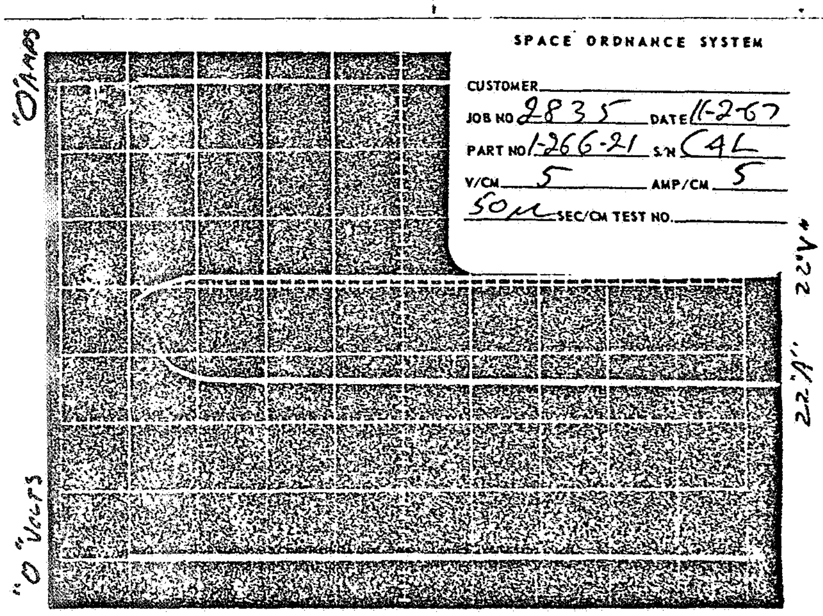
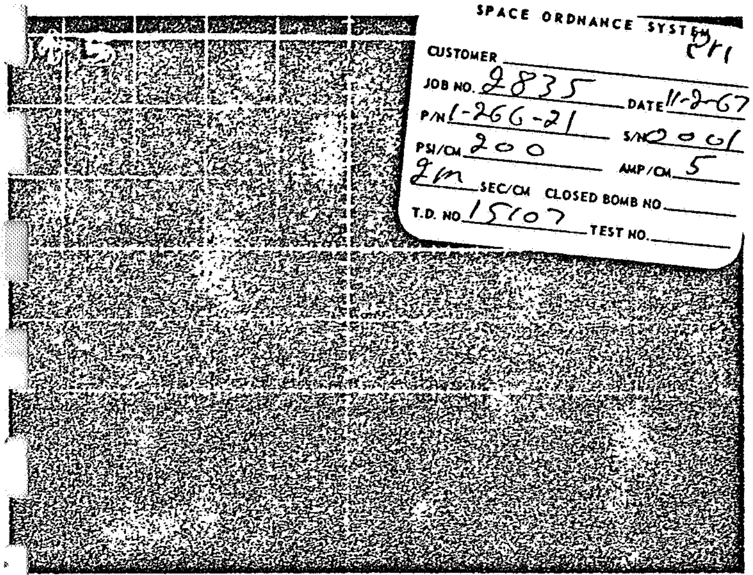
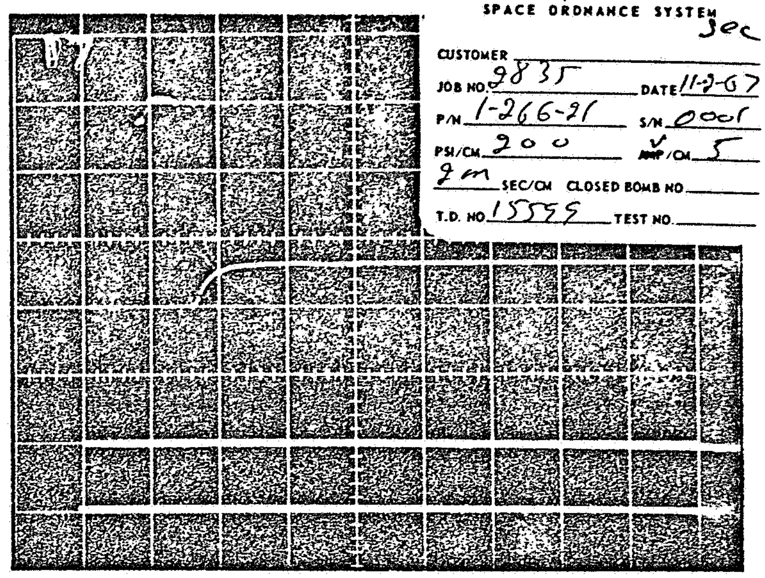
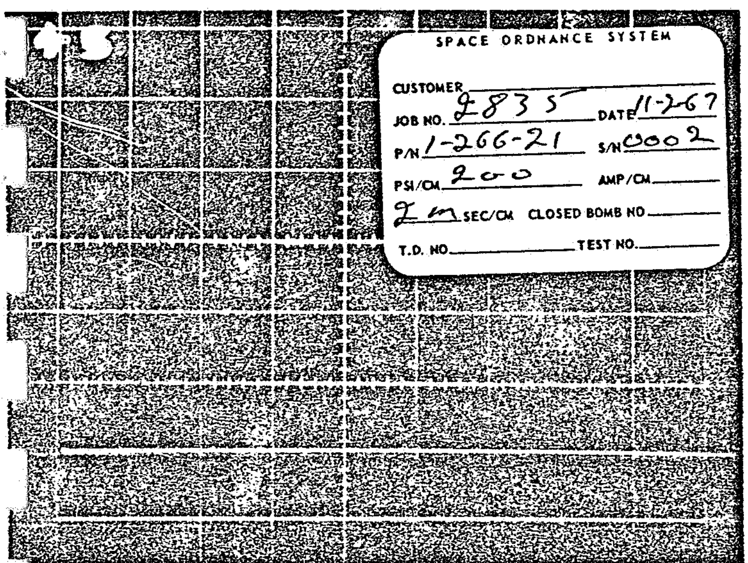


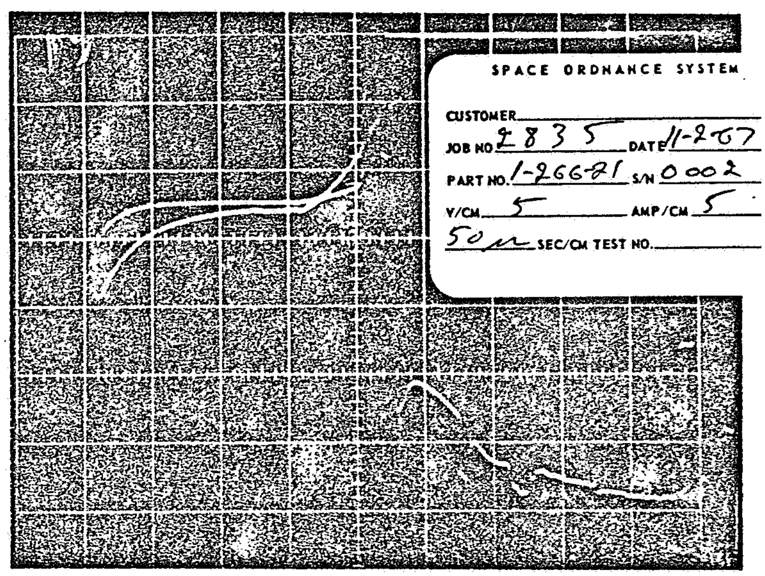
Figure 4

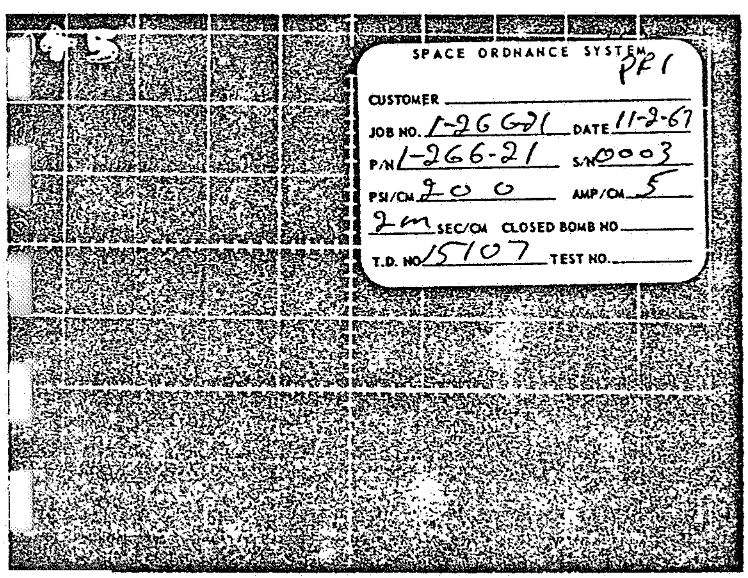
SPACE ORDNANCE SYSTEMS, INC.











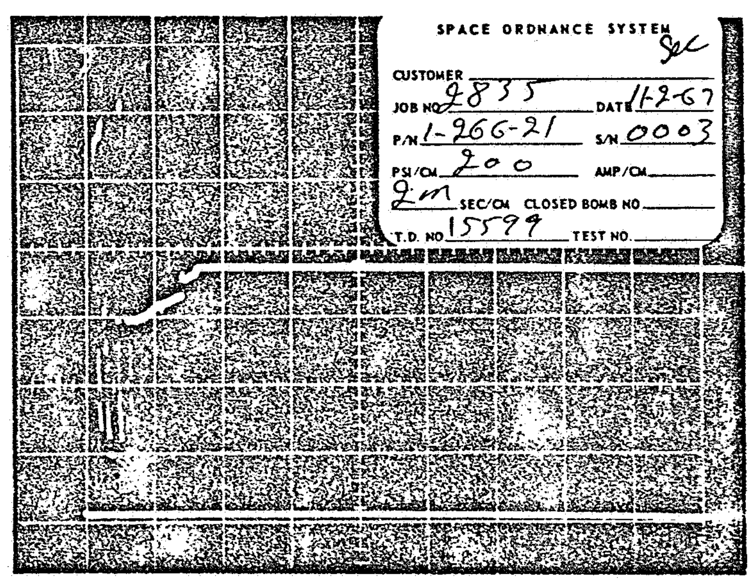
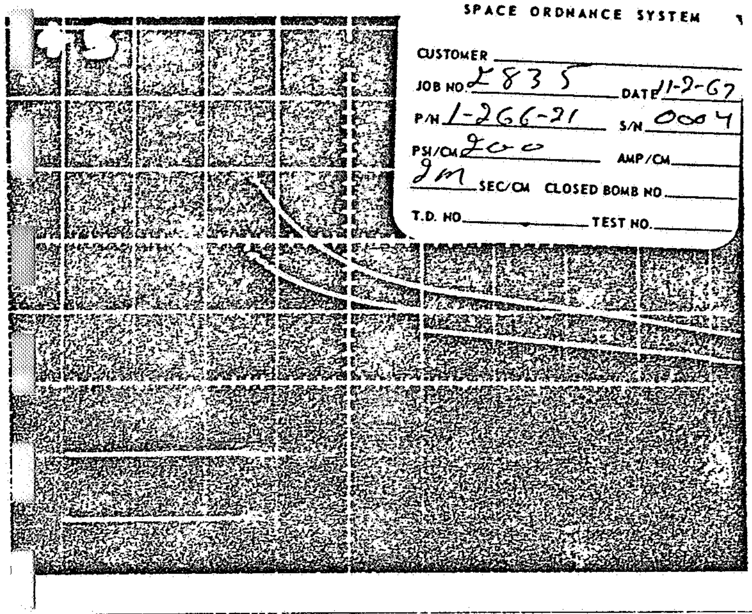
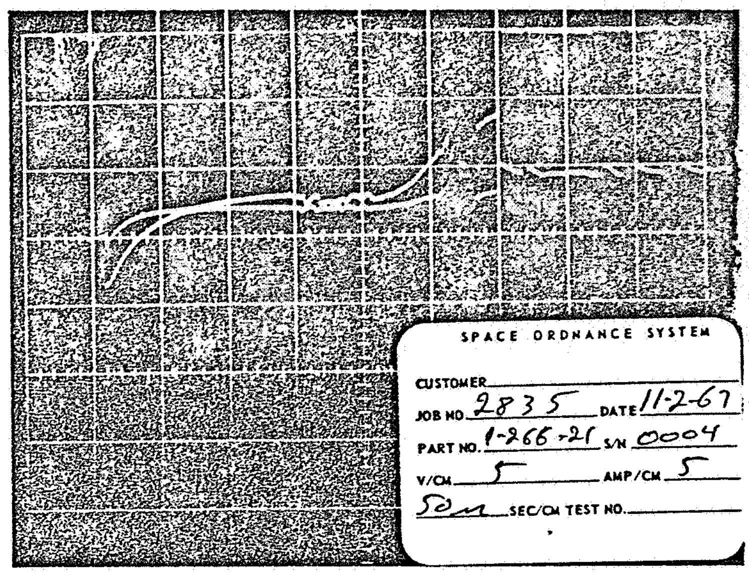
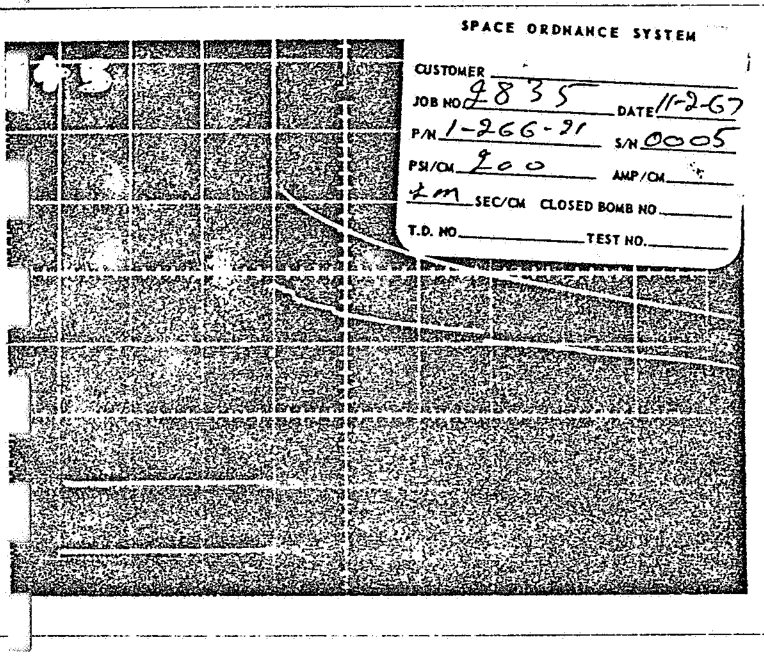


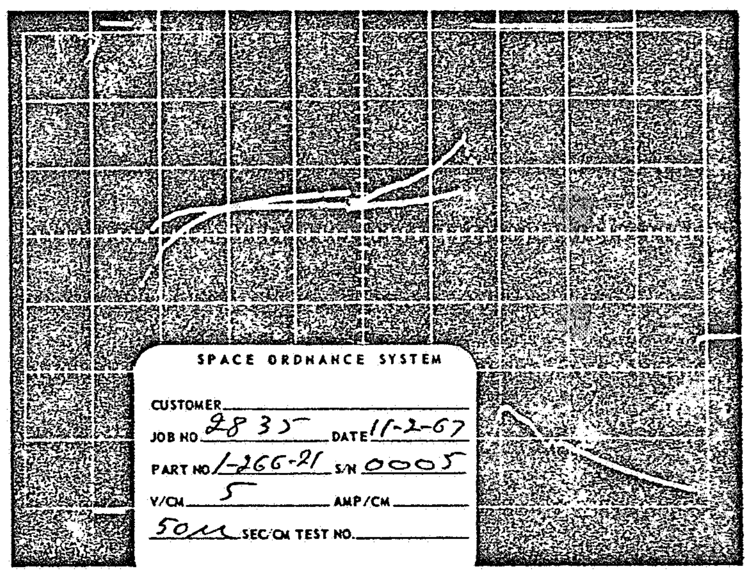
Figure 4

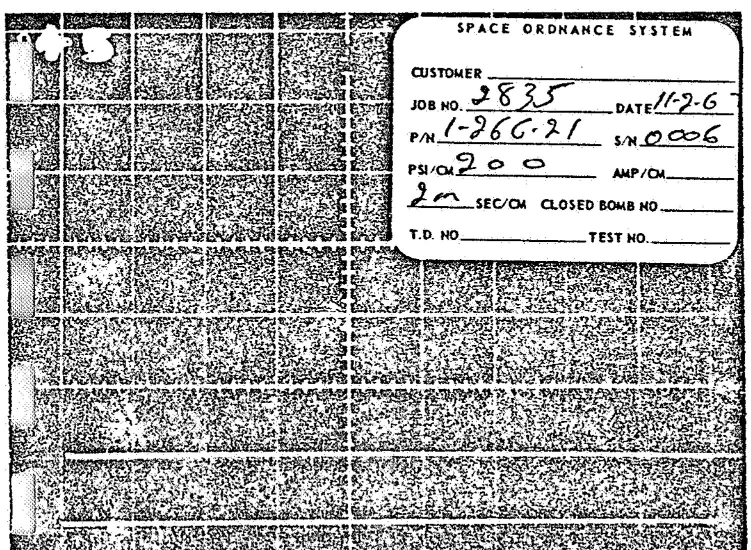
SPACE ORDNANCE SYSTEMS, INC.











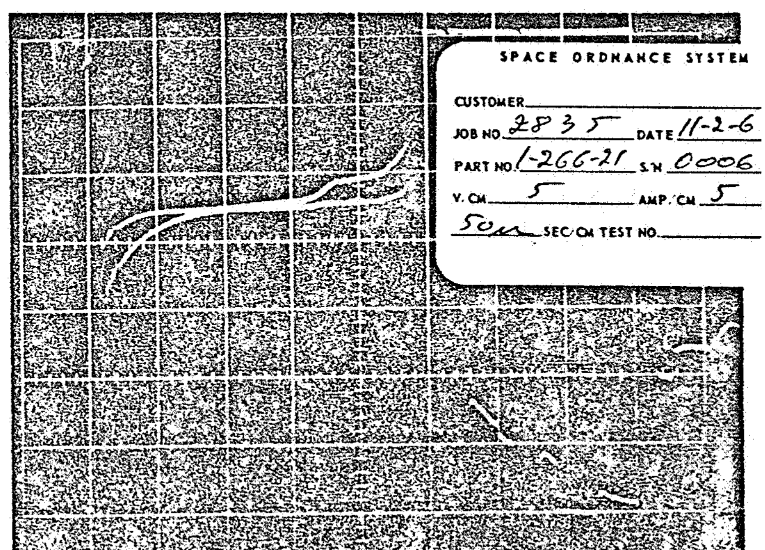
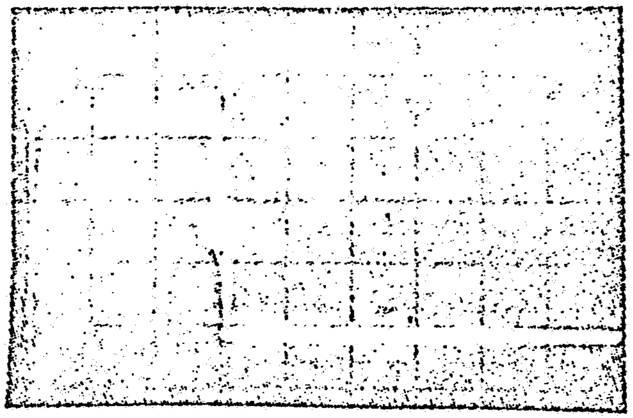
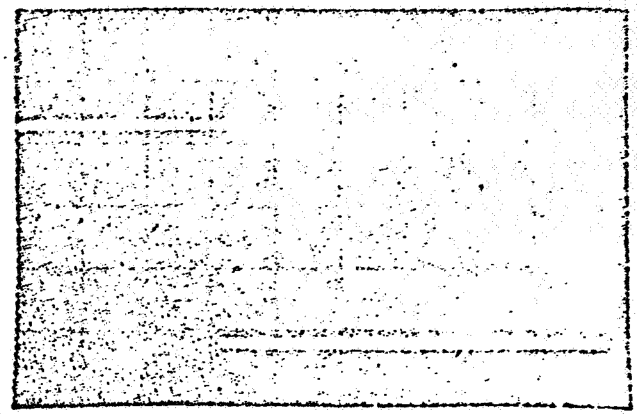


Figure 4

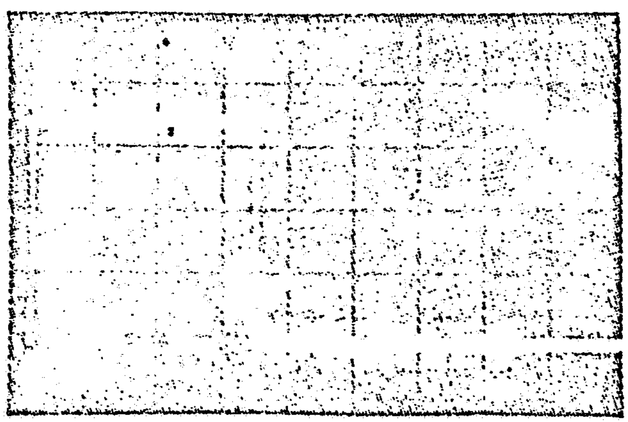
CURRENT TRACE @ 3.5 AMP



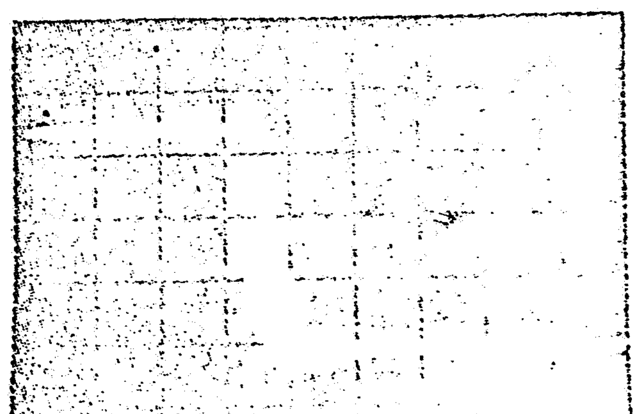
108 Slurried B.W.
ASI Header
1 Amp/cm
1 msec/cm



Bare B.W.
ASI Header
1 Amp/cm
1 msec/cm



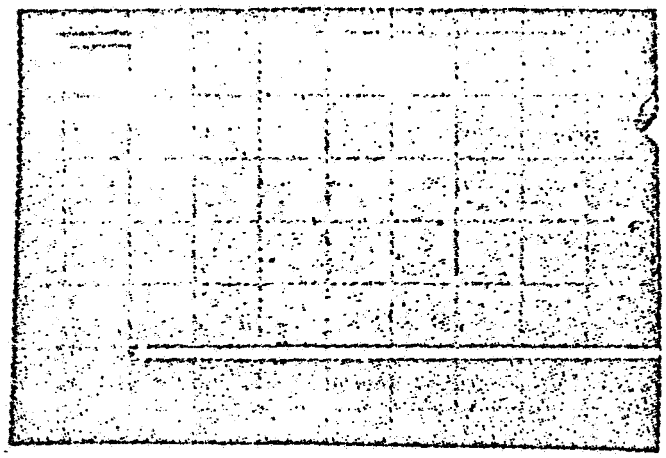
Stand off B.W.
1 Amp/cm
1 msec/cm



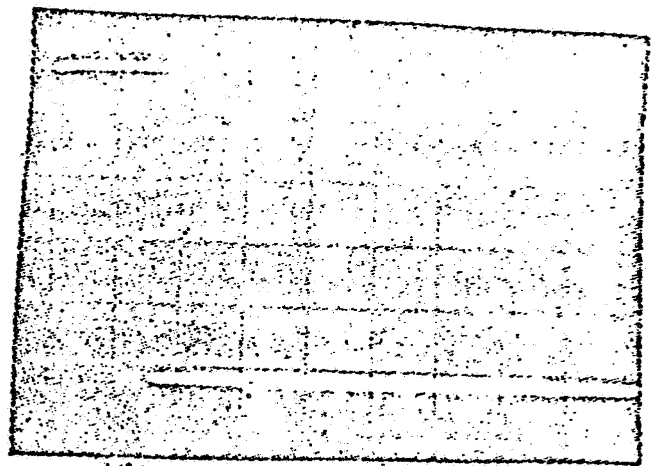
Alumina covered B.W.
ASI Header
1 Amp/cm
20 msec/cm

Figure 5

CURRENT TRACE @ 5.0 AMP

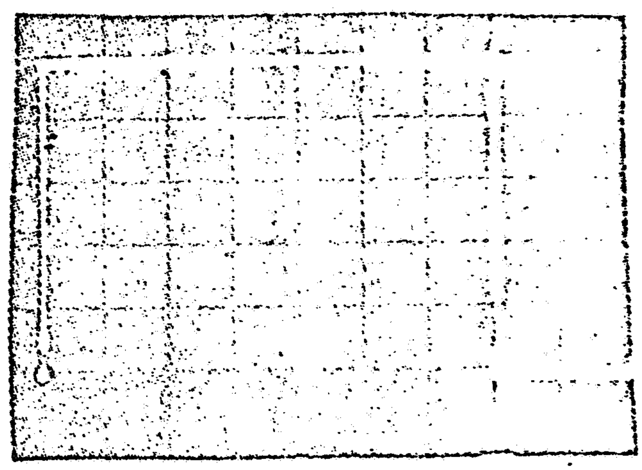


108 Slurried B.W.
ASI Header
1 Amp/cm
1 msec/cm



Bare B.W.
ASI Header
1 Amp/cm
1 msec/cm

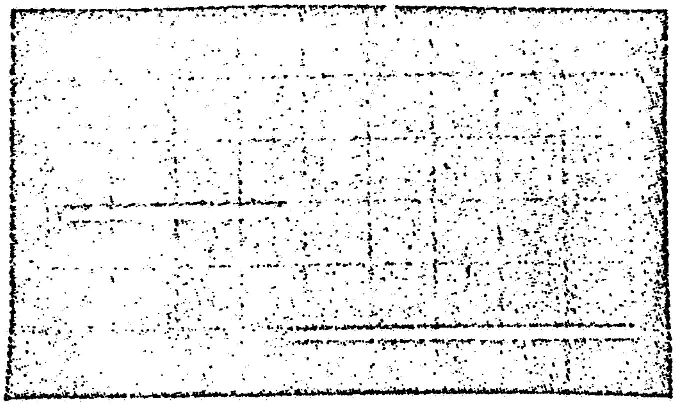
Stand off B.W.
1 Amp/cm
1 msec/cm



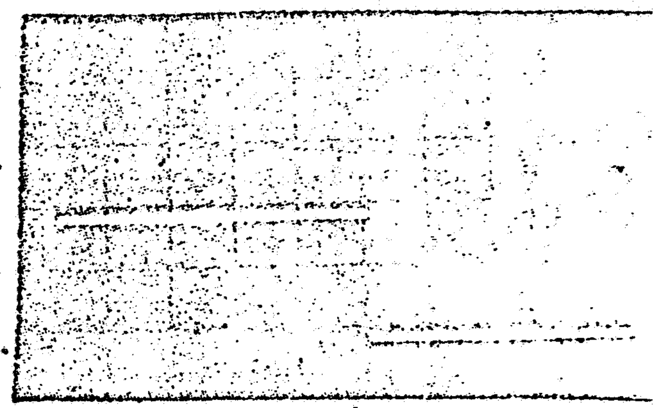
Alumina covered B.W.
ASI Header
1 Amp/cm
1 msec/cm

Figure 5

CURRENT TRACE AT 10.0 AMP

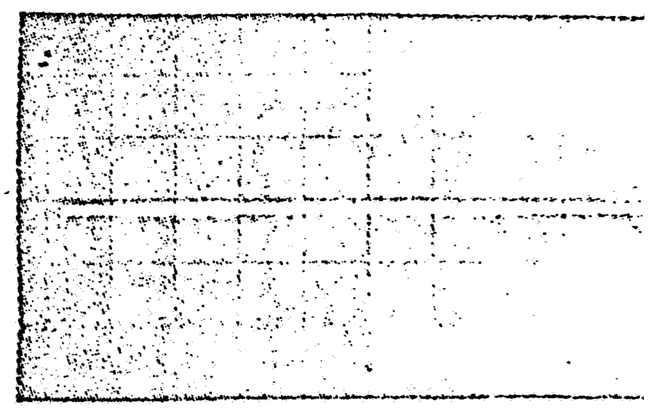


108 Slurried B.W.
ASI Header
5 Amp/cm
100μ sec/cm



Bare B.W.
ASI Header
5 Amp/cm
100μ sec/cm

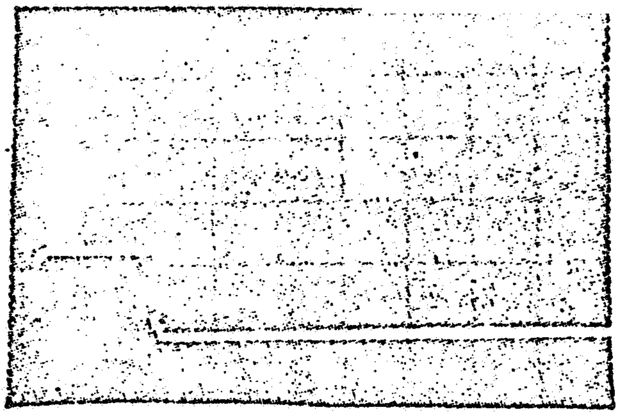
Stand off B.W.
5 Amp/cm
100μ sec/cm



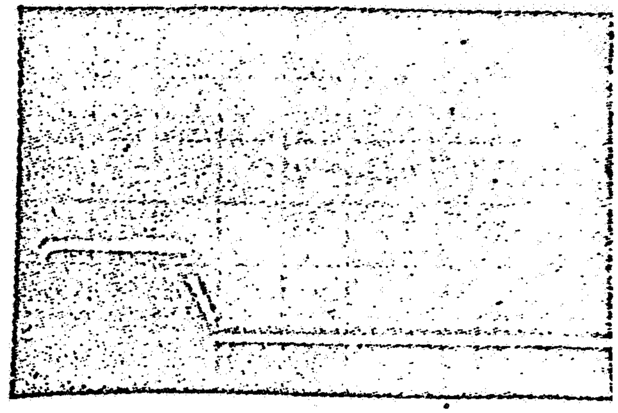
Alumina covered
ASI Header
5 Amp/cm
100μ sec/cm

Figure 5

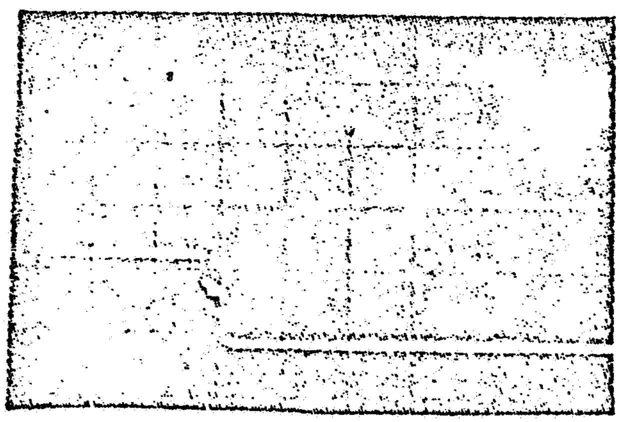
CURRENT TRACE @ 15 AMP



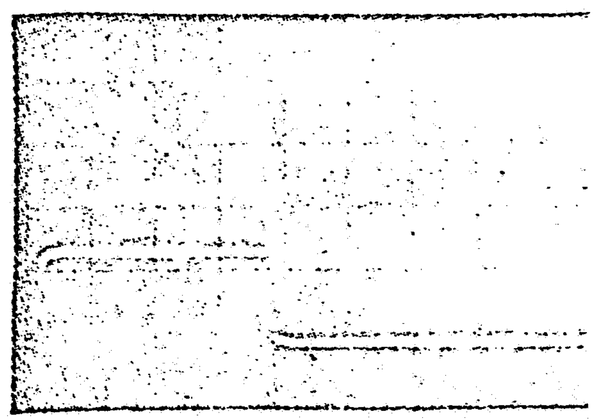
108 Slurried B.W.
ASI Header
10 Amp/cm
100μ sec/cm



Bare B.W.
ASI Header
10 Amp/cm
100μ sec/cm



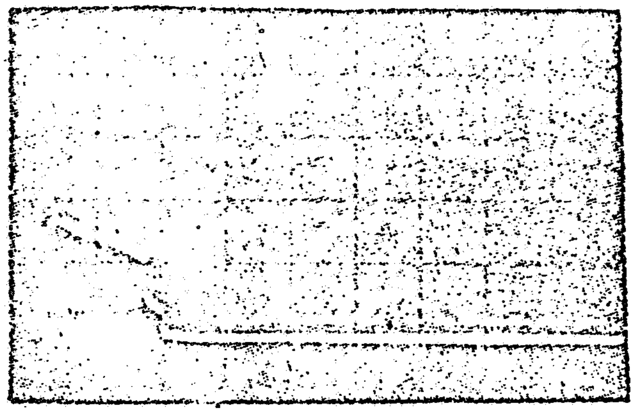
Stand off B.W.
10 Amp/cm
100μ sec/cm



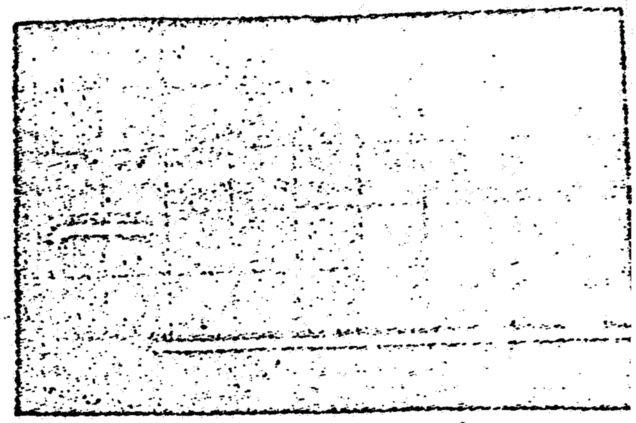
Alumina covered B.W.
ASI Header
10 Amp/cm
100μ sec/cm

Figure 5

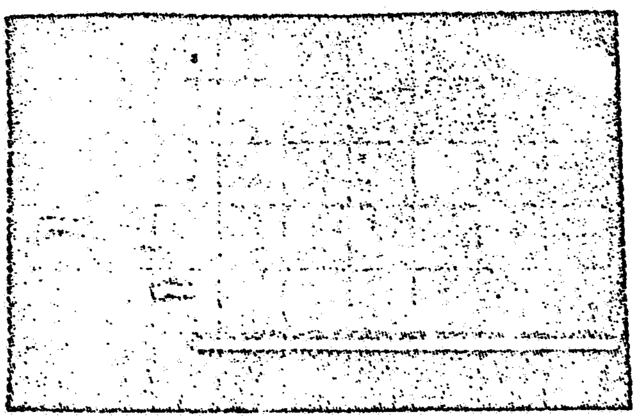
CURRENT TRACE @ 20 AMP



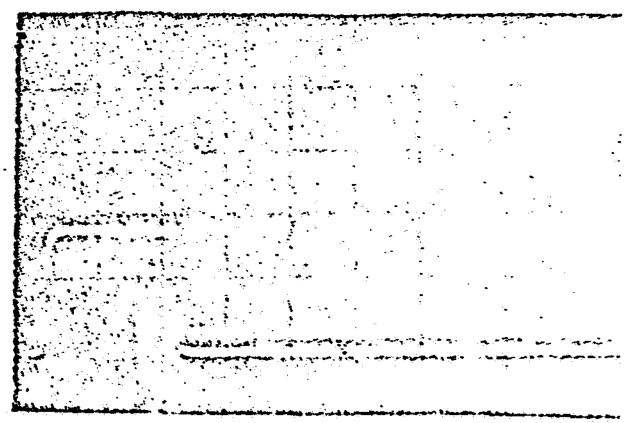
108 Slurried B.W.
ASI Header
10 Amp/cm
100μ sec/cm



Bare B.W.
ASI Header
10 Amp/cm
100μ sec/cm



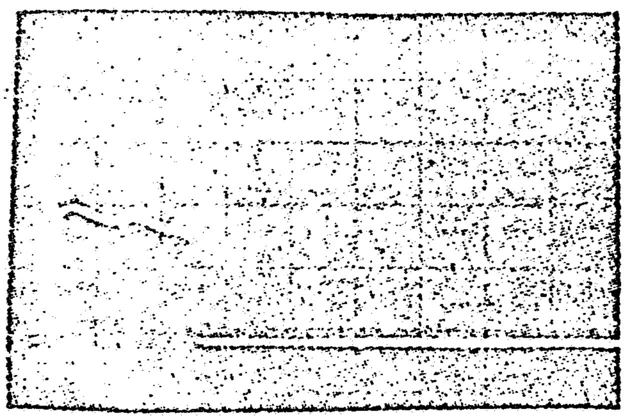
Stand off B.W.
10 Amp/cm
100μ sec/cm



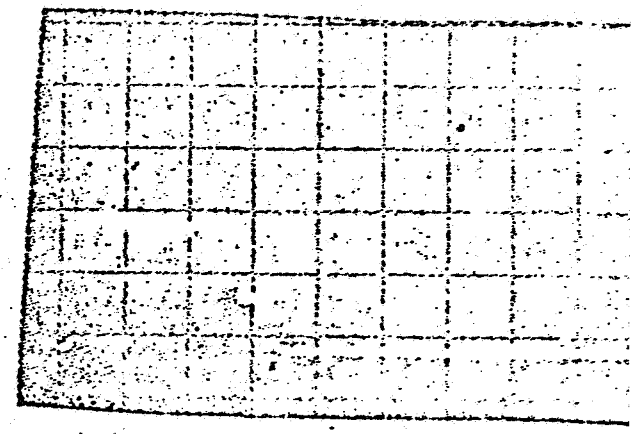
Alumina covered B.W
ASI Header
10 Amp/cm
100μ sec/cm

Figure 5

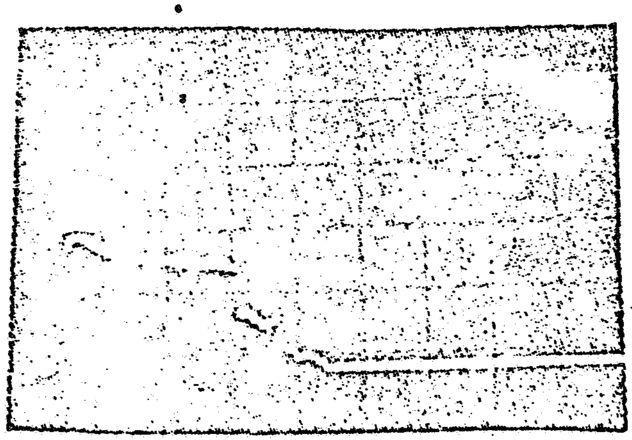
CURRENT TRACE @ 25 AMP



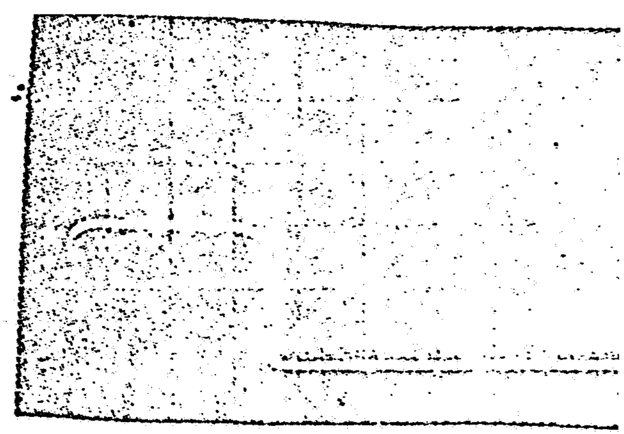
108 Slurried B.W.
ASI Header
10 Amp/cm
50µ sec/cm



Bare B.W.
ASI Header
10 Amp/cm
50µ sec/cm



Stand off B.W.
10 Amp/cm
50µ sec/cm



Alumina covered B.W.
ASI Header
10 Amp/cm
50µ sec/cm

Figure 5