FINAL TEST REPORT
FEASIBILITY DEMONSTRATION
OF
BOOSTER CROSS-OVER SYSTEM
FOR 3½ INCH S6B/MLP FRANGIBLE NUT
FOR
NASA
MARSHALL SPACE FLIGHT CENTER
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1.0 INTRODUCTION

Recent testing of the SRB/MLP Frangible Nut System (SOS Part Number 114850-9/Boosters P/N 114848-3) at NASA indicated a need to reduce the function time between boosters (2) within a single frangible nut. These boosters are initiated separately by electrical impulse(s). Coupling the output of each detonator with an explosive cross-over would reduce the function time between boosters (independent of electrical impulse) while providing additional redundancy to the system. SOS was awarded a contract (NAS8-34651) to conduct a "feasibility demonstration program".

1.1 Program Objectives

The objectives of this program were to:

A) Provide an explosive cross-over between boosters.
B) Reduce function time between boosters to less than one (1) millisecond within a given nut.
C) Reduce cost of boosters.
D) Be compatible with the existing frangible nut system.
E) Meet requirements of USBI Spec's (nut 10SPC-0030, booster 10SPC-0031).
2.0 DESIGN

The finalized design for the improved 3¼" frangible nut is shown on SOS drawing 117245 and is presented as Figure 1.

The design consists of five (5) major components:

A) Nut (modified) P/N 11784-1 as Figure 2
B) Booster Assembly P/N 117240-1 as Figure 3
C) Cross-over Assembly P/N 117239 as Figure 4
D) Adapter P/N 117238-1 as Figure 5
E) Detonator (CFE) SEB 26100094-201

As can be seen from Figure 1, the design provides an envelope that is within the existing design envelope, therefore compatible with debris container/connector installation.

2.1 Nut P/N 117184-1

The proposed design incorporates the requirements of the existing design Frangible Nut SOS P/N 114841-5. The nuts used in the verification test were nuts from a previous accepted lot and modified for this program. This demonstrates not only system compatibility, but existing nuts can be modified/reworked to the proposed design.
2.1 **Nut P/N 117184-1** (continued...)

The proposed design maintains characteristics that control the existing nut design structural capabilities.

Modifications/rework consists of mounting provisions for the cross-over assembly and the adapter.

2.2 **Booster Assembly P/N 117240-1**

The proposed booster is made from mild detonating fuse (MDF) having an aluminum sheath and RDX core. The length of MDF used in the assembly is taken from a length of MDF that has previously been tested for core load (explosive content) and detonation velocity. The end closures are aluminum and laser welded. The existing booster has a stainless steel body with the RDX core being loaded in increments. The end closures are stainless steel and resistance welded. Both designs are capable of passing a dry leak helium test (1 X 10^-6 cc/sec).

Listed below is a comparison of major characteristics of the two designs:
2.2 Booster Assembly P/N 117240-1  (continued...)

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>EXISTING DESIGN</th>
<th>PROPOSED DESIGN</th>
</tr>
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<tr>
<td>RDX per MIL-R-398</td>
<td>7.25 grams</td>
<td>7.87 grams</td>
</tr>
<tr>
<td>Output O.D. inch</td>
<td>.480/.484</td>
<td>.480/.484</td>
</tr>
<tr>
<td>Output length inches</td>
<td>2.78 inches</td>
<td>2.81 inches</td>
</tr>
<tr>
<td>Housing material</td>
<td>Stainless Steel</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Closures</td>
<td>Stainless Steel</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Welding (closures)</td>
<td>Resistance</td>
<td>Laser</td>
</tr>
<tr>
<td>Dry leak capability</td>
<td>$1 \times 10^{-6}$ cc/sec.</td>
<td>$1 \times 10^{-6}$ cc/sec.</td>
</tr>
<tr>
<td>Output plate dent in steel 0.078 inch minimum deep</td>
<td>Lot AAF</td>
<td>Lot 1</td>
</tr>
<tr>
<td>Actual</td>
<td>$(26) \bar{x} .126$</td>
<td>$(15) \bar{x} .132$</td>
</tr>
<tr>
<td></td>
<td>$0.113 \text{ min}/0.146 \text{ max.}$</td>
<td>$0.128 \text{ min}/0.136 \text{ max.}$</td>
</tr>
</tbody>
</table>

2.3 Cross-over Assembly P/N 117239-1

The cross-over assembly consists of a length of MDF (having a core load of 10 ± 1 gr./ft.), an adapter (Figure 4a) epoxied to the MDF at each end (MDF trimmed after epoxy cure), a booster cup loaded with 46 mg. of RDX, resistance welded to the adapter. This sub-assembly is housed in a stainless steel tube, welded to a retainer (Figure 4b) at each end, end booster location controlled and potted to the retainers (Figure 4). The cross-over
2.3 **Cross-over Assembly P/N 117239-1** (continued...)

is then formed into the configuration shown. The interface between the MDF and loaded cup is the same as SOS currently utilizes on other programs and has been well proven.

The relationship between CFE detonator and the cross-over booster is consistent with other "flying plate initiation" designs and can be easily controlled.

The design of the cross-over retainer (Figure 4b) provides a "symmetry" of MDF booster to retainer mounting faces, therefore eliminating the need for specific cross-over assembly installation/orientation.

The retainers (Figure 4b) have a recess on each side. One recess locates over the booster shoulder, the other indexes on the adapter (Figure 5) therefore insuring concentricity of all components/sub-assemblies.

2.4 **Adapter P/N 117238**

The adapter provides a means for retaining the installed booster (Figure 3) in place. The adapter has an internal threaded port which mates with the CFE detonator and locates the
2.4 Adapter P/N 117238 (continued...)

detonator such that the gap relationships between the detonator and booster (Figure 3) and detonator and cross-over booster (Figure 4) are controlled.

2.5 Detonator P/N SEB 26100094-201 (CFE)

The detonator is the same configuration as has been used on all frangible nut and booster testing.

2.6 Related Test Components

Components used in the test/evaluation of this design although not identical to component configuration represent the parameters being evaluated. These components include cross-over test assemblies, simulated port fixture etc., and are included in Appendix A.
3.0 TESTING

A test program outline SOS document TP8867 was prepared, submitted to and concurred with by Joe Davis (NASA, COR). The testing reported herein was in support of that outline. Test summary is shown as Table I and the testing basically consisted of evaluating seven (7) key elements of the design:

A) Detonator/cross-over - detonator as donor
B) Detonator/cross-over - cross-over as donor
C) Detonator/cross-over - cross-over @ 85% load
D) Detonator/cross-over/booster - interface compatibility
E) Detonator to booster
F) Booster performance
G) System verification

The following sub-paragraphs address these key elements in detail.

3.1 General

All testing was conducted at SOS Placerita Facility. Instrumentation used to obtain data was in accordance with SOS quality requirements (calibration, etc.).

Testing was conducted at ambient conditions.
3.1.1 Detonators SEB 26100094-201

All detonators fired during this program were CFE by NASA. Except for tests 7 - 12, which were cross-over initiated (use of a blasting cap), the detonators were electrically initiated by application of 3.5 amps/10 millisecond pulse to the detonator bridgewire.

Although specific tests were designed to evaluate certain component relationships, these pertinent data were measured and recorded for all tests where applicable.

3.2 Detonator/Cross-over - Detonator As Donor

Six (6) tests were conducted evaluating this relationship. Three (3) tests incorporated component gaps of nominal, .050 inch and three (3) tests at 50% over nominal or .075 inch.

All test units functioned successfully. The test set-up was as shown in Figure 7 and consist of tests 1 through 6.

3.3 Detonator/Cross-over - Cross-over As Donor

Six (6) tests were conducted evaluating this relationship.
3.3 Detonator/Cross-over - Cross-over As Donor (continued...)

Three (3) tests incorporated component gaps of nominal, .050 inch and three (3) tests at 50% over nominal or .075 inch.

All test units functioned successfully. The test set-up was as shown in Figure 7 and consist of tests 7 through 12.

3.4 Detonator/Cross-over - Cross-over At 85% Load

Five (5) tests were conducted evaluating this relationship. Component gaps were measured and recorded (see Figure 8).

All test units functioned successfully. The test set-up was as shown in Figure 8 and consists of tests 13 through 17.

This test series incorporated function time measurements and this data is included in Table II test results.
3.5 Full-up Propogation - Dual Detonators/Boosters

Three (3) tests were conducted evaluating the combined ordnance interfaces. Component gaps were measured and recorded (see Figure 9). The test set-up was as shown in Figure 9 and consists of tests 18, 19, and 20.

This test series incorporated function time measurements and this data is included in table II test results. In addition, booster output "plate dent" data was obtained to be used in evaluating booster performance acceptance criteria. This plate dent data is included in Table III test results.

3.6 Detonator to Booster

Three (3) tests were conducted evaluating this relationship. Two (2) tests incorporated a "minimum" design gap of 0.027 inch and one (1) test incorporated a maximum design gap of 0.063 inch.

All test units functioned successfully and all plate dent depths were in excess of the 0.078 inch depth minimum. The set-up was as shown in Figure 10 and the dent depth data is recorded in Table III.
3.7 **Booster Performance**

This series of tests was designed to evaluate booster performance that may be affected by the core load (quantity of explosive - RDX) contained in the booster. As described in Paragraph 2.2, the booster is made from MDF. The amount of explosive within the MDF-(core) is determined by a core load determination taken by a random sample through a given length of MDF. These (6) tests, three (3) at minimum and three (3) at maximum core load were selected based on these core load determinations.

All units functioned successfully. The test set-up was as shown in Figure 11 and consists of tests 24 through 29. The plate dent data is tabulated in Table III.

3.8 **Booster Acceptance Criteria**

The results of fifteen (15) tests were evaluated in an effort to:

A) compare results to specification requirements, and
B) establish acceptance performance criteria.

These test results are tabulated in Table III, performance data from tests 18 through 29. As noted in Table III results,
3.8 Booster Acceptance Criteria (continued...)

the recorded plate dents are well in excess of the required 0.078 inch minimum and exhibit a "closer" spread "minimum to maximum" than the most recent DLAT lot of boosters (SOS P/N 114848-3 lot AAF).

3.9 Verification

Three (3) tests were conducted to verify that the proposed cross-over and MDF booster were compatible with the existing frangible nut system.

The tests numbered 45, 46, and 47 functioned successfully therefore, demonstrating system compatibility.

The major endeavor of this program, as previously discussed, was to "verify cross-over function time of less than one (1) milisecond". The function time data from these three (3) tests as well as from tests 13 through 20 are recorded in Table II. As noted, maximum function time between boosters from all tests was "260 microseconds" well within the desired one (1) millisecond.
3.9.1 Test Set-up

The system that was tested utilized a frangible nut assembly SOS drawing 117245 (Figure 1). This assembly consisted of a modified frangible nut SOS drawing 117184 (Figure 2), cross-over assembly SOS drawing 117239 (Figure 4), boosters (2) SOS drawing 117240 (Figure 3) and adapter SOS drawing 117238 (Figure 5).

The instrumentation set-up was as shown in Figure 12.

For the three (3) tests, the nuts were not assembled to a test stud, therefore, no tensile load was applied during functioning.

3.10 Data

3.10.1 Gaps, Component Interface

As components were arranged into their specific test set-up, measurements were taken, gaps determined and recorded on applicable data sheets. Where required by test criteria (specific gaps) components were modified at assembly or shims added to provide their specific gaps.
3.10.2 Detonators P/N SEB 26100094-201

The forty-three (43) detonators used on this program were CFE by NASA. Serial numbers of these detonators were recorded on the data sheets for the applicable test. Where required function time, application of current to bridgewire burn-out, is recorded.

3.10.3 Function Time Analysis/Interpretations

As previously noted, the instrumentation set-up for measuring specific function time is shown schematically in Figure 12.

The scope used was a Nicolet digital scope model 2090. A firing pulse generator provided necessary current for functioning the detonators. Upon application of this current the scope triggered providing the "bridgewire" burn-out data. The "break link" box consisted of six (6) circuits and any combination of these circuits could be utilized. The "break links" were lengths of insulated wire strategically located as shown in Figure 12. These break links had a "low voltage" across them and when broken, due to an ordnance event, would cause a voltage shift and show up as a position change on the horizontal sweep of the scope picture. Therefore, each break link had a unique position on the scope and its position
3.10.3 Function Time Analysis/Interpretations (continued...)

was previously determined during the calibration process.

The Nicolet sweep speed was set at four (4) milliseconds across the full face.

Upon completion of the event and to determine exact function times, portions of the event would be expanded, utilizing the scope electronics, and very accurate time measurements could be made.

Appendix B contains a representative "functional" scope trace.

3.10.4 Post Fire Results/Nut Separation

After examination of the functional hardware tests 45, 46 and 47, the following observations were made:

A) Nut separation at the defined break plane was complete.
B) After separation, the nut was in two (2) major pieces.
C) Comparison of damage sustained at the break plane is consistent with present D-LAT post fire examination.
D) Comparison of residual debris is comparable to present D-LAT post fire results.
4.0 CONCLUSIONS

After analysis of results obtained from this test program, it has been demonstrated that the program objectives have been fullfilled:

A) Provides an explosive cross-over between boosters.
B) Function time between boosters to be less than one (1) millisecond.
C) Cost savings for manufacture and acceptance testing of the booster.
D) System is compatible with existing frangible nut system.
E) System meets post-separation performance criteria,
5.0 RECOMMENDATIONS

The following recommendations are offered for NASA consideration and future implementation:

A) Requirements for a booster cross-over assembly be incorporated into current specifications;

B) Allow use of MDF booster design as evaluated as part of this program; and

C) A "qualification" or "mini qual" program be completed so that future frangible nut systems can be furnished that reflect the design evaluated during this program.
FIGURE 3a

EXISTING BOOSTER DESIGN

DETONATOR CARTRIDGE FOR 3.5-INCH FRangible NUT

1. HOUSING
2. CLOSURE DISK, INPUT
3. CLOSURE DISK, OUTPUT
4. TAG, IDENTIFICATION
5. DISK, ISOMICA
6. CAPLUG
7. MAIN CHARGE
8. CAPLUG

BOOSTER ASSEMBLY

114847-1
114993-1
1-375-9
115322-1
1-285-46
PD-60
RDX (7250 mg)
115297-1

114848-3
ORIGINAL PAGE IS OF POOR QUALITY
SPACE ORDNANCE SYSTEMS

Nominal 0.050 Tests 1, 2, & 3
Gap
Maximum 0.075 Tests 4, 5, & 6

Adapter (Fig. 5)

TIGHT POINT
(Initiation)

Det. Output
(.280 Ø REP)

Cross-Over Test Assy
"T-71881-6 -1 FOR TESTS 1, 2, & 3
-2 FOR TESTS 4, 5, & 6"

Detonator
("Sod 26100094-201"

Fixture
("T-73881-1"

Witness
("T-73881-9"

FIGURE 6
DETONATOR CROSS-OVER TEST SET-UP
(DETONATOR AS DONOR)
SPACE ORDNANCE SYSTEMS

Nominal 0.050 TESTS 7, 8, & 9
Gap
Maximum 0.075 TESTS 10, 11, & 12

Det. Output (.280 Ø REP)

Detonator (SIB 26100094-201)

CROSS-OVER TEST ASSY
T-73881-6-1 FOR TESTS 7, 8, & 9
-2 FOR TESTS 10, 11, & 12

FIGURE 7

WITNESS/CROSS-OVER TEST SET-UP
(CROSS-OVER AS DONOR)
SPACE ORDNANCE SYSTEMS

Dent Block (T-70482-2) 2 Ea.

Sleeve (T-72665-3) 2 Ea.

Booster (2) (FIG 3)

Fixture (T-73881-1) 2

Adapter (FIG 5) 2 Ea.

Detonator (2)

GAP DETONATOR TO BOOSTER

"A" DET. (INITIATED) Cross-Over Test Assy (T-73881-6-4) 2 Ea.

"B" DET.

FULL SCALE PROPAGATION TEST SET-UP
(Dual Detonators & Boosters)
SPAC E ORDNANCE SYSTEMS

FIGURE 11

BOOSTER PERFORMANCE TEST SPEC-6P
(SEE TABLE III FOR PLATE DETAIL DATA)
SPACE ORDNANCE SYSTEMS

NICOLET SCOPE

PULSE GENERATOR

BREAK LINK BOX

ORIGINAL PAGE IS OF POOR QUALITY

BREAK LINK #4
BREAK LINK #1
BREAK LINK #6
BREAK LINK #5
BREAK LINK #3
BREAK LINK #2

BOOSTER

CROSS-OVER

DETONATOR

FIGURE 17 FUNCTION TIME - INSTRUMENTATION SET-UP
## TEST SUMMARY TABLE II

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Description</th>
<th>Test Set-Up Fig.</th>
<th>Detonator S/N Location A/B</th>
<th>Remarks</th>
</tr>
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<tr>
<td>1</td>
<td>Detonator / Cross-Over Test, Detonator as Donor (Nom. Gap 0.050 in)</td>
<td>6</td>
<td>371 356 316</td>
<td>ALL SPECIMENS Functioned Successfully</td>
</tr>
<tr>
<td>2</td>
<td>Detonator / Cross-Over Test, Detonator as Donor (Max. Gap 0.075 in)</td>
<td></td>
<td>361 352 370</td>
<td>ALL SPECIMENS Functioned Successfully</td>
</tr>
<tr>
<td>3</td>
<td>Detonator / Cross-Over Test, Detonator as Donor (Nom. Gap 0.050 in)</td>
<td></td>
<td>362 366 368</td>
<td>ALL SPECIMENS Functioned Successfully</td>
</tr>
<tr>
<td>4</td>
<td>Detonator / Cross-Over Test, Cross-Over as Donor (Nom. Gap 0.050 in)</td>
<td>7</td>
<td>362 368 369</td>
<td>SEE FIG. 8 FOR ACTUAL GAPS AT INTERFACES. SEE TABLE II FOR FUNCTION TIME DATA</td>
</tr>
<tr>
<td>5</td>
<td>Detonator / Cross-Over Test, Cross-Over as Donor (Max. Gap 0.075 in)</td>
<td></td>
<td>373 369 373</td>
<td>SEE FIG. 8 FOR ACTUAL GAPS AT INTERFACES. SEE TABLE II FOR FUNCTION TIME DATA</td>
</tr>
<tr>
<td>6</td>
<td>Detonator / Cross-Over Test, Initiate One (i) Detonator Cross-Over</td>
<td>8</td>
<td>319 351 358 374</td>
<td>SEE FIG. 9 FOR GAP DATA SEE TABLE II FOR FUNCTION TIME</td>
</tr>
<tr>
<td>7</td>
<td>Detonator / Cross-Over Test, Initiate One (i) Detonator Cross-Over</td>
<td></td>
<td>353 363 365 355 360 359</td>
<td>SEE TABLE III FOR DENT DATA</td>
</tr>
<tr>
<td>8</td>
<td>Full-Up Propagation, Dual Detonators / Boosters, Initiate One (i) Detonator</td>
<td>9</td>
<td>339 314 315 313 336 312</td>
<td>SEE TABLE III FOR GAP AND PLATE DENT DATA</td>
</tr>
<tr>
<td>9</td>
<td>Detonator to Booster (Min. Gap 0.027 in)</td>
<td>10</td>
<td>338 343 344</td>
<td>SEE TABLE III FOR GAP AND PLATE DENT DATA</td>
</tr>
<tr>
<td>10</td>
<td>Detonator to Booster (Max. Gap 0.063 in)</td>
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Original page 13 of poor quality
### Function Time - Table II

#### Test Set-Up

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#### Function Time (μsec)

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</table>

#### Breaklink Function

1. Sense 'A' Det. Output
2. Sense 'B' Det. Output
3. Sense Booster Output
4. Sense 'A' Booster Output
5. Sense 'A' Side Nut Sep.
7. Booster 'A' Side Not in Test Set-Up
8. Booster 'A' Side Not in Test Set-Up

---

**NOTES:**
- Only for Tests 10's 45, 46, 47
- Breaklink No's
- Breaklink Function Time (Microseconds)
- Breaklink Locations
- Function Time (μsec)
- Original Page of Poor Quality
- Application of Current
- Start Time Zero
- Nuts (Tests 45, 46, 47 Only)

---

**REMARKS:**
- No Scope Trigger
DENT REQUIREMENT
0.078 INCH MINIMUM
THESE 15 TESTS
× 0.132
MIN 0.128
MAX 0.136
D-LAT (LOT AAF) EXISTING DESIGN 26 TESTS
× 0.126
MIN 0.113
MAX 0.146

TABLE III BOOSTER - PLATE DENT DATA
APPENDIX A

RELATED TEST FIXTURES AND TEST HARDWARE UTILIZED IN THESE TESTS

A-1  CROSS-OVER TEST ASSY T-73881-6-1  NOM LOAD/NOM GAP
A-2  CROSS-OVER TEST ASSY T-73881-6-2  NOM LOAD/MAX GAP
A-3  CROSS-OVER TEST ASSY T-73881-6-3  85% LOAD/NOM GAP
A-4  CROSS-OVER TEST ASSY T-73881-6-4  FULL UP CONFIGURATION
A-5  FIXTURE - PORT SIMULATED T-73881-1
A-6  WITNESS - DETONATOR OUTPUT T-73881-9
A-7  SLEEVE - PLATE DENT T-72665-3
A-8  BLOCK - DENT TEST T-70482-2
TRIM LDC FLUSH WITH ADAPTER AFTER BONDING.

1. RDX MIL-R-398 TYPE II, CL7
46 ±1mg LOADED WITH 280±10LS

NOTES A-1/A-2 -37-

CROSS-OVER TEST ASSY
T-73881-6-1

wu 4/23/83
2 BENT AT ASSY. TO FIT FRANGIBLE NUT (REF FIG 4)

1 RDX MIL-R-398 TYPE II, CL 7
46±1 mg loaded with 280±10 lbs

NOTES

A-4

CROSS-OVER
TEST ASSEMBLY
T-73881-6-4

WD 6/24/83
material: alum

Witness Plate -

Diameter Output

T-738 81-9

WD 6/28/83
APPENDIX B

B-1 REPRESENTATIVE FUNCTIONAL TEST SCOPE TRACE
Representative functional test scope trace using four of six possible break link.
APPENDIX C

TEST PROCEDURE 8867
TEST PROGRAM OUTLINE

FEASIBILITY DEMONSTRATION

of

BOOSTER CROSS-OVER SYSTEM

For 3 1/2 Inch SRB/MLP Frangible Nut

For

NASA

Marshall Space Flight Center

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<td>Test Manager</td>
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SOS Sales Order No. 1348  
Customer Contract No. NAS 8-34651

Prime Contract No.  

DOCUMENT STATUS

Submitted: Date 
Approved: Yes  No  Date 
Approval Document Location: 
Approval Verification: 

SOS-19113  
Revision
# TABLE OF CONTENTS

<table>
<thead>
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<tbody>
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<td>1.0</td>
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<tr>
<td>2.0</td>
<td>DESIGN APPROCHES 2</td>
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<td>3.0</td>
<td>TESTING 4</td>
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<td>DATA 6</td>
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## FIGURES

- **1** Drawing P17161 3
- **2** Detonator Cross-Over Test Set-Up 7
- **3** Test Set-Up Deonator/To Test Assembly/To Detonator 8
- **4** Full Scale Propagation Test Set-Up 9
- **5** Detonator to Booster Test Set-Up 10
- **6** Booster Performance Test Set-Up 11
- **7** Performance Verification Test Set-Up 12
- **8** Function Time - Instrumentation Set-Up 13
1.0 INTRODUCTION

Recent testing of the SRB/MLP Frangible Nut System (SOS Part Number 114850-9/Boosters P/N 114848-3) at NASA indicated a need to reduce the function time between boosters (2) within a single frangible nut. These boosters are initiated separately by electrical impulse(s). Coupling the output of each detonator with an explosive cross-over would reduce the function time between boosters (independent of electrical impulse) while providing additional redundancy to the system. SOS was awarded a contract (NAS8-34651) to conduct a "feasibility demonstration program" in an effort to demonstrate this effort, while maintaining compatibility with the existing frangible nut.
2.0 DESIGN APPROACHES

2.1 Conceptual Design

Several design concepts were prepared by SOS. The individual designs were critiqued with trade off studies and presented to NASA for review (Ref. SOS Progress Report #1, dated 4/28/83).

A preliminary design review was conducted at SOS on May 25, 1983 (Ref. SOS Progress Report #2, dated 6/3/83). The design concept selected was that shown on SCS dwg. PL17161, Sheet 1 (Figure 1).

2.2 Preliminary Design

Detail drawings representing individual frangible nut system components were prepared. These details reflect "full-up" characteristics of the selected design approach.

These components and their relationship to each other will be evaluated during this feasibility demonstration program.
3.0 TESTING

3.1 Test Outline

The testing to be accomplished is outlined in Table I, "Feasibility Demonstration Test Matrix" and identifies the following:

A. Test description
B. Test set-up/configuration
C. Number of tests
D. Components involved in the test
E. Data to be obtained
F. Expected results/determinations

3.2 Functional Tests

For test series 1, 2, 5, 6, 7, 8, 9 and 11 initiation will be by application of 3.5 amperes (10 msec. pulse) to the detonator SEB 26100094-201 (CFE) bridgewire. Series 3 & 4 will be the initiation of the cross-over assembly by a standard electric blasting cap. Series 10 does not require functioning (reduction of data from previous tests). Instrumented set-up for obtaining function time(n) is shown in Figure 8.
### Table 1

#### Reliability Demonstration Test Matrix

<table>
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<tr>
<th>Test Date</th>
<th>Test Objective</th>
<th>Test Method</th>
<th>Test Results</th>
<th>Test Conclusion</th>
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<td>Success</td>
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<td>2</td>
<td>Method B</td>
<td>Fail</td>
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<tr>
<td>1-3-2023</td>
<td>3</td>
<td>Method C</td>
<td>Pass</td>
<td>Success</td>
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<tr>
<td>1-4-2023</td>
<td>4</td>
<td>Method D</td>
<td>Fail</td>
<td>Failure</td>
</tr>
</tbody>
</table>

**Test Objective 1:**
- **Method A**
- **Result:** Pass
- **Conclusion:** Success

**Test Objective 2:**
- **Method B**
- **Result:** Fail
- **Conclusion:** Failure

**Test Objective 3:**
- **Method C**
- **Result:** Pass
- **Conclusion:** Success

**Test Objective 4:**
- **Method D**
- **Result:** Fail
- **Conclusion:** Failure
SPACE ORDNANCE SYSTEMS

Nominal 0.050
Gap
Maximum 0.075
(Nominal +50%)

Det. Output
(.280 Ref.)

Detonator
(SEB 26100094-201)

Crossover testassy
(T-73981-6 -1 or -2)

Adapter (T-73981-2)

Target Point
(Initiation)

Fixture
(T-73881-1)

Witness
(T-73881-9)

Electric Blasting Cap
(For test series 3 & 4)

FIGURE 3
ENERY TOP/CROSS-OVER TEST SET-UP
Figure 3
Test Set-Up
Detonator/To Test Assembly/To Detonator

(Note: Test Assembly T-73881-6-3 has 85% of nominal output charge)
Figure 4
FULL SCALE PROPAGATION TEST SET-UP
(Dual Detonators & Boosters)
**SPACE ORDNANCE SYSTEMS**

**FIGURE 5**

**DETONATOR TO BOOSTER TEST SET-UP**
4.0 DATA

Functional test data to be recorded shall be as required by test matrix Table I and data sheet No. 1. In addition the test equipment used will be listed on the equipment log sheet, data sheet No. 2.
<table>
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<th>Series No.</th>
<th>Detonator S/N 26100094-201</th>
<th>&quot;Gap&quot; per Fig. (inch)</th>
<th>Detonator Initiated</th>
<th>Cross-Over Initiated</th>
<th>Booster Initiated</th>
<th>Dent Block Depth (inch)</th>
<th>Time - Application of current to B/W Burnout msec</th>
<th>Break Link</th>
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**Note:** The table and graph represent data related to detonator performance and safety parameters. The "Gap" per Fig. column indicates the minimum and maximum gap values for different series numbers. The "Detonator Initiated" column indicates whether the detonation was initiated by a specific method. The "Cross-Over Initiated" and "Booster Initiated" columns show if additional detonators were triggered. The "Dent Block Depth" column provides the depth measurements in inches. The "Time - Application of current to B/W Burnout" column shows the timing in milliseconds. The "Break Link" column lists the current break link numbers for each test series.
TABLE I
FEASIBILITY DISCUSSION TEST MATRIX

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**Notes:**
- Method A1 is designed for high stress conditions.
- Condition 1 involves a specific set of parameters that are optimized for A.
- Result 1 indicates a successful outcome under these conditions.

**Additional Information:**
- Method B2 is a backup method used in case of A failure.
- Condition 2 differs slightly from condition 1, requiring adjustment of parameters.
- Result 2 is a close match to expected outcomes.

**Further Reading:**
- Further analysis is required for methods C3 and D4 to ensure compatibility with existing systems.