DR NO. MA-6
CONTRACT NAS8-32122

CONTRACTOR'S FINAL REPORT

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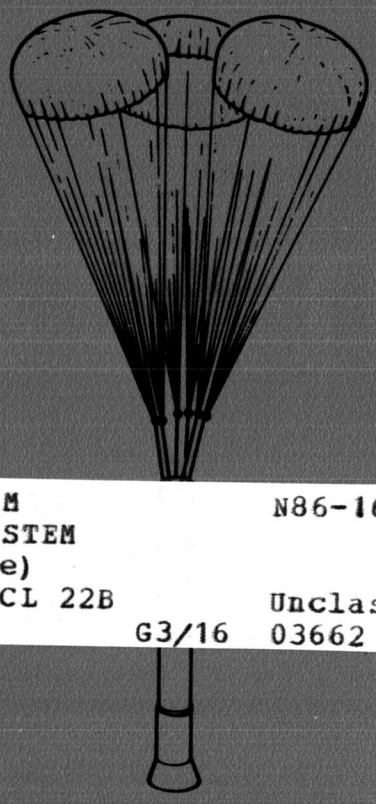
Space Shuttle Program Solid Rocket Booster Decelerator Subsystem



MARTIN MARIETTA

Pioneer Parachute Co., Inc.
A Subsidiary of
Pioneer International Corporation

DR NO. MA-6
CONTRACT NAS8-32122

SRB-DSS-MA6
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CONTRACTOR'S FINAL REPORT

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FOREWORD

This document is submitted to NASA-MSFC in response to Data Requirement DR-MA6 of the Information Requirements Document SE-019-024-2H-R for Contract NAS8-32122, for the Space Shuttle Solid Rocket Booster Decelerator Subsystem.

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1.0 INTRODUCTION

1.1 Purpose

This document presents a technical synopsis of the Space Shuttle Solid Rocket Booster Decelerator Subsystem Program conducted for NASA-MSFC under Contract NAS8-32122 during the period between 6 July 1976 (ATP) and 31 May 1985.

1.2 Scope

This report covers the work by Martin Marietta Denver Aerospace under Exhibit A, Statement of Work (SOW), to Contract NAS8-32122 to design, analyze, develop, integrate, manufacture, test, deliver, provide field support for, maintain and refurbish the SRB Decelerator Subsystem and the Decelerator Subsystem Support Equipment and Tooling. The tasks described herein are organized in accordance with the SRB DSS Work Breakdown Structure (WBS) 1.4.1.6.1, as depicted in Exhibit A, SOW, of the contract.

2.0 REFERENCE DOCUMENTATION

SE-019-075-2H	SRB DSS Configuration End Item Specification, Part I & II
ICD-3-44006	SRB DSS Forward Skirt and Nose Assembly Interface Control Document
ICD-2-4A002	SRB DSS Retrieval Station Interface Control Document

3.0 WORK PERFORMANCE SUMMARY

The purpose of the SRB Decelerator Subsystem Program under Contract NAS8-32122 was to develop and fly a parachute system to recover the Space Shuttle solid rocket boosters for refurbishment and reuse. These boosters are the heaviest payloads known to have been recovered by parachute. That this objective has been successfully achieved is evidenced by the recovery in good condition of all boosters flown to date with the exception of those from STS-4 which were lost due to a failure not associated with parachute performance. The capability of the Decelerator Subsystem to recover the boosters in good condition has also been demonstrated despite some parachute failures. The planned objective of 20-flight usage of each reusable component appears to be attainable, with indications that more reuses are possible. Martin Marietta's efforts on the SRB Decelerator Subsystem Program have resulted in a savings of millions of dollars through successful recovery and refurbishment of the solid rocket boosters.

3.1 DECELERATOR SUBSYSTEM MANAGEMENT - WBS 1.4.1.6.1.1

WBS 1.4.1.6.1.1.1 - Project Planning and Direction - From the beginning, Martin Marietta has maintained a dedicated team of technical and managerial personnel on the SRB Decelerator Subsystem program. A functional Table of Organization of the program, a brief description of each function, and a listing of key personnel is shown in Appendix I. It should be noted that in many instances key personnel have been with the program throughout its history.

A major function of SRD DSS management is support of the various reviews required during the course of the program's history. These include Preliminary Requirements Reviews (PRR), Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), CDR, Flight Readiness Reviews (FRR), Test Readiness Reviews (TRR), and Design Certification Reviews (DCR).

WBS 1.4.1.6.1.1.2 - Configuration Management - A Configuration Management Plan, SRB-DSS-CM01, was submitted, approved and published as a Type I document (requiring customer approval) in accordance with the Contract Statement of Work (SOW). The plan describes the Martin Marietta Corporation (MMC) Configuration Management system which completely satisfies the requirements of WBS 1.4.1.6.1.1.2 of the Statement of Work.

SRB Decelerator Subsystem configuration baseline is defined in the Configuration End Item specification, Part II, which has been revised at various major program milestones. The configuration baseline was revised upon approval of the Large (136 ft. D$_o$) Main Parachutes. Another update has been submitted to define the Filament Wound Case (FWC) SRB DSS and the Main Parachute Flotation Subsystem.

Change control was effected by MMC Change Control Board in conjunction with the MSFC Level III and IV CCB. Some 350 changes to the basic contract have been processed.

WBS 1.4.1.6.1.1.3 - Information Management - A Data Management system was established to process data, documentation, and information throughout the history of the program in an efficient, timely manner, in accordance with the Information Requirements Document (IRD), SE-019-024-2H-R. The IRD has been continuously reviewed for adequacy as evidenced by the thirty-nine (39) revisions made to it, the most recent in October 1984.

WBS 1.4.1.6.1.1.4 - Procurement Management (also covers WBS 1.4.1.6.1.3.2, 1.4.1.6.1.3.3 and 1.4.1.6.1.3.4) - A procurement management system was established early in the program to monitor subcontractor activity. The major subcontractor, Pioneer Parachute Company (PPC), Manchester, Connecticut, was responsible for detail design and fabrication of the parachutes, as well as development of refurbishment procedures and support to the refurbishment operations at the PRF. In addition, PPC personnel participated in the Material Review Board.

Additional subcontracts were let with Space Ordnance Systems, Inc., of Canyon Country, CA, for development and production of reefing line cutters, and Crown Rotational Molded Products, Marked Tree, Arkansas, for construction of the Wet Parachute Transportation Containers. Construction of load cells and production of some drogue parachute retention brackets was subcontracted to Beowulf Corporation, Huntsville, Alabama.

A summary of subcontract activity is presented in Appendix II.

WBS 1.4.1.6.1.1.5 - Safety, Reliability, and Quality Assurance - An Inspection System Plan was generated to satisfy the requirements of Data Requirement SRB-DSS-RA13. The plan established the controls and requirements during the design, fabrication, assembly, test, and final acceptance of program flight hardware, spares and related ground support equipment. In addition, a Quality Operating Plan was developed in support of the Parachute Refurbishment Facility (PRF) at Kennedy Space Center. All quality plans and operating procedures satisfy the requirements of NHB5300.4(IC) and were verified by both MMC and NASA quality audits.

The Martin Automated Reporting System (MARS) is used to identify, track and disposition non-conforming articles and material. This system provides rapid identification of non-conformances, controls segregation to the extent required, and provides initial review and disposition by Quality, as well as formal action by certified MRB personnel when required. The MARS directs component removal, system corrective action, and the restoration of component/system integrity. After failed parts analysis and cause identification, corrective action assignments are made to the responsible/ affected department. The MARS copies and serial numbers are reentered on affected build and test documentation. These are available for incremental review and retained for component history, as well as flowing into the centralized data system.

A System Safety Plan (SRB-DSS-RA10) was instituted to implement the requirements of NHB5300.4 (1D-2) Chapter 2, "Safety, Reliability, Maintainability and Quality Provisions for the Shuttle Procedure." This plan

was implemented upon initiation of the design phase, continued through all program phases and applied to functional organizations required for full scale development, test and evaluation, production hardware, and operations phases. This plan was supplemented by a Drop Test Safety Plan encompassing Phase I and II of the Drop Test Program at the National Parachute Test Range and Dryden Flight Research Center. Monthly Safety Summary Reports (SRB-DSS-RA22) were generated to present safety inspection results, highlight safety concerns, and track injuries/lost time for the KSC-PRF activity.

Problem and Resolution Reports (SRB-DSS-RA08) were initiated to provide problem identification, corrective action responsibilities and closure status. These are summarized in Appendix III, Table A.

Qualification testing was performed on pyrotechnically initiated reefing line cutters and parachute load sensors. These are summarized in Appendix III, Table B.

3.2 DEVELOPMENT - WBS 1.4.1.6.1.2

WBS 1.4.1.6.1.2.1 - Subsystem Analysis and Integration (including WBS 1.4.1.6.1.2.7) - Analysis was conducted to assure compatibility of the DSS with the SRB, including weight and volume constraints, interface loads, and operating conditions. Performance analyses were made for the original baseline (115 ft D_o main) DSS, the Large Main Chute (136 ft D_o) subsystem, and for the Filament Wound Case (FWC) Decelerator Subsystem. This included studies to select the DSS deployment altitude from the trajectory conditions provided, size and configure the parachutes, optimize reefing schedules, select main chute deployment altitude, and determine other detailed subsystem design parameters. The results of these analyses were published as SRB-DSS-SE16, Subsystem Analysis Report. Due to changes in SRB mass properties and predicted flight performance characteristics, changes in DSS design, and incorporation of modifications to improve performance, numerous revisions and addenda to SE16 were published. These are listed in Table A, Appendix V.

In a similar manner, the subject of loads analysis was addressed in SRB-DSS-SE11, Design Loads Analysis Report. Revisions to the basic document were made to reflect changes to the baseline mass properties and predicted flight performance characteristics as well as to update the report for Large Main Parachutes, FWC DSS design, and the Flotation Subsystem. The loading which would be induced by a single parachute failure during the flight of FWC SRBs was also addressed. These reports are enumerated in Table B, Appendix V.

Mass properties of the SRB DSS were analyzed and reported in SRB-DSS-SE01 in a number of increments including the baseline (115 ft. dia.) Small Main Chute (SMP) subsystem; the SMP DSS with corrosion resistant main parachute riser attach fittings; Large Main Parachute (136 ft. dia.) DSS; and LMPs with the new Flotation Subsystem. These reports are listed in Appendix V, Table C. The actual weights of individual subsystems as installed in SRB nose assemblies were reported in SRB-DSS-SE07 for each flight set delivered. These Actual Weight Reports are also listed in Table D of Appendix V.

A Failure Modes and Effects Analysis (FMEA) was conducted to determine the results of failure of various components in the Decelerator Subsystem. The results of this analysis as well as a list of critical components were reported in SRB-DSS-RA03, Failure Modes/Effects Analysis and Critical Items List.

Structural analysis of the SRB-DSS followed an evolutionary path dictated by changes in requirements and hardware, and refinements in load definition. Standard, accepted aerospace analysis techniques were employed on all parts. Finite element models were prepared and utilized to determine internal load and stress distributions in the Main Parachute Support Structure (MPSS), for example.

The MPSS was first designed and analyzed for loads imposed by the 115 ft. D_o main parachutes utilizing the Martin Denver Space Frame Program. In this model, the SRB frustum interfaces were represented by axial members having stiffness equivalent to the corresponding frustum attach frames. Detail elements were analyzed by hand using predicted loads from this model.

For the design modification to incorporate the 136 ft. D_o parachutes, a NASTRAN model of the MPSS was created. Loads and stresses were compared to assure equivalency with the previously developed model. Changes were made in the bipod struts, isogrid corner fitting attach bolts and forward tie ring interface splice plates to accommodate the larger loads.

For the shortened MPSS study, a second NASTRAN model was created, for the first time incorporating the forward tie ring. Here, the SRB frustum interfaces were represented by a stiffness matrix derived from the frustum finite model reduced to the specific interface locations. Based on predicted loads and stresses, hardware (bipod struts) was designed and analyzed to reinforce the shortened isogrid panels and react lateral loads at the outboard aft corners of the panels. A test-derived distribution was used as a basis for the axial acceleration input loads occurring at frustum separation. Computer predicted stresses based on this distribution were used to verify the integrity of the forward tie ring for all flight load configurations.

Loads imposed on other items such as the main and drogue deck fittings were determined by test and/or dynamic simulation analyses. The main and drogue deck fittings were also affected by changes in subsystem design and parachute loadings. These were analyzed by both hand and finite element techniques as required to assure structural integrity.

Structural stress analyses of SRB DSS mechanical components were published in the SRB-DSS-SE03, Stress Analysis Report, series. These reports, listed in Table E, Appendix V, covered subjects such as identification of critical loading conditions, free body diagrams, discussion of load path, methods of analysis, assumptions and significant margins of safety.

In addition to periodic upgrades to SE03 reflecting component changes or anomalies, addenda were used to present stress analysis for loads predicted for specific SRB flights or conditions not covered in the basic SE03

document. These addenda were usually published only where predicted loads for a given flight exceeded previously analyzed values.

At each step of subsystem design and development, care was taken to review the effect of design and design changes on interfaces. Proposed Interface Revision Notices (PIRNs) were submitted to Interface Control Document ICD-3-44006, Decelerator Subsystem SRB Forward Skirt and Nose Assembly, to define parachute riser attach fitting loads for 115 ft diameter and 136 ft diameter main parachutes. Similarly, PIRNs were submitted to ICD-2-4A002, SRB Retrieval Station, to define parachute retrieval and recovery configurations. These PIRNs were reviewed by the customer and, following approval, issued as Interface Revision Notices (IRNs) for incorporation into the applicable document.

To establish the performance requirements for design, development, manufacturing, refurbishment and verification of the SRB Decelerator Subsystem, and to formalize interface requirements by reference to the appropriate ICDs, the Configuration End Item Specification, SE-019-075-2H, was created and provided to Martin Marietta as an exhibit to the contract. This document is divided into two parts. Part I establishes the performance requirements of the SRB DSS, including as reference data initial SRB re-entry trajectory parameters. Various other requirements were also included in the Part I CEI specification. These include release of the main parachutes from the forward skirt at water impact, development flight load sensors, and anticipated environmental conditions under which the various components must successfully operate.

Even prior to STS-1, it became apparent that flight conditions on the DDT&E missions were going to exceed the design conditions defined in the basic Part I specification so that the performance requirements with regard to water impact velocities could not be met by the SRB DSS. As a result, the 20-series Appendices were created to document the differences between the original performance requirements and the anticipated subsystem performance on the DDT&E flights, STS-1 through -6. Despite the somewhat greater terminal velocities of the SRB and frustum, both were recovered in good condition on five of the six DDT&E flights. (The boosters on STS-4 were not recovered due to premature separation of the main deck fitting separation nuts, a problem not attributable to the Decelerator Subsystem.)

Additional exceptions to the basic CEI specification were established in Appendix 11 of that document, for the Large (136 ft D_o) Main Parachutes, and in Appendix 12 for the Filament Wound Case SRB Decelerator Subsystem.

Part II of SE-019-075-2H was created to establish the requirements for complete identification and acceptance of all units of the SRB DSS to be delivered to NASA-Marshall Space Flight Center. The configuration baseline was established at Configuration Inspection, in 1978, and revised in September 1984 to include 136 ft. diameter main parachutes as an alternate configuration for use with steel cased SRBs. At that time, the configurations installed on BI013 became the baseline for 115 ft D_o mains on the steel case SRBs. The configuration flown on mission 41D (STS-14) was established for Large Main Parachutes.

In July 1985, SCN 67 was submitted to United Space Boosters, Inc., to revise the Part II specification to re-baseline the SRB Decelerator Subsystem configurations. This revision, when approved, establishes the configuration to be flown on BI020 (136 ft D_o - Large Main Parachutes) as the new baseline for steel cased SRBs. The 115 ft D_o main chutes with the 52.5 ft dia. drogue parachute, as configured on BI033, becomes the Filament Wound Case (FWC) SRB DSS. In addition the Main Parachute Flotation Subsystem, as installed on BI026 and subsequent flights becomes a baseline for all systems.

Post flight analysis, originally scheduled for the first four DDT&E shuttle flights, continues on an on-going basis after each flight. This includes analysis of film data and whatever instrumentation was included on the flight. Some flights are equipped for loads measurement, but most are not. Recently, some flights have been equipped with on-board cameras set up to record the main chute deployment and inflation. A post-flight report, TM-12, is published after each flight to present the data and results of analysis.

Anomaly analysis has been conducted to identify the causes and conditions of Large Main Parachute failures which have occurred on a number of flights. Boosters continue to be recovered in good condition in spite of this problem, since the failure of a single large main chute results in a water impact velocity approximately equal to that of a booster with three small mains.

WBS 1.4.1.6.1.2.1 - Special Engineering Analysis - Technical Directives were received by MMC from MFSC directing certain activities be performed. Some of these TDs involved tasks such as review of Interface Revision Notices (IRNs) to Interface Control Documents, or shipping of certain hardware to subcontractors, etc. The majority of the 126 TDs required special engineering analyses in accordance with this WBS. A list of Technical Directives is shown in Table F, Appendix V.

The results of these and other engineering studies were published in sixty-nine Technical Notes, the subjects of which are listed in Table G, Appendix V. Fifteen of these Technical Notes were the direct product of TDs.

WBS 1.4.1.6.1.2.2 - Engineering Design - The Decelerator Subsystem design was a joint effort between Martin Marietta Corporation and its subcontractors, the principal supplier being Pioneer Parachute Corporation. Maximum use was mde of the technical expertise of each organization in its respective field.

Pioneer Parachute, for example, was responsible (subject to MMC approval) for detail design and fabrication of the parachutes, as well as development of the refurbishment techniques and repair procedures.

Following detail design by MMC, metal hardware was subject to a "make or buy" analysis and a majority of components, e.g., the Main Parachute Support Structure (MPSS), Main Riser Attach Fittings and Drogue Retention Brackets, were produced in-house at Denver. Certain other components of the

Decelerator Subsystem such as load cells and a later lot of Drogue Retention Brackets were purchased from Beowulf Corporation of Huntsville, Alabama.

Pyrotechnically actuated reefing line cutters were developed for the Decelerator Subsystem by Space Ordnance Systems based on existing technology.

Materials selection and control has been conducted in accordance with SE-020-009-2H, Rev. A, SE-019-094-2H, Rev A, and MSFC-SPEC-522A, under supervision of a Material Review Board (MRB). Processes were selected in accordance with SE-R-0006A, and a materials control and verification plan, SRB-DSS-SE09, was implemented early in the program.

Studies were conducted of factors affecting reuse and refurbishment, and design changes incorporated as necessary to assure cost effective operation of the DSS. For example, the Drogue Riser Attach Fittings were originally designed as single use items; after experience on STS-1 and -2, it was decided that they could be reclassified as reusable items and refurbishment procedures were developed, and approved by MSFC. In another example, the original prototype FWC drogue, flown on Development Air Drop Number 10, was a continuous-radial design which proved to be very difficult to repair after use. When the drogue was redesigned prior to DAD-11, one of the changes was to revert to the discrete radial-vent line-radial type of construction which facilitates repair. The baseline drogue, and both small and large main chutes already utilized this construction.

Because both sizes of main parachutes utilize the same operational main deck fittings, the Decelerator Subsystem maintains the flexibility of being able to utilize either size canopy on steel case SRBs as logistics or operational conditions dictate. (All three chutes on a given SRB must be of the same diameter, however.)

The Decelerator Subsystem has been designed to facilitate recovery of a majority of its components for refurbishment and reuse. The initial design provided for Parachute Location Aids (PLAs) to assist in recovery of the parachutes from the ocean. Although PLA mass simulators were flown on the first series of drop tests, the idea was dropped from consideration early in the program. A provision for the use of acoustic beacons (sonar "pingers") was made in the parachute design for the first six Shuttle missions, but this, too, was deleted after it was found that visual acquisition of the boosters eliminated the requirement and that the parachute risers masked too much of the sound pattern to be very effective.

On STS-1, -2 and -3, the main deck fittings were released from the SRB at water impact to permit easier handling of both the boosters and the parachutes. Pyrotechnic separation nuts holding the main parachute riser attach fittings to the forward dome of the SRB were fired at water impact, releasing the deck fittings and parachutes. The residual tension in the main parachute risers deployed the deck fittings over the sides of the boosters. The parachutes settled into the water with each chute suspended from a float attached to the apex of the parachute canopy.

During these first three flights it was found that the apex floats were subject to considerable damage during chute deployment so that a total of three parachutes failed to float and were not recovered. As a result, apex floats were omitted from further use, and the parachutes have been left attached to the boosters for STS-4 through BI025. The chutes are manually disconnected by the divers during recovery operations. This has been identified as an operation involving risk to the divers. Separation of the chutes at impact is now a requirement with the result that a different parachute flotation approach utilizing floats connected to the main deck fittings has been recently introduced. Current planning calls for inclusion of the Main Parachute Flotation Subsystem on BI026 and subsequent flights. The use of retroreflective cover material on the floats aids in spotting the floats on the ocean surface during retrieval and recovery operations. As the floats are easily spotted even under night visibility conditions, active retrieval aids remain unnecessary.

The use of a drogue chute/frustum retrieval line and retrieval line (the so-called "peanut") float to assist in retrieval of those components has continued on steel case SRB DSS. As a result of data obtained on drop test DAD-13, the retrieval line, float and retrieval line bridle have been eliminated from the FWC drogue chute configuration.

During ground tests at Space Ordnance Systems, it was found that the reefing line cutters would not consistently cut the 3-ply Kevlar FWC drogue chute reefing lines at temperatures of 200 degrees F. The cutter blades, which have been previously qualified to cut nylon reefing lines at elevated temperatures, were redesigned to use 13-8 Mo steel instead of the original 17-4 PH stainless, and subsequently qualified to cut 4-ply Kevlar at 200°F.

Following a number of flights, varying degrees of damage to main parachutes in the form of tears and friction burning has been noted. While this has not resulted in any major degradation to the Decelerator Subsystem mission performance, i.e., boosters continue to be recovered in good condition, the program design team has responded to the potential of such chute damage with a number of design changes.

In particular, some of the chute damage was determined to have been caused by contact with various surfaces of the Main Parachute Support Structure and inside surfaces of the frustum. An interim fix in the form of frustum foam fairings and bipod strut foam fairings was placed on BI013. This fix was applied in a timely manner and caused no impact on the Shuttle launch schedule. Subsequently, isogrid corner fairings were added to the DSS configuration, and have been part of the system since BI014.

Although the fairing modifications have definitely resulted in reduction of some types of damage, a problem with torn parachute ribbons has persisted. The program engineering team has continued its analysis and has come up with a number of recommendations for modifications to eliminate the problem. Some of these range from elimination of canopy bag ties and inclusion of rip-stops in the canopies to shortening of the MPSS or deployment from a softpack container.

A detailed list of the current SRB Decelerator Subsystem components is shown in the CEI Specification, Part II.

WBS 1.4.1.6.1.2.3 - Development Tests - A development test program was conducted to verify that the subsystem was ready for SRB flight application. The program consisted of a number of tests at various levels ranging from parachute element structural tests to structural tests of key parachute attachment and support hardware, to ground dynamic tests of parachute pack assemblies, and culminated in air drop tests of complete subsystems.

The range of tests is summarized in two documents: SRB-DSS-TM01 Verification Plan defines the development testing, excluding the air drop test program; SRB-DSS-TM06, Drop Test Plan, defines the air drop test program.

SRB-DSS-TM01 was prepared at the start of the program and has been updated as needed for new development tests resulting from major extensions to the subsystem. Introduction of the large main parachutes, the subsystem for the filament wound case SRB and the addition of the flotation subsystem, caused the major updates to the plan.

WBS 1.4.6.1.2.3.1 - Air Drop Tests - The Drop Test Plan also was prepared at the start of the program to define the scope, techniques and responsibilities in the drop test program. Appendices were prepared to define the specific objectives, requirements, guidelines and constraints for each drop test.

Reporting of drop tests was contained in three documents: SRB-DSS-TM09, Drop Test Quick Look Report; SRB-DSS-TM10, Drop Test Data Report; and SRB-DSS-TM11, Drop Test Final Report. The Quick Look Report was published within 3 days after a test in which a significant event occurred, the Data Report was published within 3 weeks after each drop test, and the Final Reports in four increments: one after drop tests DAD-1 and -2, one after tests -3 through -6, one after tests -7 through -9, and the last after completion of the balance of the fourteen air drop tests.

The development test program is summarized in Appendix VII, which lists test plans and reports for all development tests.

WBS 1.4.1.6.1.2.3.2 - Ground Tests - Each ground test was initiated by the preparation of a test plan that was coordinated with the customer before implementation. Upon completion of the ground tests a test report was published.

WBS 1.4.1.6.1.2.4 - Verification - A verification program was initiated in accordance with the Verification Plan, SRB-DSS-TM01, as discussed in Section 1.4.1.6.2.3 of this report. A DSS Certification of Qualification (COQ) was created and submitted to MSFC for each Shuttle flight to certify the flight readiness of the DSS. Martin Marietta document MCR-80-1343, Qualification Summary Report, defines how verification is accomplished.

WBS 1.4.1.6.1.2.5 - Support Equipment & Tooling (SE&T) and Special Test Equipment - Decelerator Subsystem support equipment is broken down into five categories:

(1) Initial Delivery Items
(2) Interim Support Equipment (ISE)
(3) Refurbishment Support Equipment (RSE)
(4) Drop Test Support Equipment
(5) VAFB Support Equipment

Initial Delivery Items were those pieces of support equipment defined under the original SOW. A list of these items is shown in Table A, Appendix VII. These items were designed, built and delivered to support the initial program operations; functional adequacy was demonstrated in the first phase of the drop test program. Three items designed and built for use in the Drop Test Program are listed in Table B, Appendix VII. These were subsequently delivered to KSC as Interim Support Equipment (ISE).

In 1978 MMC was directed to establish basic Refurbishment Support Equipment requirements and detail designs for such equipment. Document SRB-DSS-SE24-1, Design Criteria for Support Equipment, written in accordance with SW-E-0002B, established design, construction and testing criteria for RSE.

As the program developed and more parachute refurbishment experience was gained, requirements for Refurbishment Support Equipment were refined, the units fabricated and delivered. A series of Abbreviated Item Description (AID) Sheets (SRB-DSS-SE25) were written and published for the delivered RSE items. The final list of RSE is contained in Table C, Appendix VII. The quantities delivered are also shown. Items identified in the initial analysis but not built or delivered show "N/A" in the "Qty Delivered" column.

Additional items of equipment were designed to support the Air Drop Test Program. These items were primarily designed to handle components of the Drop Test Vehicle (DTV), although the ISE hardware was also utilized in support of the Drop Test Program.

Two additional support equipment items have been designed, built and delivered. These are the Parachute Reel Stand and the Wet Parachute Transportation Container. These items are utilized to support Shuttle operations at Vandenberg AFB, California. As no Parachute Refurbishment Facility exists there, it was deemed more cost effective to ship recovered SRB parachutes to the PRF at Kennedy Space Center than to build a PRF at VAFB.

The Wet Parachute Transportation Container was designed and built by Crown Rotational Molded Products of Marked Tree, Arkansas. It is designed to hold one main parachute in a wet condition to prevent salt crystallization in the nylon during cross-country shipment. Eight of these containers have been delivered to Port Hueneme, California, for use by the Air Force.

The Parachute Reel Stand is designed to hold parachute reels transferred from the recovery vessel so that the parachutes may be unrolled into the Wet Chute Container for shipment.

WBS 1.4.1.6.1.2.6 - KSC PRF Development - The KSC Operation developed from the DAD test program field operation at El Centro, CA. Some of the Martin Marietta and Pioneer Parachute drop test crew and equipment were transferred to KSC where offices were established in Hangar N at the Cape Canaveral Air Force Station. A work area was provided in Hangar "n" since the Parachute Refurbishment Facility (PRF) was currently under construction. The first flight set of parachutes for STS-1 were packed at PPC, Manchester, Connecticut, and delivered to KSC in shipping containers. The first two clustering operations for SRBs A07 and A08 (STS-1) were performed in Hangar "n" with the aid of its overhead crane. The clustering operation was performed to the procedures developed for the DAD test program.

Martin Marietta's original charter for the KSC operation was to develop procedures and an operating system to refurbish the hardware and manage the PRF for the first six DDT&E shuttle flights. During this period, MMC was to train the Booster Assembly Contractor personnel (USBI) and on the sixth refurbishment, the operation would be turned over to them. The scope of work was later reduced to four DDT&E flights, then expanded to the MBAC contract award (January 1985) in approximately one year contract increments. This evolution made long range planning and management of the PRF operation difficult.

Due to major delays in the shuttle launch schedule, it was decided to begin packing all SRB parachutes at KSC as the PRF had been completed and accepted by NASA-KSC. The parachutes for STS-2 (A09/A10) were delivered to the PRF unpacked and were packed by MMC and PPC personnel to the PPC packing procedures. Since these procedures did not comply with required NASA format standards, and equipment available in the PRF differed from that at PPC, the procedures were subsequently rewritten into MMC format.

Unlike the packing and clustering procedures which evolved from earlier operations, the procedures for handling and refurbishment of flown hardware were developed at the PRF. Table A in Appendix VIII lists all the Flight Hardware Refurbishment Procedures with original release date published under this contract.

During this contract period, the KSC operation has packed and delivered subsystems for sixteen (16) flights through Flight 51D. These include:

New 115' MC Packed	42
Refurbished 115' MC Packed	39
New 136' MC Packed	21
New 54' DC Packed	14
Refurbished DC Packed	18
New 52' DC Packed	2
	136

115' MC Clusters	27
136' MC Clusters	7
	34

Packing of mains, drogues, pilots and extraction chutes for the DAD 7-14 drop test program at China Lake, California, and the dynamic strip testing at Sandia Labs was performed in the PRF. Also, the mass simulation clusters and drogues for the MVGVT vehicles and the cluster and drogue for the VAFB FVV forward assembly were packed and assembled at the PRF.

The KSC operation conducted the post flight inspection and refurbishment of fourteen (14) flights (through 51A). Extensive investigations subsequent to flights STS-3, STS-4, STS-9, STS-11, and STS-13 resulting from major parachute damage, loss of parachutes and the loss of boosters on STS-4 were supported by the KSC operation. Visual evidence produced by a static strip test in the PRF during the STS-4 investigation was a major contribution to the resolution of that failure.

Personnel training was accomplished as delineated in SRB-DSS-LS04, Refurbishment Training Plan. Some training courses are for safety familiarization and KSC area access and are administered by various KSC contractors. Courses required to perform hands-on work on flight hardware require certifications, requirements for which are defined in the training plan.

WBS 1.4.1.6.1.2.7 - Special Studies - See WBS 1.4.1.6.1.2.1 and WBS 1.4.1.6.1.2.2.

3.3 MANUFACTURING - WBS 1.4.1.6.1.3

WBS 1.4.1.6.1.3.1 - Manufacturing Engineering - Manufacture of SRB DSS flight hardware included four categories:

(a) Metallic components of parachute/support connection structure
(b) Parachutes and other fabric components
(c) Reefing line cutters
(d) Load sensors

Category (a) items are discussed herein; items in categories (b), (c) and (d), are supplied by subcontractors and are discussed in detail under WBS 1.4.1.6.1.1.4.

The category (a) structural items were manufactured by Martin Marietta at the Denver, Colorado, facility except for one lot of Drogue Retention Ratchet Assemblies, Part No. 82700101060. A detailed list of components manufactured at the Denver plant is included in Table A, Appendix IX. Certain of the detail items were fabricated using numerically controlled machines. These parts are indicated in Table A, Appendix IX.

Several special purpose tools were designed and fabricated for the SRB DSS. These are listed in Table B, Appendix IX.

WBS 1.4.1.6.1.3.2 - Main Parachute Assembly - See WBS 1.4.1.6.1.1.4.

WBS 1.4.1.6.1.3.3 - Drogue Parachute Assembly - See WBS 1.4.1.6.1.1.4.

WBS 1.4.1.6.1.3.4 - Pilot Parachute Assembly - See WBS 1.4.1.6.1.1.4.

WBS 1.4.1.6.1.3.5 - Deleted from SOW.

WBS 1.4.1.6.1.3.6 - Other Deliverable Hardware - See WBS 1.4.1.6.1.2.5.

WBS 1.4.1.6.1.3.7 - Refurbishment of Flight Hardware and Provisioning of Support Hardware Spare Parts and Bulk Materials - Development and maintenance of procedures which provide instructions to perform flight hardware refurbishment and for Refurbishment Support Equipment (RSE) design and maintenance were completed in response to Data Requirements in the Information Requirements Document, SE-019-024-2H-R.

The refurbishment procedures provide very detailed, step-by-step instructions for performing parachute packing, inspection, repair, clustering, cleaning, metal component refurbishment and aging effects testing.

The RSE-related procedures give information on the design criteria, the description and maintenance requirements for RSE utilized in refurbishment of flight hardware.

Each procedure used for SRB DSS operations required initial validation and/or approval by MSFC for release, and approval for Procedure or Document Change Notices (PCNs, DCNs). Initial approval for all procedures was by the MSFC Contracting Officer. Validation of specific procedures was obtained by performing the first specified operations by the procedure, and incorporating redlined comments approved by each member of the validation team. Validation, PCN, and DCN approval requirements vary and have changed several times through the course of the program. The IRD Data Requirements specify these approval cycle procedures. Procedures are given either a Type 1 (approval by the customer is required), Type 1* (special approval cycle) or Type 2 (approval by the customer not required) category in accordance with the applicable DR. Type 1* documents such as the LSO3-X series, are approved in-house by MMC with subsequent approval by MSFC Program Quality Representative at KSC. Table A, Appendix VIII, lists the Flight Hardware Refurbishment Procedures.

Production operations performed at the PRF under this contract consist of refurbishment, assembly and checkout activities and production control. The refurbishment cycle for the SRB DSS hardware is presented in the Processing Flow Diagram (Figure 1, Appendix VIII), followed by a description of each phase of the cycle. Specific operating procedures are contained in the SRB DSS KSD Operations Procedures (KOP) 0-06 and 0-07, listed in Table VIII-B.

WBS 1.4.1.6.1.3.8 - Repair of Government Furnished Hardware - Repair of Government Furnished Equipment (GFE) was carried out on Main Parachute Support Structure (MPSS) S/N 0000008, which was damaged during removal from the

frustum following one of the Shuttle missions. An Engineering Change Proposal, RC5391, to repair this MPSS was submitted to and approved by MSFC. Standard MMC documentation was prepared, and inspection of the MPSS by MMC Quality Assurance was conducted to assure compliance with design drawings.

A number of load cells, which were damaged in handling at the SRB Refurbishment Facility, were refurbished by Beowulf Corporation, Huntsville, Alabama. (See Appendix II, Procurement Management, for quantities and subcontract numbers.)

3.4 CHANGE ACTIVITY - WBS 1.4.1.6.1.4

WBS 1.4.1.6.1.4.1 - Engineering Change Proposals - During the period of performance approximately 230 Class I changes were submitted via Engineering Change Proposals (ECPs) For NASA Level III change board approval. An additional 96 Class II changes were submitted for information and concurrence of classification in accordance with DD 8040.12A. These changes were also processed through the MMC Level IV change board prior to implementation.

3.5 SUPPORT EQUIPMENT - WBS 1.4.1.6.1.5

See WBS 1.4.1.6.1.2.5 and Appendix VII.

3.6 SRB/DSS REUSABLE PARTS - WBS 1.4.1.6.1.6

As a follow-on to the initial delivery of flight hardware, MMC was directed to supply two (2) complete Decelerator Subsystems less refurbishment kit items. The drawing numbers and quantities delivered were specified in Table V of the SOW of the contract. This table is reproduced as Table B, Appendix II, of this report.

3.7 LARGE MAIN PARACHUTES - WBS 1.4.1.6.1.7

See WBS 1.4.1.6.1.2.1.

3.8 FILAMENT WOUND CASE SRB DSS - WBS 1.4.1.6.1.8

See WBS 1.4.1.6.1.2.1.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The recovery of the Solid Rocket Boosters presented a major challenge. The SRB represents the largest payload ever recovered and presents the added complication that it is continually emitting hot gases and burning particles of insulation and other debris. Some items, such as portions of the nozzle, are large enough to burn through the nylon parachute material. The SRB Decelerator Subsystem program was highly successful in that no SRB has been lost as a result of inadequate performance of the DSS.

There have, however, been significant problems in the development of the SRB/DSS that in some cases remain unsolved. The most serious issue is the continuation of a pattern of friction burn damage and occasional gore failures that occur on the main parachutes. Fortunately, only one (of three) main chutes per SRB has failed so far and performance with two main parachutes has proven to be acceptable. Efforts to eliminate main parachute deployment damage has not been completely successful. Several modifications to alleviate or survive this damage are currently being evaluated. These include addition of rip-stop ribbons, deletion of canopy ties, development of an effective vent break system and reducing the severity of the main parachute deployment environment.

The majority of the damage to the main parachutes has been caused (directly or indirectly) by two requirements imposed upon the system at its inception. These requirements were deployment out of a rigid container (frustum) and attachment of flotation and/or retrieval aids to the apex of the parachutes. The location and retrieval aids have just about all been eliminated as a result of drop test and/or flight failures. If any future systems such as the SRB/DSS are to be developed, the concept definition phase must put recoverability first and retrievability second.

Several problems were encountered during the development of the 136 ft. diameter large main parachute. The first problem was a severe infold. The large diameter vent and long vent lines, resulting from the selection of a 160 gore design, prevented direct application of the parachute handbook (AFFDL-TD-78-151). We selected the vent line length after determining the as-built dimensions and load/elongation characteristics of the vent components and determining the effect of vent line length variations on vent band loads. The vent line length selection corresponded to the point at which the vent band load started to increase rapidly with increasing vent line length. The resulting configuration has eliminated the infolding problem on the LMP. Another, more obvious, effect of the large number of gores is the increase in cost of the parachute.

The selection of wide (1.75 in) vent lines in an attempt to block the large vent was a mistake, at least for clustered parachutes. This approach appears to be acceptable for single chute application where a relatively slow inflation rate can be tolerated. We were forced to install a continuous ribbon vent cap to achieve acceptable cluster performance with the LMP. Before this vent cap was installed, two chutes lagged into second stage on at least two occasions and one lagged into third stage on several occasions.

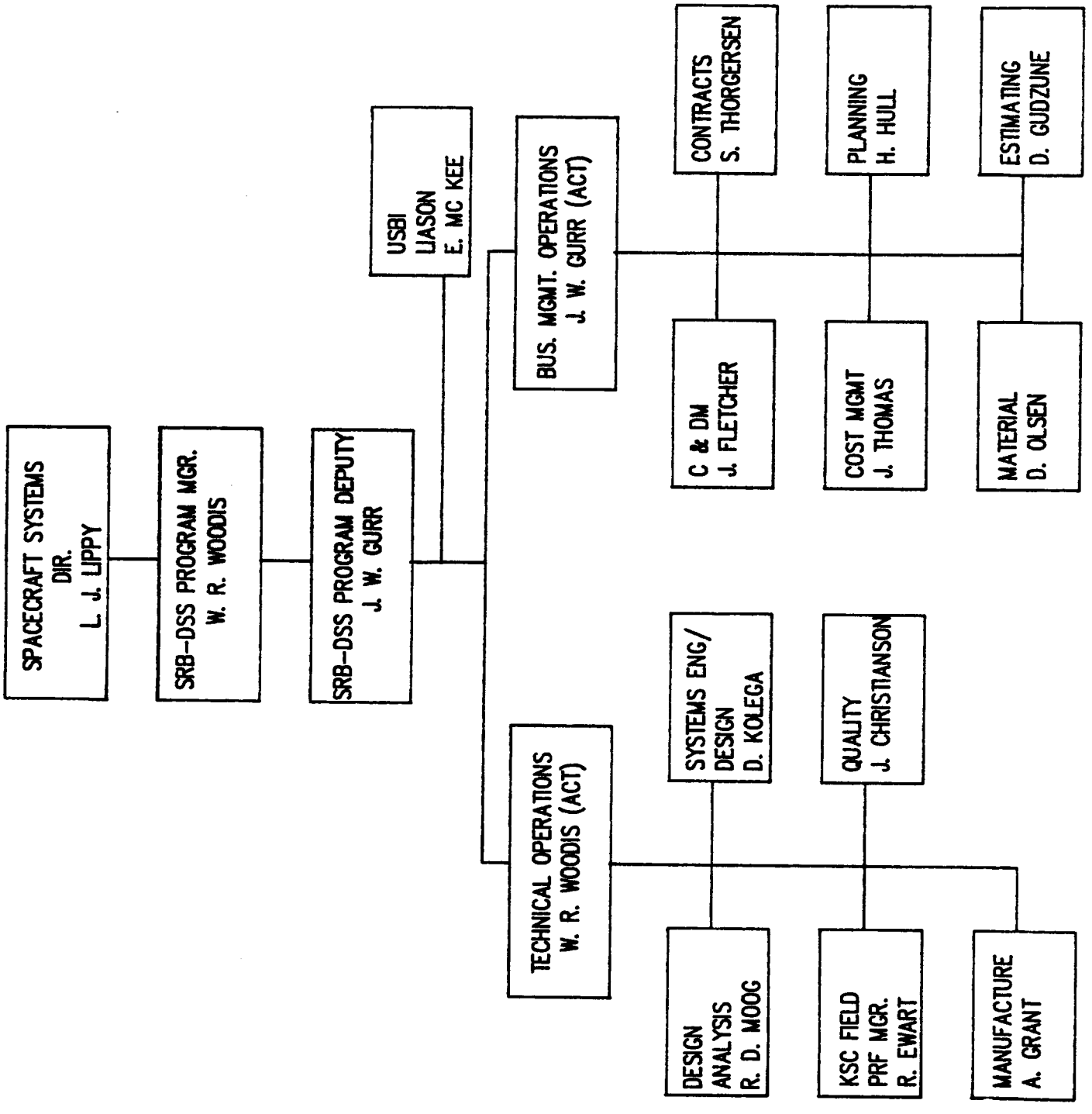
This vent modification has not eliminated the uneven cluster inflation, but based upon the limited test sample available at this writing (four cluster deployments) the cluster performance is less than desired, but is probably acceptable. The low first stage reefing ratio (17% C_DA) also contributes to the uneven cluster performance experienced with the LMP.

One final significant lesson learned during the development of the SRB/DSS related to the fabrication of the 48 ft. filament wound case (FWC) drogue. In an attempt to maximize the strength per gore of this design, a continuous suspension line (reinforced radial) concept was selected. This design was very difficult to build and during drop test (even at a load of 53% of design limit load) significant separation of the MIL-W-4088 TY 26 reinforcement from the radial occurred. This result indicated that the load was not properly shared between the radial and the reinforcing member and that unacceptable refurbishment activity would result if this design was used for the operational FWC drogue.

APPENDIX I

PROGRAM MANAGEMENT

(W.B.S. 1.4.1.6.1.1)



SRB-DSS ORGANIZATION
I-2

APPENDIX I-A - Description of SRB-DSS Major Organizational Functions

Program Manager - (W.R. Woodis) - Provides day-to-day direction to assure accomplishment of program requirements. Also currently acts as Director of Technical Operations. Reports to Martin Marietta Denver Aerospace Director of Spacecraft Systems, L.J. Lippy.

Deputy Program Manager - (J.W. Gurr) - Assures implementation, performance and completion of program requirements. Also currently acts as director of Business Management Operations. Reports to Program Manager.

Customer Liaison - (E. McKee) - Provides liaison with NASA-MSFC and USBI at Huntsville, Alabama.

Director of Technical Operations - (W.R. Woodis - Acting) - Co-ordinates technical activities and interfaces with Customer providing technical expertise on the SRB Decelerator Subsystem.

Director of Subsystem Design Analysis - (R.D. Moog) - Supervises and performs analysis of DSS pre-flight performance characteristics based on subsystem design and predicted flight conditions, as well as performing post-flight analysis and preparation of flight performance reports. Member of Flight Evaluation Group.

Systems Engineering/Design Lead - (F.I. Tallentire/D. Koleqa-Deputy) - Supervises and performs systems integration for the SRB-DSS Program, providing engineering guidance regarding design, test, configuration management and technical documentation. Applies parachute design expertise to both development and operational aspects of the program.

KSC Field Operations/Parachute Refurbishment Facility (PRF) Manager - (R. Ewart) - Supervises all facets of Martin Marietta Corporation operations at Kennedy Spaceflight Center. Co-ordinates and supervises packing, clustering and refurbishment activities at the PRF in support of Shuttle Flight Operations involving the SRB Decelerator Subsystem.

Quality Assurance - (J. Christianson) - Co-ordinates all activities involving SRB-DSS quality, reliability and safety functions. Material Review Board (MRB) Chairman; Project Board Chairman; Project Liaison for Customer and Vendor Quality; reviews and approves new or changes to engineering or procedures; manages Quality/Safety budgets; maintains hardware data packages, KSC quality procedures.

Manufacturing/Production Co-ordinator - (A. Grant) - Co-ordinates scheduling and production control of SRB-DSS hardware items manufactured in-house at Martin Marrieta.

Business Managment Operations - (J.W. Gurr - Acting) - Co-ordinates and supervises activities relating to contractual functions and negotiations between the SRB-DSS program and customers and suppliers.

APPENDIX I-A - Description of SRB-DSS Major Organizational Functions (Cont.)

Contract and Data Management - (J. Fletcher) - Supervises activities relating to preparation and submittal of engineering and contract change proposals, specification changes, data documentation, assures compatibility and accuracy of all program documentation. Also provides engineering release, implements and maintains SRB DSS configuration management system in conjunction with systems engineering.

Contracts Administration - (S. Thogersen) - Maintains contract and participates in negotiations with customer and suppliers.

Cost Management - (J. Thomas) - Prepares and issues budgets, monitors all costs against plans; co-ordinates, prepares and supports all data cost inputs to financial reports and all manpower reports as required.

Planning - (H. Hull) - Prepares and monitors schedule, supports program management in flight readiness reviews, PDR's and CDR's.

Materiel Representative - (D. Olsen) - Provides program direction, control, co-ordination and management to Materiel line operations. Supports development and preparation of program requirements, planning and scheduling, as well as implementation of procurement technical and administrative requirements. Monitors material schedules and performance. Co-ordinates purchase requisition and supports status meetings.

Estimating - (S. Gudzune) - Prepares cost estimates for preparation of proposals resulting from solicited and unsolicited changes to the basic SRB-DSS contract.

Subcontracts Administration - (A. Sustrick) - Monitors subcontractor activities including preparation of change orders, negotiating changes, monitoring production schedules.

APPENDIX I-B - Key Personnel History

Program Manager	C.W. Spieth
	R.E. Vosbeek
	W.R. Woodis
	M.E. Wakefield
	W.R. Woodis (Current)
Technical Director	W.R. Woodis (Current)
	R.D. Moog
Contract Mgr/Adm.	R.S. Shepler
	E.P. Heil, Jr.
	T.D. Hohman
	J.L. Palmer
	M.A. Osborne
	S.A. Thogersen (Current)
Parachute PIE	J.R. McCandless
Systems Eng.	F.I. Tallentire
	D.J. Kolega (Current)

SRB-DSS-MA06
September 1985

APPENDIX II

PROCUREMENT MANAGEMENT

(W.B.S. 1.4.1.6.1.1.4)

Table II-A

Listed below are procurements for the SRB/DSS Program:

Pioneer Parachute Company

O GC6-190032, CPIF/AF, Competitive Procurement, Sixty-One (61) Change Orders, Sixty-Seven (67) Amendments.

12 Each 54' Drogue Pack Assy, P/N 4200
36 Each 115' LMC Pack Assy, P/N 4300
12 Each Drogue Refurbishment Kits, P/N 4374
36 Each Main Refurbishment Kits, P/N 4375
12 Each Drogue Retention Kits, P/N 4400
12 Each Main Retention Kits, P/N 4450
12 Each Tow Pendant Attachment Lanyards, P/N 4501

Replacement Parts

6 Each 115' Main Canopies, P/N 4320
24 Each Risers, P/N 4324
48 Each Dispension Bridles, P/N 4325
2 Each Drogue Canopies, P/N 4220
24 Each Drogue Suspension Lines, P/N 4323
12 Each Pilot Pack Assy, P/N 4100

O RD3-133080, CPIF, Follow-On Procurement, One (1) Change Order, Six (6) Amendments.

C. DESCRIPTION OF WORK/ARTICLES TO BE FURNISHED BY THE CONTRACTOR

Within the scope of work set forth in paragraph B, above, the CONTRACTOR shall accomplish the following:

1. Fabricate twenty-four (24) each part number 4900-501, main parachute pack assembly: (excluding part numbers 4158-507, 4159-507, 4900-13 and 82700101062-002).

2. Fabricate eight (8) each part number 4470-501, main chute pack retention kit.

3. Fabricate thirty-six (36) each part number 4329-507, riser boot, main parachute (DDT&E).

4. Fabricate forty eight (48) each part number 4325-509, main riser, (Note: Seventy-two (72) each delivered under GC6-190032).

5. Fabricate two (2) each part number 4220-525, canopy assembly, drogue parachute.

6. Fabricate twenty-four (24) each part number 4223-503, suspension line group, drogue parachute.

- RD3-133101, CPIF, Follow-On Procurement, No Change Orders, Seven (7) Amendments.

C. DESCRIPTION OF WORK/ARTICLES TO BE FURNISHED BY THE CONTRACTOR

Within the scope of work set forth in Paragraph B, above, the contractor shall accomplish the following:

1. Fabricate thirteen (13) each part number 4920-505 canopy assemblies.

2. Fabricate thirteen (13) each part number 4910-503 deployment bag assemblies.

3. Fabricate one hundred four (104) each part number 4924-503 dispersion bridle assemblies.

4. Fabricate fifty-two (52) each part number 4325-509 main riser assemblies.

Space Ordnance Systems

- Note: Martin Marietta took over subcontracting responsibilities with SOS, from Pioneer Parachute Company, to insure on-time deliveries and lower prices. Both objectives were achieved. The results were significant.

- XD4-400876, FP, Follow-On Procurement Failure Analysis, Closed Out.

- RD4-400880, FP, Follow-On Procurement, 3 1/2 Second Cutters, Closed Out.

  6 Each 3.5 Second Delay Cutters, P/N 115460

- XD4-400890, FP, Follow-On Procurement, Lat Testing, One (1) Amendment, Closed Out.

  1 Lot LAT Testing on 14 Cutter Units for qualifying cutters to cut 2 ply Kevlar plus margin.

- XD4-400891, FP, Follow-On Procurement, Three (3) Ply Development Cutters.

  12 Each 7 Second Cutters
  12 Each 12 Second Cutters

- XD4-400895, FP, Follow-On Procurement, Development of 1.5 Second Delay Cutters, Closed Out.

  3 Each 1.5 Second Delay Cutters

Beowulf Corporation

- RC7-061604, Competition Procurement, Original Fabrication of Load Sensors.

  72 Each 125K Load Sensors, P/N 827001010029-020
  72 Each 35K Load Sensors, P/N PD7400192-039

- RD4-400875, Follow-On Procurement, Load Sensor Calibration, Closed Out.

  10 Each Drogue Load Sensors, 35K

- RD4-400877, Follow-On Procurement, Load Sensor Calibration, Closed Out.

  7 Each Drogue Load Sensors, 35K

- XD4-400878, Follow-On Procurement, Load Sensor Refurbishment, Closed Out.

  7 Each Drogue Load Sensors, 35K

- XD4-400879, Follow-On Procurement, Load Sensor Refurbishment, Two (2) Amendments, Closed Out.

  2 Each Drogue Load Sensors, 125K

- XD4-400881, Follow-On Procurement, Load Sensor Refurbishment.

  1 Lot Phase I Evaluation
  1 Each 125 K Load Sensor, P/N 82700101029-020, CAT I Repair
  23 Each 125 K Load Sensors, P/N 82700101029-020, CAT II Repair
  13 Each 35 K Load Sensors, P/N PD7400192-039, CAT I Repair
  10 Each 35 K Load Sensors, P/N PD7400192-039, CAT II Repair
  13 Each 35 K Load Sensors, P/N PD7400192-039, CAT III Repair

- XD4-400887, Follow-On Procurement, Load Sensor Refurbishment.

  6 Each 125 K Load Sensors, P/N 82700101029-020 SAT II Repair

- XD4-400888, Follow-On Procurement, Load Sensor Refurbishment.

  8 Each 125 K Load Sensors, P/N 82700101029-020, CAT I Repair
  4 Each 125 K Load Sensors, P/N 82700101029-020, CAT II Repair

- XD4-400894, Follow-On Procurement, Load Sensor Refurbishment.

  2 Each 35 K Load Sensors, P/N PD7400192-009, CAT I Repair
  4 Each 35 K Load Sensors, P/N PD7400192-009, CAT II Repair
  2 Each 125 K Load Sensors, P/N 82700101029-020, CAT I Repair

- TH3-133102, Follow-On Procurement, Tooling Order.

- TH5-400897, Follow-On Procurement, Tooling Order.

Crown Rotational Molded Products, Inc.

- RD3-133108, Single Source Procurement, Wet Parachute Transportation Containers.

  8 Each Wet Parachute Transportation Containers, P/N DP100115

- RD4-400882, Competitive Procurement, Flotation Gear.

Table II-B

SRB/DSS Reusable Parts

Martin Marietta	Nomenclature	Quantity Per Subsystem	Total Quantity
82700101050-019	Structure Assy - Support, Main Parachute	1	2
82700101057-009	Structure Assy - Main Parachute Support	3	6
82700101057-019	Structure Assy - Main Parachute Support	3	6
82700101057-020	Support Fitting Main Parachute Support	6	12
82700101063-009	Support Fitting Main Parachute Support	6	12

Pioneer	Nomenclature	Quantity Per Subsystem	Total Quantity
4320-513	Canopy Assy Main Parachute	3	6
4310-511	Deployment Bag Assy Main Chute	3	6
4324-503	Dispersion Bridle Main Parachute	24	48
4325-509	Main Riser Main Parachute	12	24
4369-7	*Bag Assy - Center Main Parachute Flotation Assy	3	6
4369-3	*Bag Assy - Right Main Parachute Flotation Assy	3	6
4369-5	*Bag Assy - Left Main Parachute Flotation Assy	3	6
4369-105	*Flotation Block - Left Main Parachute Flotation Assy	3	6
4369-103	*Flotation Block - Right Main Parachute Flotation Assy	3	6
4369-107	*Flotation Block - Center Main Parachute Flotation Assy	3	6
4369-15	*Riser Assy, Side Bag	6	12
4369-81	*Riser Assy, Center Bag	3	6
4220-523	Canopy Assy - Drogue Parachute	1	2
4223-503	Suspension Line Group - Drogue Parachute	12	24

* Shipped assembled into a subassembly. No part number assigned to the subassembly.

APPENDIX III

SAFETY, RELIABILITY AND QUALITY ASSURANCE

(W.B.S. 1.4.1.6.1.1.5)

TABLE III-A

PROBLEM & RESOLUTION REPORTS

PROBLEM REPORT NO.	PROBLEM	RESOLUTION
SRB-DSS-RA08-1	Main Riser Load Cell Failed Qualification Vib Test	Vendor Processes Updated and Additional Wire Stress Relief Provided
SRB-DSS-RA08-2	2 Reefing Line Cutters Failed 40 ft. Drop Qualification Test	40 ft. Requirement Waived
SRB-DSS-RA08-3	2 Reefing Line Cutters Failed Qualification Acceleration Test	Engineering Change Made and Design Passed Acceleration Tests
SRB-DSS-RA08-4	Drogue Parachute Failure on Development Air Drop - 3	Design Change
SRB-DSS-RA08-5	2 Reefing Line Cutters Failed Qualification Testing with Excessive Time Delays	Design Change
SRB-DSS-RA08-6	4 Reefing Line Cutters Failed During Qualification Testing - Failed To Function after 8 ft. Drop	Design and Manufacturing Process Change
SRB-DSS-RA08-7/8	Link Fittings Failed Magnetic Particle Examination Due to Cracks	Material Process and Manufacturing Process Changed
SRB-DSS-RA08-9	Rocket Sled Test Malfunction - Tow Cable Failure	Improve Test Configuration
SRB-DSS-RA08-10	Rocket Sled Test Malfunction - Incomplete and Premature Drogue Deployment	Improve Test Configuration
SRB-DSS-RA08-11	Rocket Sled Test Malfunction - Vano Chute Do Not Deploy Pilot Chute	Improve Test Configuration
SRB-DSS-RA08-12	DAD-10 Reefing Line Cutter Failures	Flight Cutters to be Used in Lieu of Lot #SWT Updated Cutters

TABLE III-A (Cont.)

PROBLEM & RESOLUTION REPORTS

PROBLEM REPORT NO.	PROBLEM	RESOLUTION
SRB-DSS-RA08-13	Development Air Drop - 13 (DAD-13) Failure	Design Change with Retrieval Line Removal and Subsequent Successful DAD-14
SRB-DSS-RA08-14/15	MPSS/Frustrum Structural Test Failure - Crack in Forward Tie Ring	Failure caused by test load strap failure. Revised analysis predicts positive forward ring margin for all flight conditions.

TABLE III-B

QUALIFICATION TESTING REPORTS

Nomenclature	Part No.	Time Delay (Sec)	Document ID	Type of Qualification
Reefing Line Cutters	PD6000207-004	0	RA05-1	Initial
	PD6000207-001	7	RA05-1	Initial
	PD6000207-010	12	RA05-1	Initial
	PD6000207-002	10	RA05-1	Initial
	PD6000207-003	17	RA05-1	Initial
	PD6000207-023	35	RA05-2	Delta Qualif. (New Delay Time)
	PD6000207-2001	7	RA05-3	Delta Qualif. (13-8 Mo. Blade)
	PD6000207-2010	12	RA05-3	Delta Qualif. (13-8 Mo. Blade)
Drogue Parachute Load Cell	PD7400192-019	N/A	RA05	Initial
Main Parachute Load Cell	PD7400192-030	N/A	RA05	Initial

APPENDIX IV

GOVERNMENT FURNISHED EQUIPMENT MANAGEMENT

(GFE)

W.B.S. 1.4.6.1.1.6

Table IV - Government Furnished Equipment - NAS8-32122

Contractor Part No.	Nomenclature	Unit	Qty
1000 Lb. Ribbon	Ribbon	Ea.	1
1000 Nylon Strip	Nylon Strip	Ea.	1
100136404	Valve	Ea.	1
10155-0038-001	Shear Pin	Ea.	6
10155-0144-001	Guide Pin	Ea.	3
10155-0145-001	Washer	Ea.	1
10304-0001-801	Thruster, LT AAE	Ea.	9
10305-0001-801	Pres Cartridge	Ea.	9
10309-0001-101	Nut, Separation	Ea.	12
10314-0001-101	CDF Assy	Ea.	3
10314-0001-102	CDF Assy	Ea.	3
10314-0001-103	CDF Assy	Ea.	3
10314-0002-823	CDF Assy	Ea.	12
10A00458-1-1	Thruster	Ea.	6
10A00461-21	CDF Initiator	Ea.	12
10A00481-15	CDF Manifold	Ea.	6
11039	Power Cable	Ea.	1
115460-1	Reefing Cutter	Ea.	1
115460-101	Reefing Cutter	Ea.	4
115460-103	Reefing Cutter	Ea.	6
115460-104	Line Cutter	Ea.	2
115460-105	Reefing Cutter	Ea.	8
115460-106	Reefing Cutter	Ea.	15
115460-2	Reefing Cutter	Ea.	2
12AC1156C10	Relay	Ea.	3
14A10501-1D101R	Nose Cap Assy	Ea.	6
1515A	Transducer	Ea.	5
16A10030-3	Cable Assy	Ea.	1
16A10033-3	Cable Assy	Ea.	1
16A10037-3	Cable Assy	Ea.	2
173OPHA09WW1250	Pump	Ea.	4

Table IV - Government Furnished Equipment - NAS8-32122 (Continued)

Contractor Part No.	Nomenclature	Unit	Qty
200421	Fitting	Ea.	12
21F96	Transformer	Ea.	1
2620008703770	Tires	Ea.	10
320-200	Valve	Ea.	3
347614A	Valve	Ea.	1
36456	Manifold	Ea.	1
4152-507	O Time Cutters	Ea.	2
4158-507	Line Cutter	Ea.	1
4162-1	Link	Ea.	1
4200-557	Para Pack Assy	Ea.	1
4331-193	Modulator	Ea.	13
4352-1	Sep. Link Booty	Ea.	20
4400-515	Retention Kit	Ea.	1
460 Lb. Ribbon	Ribbon	Ea.	1
460 Nylon Strip	460 Nylon Strip	Ea.	1
48914SS12	Valve 86768	Ea.	2
5-6024785	Valve	Ea.	10
51077-111	Manifold Assy	Ea.	7
532-498	Switch 81813	Ea.	1
5330-658-9317	Seal	Ea.	1
59457227702	Relay Armature	Ea.	1
6145 Pwr Cable	Pwr/Cable/Short	Ea.	4
61930	Gauge, Pressure	Ea.	3
62108855090	Light Indicator	Ea.	3
643XB962	Valve	Ea.	2
78878	Cable	Ea.	1
79K12903	Parachute Spool	Ea.	1
82700101029-020	Riser Attachment	Ea.	9
82700101033-003	Guide Spools	Ea.	48
82700101033-004	Pin, Riser	Ea.	36

Table IV - Government Furnished Equipment - NAS8-32122 (Continued)

Contractor Part No.	Nomenclature	Unit	Qty
82700101043-009	Riser Attachment	Ea.	48
82700101043-010	Rachet Assy	Ea.	72
82700101051-009	Panel Assy	Ea.	1
82700101057-004	Spacer	Ea.	6
82700101057-005	Shim	Ea.	6
82700101057-029	Struts	Ea.	3
82700101057-030	Clevis	Ea.	6
82700101057-039	Struts	Ea.	3
82700101060-010	Rachet Assy	Ea.	24
82700101060-029	Rachet Assy	Ea.	12
82700101065-003	Spacer	Ea.	1
82700101065-004	Spacer	Ea.	2
827001050-009	Support Structure	Ea.	2
827001057-010	Clevis Assy	Ea.	48
AM33MG8	Breaker 74193	Ea.	3
AN6234/3	Filter	Ea.	6
AR-7	Aerocoat	Gl.	2
Breakout Cable	Breakout Cable	Ea.	2
BTV Cable Cutter	BTV Cable Cutter	Ea.	13
BTV PWR CNT CBL	BTV PWR CNT CBL	Ea.	3
CABL Cutter CABL	CABL Cutter CABL	Ea.	18
Camera Cases	Shipping Cases	Ea.	2
Camera, 1B	1B Camera	Ea.	2
CR106B1	Starter	Ea.	1
DMPS-1	Demodulator	Ea.	5
Doubler Plates	Doubler Plates	Ea.	3
EMR Model 2746	PCM Decom.	Ea.	1
EMR Model 2755	Analog Display	Ea.	1
EMR Model 720	PCM Sync	Ea.	1
Film 200 Ft.	Film 200 Ft.	Rl.	6

Table IV - Government Furnished Equipment - NAS8-32122 (Continued)

Contractor Part No.	Nomenclature	Unit	Qty
Film Magazine	Magazine, Film	Ea.	2
Fire Ext	Fire Ext	Ea.	2
Frustum	Frustum	Ea.	1
GHN65690	Cylinder	Ea.	1
GHN68690	Cylinder 91940	Ea.	6
Grommet Samples	Grommet Samples	Ea.	6
H77-0151	Nosecap Lug Kit	Ea.	2
H77-0189	Nosecap Sling	Ea.	2
HA14WW1000	Pump	Ea.	1
Hays T-100	Shuttle Model	Ea.	1
Intercometer - B52	Intervecometer	Ea.	1
Lens 5.377MM	5.377MM - Lens	Ea.	2
MAF1-1/14A10601-1	Chute Brackets	Ea.	1
MAF2-1/14A10601-1	Transfer Gage	Ea.	1
MAR9032	Battery	Ea.	2
MC-4027 Gore Sect.	STS 13 Gore Sec.	Ea.	1
MC-4030 Gore Sect.	STS 13 Gore Sec.	Ea.	1
MC4027	Gore Remnant	Ea.	1
MC4030	Gore Remnant	Ea.	1
ME453-0021-0007	Detonator Cartr	Ea.	59
ME453-0021-0009	Fuse Detonating	Ea.	6
ME453-0021-0010	NSI Detonator	Ea.	2
Model 410K	TM Receiver	Ea.	1
MS20016	Bolt Internal W	Ea.	3
MS20018	Bolt Internal W	Ea.	6
MS21250-20052	Riser Att, Bolt	Ea.	13
MS24326-1	Wheel	Ea.	2
MSFC10A00481-1	CDF Manifold	Ea.	3
N65629	Manifold	Ea.	2
N65691	Cylinder	Ea.	1

Table IV - Government Furnished Equipment - NAS8-32122 (Continued)

Contractor Part No.	Nomenclature	Unit	Qty
N65693	Cylinder	Ea.	3
N718982YB	Stud	Ea.	4
N78847	Cord	Ea.	1
NAS1291-C8	Nut	Ea.	16
NAS1586-8-23	Bolt	Ea.	79
NAS1587-20C	Washer, CSK, 1	Ea.	12
NAS1587-6	Washer	Ea.	2
NAS1587-8	Washer	Ea.	16
NAS1587-8C	Washer	Ea.	16
NS091486-00	Model Shuttle	Ea.	1
Ordnance Ring Segment	Ordnance Ring	Ea.	8
Para. Spool Stand	Parachute Spool	Ea.	1
Parachute PI Assy	Parachute Pack Assy	Ea.	1
PC1C115	VA Relay	Ea.	2
PD7400192-019/39	Load Cells D. P.	Ea.	6
PD7400192-039	Sensor Load Cell	Ea.	10
PWR CBL SH 110V	PWR CBL SH 110V	Ea.	1
Reefing Cutters	Reefing Cutters	Ea.	8
Release Cable	Release Cable	Ea.	6
S200 BTV Loader	S200 BTV Loader	Ea.	2
S200 CNTRL CNSL	S200 CNTRL CNSL	Ea.	2
S201 BTV TRNSPOR	S201 BTV TRNSPOR	Ea.	2
S202 LOADR TRACK	S202 Loader Track	Ea.	1
S212 Bolster	S212 Bolster	Ea.	2
S212 Bolster Stand	S212 Bolster Stand	Ea.	3
S212 Cable/IC Box	S214 Cable/IC Box	Ea.	1
S214 Indicator C&L	S214 Cable/LK IND	Ea.	1
Seal ABZ 553	Seal ABZ 553	Ea.	19
Sealant Samplers	Sealant Samplers	Bg.	1
SEB26100001-210	Initiator	Ea.	1

Table IV - Government Furnished Equipment - NAS8-32122 (Continued)

Contractor Part No.	Nomenclature	Unit	Qty
SEB26100001-216	NASA Stand Init	Ea.	25
SEB26100094-202	NSI Detonator	Ea.	1
Sigh Bore	Bore Sigh	Ea.	1
Silicone Compound	Silicone No. 36	Cm.	1
Sled Test Hardware	Hardware	Lt.	1
STS-13 Flaps	STS 13 Flaps	Ea.	3
Tires	Tires	Ea.	2
Transport Tire	Tire, Transports	Ea.	8
Transport Tube	Transport Tube	Ea.	1
Transporter Rim	Transporter Rim	Ea.	2
VM324BC064	Nut	Ea.	3
XCH11	Cable Elec 91929	Ea.	1
XCH20	Cable Elec 91929	Ea.	1
XCH21	Cable Elec 91929	Ea.	1
XCH22	Cable Elec 91929	Ea.	1
XCH23	Cable Elec 91929	Ea.	1
XCH7	Cable Elec 91929	Ea.	1

APPENDIX V

SUBSYSTEM ANALYSIS AND INTEGRATION

(W.B.S. 1.4.1.6.1.2.1 and including 1.4.1.6.1.2.7,
1.4.1.6.1.7.1 and 1.4.1.6.1.8.1)

TABLE V-A

MASS PROPERTIES STATUS REPORT (SRB-DSS-SE01)

Report No.	Subject	Date
SE01-1	Baseline subsystem	August 1976
SE01-2	Baseline subsystem	September 1976
SE01-3	Baseline subsystem	October 1976
SE01-4	Baseline subsystem	November 1976
SE01-5	Baseline subsystem	February 1977
SE01-6	Baseline subsystem	May 1977
SE01-7	Baseline subsystem	September 1977
SE01-8	Baseline subsystem	March 1978
SE01-9	Baseline (115') DSS w/o Pingers or Flashing lights	October 1978
SE01-10	SMF (115') DSS w/corrosion resistant deck fittings	February 1982
SE01-11	LMP (136') Main chute DSS	June 1983
SE01-11, DCN-1	LMP (136') Main chute, w/flotation subsystem	April 1985

TABLE V-B

SRB-DSS-SE03 Stress Analysis Report
Directory of Changes

SE03	Basic Document	November 1976
SE03	Basic Document	December 1976
SE03	Rev. A (See Table of Contents)	June 1978

DCN's are used to update or include additional subsections or appendices to Basic Document.

DCN 1	Added Pages C-7b and C-7c to Appendix C, Ratchet Bracket Analysis	July 1978
DCN 2	Revised Pages 16, 19	September 1978
DCN 3	Revise Pgs 38-42 in App. E2, Trim FWD Tie Ring Splice Plate	October 1978
DCN 4	Added Drogue CANO Loads to Parachute Strength Analysis Pgs 1, 20 & 24, App. F	November 1978
DCN 5	Added Drogue Radial Extension 200°F Joint Test Results, Pg 22, 22a, App. F.	June 1979
DCN 6	Added Drogue Deck Fitting Reduced Heat Treat Analysis, App. A-49 through A-64	November 1979
DCN 7	Updated Main Deck Fitting Loads Analysis, D1-D18, for DTV Overload	March 1980
DCN 8	Added Sonar Beacon Mounting Bracket, D36-D45 (Cancelled)	March 1980
DCN 9	Not Applicable	Never Issued
DCN 10	Added App. G, Large Main Chute	September 1982
DCN 11	Added Drogue Deck Fitting Fatigue Analysis A65-A76	February 1984
DCN 12	Added App. H, Filament Wound Case	June 1983
DCN 13	Added MPSS Fracture Criticality Analysis, GE6-1 to GE6-6	January 1984
DCN 14	Upgrade App. G, for Large Main Parachute	September 1984
DCN 15	Main Deck Fitting Fracture Mechanics Analysis, D2-1, D2-25	September 1984

TABLE V-B (Cont.)
SRB-DSS-SE03 Stress Analysis Report
Directory of Changes (Cont.)

DCN 16	Drogue Deck Fitting Stress Analysis FWC Subsystem, HA 1.1 - HA 1.64	June 1985
DCN 17	Shortened MPSS Stress Analysis Appendix J (Pending) See DCN 19	March 1985
DCN 18	Float Stress Analysis, Added Appendix K	April 1985
DCN 19	Shortened MPSS Stress Analysis Update, Supercedes DCN 17, Appendix J	May 1985
DCN 20	FWC Drogue Deck Fitting Analysis, Subercedes DCN 16, Bridle Link Assy, FWC DSS Strength Analysis, Appendix HA1, HA2, and HF1	June 1985

ADDENDA - Are used to present Stress Analysis for specific flight predicted loads or conditions, not adequately covered in Basic Document. Addenda are not usually published when predicted loads for a given flight do not exceed previously analyzed values.

1. (6/80)	STS-1	Drogue Deck Fitting Analysis for Drogue Loads to 279.1 KIPS, Main Deck Fitting Analysis (DFE), for loads upt to 174.1 KIPS, MPSS Analysis up to 25.5 G's, Updated Parachute Strength Analysis.
2. (9/81)	STS-2,	Drogue Deck Fitting Analysis for Drogue Loads to 319.1 KIPS, Main Deck Fitting Analysis (DFI) for loads up to 197.7 KIPS, MPSS Analysis up to 27.6 G's, Updated Parachute Strength Analysis.
3. (3/82)	STS-3,	Drogue Deck Fitting Analysis for Drogue Loads to 328.1 KIPS, Updated Drogue Strength Analysis.
4. (5/82)	STS-4	Updated Parachute Strength Analysis, Reused Drogues.
5. (6/83)	STS-8	Updated Parachute Strength Analysis, Reused Mains.
6. (8/83)	STS-9	Updated Parachute Strength Analysis, Used Drogues.
7. (10/84)	51-A	Main Deck Fitting (DFI) for LMP Loads to 232.5 KIPS. Updated LMP Strength Analysis.
8. (10/84)	51-A	Main Deck Fitting (DFI) for LMP with Modified Vent Loads to 208 KIPS. Updated LMP Strength Analysis for used chutes.
9. (6/85)	BI020-24	Operational Main Deck Fittings for LMP Loads to 208 KIPS.

TABLE V-C

Actual Weight Reports (SRB-DSS-SE07)

SE07-1	SRBA07	STS-1	April 1981
SE07-2	SRBA08	STS-1	April 1981
SE07-3	SRBA09	STS-2	April 1981
SE07-4	SRBA10	STS-2	April 1981
SE07-5	SRBA11	STS-3	October 1981
SE07-6	SRBA12	STS-3	October 1981
SE07-7	SRBA13	STS-4	May 1982
SE07-8	SRBA14	STS-4	May 1982
SE07-9	SRBA15	STS-5	May 1982
SE07-10	SRBA16	STS-5	May 1982
SE07-10 DCN1	SRBA16	STS-5	May 1982
SE07-11	SRBA17	STS-6	September 1982
SE07-12	SRBA18	STS-6	September 1982
SE07-13	SRBA51	STS-7	February 1983
SE07-14	SRBA52	STS-7	February 1983
SE07-15	SRBA53	STS-8	March 1983
SE07-16	SRBA54	STS-8	March 1983
SE07-17	SRBA55	STS-9	September 1983
SE07-18	SRBA56	STS-14/16 (41D)	September 1983
SE07-19	SRBA57	STS-11 (41B)	September 1983
SE07-20	SRBA58	STS-11 (41B)	September 1983
SE07-21	SRBA59	STS-14/16 BIO11L (41D)	January 1984
SE07-22	SRBA60	STS-9	January 1984
SE07-23	SRBA56 (Repack)	(STS-1416 - 41D)	May 1984
SE07-24	SRBA59 (Repack)		May 1984
SE07-25	SRBA61	STS-13 (41C)	May 1984
SE07-26	SRBA62	STS-13 (41C)	May 1984
SE07-27	SRBA63	BIO13L/STS-17(41G)	May 1984
SE07-27 Rev A	SRBA63	BIO13L/STS-17(41G)	November 1984
SE07-28	SRBA64	BIO13R/STS-17(41G)	May 1984
SE07-28 Rev A	SRBA64	BIO13R/STS-17(41G)	November 1984

TABLE V-C (Cont.)

Actual Weight Reports (SRB-DSS-SE07)

SE07-29	SRBA65	BI014L(STS-19(51A)	November 1984
SE07-30	SRBA66	BI014R(STS-19(51A)	November 1984
SE07-31	SRBA67	BI015L(STS-20(51C)	November 1984
SE07-32	SRBA68	BI015R(STS-20(51C)	November 1984
SE07-33	SRBA69	BI016R(STS-24(51B)	November 1984
SE07-34	SRBA70	BI016R(STS-24(51B)	November 1984
SE07-37	SRBA73	BI018L(STS-23/51D)	March 1985
SE07-38	SRBA74	BI018R(STS-23/51D)	March 1985
SE07-39	SRBA75		March 1985
SE07-40	SRBA76		March 1985

TABLE V-D Design Loads Analysis Report (SRB-DSS-SE11)

Report No.	Subject	Date
SE11-1	Design loads analysis report	August 1976
Rev B		March 1978
DCN1	LMP	October 1982
DCN2	Single chute failure; FWC	April 1983
DCN3	Single chute failure; FWC	November 1983
DCN4	LMP	February 1984
DCN7	Rev. FWC Section 10 (CDR)	June 1985
DCN6	Flotation Subsystem	April 1985
Addendum 1	STS1	May 1980
Addendum 2	STS2	September 1981
Addendum 3	STS3	March 1982
Addendum 4	STS4	May 1982
Addendum 5	STS5	October 1982
Addendum 6	STS6	January 1983
Addendum 7	STS7	April 1983
Addendum 8	STS8	June 1983
Addendum 9	STS9	August 1983

TABLE V-E

Subsystem Analysis Report (SRB-DSS-SE16)

Report No.	Subject	Date
SE16-2	Subsystem Analysis Report	November 1976
SE16-3	Subsystem Analysis Report	May 1979
DCN1 to SE16-3	LMP	October 1982
SE16 Addendum 1	(STS-1)	June 1980
DCN3 to SE16-3	Subsystem Analysis (FWC)	November 1983
DCN4 to SE16-3	LMP	May 1984
DCN5 to SE16-3	Revise FWC SRB Sect.: PDR	July 1984
DCN6 to SE16-3	Revise FWC	June 1985

TABLE V-F
TECHNICAL DIRECTIVES

TDR No.	Subject
001	Parachute Compartment Temp. Limits
002	Drop Test Program Documentation
003	Reference Data for Parachute Refurbishment
004	SRB & Components Transporation Limits
005	DSS PRR RID's
006, 006A and 006B	Water Impact Assessment of MPSS
007	Simulated Drogue Risers
008	Crystal Switching in PLA
009	Parachute Support Structure
010	Theoretical First Unit Costs
011	Min. Altitude Deployment Study 2/23/77
012	Main Chute Tether Study
013 & 013A	SRB Main & Drogue Chute Rotation Device; cancellation 3/3/77
014	PLA Optimization & Alt.
015	Ident. of DTV Main Chute Canopies
016	Eval. of KSC PRF
017	Component Test Requirements Spec. (CTRS) sheets
018	Para. Recyling Line Length for DAD 1 & 2
019	SRB Retrieval System GSE PDR Data Pkg. RID's
020	SRB DSS Fracture Control Study
021	Support for Parachute Retrieval Simulations
022	DTV Aerosynamic Stability Requirements
023	Install Monorail at NPTR
024	(Not Used)
025	Impact of Revised DSS Drop Test Overload Conditions
026	GFE Nose Cap Assy
027	Sonar Beacon Mass Simulation
028	Metallic Mat'ls Test Specimens
029	KSC Retrieval System CDR Pkg. Eval.
030	Nose Cap, Frustum Separation Connectors

TABLE V-F (Cont.)
TECHNICAL DIRECTIVES

TDR No.	Subject
031	Analysis of SRB DSS DTV Wind Tunnel Test
032	Support for KSC Ocean Retrieval Tests
033	Provide Main Deck Fittings to SOS
034	Fracture Criticality Study of the DSS
035	Update ICD to Reflect Latest Design Requirements
036	Review of SE-019 -112 -2H (Retrieval & Disassembly Proc. Spec.)
037	Review of ICD-3-44006 Rev. A
038	Support for DSS Independent Assessment Team
039	Adoptions of Kevlar Material for SRBDSS Reefing Line Design
040	Recommendations of the Independent Assessment Team
041	Review of OMI B5506, SRB Parachute Installation
042	Eval. Support Equip. Doc. for Drogue & Pilot Install
043 & 43A	Shelf Life of Reefing Cutters
044	Sonar Acoustic Beacon Propagation Test Specimen
045	SRB Drawings
046	Marine Microbiology Meeting at MSFC
047	Sonar Acoustic Beacon Retainers/R047A Redesign Retainer
048	Joint Strength Meetings
049	Reefing Cutter Lot Cert. Reviews
050	Marine Joint Samples - Preparation of -
051	Evaluation of NASA TM78204
052	DSS Design Cert. Reveiw (DCR)
053	ICD-3-44006 Drogue/Pilot Clearance Envelope
054	Safe Alert LaRC - S-79-01 "Mat'ls, Rubber, Band, Parachute"
055	VAFB Ops. Review
056	STS-1 Altitude Switch Setting Analysis/R056A Study Potential Changes in SRB Aerodynamics
057	Evaluation of PIRN R-26 to ICD-3-44006
058	Review of Reuse Assessment Plans
059	Ident. of Maint. & Storage Reqmts. for Hdware @ KSC

TABLE V-F (Cont.)
TECHNICAL DIRECTIVES

TDR No.	Subject
060	SRB-OMRSD Review
061	SRB Retrieval OPS Plan
062	Strength Adequacy of Suspect Reynolds Aluminum
063	Review of Verifications Plan for VAFB V30
064	SRB Dwgs
065	Reynolds Aluminum Plate Stock used in SRB-DSS
065A	Reynolds Al Plate used in the SRB-DSS
066	Pinger Performance (Pinger Attach)
067	Review of 90% Design Review Pkg. for VAFB Station Set V30
068	SRB-DSS Dwgs.
069 & 069A	Devel. Hdware to Support SRB Retrieval Tag
070	Eval. of IRN R-28 to ICD-3-44006 Rev A
071	Review of OMI B5626
072	Review ICD-3-44006, Rev B
073	Support FEWG Meeting
074	DSS Qual. Summary Report
075	DSS Storage Reqmts./Supporting Rationale - Ltr. Response
076	Review SRB-DSS Refurb. Spec. (USBI) Affected USBI SE-2)
077	Not used
078	DSS Sequence Information
079	Review IRN's to ICD2-4A002
080	Drogue Performance Study
081	SRB/DSS Improvement Recommendations
082	Pinger Mount Bracket (2-1/2 - 2-3/4" O.D. Pinger) Capability
083	Impact of "RSE Critical Weld Method"
084	SRB/DSS Planning - List of Delivered Flt. Hdware
085	Approval of SOW for Load Cell Rework
086	SRI Validation Report
087	STS-4 Config. -- Packing O.D. for STS-4
088	STS-5/STS-6 Config.

TABLE V-F (Cont.)
TECHNICAL DIRECTIVES

TDR No.	Subject
089	USBI 7000 - SE-2
090	PRF Transition Planning
091	Impact of Revised Main Chute Size on Velocity
092	136 ft. Main Study
093	Test of SRB Impact Loads -- Analysis Support
094	Proof Test RSE
095	STS-7/STS-8 Config.
096	Optimization of Main Chute Deployment Bag Location (Lower)
097	STS-1 Reuse Rationale
098	Main Chute Retrieval Line Def.
099	Revised TDR095 - STS-7 Re-use Mix
100	FWC Performance Study
101	Support to STS-4 Post Flight
102	STS 5/6 Config.
103	Main Chute Mass Simulators
104	SRB Lightening Susceptibility
105	Wet Chute Shipping Box
106	STS-6/7 Drogue Chutes
107	SRB Recovery Loads Test
108	RSE Reqmts.
109	STS-9 Config.
110	Drogue Chute w/o Reefing Ring Retainer Snatch Load Tests
111	Support to SRB Impact Tests
112	STS-10 Delivery Dates
113	LMP Deck Fitting Floats
114	STS-11 Config.
115	STS-12 Config.
116	(54') Drogue Parachute Upgrade Load Study (TN32122-57 Revised CANO Parachute Canopy Analysis Results)
117	Prep. Chutes for Retrieval Testing

TABLE V-F (Cont.)
TECHNICAL DIRECTIVES

TDR No.	Subject
118	Shorten MPSS Feas.
119	Main Chute Sled Test
120	Elim. Canopy Ties
121	Soft Pack
122	FVV Hardware Support
123	Update Part Ii CEI Spec.
124	Eval. of Freezing Effects on SRB Chute Mat'l.
125	SRB-DSS Delivery Dates - BI 017, 018, 019
126	SRB-DSS Delivery Reqmts. BI 018, 017, 019, 025, 020, 021

TABLE V-G

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-001	Temperature Response of Parachute Material to Thermal Environment	11 Aug. 1976
TN-32122-002	Proposed Deletion of the DTV Lightweight Nose Cap; Cost, Safety and Reliability Improvements	20 Aug. 1976
TN-32111-003	Dollar Value of Reliability	25 Aug. 1976
TN-32111-004	Telemetered Instrumentation for the SRB Decelerator Drop Tests	13 Sept. 1976
TN-32111-005	Total Pressure Measurement and DTV Ballast Separation Using Baroswitch	28 Sept. 1976
TN-32111-006	Aerodynamic Coefficients for Three DTV Configurations	01 Oct. 1976
TN-32111-007	Main and Drogue Parachute Aerodynamic Performance Study	08 Oct. 1976
TN-32000-008	Location of Load Cells in Drogue Chute Risers	13 Oct. 1976
TN-32000-009	Nose Cap/Pilot Parachute Static Line Design (RID No. 61)	18 Oct. 1976
TN-32000-010	Dollar Value of DTV Reliability	29 Oct. 1976
TN-32000-011	CANO - Parachute Canopy Analysis Results	30 Oct. 1976

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-012	FMEA & CIl for DTV including a Cost Effective Study of Redundant Programmers and/or Relay Boxes	Nov. 1976
TN-32122-013	Water Impact Assessment of the Parachute Support Structure	22 Nov. 1976
TN-32122-014	DTV Test #1, Sequence of Events, Nominal and Worse Case. Preliminary	08 Dec. 1976
TN-32122-015	Redundant Programmers for the DTV	08 Dec. 1976
TN-32122-016 (TDR 008)	Crystal Switching Study for the PLA per MSFC Technical Directive R008.	08 Dec. 1976
TN-32122-017 (TDR R009)	Feasibility of Deletion of the SRB Struts from the Parachute Support Structure Interface	09 Dec. 1976
TN-32122-018	Minimum Deployment Altitude Terminal Q Study	08 Feb. 1977
TN-32122-019	Trade Study of Cost Effectiveness of Various Metals for Usage in the Decelerator Subsystem	09 Feb. 1977
TN-32122-020	Retention of Pilot Parachute and Drogue Bag/ Flotation at the Drogue Canopy Apex	14 Feb. 1977

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-021 (R012)	Evaluation of Concepts for Tethering Main Parachutes to the SRB at Splashdown	20 Feb. 1977
TN-32122-022	DTV Configuration No. 2 Stability	21 Feb. 1977
TN-32122-023 (TDR 014)	Parachute Location Aid (PLA) Optimization, Alternate Configurations	25 Feb. 1977
TN-32122-024	Main parachute Attachment Fitting Recoil	03 Mar. 1977
TN-32122-025 PDR D-M017	Drogue Pack Retension Cut-Loop Actuation	07 Mar. 1977
TN-32122-026	Evaluation of the KSC PRF Operationsl Capability to Support the Planned Shuttle Launch Rate.	14 Mar. 1977
TN-32122-027	Determination of Overpressures for DTV Linear Shapped Charges	16 Mar. 1977
TN-32122-028	PLA Flotation Analysis	21 Jan. 1977
TN-32122-029	Chase Plane Safety Considerations for DTV Test Number 1	21 Apr. 1977
TN-32122-030	DTV Drop Test Number 1 Illustrations of Drop Sequence	18 May 1977

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-031	DTV-1, Flight 1, DTV/B-52 Mate and Disengagement Demonstration	06 June 1977
TN-32122-030-A	DTV Drop Test Number 2 Illustrations of Drop Sequence	18 July 1977
TN-32122-032	Parachute Retrieval Demonstration	02 Sept. 1977
TN32122-033 (TDR 022)	DTV Aerodynamic Stability Requirements	30 Sept. 1977
TN-32122-030-B	DTV Drop Test Number 3 Illustrations of Drop Sequence	Nov. 1977
TN-322122-034 (TDR 031)	Aerodynamic Coefficients For The Three Finned DTV	05 Apr. 1978
TN-32122-035 (TDR 034)	FRACTURE CRITICALITY STUDY OF THE DECELERATOR SYSTEM	11 Apr. 1978
TN-32122-030-C	DTV DROP TEST NUMBER 4 ILLUSTRATIONS OF DROP SEQUENCE	13 Apr. 1978
TN-32122-036 (DR RID M033)	MINIMUM DEPLOYMENT ALTITUDE TERMINAL Q REVIEW	13 Apr. 1978
TN-32122-030-D	DTV DROP TEST NUMBER 5 ILLUSTRATIONS OF DROP SEQUENCE	May 1978

TABLE V-G (Cont.)

TECHNICAL NOTES

TReport No.	Subject	Date
TN-32122-031	DTV-1, Flight 1, DTV/B-52 Mate and Disengagement Demonstration	06 June 1977
TN-32122-030-F	DTV DROP TEST NUMBER 7 ILLUSTRATIONS OF DROP SEQUENCE	Aug. 1978
TN-32122-030-G	DTV DROP TEST NUMBER 10 ILLUSTRATIONS OF DROP SEQUENCE	Mar. 1984
TN-32122-030-H	DAD-11 Illustration of DROP SEQUENCE	Jul. 1984
TN-32122-030-I	DAD-12 Illustration of DROP SEQUENCE	Oct. 1984
TN-32122-030-J	DAD-13 Illustration of DROP SEQUENCE	Nov. 1984
TN-32122-030-K	DAD-14 Illustration of DROP SEQUENCE	Mar. 1984
TN-32122-037 (TDR056A)	STS-1 Parachute Loads Analysis	Jun. 1979
TN-32122-038 (TDR 056)	Baroswitch Setting Study for STS-1 (TDR 056)	Sept. 1979
TN-32122-039 (TDR 050)	Marine Microbiology Contaminated Material Test Results (TDR 050)	Aug. 1979
TN-32122-040 (TDR 062)	Strength Adequency of Suspect Reynolds Aluminum	Sept. 1979
TN-32122-041 (TDR 080)	SRB DSS Drogue Performance Study	Nov. 1980

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-042	Preflight Prediction Report STS-1	Feb. 1981
TN-32122-042	Rev. A - Preflight Prediction Report STS-1	27, 28 Mar. 1981
TN-32122-043	Rev. A - Preflight Prediction Report STS-2	Aug. 1981
TN-32122-044	Filament Wound Case Performance Study	18 Sept. 1981
TN-32122-045	Preflight Prediction Report, STS-3	Feb. 1982
TN-32122-046 (TDR 096)	Optimization of Main Parachute Deployment Bag Location	May 1982
TN-32122-047	Preflight Prediction Report STS-4	May 1982
TN-32122-049	Preflight Prediction Report STS-5	06 Oct. 1982
TN-32122-050	Preflight Prediction Report STS-6	23 Nov. 1982
TN-32122-051	Chase Plane Safety Considerations for DAD-7	02 Feb. 1983
TN-32122-052	Preflight Prediction Report STS-7	21 Apr. 1983
TN-32122-053	Preflight Prediction Report STS-8	20 Jun. 1983
TN-32122-054	Preflight Prediction Report STS-9	21 Jul. 1983
TN-32122-055	Fracture Criticality - Update to TN-32122-35	12 Aug. 1983

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-056	Revised CANO Parachute Canopy Analysis Results	26 Aug. 1981
TN-32122-057	Drogue Parachute Upgrade Load Study	01 Sept. 1983
TN-32122-058	Optimum Vent Line Length Study	22 Nov. 1983
TN-32122-059	Preflight Prediction Report Mission 41R Formerly STS-11	16 Dec. 1983
TN-32122-060	Preflight Prediction Report, Mission 41-C	28 Feb. 1984
TN-32122-061	Preflight Prediction Report, Mission 41-D	27 Apr. 1984
TN-32122-062	Preflight Prediction Report, Mission 41-G	24 Aug. 1982
TN-32122-063	Preflight Prediction Report, Mission 51-A	25 Oct. 1984
TN-32122-064	Preflight Prediction Report, Mission 51-C	25 Oct. 1984
TN-32122-065	Reefing Cutter Tolerances (Lot AAC)	13 Dec. 1984
TN-32122-066	Preflight Prediction Report Mission 51E, Mission 51D, Mission 51B	16 Jan. 1985
TN-32122-067	Summary Final Report, Preliminary Design Sutdy for Main Parachute Deployment from "Soft" Container	14 Apr. 1985

TABLE V-G (Cont.)

TECHNICAL NOTES

Report No.	Subject	Date
TN-32122-068	Preflight Prediction Report, Mission 51-F (BI017)	29 May 1985
TN-32122-069	Preflight Prediction Report, Missions 51I, 51J, 61A, 61B, 61C	07 Jun. 1985

APPENDIX VI

DEVELOPMENT TESTS

W.B.S. 1.4.1.6.1.2.3

Appendix VI Development Tests

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Static Tests			
Flight Hardware			
Drogue Parachute Attach Fitting			
Static Structural Test, High Heat Treatment	SRB-DSS-TM15-2	SRB-DSS-TM03-12	
Static Structural Test, Low Heat Treatment	SRB-DSS-TM15	SRB-DSS-TM03-16	
Proof Load Test, High Heat Treatment	MCR-79-1338		
Proof Load Test, Low Heat Treatment	MCR-80-1347		
Sustained Load Test, High Heat Treatment	MCR-79-1340		
Sustained Load Test, Low Heat Treatment	MCR-80-1355		
Drogue Retention Fitting Static Structural Test	SRB-DSS-TM15-3	SRB-DSS-TM03-14	
Main Parachute Attach Fitting			
Instrumented Static Structural Test	SRB-DSS-TM15-1	SRB-DSS-TM03-13	
Operational Static Structural Test	SRB-DSS-TM15-5	SRB-DSS-TM03-17	
Main Parachute Support Structure			
Baseline Static Structural Test	SRB-DSS-TM15-4	SRB-DSS-TM03-15	
LMP Static Structural Test	SRB-DSS-TM15-13	SRB-DSS-TM03-29	MPSS/Frustum Forward Ring Test

Appendix VI Development Tests (Continued)

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Static Tests			
Drogue Bag Bridle Link Assy			
Static Structural Test		SRB-DSS-TM03-22	
Parachute Element Tests		SRB-DSS-TM03-11	Tests of Parachute elements after DAD-3.
Main Parachute Riser Test		MCR-82-1318	
Dispersion Bridle Joint Efficiency Test LMP		SRB-DSS-TM03-18	
Dispersion Bridle Joint Efficiency Test LMP		SRB-DSS-TM03-21	
Passive Load Measurement Test		SRB-DSS-TM03-20	Development of Passive Load Measurement Concepts
Parachute Element Tests			
Parachute Material Tensile Tests		SSPO-659* SSPO-620* SSPO-620* SSPO-619*	
Parachute Material Load/Elongation Tests		SSPO-302*	
Parachute Seam and Joint Tensile		SSPO-485* SSPO-1270*	
Parachute Energy Absorber Tensile Tests		SRB-DSS-TM03-4	
Parachute Material Preliminary Reuse Tests		SSPO-692*	
Parachute Seam and Joint Reuse Tests		SSPO-692*	
Parachute Refurbishment Tests		SSPO-693*	

* Pioneer Parachute Documents

Appendix VI Development Tests (Continued)

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Static Tests			
10 Ft. Dia. Pilot Parachute Stress Analysis		Doc. No. 1233*	
Seam and Joint Test Results, 10 Ft. Dia. Pilot Parachute		Doc. No. 1234*	
Stress and Design Load Analysis, 52 Ft. Dia. Drogue Parachute and Deployment Bag		Doc. No. 1235*	
Stress and Design Load Analysis, 136 Ft. Dia. Main Parachute		Doc. No. 1289*	
Seam and Joint Test Results, 52 Ft. Dia. Drogue Parachute		Doc. No. 1290*	
Stress and Design Load Analysis, Flotation Assembly		Doc. No. 1291*	
Seam and Joint Test Results, 136 Ft. Dia. Main Parachute		Doc. No. 1292*	
Results of 70° Skewed Horizontal Ribbon Joint Tests		Doc. No. 1293*	
Seam and Joint Test Results, Main Deck Fittings Flotation Subsystem		Doc. No. 1297*	
Parachute Material Humidity Tests		SSPO-271*	
Parachute Static Pack and Pull Tests		SSPO-367* SSPO-368* SSPO-426*	
DTV Hardware			
DTV Drogue Parachute Attach Fitting		SRB-DSS-TM03-5	
DTV Main Parachute Attach		SRB-DSS-TM03-6	

* Pioneer Parachute Documents

Appendix VI Development Tests (Continued)

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Dynamic Tests			
Flight Hardware			
Main Parachute Dynamic Strip Test		SRB-DSS-TM03-1	
Drogue Parachute Dynamic Strip Test	SRB-DSS-TM15-6	SRB-DSS-TM03-2	
Pilot Parachute, Dynamic Strip Test		SRB-DSS-TM03-3	
Energy Absorber Dynamic Strip Test		SRB-DSS-TM03-4	
Drogue Parachute Acceleration Test		SRB-DSS-TM03-8	
Drogue Parachute Vibration Test		SRB-DSS-TM03-9	
Nose Cap Ejection Rocket Sled Test		SRB-DSS-TM03-10	Baseline Pilot and Drogue Deployment Test
Drogue Chute Dynamic Strip Test	SRB-DSS-TM15-7	SRB-DSS-TM03-19	Rocket Sled Powered Test
Drogue Chute Dynamic Strip Tests (110%)	SRB-DSS-TM15-10	SRB-DSS-TM03-23	Rocket Sled Powered FWC Drogue Chute Tests
FWC Drogue Chute Dynamic Deployment	SRB-DSS-TM15-8 RWA	SRB-DSS-TM03-24 SRB-DSS-TM03-25	FWC Pilot Chute Dynamic Strip Test
Pilot Chute Overload Dynamic Test (110%)	SRB-DSS-TM15-11	SRB-DSS-TM03-26	Rocket Sled Test, FWC Pilot Chute Overload
Pilot Chute Overload Deployment Test (110%)	SRB-DSS-TM15-9		

Appendix VI Development Tests (Continued)

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Dynamic Tests			
Main Parachute Flotation			
Ocean Flotation Test		SRB-DSS-TM03-27	
Dynamic Deployment Test		SRB-DSS-TM03-28	
DTV Hardware			
Pyro Separation Function Tests		SRB-DSS-TM03-7	DTV Separation Charge Function Tests
Air Drop Tests			
Baseline System			
DAD-1	SRB-DSS-TM06 Appendix I		
DAD-2	SRB-DSS-TM06 Appendix II	SRB-DSS-TM10-2 SRB-DSS-TM11-1	Final Report DAD 1 & 2
DAD-3	SRB-DSS-TM06 Appendix III	SRB-DSS-TM09-3 SRB-DSS-TM10-3	
DAD-4	SRB-DSS-TM06 Appendix IV	SRB-DSS-TM09-4 SRB-DSS-TM10-4	
DAD-5	SRB-DSS-TM06 Appendix V	SRB-DSS-TM09-6 SRB-DSS-TM10-6	
DAD-6	SRB-DSS-TM06 Appendix VI	SRB-DSS-TM10-6 SRB-DSS-TM11-2	Final Report DAD 3,4,5 & 6
Large Main Parachute System			
DAD-7	SRB-DSS-TM06-1 Appendix VII (DCN 1 & 2)	SRB-DSS-TM09- SRB-DSS-TM10-7	
DAD-8	SRB-DSS-TM06-1 Appendix VIII	SRB-DSS-TM09-3 SRB-DSS-TM10-8	

Appendix VI Development Tests (Continued)

Subsystem Verification Test	SRB-DSS-TM01, Verification Plan Plans	Reports	Remarks
Ground Dynamic Tests			
DAD-9	SRB-DSS-TM06-1 Appendix IX	SRB-DSS-TM09- SRB-DSS-TM10-9 SRB-DSS-TM11-3	Final Report DAD 7,8 & 9
Filament Wound Case System			
DAD-10	SRB-DSS-TM06-1 Appendix X	SRB-DSS-TM10-10	
DAD-11	SRB-DSS-TM06-1 Appendix XI	SRB-DSS-TM09-11 SRB-DSS-TM10-11	
DAD-12	SRB-DSS-TM06-1 Appendix X	SRB-DSS-TM10-12	
DAD-13	SRB-DSS-TM06-1 Appendix XI	SRB-DSS-TM09-14	
DAD-14	SRB-DSS-TM06-1 Appendix XII	SRB-DSS-TM09-14 SRB-DSS-TM10-14 SRB-DSS-TM11-4	Final Report DAD 10,11,12, 13 & 14

APPENDIX VII

SUPPORT EQUIPMENT AND TOOLING (SE&T) AND SPECIAL TEST EQUIPMENT (STE)

W.B.S. 1.4.1.6.1.2.5 AND ALSO INCLUDING 1.4.1.6.1.3.6 AND 1.4.1.6.1.5 AND SUBPARAGRAPHS

Table VII-A

SUPPORT EQUIPMENT - INITIAL DELIVERY ITEMS

NASA Model No.	MMC DWG No.	Nomenclature	Qty Delivered
A77-0188 Part 1	82700201026	Main Parachute Cluster Buildup Platform	2
A77-0188 Part 2	82700201028	Main Parachute Cluster Buildup Access Platform	2
H77-0195	82700201029	Drogue Parachute Handling Sling	5
P77-0159	82700201030	Main Parachute Cluster Transportation Pallet	4

Table VII-B

INTERIM SUPPORT EQUIPMENT

MMC DWG NO.	Item	Qty
82700201127*	Container Handling Sling	1
82700201156*	Main Parachute Hoisting Sling	1
82700201155*	Main Parachute Transportation Dolly	1

* Also used in drop test program.

Table VII-C

REFURBISHMENT SUPPORT EQUIPMENT

NASA Model No.	MMC DWG No.	Nomenclature	Qty Delivered
A77-0265	82700201033	Drogue Chute Package Container	2
A77-0264	82700201034	Main Parachute Packing Container	4
P77-0161	82700201035	MPSS Transportation Pallet	2
A77-0644	82700201036	MPSS Transportation Pallet Cover	2
	82700201038	Reefing Line Installation Device, Overhead	N/A
H77-0229	82700201041	Shipping Container Cover Handling Sling	3
H77-0224	82700201042-009	Cluster/MPSS Pallet Sling	2
H77-0224	82700201042-039	MPSS Pallet Basket Sling	6
H77-0225	82700201043	Main Parachute Pack Clustering Dolly	4
	82700201046	Suspension Line Keeper Kit	N/A
	82700201049	Profile Checking Tool, Drogue Chute	N/A
A77-0262	82700201051	Drogue Shipping & Storage Container	6
	82700201056	Main Parachute Shipping & Storage Container	N/A
	82700201057	Tensioning Device Adapter, Main Chute	N/A
	82700201058	Tacking & Alignment Fixtures, Dispension Bridles & Risers	N/A
A77-0613	82700201059	Material Tensioning Device	2
H77-0226	82700201061	Main Chute Pack Handling Sling	3
A77-0615	82700201063	Tensioning Device Adapter, Drogue	3

Table VII-C (Continued)

REFURBISHMENT SUPPORT EQUIPMENT

NASA Model No.	MMC DWG No.	Nomenclature	Qty Delivered
A77-0616	82700201066	Parachute Packing Spider Press	3
	82700201067	Rotating Sling, Drogue Pack	N/A
	82700201069	Drogue Suspension Line Separator, Overhead	N/A
	82700201070	Droque Suspension Line Separator, Table	N/A
	82700201071	Parachute Packing Table	N/A
H77-0227	82700201072	Shipping Container Handling Sling	3
A77-0622	82700201075	Sewing Machine Table	1
	82700201076	Parachute Rotating Pad	N/A
	82700201077	Parachute Apex Tensioning Anchor	N/A
	PPC 4173	Main Chute Cluster Protective Cover	4
	82700201079	Wet Chute Container Handling Sling	2
	82700201080	Parachute Reel Stand	1
	CRM: DP100115	Wet Parachute Container	8
A77-0277		Sewing Machine, 131WSV17 (Med. Duty, 4 Needle)	1
A77-0278		Sewing Machine, 112W116, (Med. Duty, 2 Needle)	1
A77-0279		Sewing Machine, Single Needle, F Thread	1
A77-0280		Sewing Maching, Single Needle, EE Thread	1
A77-0281		Sewing Maching, Single Needle, Three Cord	1

Table VII-C (Continued)

REFURBISHMENT SUPPORT EQUIPMENT

NASA Model No.	MMC DWG No.	Nomenclature	Qty Delivered
A77-0282		Sewing Machine, Single Needle, Six Cord	1
A77-0283		Sewing Machine, Light Duty, Darning	1
A77-0602		Sewing Machine, 7 Class	1
A77-0603		Sewing Machine, Long Arm, Heavy Duty	1
A77-0604		Sewing Machine, Med. Duty, Zig Zag	1
TBD		Sewing Machine, Heavy Duty, Automatic, 1 Needle	2
TBD		Sewing Machine, Light Duty, Automatic, 1 Needle	2

Table VII-D

DROP TEST SUPPORT EQUIPMENT

Drawing Number	Nomenclature
82700201149	Lifting Bar - DTV (Sling Assy)
82700201130A	Sling Assembly
82700201129	Sling Assembly
82700201127*	Handling Sling Assembly
82700201130	Frustum Adapter
82700201131	Multipurpose Sling Assembly
82700201135	Frustum Horizontal Support Fixture
82700201144	Bracket Assembly, Nose Cone Sling Attachment
82700201145	Sling Attachment Plate SRB Separation Ring
82700201132	Lifting Bar - DTV
82700201150	Adapter Ring Multipurpose Sling
82700201156*	Main Parachute Hoisting Sling
82700201155*	

* Also were ISE items.

APPENDIX VIII

FIELD SUPPORT

W.B.S. 1.4.1.6.1.2.6

Table VIII-A

FLIGHT HARDWARE REFURBISHMENT PROCEDURES

Procedure Number	Procedure Title	Original Release
SRB-DSS-LS03-1	Post Flight Inspection, Damage Assessment and Disposition Procedure	02 Nov 81
SRB-DSS-LS03-2	Standard Repair Procedures	03 Nov 81
SRB-DSS-LS03-3	Packing Procedure, Drogue Parachute Pack Assembly	11 May 81
SRB-DSS-LS03-4	Packing Procedure, Main Parachute Pack Assembly	22 May 81
SRB-DSS-LS03-6	Main Parachute Cluster Assembly Procedure	05 Feb 81
SRB-DSS-LS03-7	Transportation and Handling Procedure for SRB-DSS Components at KSC	07 Feb 81
SRB-DSS-LS03-8	Refurbishment Procedure SRB-DSS Metal Components	29 Oct 82
SRB-DSS-LS03-9	SRB-DSS Aging Effects Procedure	29 Jun 83
SRB-DSS-LS03-10	Packing Procedure, 136 Foot Main Parachute Pack Assembly	30 Jan 84
SRB-DSS-LS03-12	Post Flight Disassembly and Cleaning	25 May 84
SRB-DSS-LS03-13	136 Foot Main Parachute Clustering Procedure	10 Feb 84
MCR-80-1371	Packing Procedure, Pilot Parachute Pack Assembly	19 Nov 80

Additional procedures were written to define the disciplines and responsibilities to manage the PRF operation. These KSC Operations Procedures (KOPS) were written by MMC PRF personnel and were structured after the KSC Pre-flight Operations Procedures (POP) which are a NASA requirement of other KSC contractors. The PRF KOPS are listed in Table B.

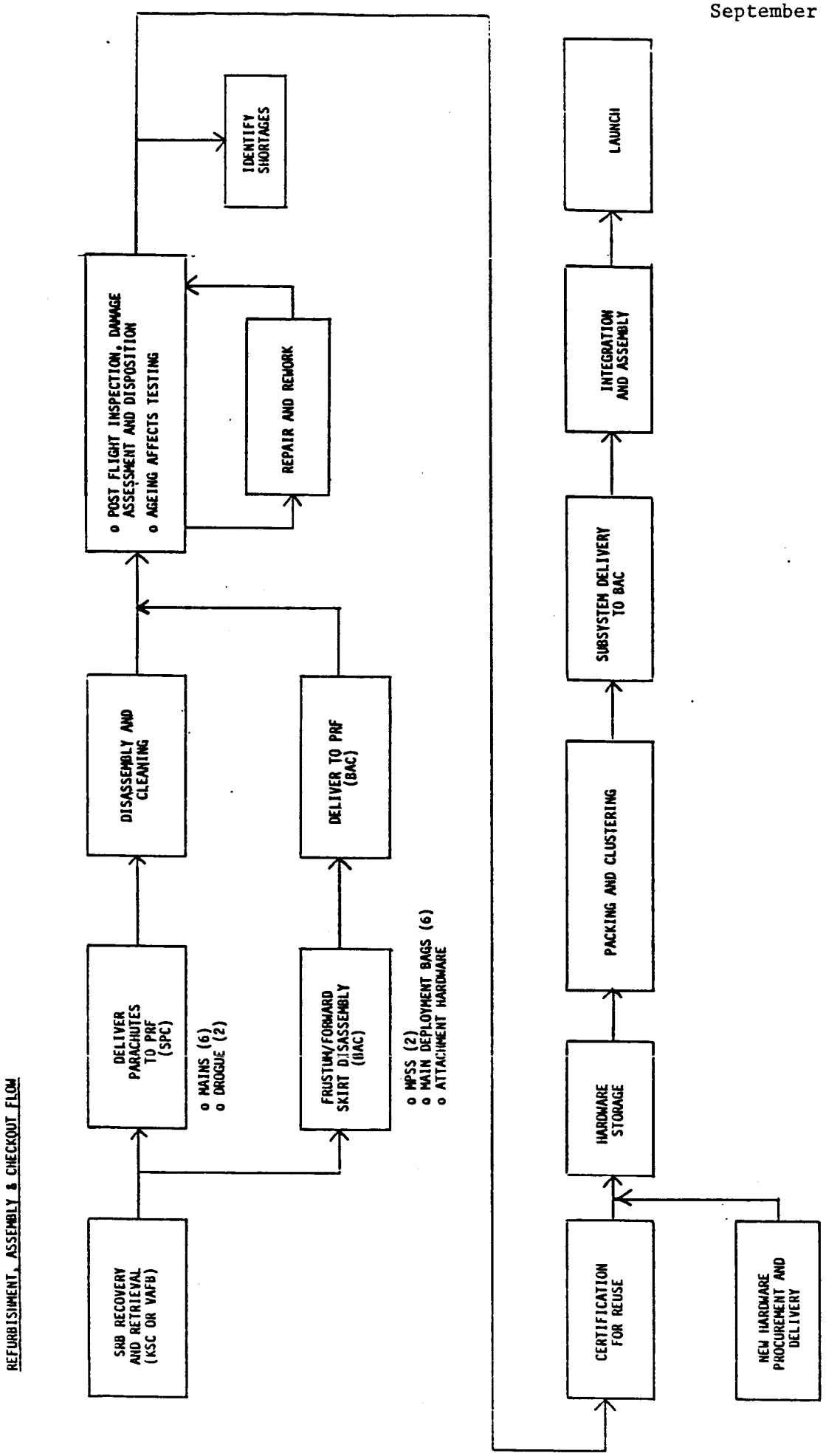

REFURBISHMENT, ASSEMBLY & CHECKOUT FLOW
SRB RECOVERY AND RETRIEVAL (KSC OR VAFB)
DELIVER PARACHUTES TO PRF (SPC)
o MAINS (6)
o DROGUE (2)
FRUSTUM/FORWARD SKIRT DISASSEMBLY (IAC)
o MPSS (2)
o MAIN DEPLOYMENT BAGS (6)
o ATTACHMENT HARDWARE
DISASSEMBLY AND CLEANING
DELIVER TO PRF (BAC)
o POST FLIGHT INSPECTION, DAMAGE ASSESSMENT AND DISPOSITION
o AGEING AFFECTS TESTING
REPAIR AND REWORK
IDENTIFY SHORTAGES
CERTIFICATION FOR REUSE
NEW HARDWARE PROCUREMENT AND DELIVERY
HARDWARE STORAGE
PACKING AND CLUSTERING
SUBSYSTEM DELIVERY TO BAC
INTEGRATION AND ASSEMBLY
LAUNCH

FIGURE I

A. Recovery and Retrieval - The recovery and retrieval of SRB's and DSS components after launch from KSC is the responsibility of the Shuttle Processing Contractor (SPC). The parachutes are delivered directly to the PRF, on the covered retrieval reels, by the SPC. It is necessary to maintain the parachute materials wet, until washed with fresh water at the PRF, to prevent salt crystallization and consequent damage to the parachute.

B. Disassembly and Cleaning - The Main Parachute Support Structures (MPSS), main parachute deployment bags, MPSS bipod struts and clevises and drogue parachute attachment fittings are removed from the frustum and the drogue parachute attachment fittings are removed from the frustum and the main parachute attachment fittings are removed from the forward skirt by the BAC. These metallic items are rinsed with fresh water, corrosion preventive compound applied, then they are transferred to the PRF for refurbishment.

Disassembly, defoul, washing and drying of the parachutes is performed in the PRF in accordance with procedure, SRB-DSS-LS03-12. Defoul operations generally begin approximately 48 hours after launch and all parachutes are complete with the wash/dry operation within four working days.

C. Post Flight Inspection, Damage Assessment and Disposition - The inspection, damage assessment, post flight evaluation and return of flown DSS hardware to flight worthy status is performed in accordance with the Post Flight Inspection, Damage Assessment and Disposition Procedure, SRB-DSS-LS03-1.

Each reusable component of DSS hardware returned from flight is thoroughly inspected for fabric damage in accordance with the requirements of LS03-1. SRB-DSS Metal Components, are inspected in accordance with SRB-DSS-LS03-8. Non-conformances are dispositioned in one of the following categories:

- Acceptable as-is (MRB)
- Standard repair per SRB-DSS-LS03-2, Section 3
- Non-Standard Repair (MRB)
- Scrap (MRB)

Non-reusable metal and fabric components are physically segregated from other flight hardware and dispositioned as excess in accordance with MCR-83-1300, Plan for Materials Returned from Space.

In order to evaluate the relationship between the age and/or number of uses of an SRB DSS parachute and the strength of its component materials, various elements are removed from the parachute components and tested in accordance with SRB-DSS-LS03-9, Aging Effects Test Procedure.

D. Repair and Rework - Repair procedures for the most commonly identified anomalies or damage occurrences to SRB-DSS hardware are identified in the Standard Repair Manual. SRB-DSS-LS03-2 for fabric items and in SRB-DSS-LS03-8 for metallic items. Non-standard repairs are dispositioned by engineering with MRB concurrence. Validation testing is required in most cases at the discretion of the MRB. Rework of flight hardware is accomplished with modification instructions, Time Compliance Technical Instruction (TCTI), prepared and authorized by SRB-DSS engineering in Denver.

E. Certification for Reuse and Storage - Upon completion of the disposition instructions for a particular component and acceptance by QC, the component is certified for reuse. Once a previously flown component of DSS hardware has been certified for reuse, it is placed in storage with other DSS hardware until issued out for a subsequent SRB-DSS build-up.

No distinction has been made between new and reused flight hardware. The utilization of reused hardware takes precedence over new hardware in order to gain useful life data. Hardware in storage is considered as "open stock" and no attempt is made to ensure that components which previously flew together, fly together in future missions.

F. Packing and Clustering - Main parachute packing operations are performed in accordance with SRB-DSS-LS03-4 for SMP and SRB-DSS-LS03-10 for LMP. Main parachute clustering, the assembly of three main parachutes to the MPSS, is performed in accordance with SRB-DSS-LS03-6 for SMP and SRB-DSS-LS03-13 for LMP. The complete cluster assembly is then placed on a transportation pallet for delivery to the M-BAC.

Drogue parachute packing operations are performed in accordance with SRB-DSS-LS03-3. The packed drogue parachute is placed in a shipping container for delivery to the M-BAC.

Pilot parachutes are generally delivered prepacked in refurbishment kits. Many pilots, however, were modified and packed in the PRF in accordance with MCR-80-1371. Pilot parachutes, drogue retention kits, main and drogue attachment fittings, ratchet assemblies, struts and clevises are delivered as individual items to the M-BAC since these are assembled directly to the SRB structure.

G. Integration and Assembly - Installation of SRB-DSS hardware into the SRB frustum is performed in accordance with M-BAC assembly procedures. Martin Marietta PRF personnel performed the drogue and pilot integration and main riser assembly portions of the assembly procedure since certain critical parachute rigging operations were involved. All other DSS installation operations such as the cluster installation into the frustum, pilot chute bridle attachment to the nose cap and installation of attachment fittings to the frustum is performed by the M-BAC.

H. Configuration Management and Modifications - Configurations of the SRB-DSS is defined by Denver engineering per the usage and allocation DWG 82700100022. Requirements are delineated in "Configuration Requirements Lists" specifying current engineering revision levels and component configuration.

Hardware modifications resulting from design changes are performed to TCTI modification instructions developed by Denver Engineering and approved by the MMC Program Manager and customer engineering. An Incorporation Notification Card (INC) is submitted upon completion of the TCTI effort on all affected components.

Acceptance data packages are delivered with each major subsystem element identify the "authorized" and "as-built" configuration level and certification thereof. Detailed configuration management procedures are contained in KOP-0-05. Configuration changes to the DSS that affect assembly procedures, such as a component part number changes or a change in packing methods, are controlled by Procedure Change Notice (PCN) revisions to the assembly procedures.

I. Facilities - Facilities in support of this contract are the Parachute Refurbishment Facility, KSC building M7-657 and a 2000 square foot storage area in CCAFS building 60510. A 3000 square foot addition to the PRF for storage of DSS hardware has been authorized through MSFC FY86 funding.

J. Sewing Machines - Originally eleven (11) refurbished Singer Sewing Machines were purchased for the PRF operation. Except for two heavy duty 97-10 machines, each was a different machine for specific sewing operations based on Pioneer Parachutes production experience. These machines served the operation well through the early repair procedure development stages and when refurbishment production rates were low. Some of the machines, such as two-needle, four-needle and darning did not lend themselves to the refurbishment process and were never used.

Since the Singer Machines were no longer in production, replacement parts were becoming difficult to find and additional machines were needed to support the rapidly increasing shuttle launch rates. An effort to select an alternate sewing machine supplier was undertaken. Adler Sewing Machines was selected due to: (1) greater machine flexibility requiring fewer different models; (2) state-of-the-art automatic features for increased productivity; (3) parts availability; and (4) local service representatives.

Table VIII-B

KSC OPERATIONS PROCEDURES

Number	Title	Original Release
0	OPERATIONS	
0-01	Work Control - Flight Hardware	11/20/80
0-02	Work Control - Support Equipment	09/02/80
0-03	Scheduling and Progress Reporting	11/20/80
0-04	Procedure Release and Change Control	09/08/80
0-05	Configuration and Change Control	09/08/80
0-06	Flight Hardware Flow	11/20/80
0-07	Refurbishment and Recertification of Hardware	09/02/80
0-08	Test Sample Fabrication, Test and Information Control Procedure	12/15/84
0-09	Photographic Support Procedure	12/15/84
0-10	Tinius Olsen Tensile Testing Machine Operation Procedure	12/15/84
L	LOGISTICS	
L-01	Hardware Accountability	11/20/80
L-02	Shipping and Receiving of Hardware	11/20/80
L-03	Storage and Transfer of Hardware (On-Site)	09/02/80
L-04	Base Support	09/02/80
L-05	Storage Area Access Control	09/02/80
Q	Quality	
Q-01	Receiving Inspection and Data Control	11/20/80
Q-02	Nonconformance Reporting	09/02/80
Q-03	Material Review Board	09/02/80
Q-04	Audits and Periodic Inspections	09/02/80
Q-05	Stamps and Stamping Practices	09/02/80
Q-06	Operating Records, Historical Files and Acceptance Data Packages	11/20/80
S	SAFETY	
S-01	Safety Requirements	11/06/80
S-02	Accident/Incident Notification	11/06/80
T	TRAINING	
T-01	Certification of Personnel	11/20/80

APPENDIX IX

SRB DSS STRUCTURAL ITEMS

MANUFACTURED BY

MARTIN MARIETTA CORPORATION

Table IX-A
SRB-DSS Fabricated Structural Items

PART NUMBER	DESCRIPTION	NUMERICAL CONTROLLED MACHINE/TAPE ID
82700101029-020	Riser Attachment, Main	
82700101033-003	Guide Spool	
82700101033-004	Riser Pin	
82700101041-001	Link Forging	
82700101041-002	Deck Forging	
82700101042-001	Link Ftg.	
82700101042-002	Deck Ftg.	
82700101042-003	Tube Spacer	
82700101043-009	Riser Attachment	
82700101043-001	Tube Spacer	
82700101047-010	Deck Ftg. Assy.	
82700101047-011	Index Pin	
82700101047-013	Deck Ftg.	
82700101047-014	Deck Ftg.	
82700101047-015	Spreader Plate	
82700101047-016	Spreader Plate	
82700101047-017	Bushing	
82700101047-023	Washer	
82700101047-024	Sleeve	
82700101049-020	Load Plate Assy.	
82700101049-002	Washer	
82700101050-019	Structure Assy.	
82700101051-009	Panel Assy.	Giddings & Lewis/ *
82700101051-001	Strap	
82700101052-001	Panel	Giddings & Lewis/ *
82700101052-002	Plate	
82700101053-004	ID Plate	
82700101054-001	Ring	Giddings & Lewis/ *
82700101054-002	Strut Ftg.	
82700101055-001	Splice Post	
82700101055-002	Ring Segment	
82700101056-011	Spacer	
82700101056-002	Mounting Plate	
82700101056-003	Gusset	
82700101056-004	Spacer	
82700101056-012	Spacer	
82700101057-004	Spacer	
82700101057-005	Shim	
82700101057-001	Clevis	
82700101057-003	Support Fitting	
82700101057-006	Support Fitting	
82700101057-008	Clevis, Female	
82700101057-002	Tube	
82700101057-007	Clevis, Male	

Table IX-A
SRB-DSS Fabricated Structural Items (Continued)

PART NUMBER	DESCRIPTION	NUMERICAL CONTROLLED MACHINE/TAPE ID
82700101059-001	ID Plate	
82700101060-010	Ratchet Assembly	
82700101060-029	Ratchet Assy.	
82700101060-020	Bracket Assy.	
82700101060-003	Base	
82700101060-002	Plate	
82700101060-019	Bracket Assembly	
82700101061-009	Buckle Assy.	
82700101061-001	Shim	
82700101063-009	Main Deck Fitting	
82700101062-001	Deck Fitting	Giddings & Lewis/ *
82700101062-002	Riser Spool	
82700101062-003	Spool Pin	
82700101066-009	Link Assy.	
82700101067-001	Tubing	
82700101067-002	Block	
82700101067-003	Center Fitting	
82700101067-004	Washer, Laminated	
82700101067-005	Washer, Laminated	

*Originally machined on ONSRUD. Converter to G&L. ONSRUD tape obsolete.

Table IX-B
Active Test Tools by Contract

TOOL NUMBER	DESCRIPTION
T0531500-001	Handling Fixture
T0531501-001	Handling Pallet
T0531502-001	Handling Stand
T0531503-001	Handling Fixture
T2531500-001	Drill & Saw Fixture
T2531501-001	Mark Template
T2531502-001	Hydrotel Profile Temp.
T2531503-001	Drill Template
T2531504-001	Drill Template
T2531505-001	Mark & Drill Template
T2531506-001	Mark & Drill Template
T2531507-001	Mark & Drill Template
T4531375-001	Stretch Block
T4531376-001	Form Block
T4531377-001	Stretch Block
T5531476-001	Weld Bevel Kit
T5531477-001	Weld Fixture
T6531626-001	Holding Fixture
T6531627-001	Drill Plate
T6531636-001	Drill Plate
T6531643-001	Drill & Saw Plate, Strap
T6531644-001	Drill Plate Splice Post
T6531645-001	Drill Fixture
T6531646-001	Drill Fixture
T6531647-001	Drill Fixture
T6531648-001	Lathe Holding Fixture
T7531205-001	Special Mill Kit
T7531400-001	Assembly Drill Fixture
T7531401-001	Drill Plate
T7531402-001	Drill Kit
T7531403-001	Drill Plate
T7531404-001	Locating & Check Fixture
T7531405-001	Chute Profile Check Tool
T7531406-001	Drill Plate
T7531407-001	Special Mills
T7531408-001	Drill Plate, Center Plate
T7531409-001	Simulator, Fim Alignment
T7531410-001	Fixture Assembly & Drill
T7531411-001	Drill Plate
T7531412-001	Drill Template Kit
T7531413-001	Locating and Drill Block
T7531414-001	Check Tool
T9531450-001	Special Airfeed Drill Kit
T9531451-001	DTV Drill Kit
T9531452-001	Drill Kit
T9531473-001	Milling Kit