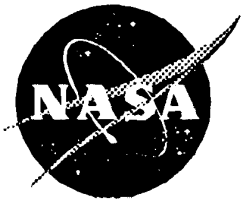

National Aeronautics and
Space Administration

NSTS 08060
REVISION J
MARCH 19, 2003

Lyndon B. Johnson Space Center
Houston, Texas 77058

REPLACES
NSTS 08060
REVISION H

SPACE SHUTTLE

SYSTEM
PYROTECHNIC SPECIFICATION

REVISION LOG

REV LTR	CHANGE NO	DESCRIPTION	DATE
		BASELINE ISSUE	08/31/73
A	4	REVISION A (Reference: Level II PRCBD S00029AR1) also includes Changes 1 thru 3.	08/29/75
B	7	REVISION B (Reference: Level II PRCBD S03474, dated 1/12/77) also includes PRCBDs S00029C, S00084B, S00084C, S01038AR1, S03346 and Changes 5 and 6.	01/12/77
C	17	REVISION C (Reference: Level II PRCBD S13703, dated 3/17/80) also includes PRCBDs S03422B, S04648, S01311R2, S13594R2 and Changes 8 thru 16.	05/09/80
D	28	REVISION D (Reference: Level II PRCBD S21391, dated 12/9/82) also includes Changes 18 thru 27.	01/28/83
E	38	REVISION E (Reference: Level II PRCBD S40129, dated 7/23/86) also includes Changes 29 thru 37.	10/21/86
F	39	REVISION F (Reference: Level II PRCBD S41062, dated 1/27/88) also includes PRCBDs S40019R3, S40481, S40815 and S92329.	03/21/88
G	71	REVISION G (Reference: Space Shuttle PRCBD S041062B, dated 4/5/93) also includes PRCBDs S011556N, S011556P, S093510H, CAR S041062B and Changes 40 thru 70.	06/10/93
H	75	REVISION H (Reference: SSP DOC–158, dated 12/15/93) also includes Space Shuttle PRCBDs S052730A, S060411, S086783A and Changes 72 thru 74.	02/11/94
J	99	REVISION J (Reference: Space Shuttle PRCBD S041062ADR1, dated 3/10/03) also includes PRCBD S041062AD, SSP DOC-425 and Changes 76 thru 98.	03/19/03

CHANGE SHEET

FOR

NSTS 08060 - Space Shuttle
System Pyrotechnic Specification

CHANGE NO. 106

Program Requirements Control Board Directive No. S063601/(1-1), dated 5/11/07; SSP DOC-630A; SSP DOC-651 and SSP DOC-657.(1)

June 4, 2007

Kathleen E. Kaminski
Secretary, Program Requirements
Control Board

CHANGE INSTRUCTIONS

1. Remove the following listed pages and replace with the same numbered attached pages:

Page	PRCBD No.
iii	SSP DOC-630A, SSP DOC-651
iv	
2-1	SSP DOC-651
2-2	
7-3	S063601
7-4	
9-3 - 9-4	S063601
11-3	SSP DOC-657
11-4	
11-5	S063601
11-6	
12-1	
12-2	S063601

NOTE: A black bar in the margin indicates the information that was changed.

2. Remove the List of Effective Pages, dated January 7, 2005 and replace with List of Effective Pages, dated June 4, 2007.

3. Sign and date this page in the space provided below to show that the changes have been incorporated and file immediately behind the List of Effective Pages.

_____ _____

Signature of person incorporating changes Date

NSTS 08060 - Space Shuttle
Systems Pyrotechnic Specification

*Revision J (Reference PRCBD Nos. S041062AD, dated 2/18/03; S041062ADR1, dated 3/10/03 and SSP DOC-425)

LIST OF EFFECTIVE PAGES

June 4, 2007

The current status of all pages in this document is as shown below:

Page No.	Change No.	PRCBD No.	Date
(i) - (v)	Rev. J	*	March 19, 2003
(vi)	100	SSP DOC-578	October 7, 2003
(vii)	105	S095023A	December 13, 2004
(viii) - (ix)	103	S092155B	April 20, 2004
(x) - (xi)	102	S041062AE	March 26, 2004
(xii)	Rev. J	*	March 19, 2003
(1) - (6)	Rev. J	*	March 19, 2003
(7) - (8)	104	S062157C	May 21, 2004
(9)	Rev. J	*	March 19, 2003
(10)	101	S092329D	March 9, 2004
(11)	105	S095023A	December 13, 2004
(12)	101	S092329D	March 9, 2004
(13) - (14)	103	S092155B	April 20, 2004
(15) - (16)	Rev. J	*	March 19, 2003
(17) - (20)	100	S060042DR1	October 6, 2003
(21) - (24)	102	S041062AE	March 26, 2004
i - ii	Rev. J	*	March 19, 2003
iii	106	SSP DOC-630A SSP DOC-651	August 21, 2006, August 21, 2006
iv - xii	Rev. J	*	March 19, 2003
1-1 - 1-2	Rev. J	*	March 19, 2003
2-1	106	SSP DOC-651	August 21, 2006
2-2 - 2-20	Rev. J	*	March 19, 2003
3-1 - 3-14	Rev. J	*	March 19, 2003
3-15	105	S095023A	December 13, 2004
3-16	Rev. J	*	March 19, 2003
3-17	102	S041062AE	March 26, 2004
3-18 - 3-19	Rev. J	*	March 19, 2003
3-20	100	SSP DOC-577	October 7, 2003
3-21 - 3-24	Rev. J	*	March 19, 2003

LIST OF EFFECTIVE PAGES

June 4, 2007

Page No.	Change No.	PRCBD No.	Date
3-25	102	S041062AE	March 26, 2004
3-26	Rev. J	*	March 19, 2003
3-27	100	S060042DR1	October 6, 2003
3-28	103	S092155B	April 20, 2004
3-29 - 3-30	Rev. J	*	March 19, 2003
4-1 - 4-2	Rev. J	*	March 19, 2003
4-3	102	S041062AE	March 26, 2004
4-4 - 4-16	Rev. J	*	March 19, 2003
5-1 - 5-8	Rev. J	*	March 19, 2003
6-1 - 6-4	Rev. J	*	March 19, 2003
7-1	Rev. J	*	March 19, 2003
7-2	101	S092329D	March 9, 2004
7-3	106	S063601	May 11, 2007
7-4 - 7-6	Rev. J	*	March 19, 2003
8-1 - 8-4	Rev. J	*	March 19, 2003
9-1 - 9-2	Rev. J	*	March 19, 2003
9-3 - 9-4	106	S063601	May 11, 2007
9-5 - 9-6	Rev. J	*	March 19, 2003
10-1 - 10-6	Rev. J	*	March 19, 2003
11-1 - 11-2	Rev. J	*	March 19, 2003
11-3	106	SSP DOC-657	October 26, 2006
11-4	Rev. J	*	March 19, 2003
11-5	106	S063601	May 11, 2007
11-6 - 11-10	Rev. J	*	March 19, 2003
12-1	Rev. J	*	March 19, 2003
12-2	106	S063601	May 11, 2007
12-3 - 12-4	Rev. J	*	March 19, 2003
A-1 - A-31	Rev. J	*	March 19, 2003
A-32 - A-33	104	S062157C	May 21, 2004
A-34 - A-34B	105	S095023A	December 13, 2004
A-35 - A-40D	101	S092329D	March 9, 2004
A-41 - A-46	103	S092155B	April 20, 2004
A-47 - A-52	Rev. J	*	March 19, 2003
A-53 - A-56	100	S060042DR1	October 6, 2003
A-57	Rev. J	*	March 19, 2003
A-58 - A-74	102	S041062AE	March 26, 2004

DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT

This section contains only currently approved Deviations/Waivers to the requirements of NSTS 08060. Deviations/Waivers to these requirements that were approved prior to the STS 51-L accident have been rescinded and are retained in Appendix A of this volume for historical purposes.

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INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT

INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT – Continued

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INDEX OF DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT - Concluded

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DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT

1. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

2. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

3. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

4. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

5. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

6. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

7. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

8. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

9. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

10. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

11. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

12. **REQUIREMENT:** Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

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17. REQUIREMENT: Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

18. REQUIREMENT: Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

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31. REQUIREMENT: Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

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49. REQUIREMENT: Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

50. REQUIREMENT: Rescinded. (Reference Level II PRCBD S40019R3, dated 8/26/87.) See Appendix A.

51. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061736, dated 12/7/01.) See Appendix A.

52. REQUIREMENT: Retired per SSP DOC-452, dated 2/9/00. (Reference Level II PRCBD S03422C, dated 6/18/88.) See Appendix A.

53. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061736, dated 12/7/01.) See Appendix A.

54. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061736, dated 12/7/01.) See Appendix A.

55. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061736, dated 12/7/01.) See Appendix A.

56. REQUIREMENT: Retired (Reference CAR). See Appendix A.

57. REQUIREMENT: Paragraph 8.2.3, Wire Routing, specifies that firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electrical control, RF transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

WAIVER: This waiver allows Orbiter vehicles OV-102, OV-103, OV-104, and OV-105 to route the following pyro firing circuits with "HO" coded wiring (6-40 VDC) in the following vehicle locations:

Avionics Bay 2.

Affects the following pyro circuits:
- ET Tk Fwd Str Sep "B"
- NLG Bu Uplk RLS No. 2
- NLG Ext Pwr Asst. No. 2
- Bay 1 Fire Suppression
- LMG Bu Uplk RLS No. 2
- RMG Bu Uplk RLS No. 2

Avionics Bay 3A.

Affects the following pyro circuits:
- NLG Bu Uplk RLS No. 1
- NLG Ext Pwr Asst. No. 1
- Bay 2 Fire Suppression
- LMG Bu Uplk RLS No. 1
- RMG Bu Uplk RLS No. 1

ECLSS Bay.

Affects the following pyro circuits:
- LMG Bu Uplk RLS No. 2
- RMG Bu Uplk RLS No. 2
- NLG Bu Uplk RLS No. 1
- NLG Ext Pwr Asst. No. 1
- Bay 2 Fire Suppression
- LMG Bu Uplk RLS No. 1

Ku-Band Ant Jett Guill “A”
Ku-Band Ant Jett Nut “A”
Bay 3 Fire Suppression

AUTHORITY: Level II PRCBD S03422D, dated 6/18/88.

58. REQUIREMENT: Paragraph 8.1.5, Malfunction, specifies that malfunction and inadvertent operation of control circuits caused by extremes of ground and flight environments shall be avoided by protective design features. JSCM 8080-20 is applicable.

WAIVER: This waiver allows Orbiter vehicles OV-102, OV-103, OV-104, and OV-105 to route redundant pyro firing circuits for the following pyro function in the following vehicle locations:

ECLSS Bay and standard mid-body wire tray-redundant pyro firing circuits routed together.
Affects the following pyro circuits:
LMG Bu Uplk RLS No. 1
LMG Bu Uplk RLS No. 2

AUTHORITY: Level II PRCBD S03422D, dated 6/18/88.

59. REQUIREMENT: Paragraph 3.4.1.1, Mating Electrical Connector, specifies that MSFC connector 40M38298 shall be used throughout the Space Shuttle to connect firing circuits to the NSI-1. Connector indexing configurations are shown in the NASA JSC control drawing, NASA Standard Initiator SLB26100052, and the sketch below. JSCM 8080-3 is applicable.

WAIVER: This waiver allows Orbiter vehicles OV-102, OV-103, and OV-104 to use identically keyed connectors for the RMS jettison functions for latch and guillotine.

AUTHORITY: Level II PRCBD S03422E, dated 6/24/88.

60. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S040732P, dated 5/31/01.) See Appendix A.

61. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S040732P, dated 5/31/01.) See Appendix A.

62. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S040732P, dated 5/31/01.) See Appendix A.

63. REQUIREMENT: Retired. (Reference Level II PRCBD S40732F, dated 6/24/88.) See Appendix A.

64. REQUIREMENT: Retired. (Reference Level II PRCBD S40732F, dated 6/24/88.) See Appendix A.

65. REQUIREMENT: Retired. (Reference Level II PRCBD S40732F, dated 6/24/88.) See Appendix A.

66. REQUIREMENT: Retired per SSP DOC-452, dated 2/9/00. (Reference Level II PRCBD S013110E, dated 8/29/88.) See Appendix A.

67. REQUIREMENT: Retired. (Reference Level II PRCBD S40732L, dated 8/12/88.) See Appendix A.

68. REQUIREMENT: Retired per SSP DOC-478, dated 10/16/00. (Reference Level II PRCBD S41299, dated 8/12/88.) See Appendix A.

69. REQUIREMENT: Retired. (Reference Level II PRCBD S92305D, dated 8/29/88.) See Appendix A.

70. REQUIREMENT: Retired per Space Shuttle PRCBD S062157C, dated 5/21/04. (Reference Level II PRCBD S13110D, dated 9/2/88.) See Appendix A.

71. REQUIREMENT: Paragraph 5.4.1, Lot Acceptance Data Information, specifies the supplier shall make the following data as a minimum available for review by the review team.

a. Receiving inspection records of piece parts.

WAIVER: The above requirement is waived for 180 degree inert connectors (MC325-0004-0007, L/N WAB) of the crew escape energy transfer system for OV-103, Flights 7 thru STS-999.

AUTHORITY: Level II PRCBD S76233A, dated 9/10/88.

72. REQUIREMENT: Paragraph 4.5.3.3.3, Detonation Velocity, specifies each detonating cord sample of Paragraph 4.5.3.3.2 shall be detonated after being subjected to the bending test. The detonation velocity shall be measured with an electronic time-interval meter or similar equipment. The detonation velocity of HMS shall be 6000-6900 m/sec and that for RDX and HMX shall be a minimum of 6500 m/sec. If the measured value for any sample fails to meet the applicable requirement the entire cord lot shall be rejected.

WAIVER: The above requirement is waived for the expanding tube assemblies of the collar severance systems (P/Ns MC325-0040-0001 and -0002, L/N WAA) for STS-26 and subs.

AUTHORITY: Level II PRCBD S76233B, dated 9/10/88.

73. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: The above requirement is waived for the expanding tube assemblies of the collar severance systems (P/Ns MC325-0040-0001 and -0002, L/N WAA) for STS-26 and subs.

AUTHORITY: Level II PRCBD S76233C, dated 09/10/88.

74. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: The above requirement is waived for the hinge severance assembly (P/Ns MC325-0043-0001, -0002, -0004 and -0005, L/N WAA) for STS-26 and subs.

AUTHORITY: Level II PRCBD S76233C, dated 9/10/88.

75. REQUIREMENT: Paragraph 3.5.3.1, High Explosive Materials, specifies the use of reclaimed high explosive materials is prohibited. The number and type of high explosives in the Space Shuttle

system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials. All high explosives except HNS may be furnished by the contractors and procured to the following specifications:

Material	Specification
HMX	MIL-H-45444
RDX	MIL-R-398
PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225B

HNS shall be Government Furnished Material (GFM) supplied by JSC to WS5003.

WAIVER: The above requirement is waived for the Flexible Confined Detonating Cords (FCDC) of the crew escape energy transfer system (MC325-0004-2001 through -2011, L/N WAG) for STS-26 and subs.

AUTHORITY: Level II PRCBD S76233E, dated 9/10/88.

76. REQUIREMENT: Retired per Space Shuttle PRCBD S092329D, dated 3/9/04. (Reference Level II PRCBD S92329A, dated 9/10/88.) See Appendix A.

77. REQUIREMENT: Retired per Space Shuttle PRCBD S095023A, dated 12/13/04. (Reference Level II PRCBD S95023, dated 9/10/88.) See Appendix A.

78. REQUIREMENT: Retired. (Reference Level II PRCBD S76233, dated 9/10/88.) See Appendix A.

79. REQUIREMENT: Retired. (Reference Level II PRCBD S076233T, dated 2/13/90.) See Appendix A.

80. REQUIREMENT: Retired. (Reference Level II PRCBD S94991, dated 9/27/88.) See Appendix A.

81. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S041062B, dated 4/5/93.) See Appendix A.

82. REQUIREMENT: Retired. (Reference Level II PRCBD S50728, dated 6/29/89.) See Appendix A.

83. REQUIREMENT: Retired. (Reference Level II PRCBD S50728, dated 6/29/89.) See Appendix A.

84. REQUIREMENT: Retired. (Reference Level II PRCBD S50728, dated 6/29/89.) See Appendix A.

85. REQUIREMENT: Retired. (Reference Level II PRCBD S76233M, dated 10/5/89.) See Appendix A.

86. REQUIREMENT: Retired. (Reference Level II PRCBD S83081, dated 10/13/89.) See Appendix A.

87. REQUIREMENT: Retired per Space Shuttle PRCBD S092329D, dated 3/9/04. (Reference Level II PRCBD S092329B, dated 4/5/90.) See Appendix A.

88. REQUIREMENT: Retired. (Reference Level II PRCBD S083859, dated 5/4/90.) See Appendix A.

89. REQUIREMENT: Retired. (Reference Level II PRCBD S086233G, dated 11/1/90.) See Appendix A.

90. REQUIREMENT: Retired. (Reference Level II PRCBD S086233H, dated 11/1/90.) See Appendix A.

91. REQUIREMENT: Retired. (Reference Level II PRCBD S086233H, dated 11/1/90.) See Appendix A.

92. REQUIREMENT: Retired. (Reference Change Action Request filed with Level II PRCBD S086233J, dated 2/1/91.) See Appendix A.

93. REQUIREMENT: Retired per Space Shuttle PRCBD S092155B, dated 4/20/04. (Reference Level II PRCBD S092155A, dated 2/14/91.) See Appendix A.

94. REQUIREMENT: Retired. (Reference Level II PRCBD S077725, dated 2/22/91.) See Appendix A.

95. REQUIREMENT: Retired per SSP DOC-452, dated 2/9/00. (Reference Level II PRCBD S086136, dated 8/28/91.) See Appendix A.

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96. REQUIREMENT: Retired. (Reference Change Action Request filed with Level II PRCBD S086137, dated 10/9/91.) See Appendix A.

97. REQUIREMENT: Retired. (Reference Level II PRCBD S052607, dated 1/6/92.) See Appendix A.

98. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S086361, dated 4/22/92.) See Appendix A.

99. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061439R1, dated 2/7/01.) See Appendix A.

100. REQUIREMENT: Paragraph 4.5.1.1 Test Plans and Procedures. All acceptance testing shall be performed in accordance with approved detailed test plans and procedures. Specific acceptance and rejection criteria, as well as details of test fixtures, equipment, instrumentation, and other matters adequate to permit duplication of testing by other facilities, such as the launch site, shall be included.

WAIVER: The above requirement is waived for use of lot HBR common cartridge. During Destructive Lot Acceptance Testing (DLAT), unit S/N 76 produced a pressure of 5140 psi which exceeds the closed bomb pressure requirement of 4800 $\pm$ 300 psi.

RATIONALE: A positive margin of safety on cartridge overpressurization exists based on proof testing. The lot of cartridges is used in mechanisms located in the payload bay. These are used only for additional flight safety in a contingency situation where the vehicle must be returned from flight. Pressure data from the failed unit is only slightly higher than the requirement. Moisture in the closed bomb is suspected of contributing to the higher pressure.

EFFECTIVITY: Common Cartridge Lot HBR

AUTHORITY: Space Shuttle PRCBD S086362, dated 6/2/92.

101. REQUIREMENT: Paragraph 4.5.2.1 General. Any cartridge found to be defective in any nondestructive test shall be rejected and the supplier shall correct all deficiencies prior to resubmitting for retest; documented evidence of all rework, corrective actions, and testing shall be made a part of the acceptance data package. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2. Detonating cartridges shall be fired with a test indentation fixture in accordance with Test Procedure, MIL-STD-331. Neither the device or the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

WAIVER: The above requirement is waived for use of lot HBR common cartridge. During Destructive Lot Acceptance Testing (DLAT), unit S/N 76 produced a pressure of 5140 psi which exceeds the closed bomb pressure requirement of 4800 $\pm$ 300 psi.

RATIONALE: A positive margin of safety on cartridge overpressurization exists based on proof testing. The lot of cartridges is used in mechanisms located in the payload bay. These are used only for additional flight safety in a contingency situation where the vehicle must be returned from flight. Pressure data from the failed unit is only slightly higher than the requirement. Moisture in the closed bomb is suspected of contributing to the higher pressure.

EFFECTIVITY: Common Cartridge Lot HBR

AUTHORITY: Space Shuttle PRCBD S086362, dated 6/2/92.

102. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S086482, dated 9/2/92.) See Appendix A.

103. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S052607A, dated 12/2/92.) See Appendix A.

104. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S011556N, dated 4/5/93.) See Appendix A.

105. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S011556P, dated 4/5/93.) See Appendix A.

106. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S011556P, dated 4/5/93.) See Appendix A.

107. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S093510H, dated 4/19/93.) See Appendix A.

108. REQUIREMENT: Retired per Space Shuttle PRCBD S060042DR1, dated 10/6/03. (Reference Space Shuttle PRCBD S060042D, dated 6/26/93.) See Appendix A.

109. REQUIREMENT: Retired per Space Shuttle PRCBD S060042DR1, dated 10/6/03. (Reference Space Shuttle PRCBD S060042D, dated 6/26/93.) See Appendix A.

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110. REQUIREMENT: Paragraph 3.6.18.1.1 Propellant Gas Operated Devices. Propellant gas operated devices shall be capable of the required performance with a single cartridge loaded with 85% (by weight of each pyrotechnic element except the NSI-1) of the minimum allowable charge. This must be accomplished by simultaneously downloading all of the elements except the NSI-1. Flight certified NSI-1s shall be used for this testing. Simulated, inert cartridges shall be installed in the redundant cartridge port(s) when demonstrating this capability. The 85% single cartridge requirement must be demonstrated during qualification testing. When downloaded cartridges are not available, as in the case of the NSI-1 or a cartridge carried over from a prior program, other suitable methods to satisfy the intent of this requirement may be employed. Time delays are exempt from this requirement. These requirements shall be demonstrated by test in the qualification program, or by analysis if testing is not practical.

WAIVER: The above requirement is waived for the MC325-0052-0005 drag chute retractor which requires two 100% MC325-0052-0004 charge load cartridges be installed in the cartridge ports.

RATIONALE: Vehicle condition under which 85% single cartridge load firing test failed would be an emergency release condition. Single cartridge at 100% load successfully releases drag chute. Both cartridges fire even if only one cartridge electrically initiated (due to sympathetic firing condition existence in the design).

EFFECTIVITY: STS-59 thru STS-999

AUTHORITY: Space Shuttle PRCBD S086782, dated 11/5/93.

111. REQUIREMENT: Paragraph 3.8.4.4.5 Pressure Actuated Devices. Pressure actuated devices must be capable of the required performance with a single cartridge loaded with 85% of the minimum allowable charge weight. If multiple cartridges are used to achieve redundancy, this requirement must be satisfied using a single 85% cartridge.

WAIVER: The above requirement is waived for the MC325-0052-0005 drag chute retractor which requires two 100% MC325-0052-0004 charge load cartridges be installed in the cartridge ports.

RATIONALE: Vehicle condition under which 85% single cartridge load firing test failed would be an emergency release condition. Single cartridge at 100% load successfully releases drag chute. Both cartridges fire even if only one cartridge electrically initiated (due to sympathetic firing condition existence in the design).

EFFECTIVITY: STS-59 thru STS-999

AUTHORITY: Space Shuttle PRCBD S086782, dated 11/5/93.

112. REQUIREMENT: Paragraph 3.5.9.1 Heat Treated Component. Tensile coupons and chemical analysis data shall be required from component parts which are heat treated after machining and exposed to operating pressures and/or primary structural loads. The supplier shall establish and the NASA Project Office shall approve the minimum acceptance criteria of the material properties listed below. Failure to meet these minimum acceptance criteria shall be cause for rejection of the component parts associated with those test coupons. Prior to acceptance, the supplier shall conduct tensile tests on each coupon part as defined by the procuring agency. A minimum of three standard tensile coupons from the component part lot materials shall be processed with the component parts. These coupons shall be tested in accordance with the detail drawing/specification requirements. The following data shall be obtained from the test coupons and recorded on the lot acceptance data sheets:

a. Ultimate tensile strength

b. 0.2% offset yield

c. Elongation

d. Reduction of area

WAIVER: The above requirement is waived for the MC325-0052-0005, 6085100-101-03 Retractor Assembly, S/Ns 9345500041WAC thru 9345500055WAC to allow testing only two tensile coupons instead of three for the piston and cap in Lot WAC.

RATIONALE: The results of the two coupons tested for each material indicates that the material meets all tensile test requirements. Tensile parameters for two specimens vary less than 2.5% for each material.

Each drag chute retractor is subjected to a proof pressure test of 1.2 times maximum operating pressure as an acceptance test requirement.

Piston and end cap, as installed in retractor, are subjected to this pressure test.

Each retractor is subjected to X-ray inspection subsequent to proof pressure test.

EFFECTIVITY: Non Flight Specific

AUTHORITY: Space Shuttle PRCBD S086783A, dated 12/16/93.

113. REQUIREMENT: Retired per SSP DOC-452, dated 2/9/00. (Reference Space Shuttle PRCBD S086861, dated 1/21/94.) See Appendix A.

114. REQUIREMENT: Retired. (Reference Change Action Request filed with Space Shuttle PRCBD S060445, dated 2/4/94.) See Appendix A.

115. REQUIREMENT: Retired per SSP DOC-452, dated 2/9/00. (Reference Space Shuttle PRCBD S064489, dated 11/8/95.) See Appendix A.

116. REQUIREMENT: Retired per Space Shuttle PRCBD S041062AE, dated 3/26/04. (Reference Space Shuttle PRCBD S041062H, dated 6/27/97.) See Appendix A.

117. REQUIREMENT: Retired per Space Shuttle PRCBD S041062AE, dated 3/26/04. (Reference Space Shuttle PRCBD S041062H, dated 6/27/97.) See Appendix A.

118. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S092194, dated 6/9/98.) See Appendix A.

119. REQUIREMENT: Retired. (Reference Space Shuttle PRCBD S061439R1, dated 2/7/01.) See Appendix A.

120. REQUIREMENT: Retired per Space Shuttle PRCBD S041062AE, dated 3/26/04. (Reference Space Shuttle PRCBD S041062L, dated 5/1/00.) See Appendix A.

121. REQUIREMENT: Retired per SSP DOC-493, dated 2/22/01. (Reference Space Shuttle PRCBD S041062M, dated 8/28/00.) See Appendix A.

122. REQUIREMENT: Retired per SSP DOC-493, dated 2/22/01. (Reference Space Shuttle PRCBD S041062N, dated 8/28/00.) See Appendix A.

123. REQUIREMENT: Paragraph 3.7.1.3.1 Functional Testing of Samples from the Lot. The preferred method of performing age life testing is by functional testing of samples from the production lot. Lot samples shall be randomly chosen when practical. Each age life test shall consist of a minimum of five units each.

WAIVER: The above requirement is waived to permit use of the side hatch thruster pressure cartridges (P/N MC325-0041), lot WAB, with test results from only four test firings.

RATIONALE: All five firings were successfully completed. No data was recorded on firing No. 4 due to a pretrigger of the oscilloscope. Test results from the four firings were analyzed and demonstrated the functional reliability of lot WAB. Data from four of the five firings was well within the test pass/fail criteria. The unit for which no data was recorded fired with no anomalies observed during the post closed bomb inspection.

EFFECTIVITY: STS-98, STS-100, STS-102, STS-104, STS-105, STS-107 thru STS-999.

AUTHORITY: Space Shuttle PRCBD S061439R1, dated 2/7/01.

124. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S041062U, dated 3/7/01.) See Appendix A.

125. REQUIREMENT: Retired per SSP DOC-519, dated 9/4/01. (Reference Space Shuttle PRCBD S041062W, dated 3/28/01.) See Appendix A.

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NSTS 08060

SPACE SHUTTLE

SYSTEM
PYROTECHNIC SPECIFICATION

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FOREWORD

Efficient management of the Space Shuttle Program (SSP) dictates that effective control of program activities be established. Requirements, directives, procedures, interface agreements, and system capabilities shall be documented, baselined, and subsequently controlled by SSP management.

Program requirements controlled by the Manager, Space Shuttle Program, are documented in, attached to, or referenced from Volumes of NSTS 07700.

This specification provides a single, comprehensive document pertaining to all Space Shuttle pyrotechnics for use at the various levels of activity and minimizes the inclusions and repetitions of the specialized requirements peculiar to pyrotechnics in other program documents of more general nature and use. This document requires maximum commonality of hardware, technology, practices, and procedures relating to pyrotechnics throughout the Space Shuttle and further requires that the experience gained in prior space programs is applied to the pyrotechnics in the SSP.

This specification is the source for the expanded definition of pyrotechnic requirements for all elements of the Space Shuttle system which are documented in Contract End Item (CEI) specifications and other documents. This specification is subordinate to NSTS 07700, but takes precedence over element project documents, CEI specifications, and other SSP documents insofar as they pertain to pyrotechnics.

All elements of the SSP must adhere to these baselined requirements. When it is considered by the Space Shuttle program element/project managers to be in the best interest of the SSP to change, waive or deviate from these requirements, an SSP Change Request (CR) shall be submitted to the Program Requirements Control Board (PRCB) Secretary. The CR must include a complete description of the change, waiver or deviation and the rationale to justify its consideration. All such requests will be processed in accordance with NSTS 07700, Volume IV - Book 1 and dispositioned by the Manager, Space Shuttle Program, on a Space Shuttle PRCB Directive (PRCBD).

N. Wayne Hale, Jr.
Director, Space Shuttle Operations

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APPENDICES

TABLES

1.0 SCOPE

This specification is of extremely broad scope and covers all phases of pyrotechnics, including design, development, qualification, production, acceptance, shipping, storage, handling, installation, and checkout. The specification also contains requirements and guidelines from the functional system level to those related to specific pyrotechnic devices and components thereof. Control avionics and circuitry, Ground Support Equipment (GSE), launch accessory systems, Orbiter, External Tank (ET), and Solid Rocket Boosters (SRBs) are covered.

1.1 APPLICABILITY

This specification is applicable to all Space Shuttle pyrotechnic activities, including NASA centers, their contractors, subcontractors and suppliers engaged in these activities, including design, development, qualification, production, acceptance, and use of pyrotechnics. Payload pyrotechnics are not subject to the requirements of this document. Implementation of this specification is applicable with the next production lot of hardware. Previously approved Shuttle hardware does not need to be requalified to the requirements of Revision G. The order of precedence is:

a. NSTS 07700, Volume X, Flight and Ground System Specification.

b. NSTS 07700-10-MVP-01, Shuttle Master Verification Plan, Volume I, General Approach and Guidelines.

c. This specification.

d. Documents referenced in NSTS 07700, Volume X to the extent specified therein.

e. Documents referenced in this specification to the extent specified herein.

1.1.1 Military Designated Pyrotechnics

Equipment worn by the crew such as the Crew Escape Personal Parachute Assembly and Survival Kit which will include line cutters, flares, and automatically actuated devices, are exempt from this specification.

1.1.2 SRB Salt Water Activated Parachute Release Device

The salt water activated release device used to disconnect the SRB main parachutes from the SRB at water impact is exempt from this specification.

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2.0 APPLICABLE DOCUMENTS

The following documents of the date and issue shown form a part of this document to the extent specified herein. "(Current Issue)" is shown in place of a specific date and issue when the document is under Space Shuttle PRCB control. The current status of documents shown with "(Current Issue)" may be determined from NSTS 08102, Program Document Description and Status Report.

The listed issue or, if so designated, a later issue of the same document may be used. When a later issue is used, the project shall assure traceability of the design and certification baselines from the listed issue to the later issue.

For documents not marked with a specified date or issue, the issue in effect on the date of the contract shall apply.

2.1 GOVERNMENT

2.1.1 National Aeronautics and Space Administration

Volumes of NSTS 07700 (Current Issue)	Program Definition and Requirements Ref. Foreword, Para. 3.0
NSTS 07700 Volume IV - Book 1 (Current Issue)	Configuration Management Requirements, Requirements Ref. Foreword
NSTS 07700 Volume VI (Current Issue)	Flight Support Equipment (FSE) Management Ref. Para. 9.2
NSTS 07700 Volume X (Current Issue)	Flight and Ground System Specification Ref. Para. 1.1, 3.0

NSTS 07700 Volume X - Book 1 (Current Issue)	Flight and Ground System Specification, Requirements Ref. Para. 3.1, 3.4.1.2, 3.6.6
NSTS 07700 Volume X - Book 2 (Current Issue)	Flight and Ground System Specification, Environment Design, Weight and Performance, and Avionics Events Ref. Para. 3.8.1
NSTS 07700 Volume XII (Current Issue)	Program Logistics and Supportability Requirements Ref. Para. 6.1
NSTS 07700-10-MVP-01 (Current Issue)	Shuttle Master Verification Plan, Volume I, General Approach and Guidelines Ref. Para. 1.1
NSTS 5300.4(1D-2) (Current Issue)	Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program Ref. Para. 3.1, 3.2, 3.2.2, 3.3, 5.0
NSTS 07636 (Current Issue)	Lightning Protection, Test and Analysis Requirements Ref. Para. 8.3.1.1
NSTS 08126 (Current Issue)	Problem Reporting and Corrective Action (PRACA) System Requirements Ref. Para. 10.5

JSC 17849 December 1, 1981	Contractor Calibration Procedure for GFE SFU, Model C72-0833 Ref. Para. 9.2.3.2.1
JSC 20431 March 1985	NASA JSC Neutron Radiography Specification Ref. Para. 4.5.2.4.2, 4.5.3.2.2
NSTS 37330 (Current Issue)	Bonding, Electrical, and Lightning Specifications Ref. Para. 3.6.10, 8.4.2
SE-R-0006 (Current Issue)	General Specification Space Shuttle System Requirements for Materials and Processes Ref. Para. 3.5, 3.5.6
ESTA/GOPM	Energy Systems Test Area/General Operating Procedure Manual Ref. Para. 3.2.2.1
JSC/SEB26100001	Initiator, NASA Standard Ref. Para. 3.4.1
JSC/SED26100107-301/302	Initiator, SRM Ignition Ref. Para. 3.4.1
JSC/SKB26100066	Design and Performance Specifications for NSI-1 (NASA Standard Initiator-1) Ref. Para. 3.4.1

JSC/SKD26100109	Design Performance Specifications for the SRB Initiator (SRM Ignition) Ref. Para. 3.4.1
JSC/SKD26100132	Performance Specification for NSTS Use of Percussion Primers Ref. Para. 3.6.17.2
KHB 1710.2	Kennedy Space Center Safety Practices Handbook Ref. Para. 3.2.2.2
MM 1700.4	MSFC Safety Standard Explosive Device and Material Ref. Para. 3.2.2.3
MSFC-SPEC-30A90506	Specification for Shuttle Range Safety System Ref. Para. 3.2.3
NASA-STD-8739.3	Soldered Electrical Connections Ref. Para. 8.2.5
NHB 5300.4(1C)	Inspection System Provisions for Aeronautical and Space System Materials Parts, Components and Services Ref. Para. 3.3, 5.0
NHB 5300.4(3A-1)	Requirements for Soldered Electrical Connections Ref. Para. 8.2.5

NHB 5300.4(3A-2)	Requirements for Soldered Electrical Connections Ref. Para. 8.2.5
NHB 6000.1	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment and Associated Components Ref. Para. 3.8.3, 6.1
NPG 6000.1 Revision E or Later	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment and Associated Components Ref. Para. 3.8.3, 6.1

Manned Spacecraft Criteria and Standards

JSCM 8080 April 1, 1991	Manned Spacecraft Criteria and Standards Ref. Para. 3.6.1, Table 2.0
NSTS 08080-1	Manned Spacecraft Criteria and Standards Ref. Table 2.0 NOTE: A cross-reference between the standards contained in JSCM 8080 and the corresponding NSTS 08080-1 standards can be found in Table 2.0. This specification references JSCM 8080 standards.
E-1	Mating Provisions for Electrical Connectors Ref. Para. 3.4.1.1, 8.1, Table 2.0
E-3	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs Ref. Para. 8.1, Table 2.0

E-4	Electrical Connectors - Moisture Protection Ref. Para. 8.1, Table 2.0
E-7	Tantalum Wet Slug Capacitors - Restriction on Use Ref. Para. 8.1, Table 2.0
E-8	Electrical and Electronic Supplies and Loads - Verification Tests Ref. Para. 8.1, Table 2.0
E-9	Electrical Circuits - De-engergizing Requirement Ref. Para. 8.1, Table 2.0
E-10	Cleaning of Electrical and Electronic Equipment Ref. Para. 3.6.8, Table 2.0
E-11	Protective Covers or Caps for Electrical Receptacles and Plugs Ref. Para. 6.4, 7.3, 8.1, Table 2.0
E-14	Electrical Wire Harness - Dielectric Tests Ref. Para. 8.1, Table 2.0
E-15	Electrical Power Distribution Circuits - Overload Protection Ref. Para. 8.3.1.1, Table 2.0
E-16	Testing Protective Devices for Solid State Circuits Ref. Para. 8.1, Table 2.0

E-17	Electrical and Electronic Piece Parts - Closure Construction Ref. Para. 8.1, Table 2.0
E-19	Equipment Design - Power Transients Ref. Para. 8.1, Table 2.0
E-24	Electrical Wire and Cable Acceptance Tests Ref. Para. 8.4.1, Table 2.0
G-1	Equipment Accessibility for Maintenance Ref. Para. 3.6.1.2, Table 2.0
G-3	Systems Checkout Provisions Ref. Para. 7.3, Table 2.0
G-8	Redundant Paths - Verification of Operation Ref. Para. 8.1, 8.1.5, Table 2.0
G-10	Control of Limited Life Components Ref. Table 2.0
G-11	Procurement Document Identification for Manned Space Flight Vehicle Items Ref. Para. 3.3, Table 2.0
G-13	Shipping and Handling Protection for Spaceflight Hardware Ref. Para. 6.1, Table 2.0

G-18	Safety Precautions - Test and Operation Procedures Ref. Para. 3.2.1, 4.5.1.9, 7.3.5, Table 2.0
G-30	Switch Protection Devices Ref. Para. 8.3.1, Table 2.0
M/P-2	Flammability of Wiring Material Ref. Para. 8.1, Table 2.0
M/P-3	Toxicity of Materials Used in Crew Compartment - Wire Insulation, Ties, Identification Marks, and Protective Covering Ref. Para. 3.5.1, Table 2.0
M/P-4	Metals and Metal Couples - Restriction on Use Ref. Para. 3.5.8, Table 2.0
M/P-7	Materials Detrimental to Electrical Connectors Ref. Para. 8.1, Table 2.0
M/P-15	Mercury - Restriction on Use Ref. Para. 3.5.1, Table 2.0
M/P-18	Etching Fluorocarbon Insulated Electrical Wire Ref. Para. 8.1, Table 2.0
M/P-21	Beryllium - Restricted Use Within Crew Compartments Ref. Para. 3.5.1, Table 2.0

M/P-24	Cadmium - Restrictions on Use Ref. Para. 3.5.1, Table 2.0
M/S-3	Wire Bundles - Protective Coating Ref. Para. 8.1, Table 2.0
P-1	Explosive Devices - Arming and Disarming Ref. Para. 8.1, Table 2.0
P-2	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites Ref. Para. 7.1, Table 2.0
P-3	Wire Splicing Ref. Para. 8.4.1, Table 2.0
P-4	Explosive Devices - Packaging Material Ref. Para. 6.2.1, Table 2.0
P-6	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridgewire Initiators Ref. Para. 8.1, Table 2.0
P-7	Explosive Devices - Color Coding Requirements Ref. Para. 3.6.11, 3.9.4, 7.3.6, Table 2.0

2.1.2 Other

Department of Defense (DOD)

AFJMAN 24-204	Preparing Hazardous Materials for Military Air Shipments Ref. Para. 6.1, 6.2.4, 6.2.4.3
DOD-D-1000 Revision B	Drawings, Engineering and Associated Lists Ref. Para. 3.4.4
DOD-STD-100C Notice 6	Engineering Drawing Practices Ref. Para. 3.4.4
DOD 4145.26-M	DOD Contractors Manual for Ammunition, Explosives and Related Dangerous Material Ref. Para. 3.5.3.2
ERR 127-1 June 30, 1993	Eastern Range Regulation 127-1, Range Safety Ref. Para. 3.2.3
ESMCR 127-1	Eastern Test Range Safety Manual Ref. Para. 3.2.3
EWR 127-1 March 31, 1995	Eastern and Western Range 127-1, Range Safety Requirements Ref. Para. 3.2.3
FED-STD-H28/20 Revision A or Later	Screw - Thread Standards for Federal Services Inspection Section 20 Methods for Acceptability of UN, UNR, UNJ, M, and MJ Screw Threads Ref. Para. 3.6.6

MIL-DTL-398	RDX (Cyclotrimethylenetrinitramine) Ref. Para. 3.5.3.1
MIL-DTL-45444	HMX (Cyclotetramethylenetetranitramine) Ref. Para. 3.5.3.1
MIL-H-45444B February 27, 1974	HMX Ref. Para. 3.5.3.1
MIL-I-26860 Revision B or Later	Indicator, Humidity, Plug, Color Change Ref. Para. 6.2.2.2
MIL-L-3055 Type I September 28, 1962	Lead Azide Ref. Para. 3.5.3.1
MIL-L-46225 March 29, 1964	Lead Azide RD-1333 Ref. Para. 3.5.3.1
MIL-P-116	Methods of Preservation Ref. Para. 6.1, 6.2.2.1, 6.2.2.2
MIL-P-387 December 8, 1976	Pentaerythrite Tetranitrate (PETN) Ref. Para. 3.5.3.1
MIL-R-398 August 14, 1973	RDX Explosive Ref. Para. 3.5.3.1

MIL-S-22473	Sealing, Locking and Retaining Compounds, Single Component Ref. Para. 3.6.5
MIL-STD-105 Revision D or Later	Sampling Procedures and Tables for Inspection by Attributes Ref. Para. 3.3, 3.3.1
MIL-STD-129 Revision E or Later	Standard Practice for Military Marking Ref. Para. 6.2.4.3
MIL-STD-130 Revision D or Later	Identification Marking of U.S. Military Property Ref. Para. 3.9.2
MIL-STD-143	Specifications and Standards, Order of Precedence for the Selection of Ref. Para. 3.4.3
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts, Method 112, Seal Ref. Para. 4.5.2.3.1
MIL-STD-331	Fuze and Fuze Components, Environmental and Performance Test for Ref. Para. 4.4.1.3.3, 4.5.1.7, 4.5.2.1, 11.0
MIL-STD-453	Inspection, Radiographic Ref. Para. 4.5.2.4.1, 4.5.3.2.1

MIL-STD-794 Revision B or Later	Parts and Equipment, Procedures for Packaging of Ref. Para. 6.2.2, 6.2.2.1, 6.2.4.1
MIL-STD-810 Revision C or Later	Environmental Test Methods and Engineering Guidelines Ref. Para. 3.8.2
MIL-STD-2073	DOD Material, Procedures for Development and Application of Packaging Requirements Ref. Para. 6.1, 6.2.1
MIL-STD-2073-1 Revision D or Later	Standard Practice for Military Packaging Ref. Para. 6.1, 6.2.1, 6.2.2, 6.2.2.1, 6.2.2.2, 6.2.4.1
MIL-STD-45662	Calibration System Requirements Ref. Para. 7.3.8
MS-20995	Wire, Safety or Lock Ref. Para. 3.6.5

Federal

CFR, Title 49	Code of Federal Regulations, Title 49 (Parts 100 through 199), Department of Transportation Ref. Para. 6.1, 6.2.4, 6.2.4.3
FED-STD-101 April 25, 1975	Preservation, Packaging and Packing Materials: Test Procedures Ref. Para. 6.2.4.1

2.2 NON-GOVERNMENT

WS 5003F	Material Specification for HNS Explosive Ref. Para. 3.5.3.1

Industry Standards and Specifications

AIA/NAS NASM20995	Wire, Safety or Lock Ref. Para. 3.6.5
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes Ref. Para. 3.3, 3.3.1
ANSI/NCSL Z450-1	Calibration Laboratories and Measuring and Test Equipment - General Requirements Ref. Para. 7.3.8
ASME B46.1	Surface Roughness, Waviness and Lay Ref. Para. 3.6.7
ASTM D257	Standard Test Methods for DC Resistance or Conductance of Insulating Materials Ref. Para. 6.2.1
ASTM E8	Standard Test Methods of Tension Testing of Metallic Materials Ref. Para. 3.5.9

ASTM E18	Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials Ref. Para. 3.5.9
ASTM E1742	Standard Practice for Radiographic Examination Ref. Para. 4.5.2.4.1, 4.5.3.2.1
IATA DGR	International Air Transport Association Dangerous Goods Regulations Manual Ref. Para. 6.1

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TABLE 2.0

MANNED SPACECRAFT CRITERIA AND STANDARDS (JSCM 8080* AND NSTS 08080-1) CROSS-REFERENCE OF STANDARDS REFERENCED IN NSTS 08060

JSCM 8080 Standard		NSTS 08080-1 Standard	
E-1	Mating Provisions for Electrical Connectors	3A	Electrical Connectors - Keying
E-3	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs	13	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs
E-4	Electrical Connectors - Moisture Protection	31 80	Electrical Connectors - Moisture Protection Protection of Electrical/Electronic Assemblies from Moisture Damage
E-7	Tantalum Wet Slug Capacitors - Restriction on Use	52	Tantalum Wet Slug Capacitors - Restriction on Use
E-8	Electrical and Electronic Supplies and Loads - Verification Tests	68	Electrical and Electronic Supplies and Loads - Verification Tests
E-9	Electrical Circuits - De-energizing Requirement	69	Electrical Circuits - De-energizing Requirement
E-10	Cleaning of Electrical and Electronic Equipment	81	Ultrasonic Cleaning of Electrical and Electronic Assemblies
E-11	Protective Covers or Caps for Electrical Receptacles and Plugs	85A	Protective Covers or Caps for Receptacles and Plugs - Electrical
E-14	Electrical Wire Harnesses - Dielectric Tests	133D	Electrical Wire Harnesses - Dielectric Tests
E-15	Electrical Power Distribution Circuits - Overload Protection	134	Electrical Power Distribution Circuits - Overload Protection
E-16	Testing Protective Devices for Solid State Circuits	148	Testing Protective Devices for Solid State Circuits
E-17	Electrical and Electronic Piece Parts - Closure Construction	19	Electrical and Electronic Piece Parts - Closure Construction
E-19	Equipment Design - Power Transients	146	Equipment Design - Power Transients
E-24	Electrical Wire and Cable Acceptance Tests	95E	Electrical Wire and Cable Acceptance Tests
G-1	Equipment Accessibility for Maintenance	1A 136	Equipment Accessibility for Maintenance Panel Mounted Displays and Controls - Maintainability
G-3	Systems Checkout Provisions	7	Systems Checkout Provisions

TABLE 2.0

MANNED SPACECRAFT CRITERIA AND STANDARDS (JSCM 8080* AND NSTS 08080-1) CROSS-REFERENCE OF STANDARDS REFERENCED IN NSTS 08060 - Continued

JSCM 8080 Standard		NSTS 08080-1 Standard	
G-8	Redundant Paths - Verification of Operation	36	Redundant Paths - Verification of Operation
G-10	Control of Limited Life Components	77	Control of Time-Sensitive Components
G-11	Procurement Document Identification for Manned Space Flight Vehicle Items	79	Procurement Document Identification for Manned Space Flight Vehicle Items
G-13	Shipping and Handling Protection for Spaceflight Hardware	84A	Shipping and Handling Protection for Spaceflight Hardware
G-18	Safety Precautions - Test and Operation Procedures	115	Safety Precautions - Test and Operation Procedures
G-30	Switch Protection Devices	59	Crew Compartment - Switch Coverguards
M/P-2	Flammability of Wiring Material	22A	Flammability of Wiring Material
M/P-3	Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Covering	23	Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Covering
M/P-4	Metals and Metal Couples - Restriction on Use	63	Metals and Metal Couples - Restriction on Use
M/P-7	Materials Detrimental to Electrical Connectors	101	Materials Detrimental to Electrical Connectors
M/P-15	Mercury - Restriction on Use	116	Mercury - Restriction on Use
M/P-18	Etching Fluorocarbon Insulated Electrical Wire	98 109A	Wire Insulation, Potting Preparation - Etching Etching Fluorocarbon Insulated Electrical Wire
M/P-21	Beryllium - Restricted Use Within Crew Compartments	51	Beryllium - Restricted Use Within Crew Compartments
M/P-24	Cadmium - Restrictions on Use	125	Cadmium - Restrictions on Use
M/S-3	Wire Bundles - Protective Coating	25	Wire Bundles - Protective Coating
P-1	Explosive Devices - Arming and Disarming	39A	Explosive Devices - Arming and Disarming
P-2	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites	105B	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites

TABLE 2.0

MANNED SPACECRAFT CRITERIA AND STANDARDS (JSCM 8080* AND NSTS 08080-1) CROSS-REFERENCE OF STANDARDS REFERENCED IN NSTS 08060 - Concluded

JSCM 8080 Standard		NSTS 08080-1 Standard	
P-3	Wire Splicing	88A	Wire Splicing
P-4	Explosive Devices - Packaging Material	90B	Explosive Devices - Packaging Material
P-6	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridgewire Initiators	46	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridgewire Initiators
P-7	Explosive Devices - Color Coding Requirements	103	Explosive Devices - Color Coding Requirements

*NSTS 08060 references JSCM 8080 standards

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3.0 REQUIREMENTS

The requirements contained in NSTS 07700, Program Definition and Requirements Document, are applicable to all pyrotechnics in Shuttle elements except payloads. NSTS 07700, Volume X, Flight and Ground System Specification, defines the technical requirements.

3.1 RELIABILITY

All pyrotechnic devices and system shall comply with the applicable provisions of NSTS 07700, Volume X - Book 1, Flight and Ground System Specification, Requirements, Paragraph 3.5.1. All devices whose functions are required for the safe recovery of Orbiter vehicle and crew shall not be less than fail-safe. Crew and mission criticality shall be the primary consideration in redundancy requirements. Elimination of single failure points is the primary reliability consideration in the design of pyrotechnics. Each redundant path shall be verified by test. Reliability shall comply with the provisions of NSTS 5300.4(1D-2), Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program.

3.2 SAFETY

Only personnel formally trained and/or certified in the installation of Shuttle pyrotechnics shall handle, test, or install pyrotechnic devices. Safety programs shall comply with NSTS 5300.4(1D-2).

3.2.1 Flight Safety

JSCM 8080, Standard G-18 is applicable.

3.2.2 Ground Safety

Ground safety requirements and procedures shall conform to the requirements of NSTS 5300.4(1D-2) and this specification.

3.2.2.1 JSC Safety

No pyrotechnics shall be shipped to JSC without proper notification of the Pyro Facility Manager. The facility safety requirements are delineated in and controlled by ESTA/ GOPM, Energy Systems Test Area/General Operating Procedure Manual, Section 6.09. The requirements therein shall govern the storage and use of pyrotechnics at that facility. Shipping requirements shall be in accordance with Paragraph 6.3.1.

3.2.2.2 KSC Safety

KHB 1710.2, Kennedy Space Center Safety Practices Handbook, is the basic document on safety requirements at KSC and the requirements thereof shall govern the storage and use of pyrotechnics at that installation.

3.2.2.3 MSFC Safety

Marshall Manual MM 1700.4, MSFC Safety Standard Explosive Device and Material, is the safety standard for explosive devices and materials at MSFC and the requirements thereof shall govern the storage and use of pyrotechnic at that installation.

3.2.3 Range Safety

The Shuttle shall meet the flight termination system applicable requirements of ESMCR 127-1, Eastern Test Range Safety Manual. New designs initiated after June 30, 1993 and prior to January 1, 1996 shall comply with ERR 127-1, Eastern Range Regulation 127-1, Range Safety. New designs initiated after January 1, 1996 shall comply with EWR 127-1, Eastern and Western Range 127-1, Range Safety Requirements. For these new designs, specific system/component design requirements will be tailored from the ERR 127-1 or EWR 127-1 requirements through DOD/NASA negotiations and documented in MSFC-SPEC-30A90506, Specification for Shuttle Range Safety System.

3.3 QUALITY ASSURANCE (QA)

The QA program shall satisfy the requirements of NSTS 5300.4(1D-2) or NHB 5300.4(1C), Inspection System Provisions for Aeronautical and Space System Materials Parts, Components and Services, as appropriate, to ensure that all pyrotechnics are manufactured in conformance with the requirements of all applicable documents and satisfy the design requirements and intent. These provisions shall be implemented and maintained throughout all phases of design, development, manufacturing, testing, handling, transportation, storage, and installation. Inspection levels shall be established by the appropriate design center's QA office and shall conform to MIL-STD-105, Sampling Procedures and Tables for Inspection by Attributes, or ANSI/ASQC Z1.4, Sampling Procedures and Tables for Inspection by Attributes. JSCM 8080, Standard G-11 is applicable.

3.3.1 Sampling

Use of sampling inspection and sample plans shall be approved by the appropriate design center QA organization. When used, sampling inspection shall be in accordance with MIL-STD-105, or ANSI/ASQC Z1.4, with the following exception: Whenever sampling inspection reveals one or more nonconforming items and the sampling plan does not require rejection of the lot, all items in the lot shall be inspected for the identified nonconforming characteristic.

3.4 SELECTION OF DEVICES, SPECIFICATIONS, AND STANDARDS

3.4.1 NASA Standard Initiator (NSI) and Reusable Solid Rocket Motor (RSRM) Initiator

JSC/SEB26100001, Initiator, NASA Standard, shall be the standard Electro Explosive Device (EED) for the Space Shuttle, excluding the RSRM Initiators, and shall be provided as Government Furnished Equipment (GFE) to all users by JSC, and shall conform to JSC/SKB26100066, Design and Performance Specifications for NSI-1 (NASA Standard Initiator-1). The RSRM Initiator, JSC/SED26100107-301/302, Initiator, SRM Ignition, shall be the standard initiator for the RSRM and shall be provided as GFE to the RSRM Project by the JSC and shall conform to JSC/SKD26100109, Design Performance Specifications for the SRB Initiator (SRM Ignition).

3.4.1.1 Mating Electrical Connector

MSFC connector 40M38298 shall be used throughout the Space Shuttle to connect firing circuits to the NSI-1. Connector indexing configurations are shown in the NASA JSC control drawing, NSI SLB26100052. JSCM 8080, Standard E-1 (formerly JSCM 8080-3A) is applicable.

Deviation/Waiver 59 is applicable to Paragraph 3.4.1.1.
Refer to the Deviations/Waivers Section in front of the document.

NSI-1 Indexing and Dash Numbering

Reference Configuration Control Drawing SLB26100052	
Basic Part Number (P/N) and Configuration	Designation
SEB26100001 -1XX	Prototype, Developmental Experimental
-2XX	Flight Configuration
-X1X	Spanner Type (Weld Washer)
-X2X	Not Designated
-X3X	Not Designated
-X4X	Not Designated
-X5X	No Weld Washer
-8XX	Inert Device
-XX1	Keyways 1 and 6 closed (Non-flight)
-XX2	Keyways 2 and 6 closed (Flight)
-XX3	Keyways 3 and 6 closed (Flight)

Reference Configuration Control Drawing SLB26100052	
Basic Part Number and Configuration	Designation
-XX4	Keyways 4 and 6 closed (Flight)
-XX5	Keyways 5 and 6 closed (Flight)
-XX6	Keyways 1 and 2 closed (Flight)
-XX7	Keyways 1 and 3 closed (Flight)
-XX8	Keyways 1 and 4 closed (Flight)
-XX9	Keyways 1 and 5 closed (Flight)
-XX0	All Keyways Open (Requires Specific JSC Authority for Use)

MATING CONNECTORS
(MSFC Specification 40M38298)

NSI Configuration (Dash Number)	Straight Backshell	Right Angle Backshell
-XX6	9GE8-2SE	8GE8-2SE
-XX7	9GE8-2SF	8GE8-2SF
-XX8	9GE8-2SG	8GE8-2SG
-XX9	9GE8-2SH	8GE8-2SH
-XX0	ALL	ALL

3.4.1.2 Authorized Configurations

The only connector configurations (straight backshell) authorized for use on NSI-1 connections shall be P/Ns: NBS9GE8-2SE, -2SF, -2SG and -2SH. These four authorized configurations are restricted from use in non-pyrotechnic circuits in the vicinity of an installed NSI-1.

Approval has been granted for the use of a right-angle backshell mating connector and a straight no backshell mating connector at two specific locations on the Space Shuttle per NSTS 07700, Volume X - Book 1, Paragraph 3.6.3.1.

a. NBS8GE8-2SE connector configuration shall be used to connect ET/SRB strut pyrotechnic firing circuits to the NSI-1.

   NOTE: When using this connector, assure that there is adequate structural clearance.

b. NBS6GE8-2SE connector configuration shall be used for the NSI connection on the SRB hold-down posts due to structural clearance restrictions.

Use of any other configuration (straight and/or right-angle backshell) on an NSI-1 shall require a waiver/deviation to this specification. A waiver/deviation for use of right angle connector shall include the methods used to prevent backshell/endbell loosening.

EXCEPTION: NBS6GE connector type configuration shall be used for the NSI connection on the ET vent arm umbilical, ET T-0 static lanyard, H2 burn-off ignitors, and Tail Service Mast (TSM) release pyrotechnic firing line cables.

3.4.2 Selection of Pyrotechnic Devices and Assemblies

The selection process shall minimize the number of different devices, styles, and generic types in the Space Shuttle system.

3.4.3 Selection of Standards and Specifications

Specifications and standards for use in design and construction of Space Shuttle system pyrotechnic devices shall be selected in accordance with MIL-STD-143, Specifications and Standards, Order of Precedence for the Selection of, except that NASA documents, where specified, shall take precedence.

3.4.4 Drawing Standards

Drawings shall be prepared in accordance with DOD-D-1000, Drawings, Engineering and Associated Lists, Revision B, and DOD-STD-100, Engineering Drawing Practices, Revision C, Notice 6.

3.5 MATERIALS

All materials shall be of uniform high quality and shall be capable of withstanding the ground and flight environments specified for the device in which used. They shall conform to the applicable requirements of SE-R-0006, General Specification Space Shuttle System Requirements for Materials and Processes.

3.5.1 Prohibited and Restricted Materials

The following restrictions are applicable to the materials indicated.

a. Cadmium plating shall not be used unless it is absolutely essential. If used, it shall conform to JSCM 8080, Standard M/P-24.

b. Room Temperature Vulcanizing (RTV) silicon rubbers that generate acetic acid during the cure cycle shall not be used in the proximity of, or in contact with lead, lead alloys, or lead/tin solder.

c. The use of copper or its alloys is prohibited where such metal can come into contact with lead azide or other materials with which copper or its alloys exhibits any incompatibility whatsoever.

d. Mercury shall not be used as a material where it could come into contact with the spacecraft or the spaceflight equipment. JSCM 8080, Standard M/P-15 is applicable.

e. Unalloyed beryllium shall not be used within the crew compartment. JSCM 8080, Standard M/P-21 is applicable.

f. Materials that produce toxic or noxious fumes or dust shall not be used in the crew compartment. JSCM 8080, Standard M/P-3 is applicable.

3.5.2 O-Rings

Fluoroelastomer O-rings, or equivalent are preferred.

3.5.3 Explosive, Propellant, and Pyrotechnic Materials

All explosive materials, including propellants and pyrotechnics, shall be approved by the appropriate NASA Project Office. Only one lot of each explosives or pyrotechnic material shall be used in the manufacture of any production lot of devices.

3.5.3.1 High Explosive Materials

The use of reclaimed high explosive materials is prohibited. The number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials, copper, and copper containing alloys. All high explosives may be furnished by the contractors and procured to the following specifications:

Material	Specification
HNS	WS 5003F
HMX	MIL-H-45444B or MIL-DTL-45444
RDX	MIL-R-398 or MIL-DTL-398
PETN	MIL-P-387
Lead Azide Type I	MIL-L-3055
Lead Azide RD-1333	MIL-L-46225

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command. Requests for such letters shall be forwarded to the appropriate NASA Project Office for action.

Each lot of high explosives shall be tested/analyzed for conformance to the applicable military specification requirements. Whenever practical, high explosives shall be procured directly from the original manufacturer. A certification of conformance, including

original test/analysis results from the explosive manufacturer, shall be supplied with each lot of high explosive material. If the high explosive lot was procured directly from the original explosive manufacturer, and five years or less has elapsed between the date of manufacture of the high explosive lot and the loading date of NASA pyrotechnic devices, the explosive manufacturer's original test/analysis results may be used as the basis for determining acceptability of the explosive lot. If the high explosive lot was not procured directly from the original explosive manufacturer, or more than five years has elapsed between the date of manufacture of the high explosive lot and the date of loading of NASA pyrotechnic devices, a new test/analysis shall be performed prior to the start loading of operations. The original explosive manufacturer, or a suitable test facility approved by the element contractor and cognizant NASA design center, may perform this test/analysis. Test/analysis results shall be compared with the original test/analysis results for evidence of significant degradation that could impact the functional performance or shelf life of the affected pyrotechnic devices. Test/analysis of high explosive materials shall be repeated at consecutive five-year intervals until the high explosive lot is no longer used for loading of NASA pyrotechnic devices. The results of these subsequent tests/analyses shall be compared with all prior tests/analyses results for evidence of significant degradation that could impact functional performance or shelf life. In the event the test facility performing the test/analysis of the high explosive materials wishes to utilize test methods different from those prescribed in the applicable military specification, detailed test procedures shall be prepared and submitted to the appropriate NASA center and element contractor, as applicable, for approval.

Deviation/Waiver 75 is applicable to Paragraph 3.5.3.1.
Refer to the Deviations/Waivers Section in front of the document.

3.5.3.2 Explosive Material Contamination Control

Special precautions shall be taken to ensure that explosive material drawn for production use does not become contaminated. Specific instructions for in-process explosive material storage and handling shall be incorporated in supplier pyrotechnic device manufacturing procedures.

Bulk explosive materials shall be stored using techniques that satisfy the requirements of DOD 4145.26-M, DOD Contractors Manual for Ammunition, Explosives and Related Dangerous Material. In order to ensure that explosive materials do not become contaminated, special emphasis shall be placed on good housekeeping, container integrity, container placement, and elimination of all contaminant-promoting conditions. In addition, a rodent and insect-abatement program shall be instituted to prevent possible contamination from those sources. Detailed procedures shall be prepared by each pyrotechnic device supplier for contamination control of bulk explosive materials.

These procedures shall be approved by the cognizant element contractor or NASA center, as appropriate.

3.5.4 Compatibility

All materials used in pyrotechnic devices shall be compatible with each other to the extent that no reaction occurs which might adversely affect the component or system performance or safety including transient compounds, liquid or gaseous, generated during curing or storage. Stability and compatibility testing shall be conducted on all explosive/component interfaces, including sealing materials, where test data or analyses for demonstrating stability of materials or compatibility of components is not available.

3.5.5 Fungus Resistant Materials

Non-nutrient materials shall be used wherever possible. Materials which are nutrients for fungi shall be treated with an approved fungicidal agent before use.

3.5.6 Proprietary Materials and Processes

The use of proprietary materials and processes shall be avoided whenever possible. Complete disclosure of all proprietary materials and processes shall be provided to the NASA prior to their approval for use in accordance with SE-R-0006.

3.5.7 Protective Treatment

Materials and parts that are subject to corrosion shall be treated with a protective coating that will not crack, chip, peel, or scale with age or when subjected to the environmental extremes applicable to the specific part or device.

3.5.8 Dissimilar Metals

Dissimilar metals which tend toward active electrolytic or galvanic corrosion when in direct contact with each other shall not be used in applications requiring direct contact. JSCM 8080, Standard M/P-4 is applicable.

3.5.9 Material Certification, Component Parts (ASTM E8, ASTM E18)

3.5.9.1 Heat Treated Component

Tensile coupons and chemical analysis data shall be required from component parts which are heat treated after machining and exposed to operating pressures and/or primary structural loads. The supplier shall establish and the NASA Project Office shall approve the minimum acceptance criteria of the material properties listed below.

Failure to meet these minimum acceptance criteria shall be cause for rejection of the component parts associated with those test coupons. Prior to acceptance, the supplier shall conduct tensile tests on each coupon part as defined by the procuring agency. A minimum of three standard tensile coupons from the component part lot materials shall be processed with the component parts. These coupons shall be tested in accordance with the detail drawing/specification requirements. The following data shall be obtained from the test coupons and recorded on the lot acceptance data sheets:

a. Ultimate tensile strength

b. 0.2% offset yield

c. Elongation

d. Reduction of area

Deviation/Waiver 112 is applicable to Paragraph 3.5.9.1
Refer to the Deviations/Waivers Section in front of the document.

3.5.9.2 Non-Heat Treated Component

For pyrotechnic device metallic component parts which are not heat treated after machining or exposed to operating pressures or primary structural loads, the standard material chemical analysis and mechanical properties test reports delivered with the material will suffice. Data from these reports will be recorded on the lot acceptance data sheets, provided items a, b, and c above as a minimum, are included in the reports.

3.6 DESIGN DEVELOPMENT TECHNOLOGIES AND PRACTICES

3.6.1 NASA/JSC Standards

Pyrotechnic devices and system shall comply with the requirements of JSCM 8080, Manned Spacecraft Criteria and Standards, listed in Paragraph 2.1.1.

3.6.1.1 General Requirements

All design and construction details shall provide for maximum reliability, safety, and operating efficiency, as well as for minimum weight. Performance margins shall be provided in the designs to provide for charge variations and tolerances. No components shall work loose and all components shall be capable of withstanding strains, impacts, vibration, and other conditions incidental to shipping, storage, installation, and service. The alignment and fit of parts and mating surfaces shall assure proper functioning

within the specified environmental extremes. All designs shall assure the producibility of high quality parts.

3.6.1.2 Accessibility

Pyrotechnic systems shall be designed for optimum accessibility of all subsystems, assemblies, and components. Components shall be located near existing access panels and work platforms, where possible. Cartridges and independently installed NSI-1 shall be located as near as practical to the first point of element entry to facilitate installation and changeout. JSCM 8080, Standard G-1 is applicable.

3.6.1.3 Maintenance

Maintenance of pyrotechnic systems and devices installed on the vehicle shall be limited to removal and replacement. No scheduled maintenance shall be performed on pyrotechnic subsystems and devices (except electrical circuits and components) after vehicle installation.

3.6.2 Installation, Replaceability, Maintainability, and Interchangeability

Installation of all components and subsystems shall be controlled by detailed procedures specifying step-by-step details, including techniques and the equipment to be used for inspection. Provisions shall be made for design tolerances and buildups such that items having the dimensions and characteristics permitted by the item specification or drawing are interchangeable without selection or departure from the specified equipment performance. Appropriate warnings pertaining to the fragility and hazardous nature of pyrotechnic devices shall be incorporated into all assembly and installation procedures. Wherever practicable, but consistent with the provisions of Paragraph 3.6.1.2, the loaded pyrotechnic device (e.g., NSI-1 or cartridge assembly) shall be designed to be accessible for inspection and/or changeout. Duplication of thread sizes on cartridges shall be avoided (reference Paragraph 4.6.1) to prevent installation of an incorrect cartridge. Where appropriate, adjacently located cartridges shall utilize the NSI-1 connector indexing technique (reference Paragraph 3.4.1.1) to prevent errors in electrical connector installations. Pyrotechnic devices shall not be installed in the proximity of heat sources that could cause ignition or degradation of the pyrotechnic components.

3.6.3 Explosive Interfaces

All explosive interfaces (e.g., detonator-to-detonator, booster-to-booster) and other initiator or detonator transfer connections shall be designed and installed to ensure positive gap and angle control. Joints and interfaces shall be standardized to the greatest possible extent. Optimum spacing and margins for initiation and detonation transfer joints

shall be determined and demonstrated by gap separation and/or angle and offset tests. Unless different explosive materials are known to be compatible, they shall be separated by inert barriers.

3.6.4 Sealing

All pyrotechnic devices shall be appropriately sealed to protect explosive materials from contaminants and exposure to vacuum environment. The sealing process shall in no way change the electrical characteristics of the initiator, when used. Where sealing is accomplished by non-metallic seals (e.g., metal end-caps bonded to Linear Shaped Charge [LSC]/Mild Detonating Fuse [MDF] with adhesive, end-to-end electrical conductivity shall be maintained to assure that there is no buildup of electrical charge potential). The SRB/ET Confined Detonating Fuse (CDF) assemblies do not require hermetic sealing of end tips.

3.6.5 Locking Threaded Parts

All threaded parts shall be positively locked. Appropriate control procedures shall be established for the reuse of self-locking devices where applicable. Acceptable locking methods are as follows:

a. Metallic self-locking nuts

b. Castellated nuts and cotter pins

c. Lockwire conforming to MS-20995, Wire, Safety or Lock or AIA/NAS NASM20995, Wire, Safety or Lock

d. Screw-locking screw thread fasteners

e. Welding, brazing, or soldering

f. Sealant per MIL-S-22473, Sealing, Locking and Retaining Compounds, Single Component

g. Roll pin

h. Epoxy type sealants qualified for the intended use

3.6.6 Screw Threads

Screw threads for pyrotechnic devices and for threaded fasteners, except for frangible nuts and mating studs, shall be in compliance with NSTS 07700, Volume X - Book 1, Paragraph 3.6.17, Screw Threads. Threaded pyrotechnic devices, that require structural load tests for each piece part as acceptance criteria, may utilize the appropriate

inspection system per FED-STD-H28/20, Screw - Thread Standards for Federal Services Inspection Section 20 Methods for Acceptability of UN, UNR, UNJ, M, and MJ Screw Threads, for pretest acceptance inspection. This requirement does not apply to buttress threads.

3.6.7 Surface Wear

Mating surfaces shall be sufficiently smooth and wear-resistant to minimize the generation of metal-to-metal and seal wear particles. Surface roughness shall conform to ASME B46.1, Surface Roughness, Waviness and Lay.

3.6.8 Ultrasonic Cleaning

Ultrasonic cleaning of electronic/electrical components shall conform to JSCM 8080, Standard E-10.

3.6.9 Prohibited and Restricted Practices

3.6.9.1 Nylon or Other Non-Metallic Insert Thread Locking Devices

Nylon or other non-metallic insert thread locking devices shall not be used. An exception to this requirement is for the RSRM/SRB Safe and Arm (S&A) leak check port plugs through RSRM-83.

3.6.9.2 Insulation Resistance (IR) Testing

Subsequent to NSI-1 lot acceptance shall be limited to the following:

a. In cartridge lot acceptance tests: Destructive test sample, one test per part at 250 VDC; deliverable units, one test per part at 50 VDC (maximum). (Reference Paragraph 4.5.2.5.3). No IR test is to be performed prior to higher assembly buildup.

b. Installation site receiving test: One test per part is optional at 50 VDC maximum.

c. Flight vehicle preinstallation test: One test only (250 VDC) per part is mandatory (reference Paragraph 7.2.4.3). Further IR testing shall be performed at 50 VDC maximum.

d. Firing tests: One test per part is optional at 250 VDC maximum.

3.6.9.3 Dielectric Testing

Dielectric testing of any NSI-1 is prohibited.

3.6.10 Electrical Bonding

Electrically initiated pyrotechnic devices or those containing primary explosives shall be designed so that electrical bonding between the metal exterior of the device and the

next adjoining device or contact surface, if mechanically joined, may be accomplished to meet class “R” bonding requirements (2.5 milliohms) per NSTS 37330, Bonding, Electrical, and Lightning Specifications, Paragraph 3.3.5. The SRB reefing line cutter and the RSRM nozzle severance LSC are exempted from this requirement.

3.6.11 Mockups

Except as otherwise required, pyrotechnic mockups shall use production hardware without charges or with dummy or inert charges. All mockups of explosively loaded components shall be color coded red in accordance with JSCM 8080, Standard P-7.

3.6.12 Blast Containment

The effect of shock, debris, and hot gas resulting from the operation of pyrotechnics shall be important considerations in their selection and design and these effects shall be minimized.

3.6.13 Locked-Shut Capability

Pressure actuated devices shall be capable of withstanding internal pressures generated in operation with the movable part restrained in its initial position and without rupture or the release of shrapnel, debris, or hot gases which could compromise crew safety or mission success. Where applicable, this capability shall be demonstrated with redundant charges operating simultaneously. If locked-shut damage is of secondary consequence to mission loss/crew safety then this capability need not be demonstrated.

3.6.14 Yield Factor

The yield factor shall be a minimum of 1.1 applied to the limit load. Components shall have adequate strength to withstand limit loads without loss of operational capability for the life of the component. (This factor is not applicable to the loads generated by the firing of the pyrotechnic charge).

3.6.15 Design Ultimate Factor of Safety

The design ultimate factor of safety shall be a minimum of 1.4 applied to the limit load. Components shall have adequate strength to withstand ultimate loads without failure. The 1.4 factor is not applicable to loads generated by the firing of the pyrotechnic charge. When the ultimate tensile strength of a selected material is more than 1.4 times the yield strength of the material, the design shall be based on the limit load and the yield strength of the material.

3.6.16 Special Tools

Pyrotechnic devices shall be designed to require a minimum of special assembly and installation tools.

3.6.17 Initiation Mechanisms and Devices

3.6.17.1 Electro Explosive Device

EED shall be as specified in Paragraph 3.4.1.

3.6.17.2 Mechanical Initiation Devices

Mechanical initiation shall be accomplished using percussion primers conforming to the following specifications:

Primer Type	Specification
M42 C1	JSC/SKD26100132
M42 C2	JSC/SKD26100132

The responsible project office shall be responsible for certifying the primers used in Shuttle pyrotechnic applications. Certifications and associated testing shall be performed and maintained for the respective lot of primers by the responsible project office. The certifications and associated testing required by this specification apply to the primers prior to their installation into the next higher assembly. Subsequent to their installation, testing of the next higher assembly is sufficient to demonstrate the continued acceptability of the installed primers.

3.6.18 Propellant Operated Devices

3.6.18.1 General

For this type of device a separable cartridge assembly is preferred over an integral charge for safety, ease of installation and replacement, and to allow flexibility of installation scheduling during prelaunch operations. All components exposed to operating pressure shall be capable of withstanding the following pressures:

a. An internal proof pressure of 1.2 times the maximum operating pressure without permanent deformation or leakage. The maximum operating pressure shall be defined as the highest measured operating pressure from a minimum of five firings using nominal cartridge load. If the cartridge design, propellant or application make direct pressure measurements impractical or if a measured

transient pressure spike establishes an unrealistic proof pressure requirement, an analytically derived proof pressure requirement may be established. This analysis shall be approved by NASA Engineering, NASA Safety, Reliability and Quality Assurance (SR&QA) and the project office at the responsible field center. This requirement must be demonstrated on all qualification and production hardware. The following SRB components are excluded from this requirement:

10301-0001	Forward Separation Bolt
10302-0001	Aft Separation Bolt
10303-0001	NSI Pressure Cartridge
10304-0001	Nose Cap Thruster
10305-0002	Thruster Pressure Cartridge
10308-0003	CDF Initiator
10320-0001	Delay Cutter Assembly
10320-0004	Delay Cutter Assembly

b. An internal burst pressure of 1.25 times the proof pressure level as determined in Paragraph 3.6.18.1a without structural failure (burst).

c. A locked-shut firing test, without fragmentation, shall be conducted to demonstrate this capability for devices such as mortars, thrusters, and circuit interrupters.

3.6.18.1.1 Propellant Gas Operated Devices

Propellant gas operated devices shall be capable of the required performance with a single cartridge loaded with 85% (by weight of each pyrotechnic element except the NSI-1) of the minimum allowable charge. This must be accomplished by simultaneously downloading all of the elements except the NSI-1. Flight certified NSI-1s shall be used for this testing. Simulated, inert cartridges shall be installed in the redundant cartridge port(s) when demonstrating this capability. The 85% single cartridge requirement must be demonstrated during qualification testing. When downloaded cartridges are not available, as in the case of the NSI-1 or a cartridge carried over from a prior program, other suitable methods to satisfy the intent of this requirement may be employed. Time delays are exempt from this requirement. These requirements shall be demonstrated by test in the qualification program, or by analysis if testing is not practical.

Deviation/Waiver 110 is applicable to Paragraph 3.6.18.1.1.
Refer to the Deviations/Waivers Section in front of the document.

3.6.18.2 Cartridge Torque

Each cartridge assembly shall be capable of withstanding 1.5 times the specified maximum allowable installation torque without physical damage.

3.6.19 High Explosive Operated Devices

3.6.19.1 LSC, MDF, and LSC/MDF Assemblies

LSC and MDF shall be standardized as to size, core loading, sheath materials, type of explosive, configuration, end coupler and booster design to the greatest possible extent without compromising performance or reliability.

3.6.19.1.1 Core Charges

A production lot shall consist of all LSC/MDF produced in a single production run. It may consist of LSC/MDF made from more than one tube; however, only one lot of bulk explosive and tube materials shall be used in one lot of LSC/MDF. A tube shall be a length of tubing loaded with explosive material prior to being reduced to the required configuration.

3.6.19.1.2 Sheath Geometry

Sheath geometry, thickness, apex thickness (for LSC) and concentricity (for MDF) shall be established for each core charge.

3.6.19.1.3 Explosive Material

LSC/MDF core explosive shall be selected in accordance with Paragraph 3.5.3 and the core load, in grains per foot, shall be verified in accordance with Paragraph 4.5.3.3.1.

3.6.19.1.4 Splicing

LSC/MDF core charges shall not be spliced.

3.6.19.2 Charge Holder Assemblies

Where appropriate, LSC/MDF core charges and explosive trains shall be mounted in charge holders to protect the explosive components from damage. Assembly of the explosive items into charge holders at the supplier is preferred in order to provide increased protection from damage during shipping and handling operations.

3.6.19.2.1 LSC Assemblies

LSC charge holders shall be designed to permit inspection of the standoff and/or provide dimensional control of the standoff after installation. Provisions shall be made to

ensure that no contamination enters the LSC apex area after installation into the charge holder or installation of the charge holder into the next higher assembly. When redundancy is required and dual charges are utilized to meet this requirement, a separation barrier shall be used to prevent dudding of one charge by the other. At least one initiation point is required for each charge and either charge shall be capable of performing the required function. Piggyback configurations shall not be used to achieve redundancy. The capability of a redundant design to prevent dudding and the proper performance of both charges shall be demonstrated during qualification. A simplex LSC design is allowed for use in the SRB/Advanced Solid Rocket Booster (ASRB) and ET Range Safety Destruct Systems and the SRB/ASRB Recovery System.

3.6.19.2.2 MDF Separation Assemblies

MDF separation systems shall utilize multiple initiation points and dual MDF core charges. MDF core charges shall be positioned side-by-side in the charge holder assembly and either charge shall be capable of performing the separation function and this capability shall be demonstrated by test.

3.6.20 Frangible Devices

3.6.20.1 Frangible Devices

A 15% margin shall be demonstrated in a manner dependent on the design of the device. Frangible devices shall be capable of the required performance with a production cartridge/charge. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. This test should be performed under the minimum allowable loading conditions that can exist at the time of functioning of the frangible device.

3.6.20.2 Frangible Nuts

The margin shall be demonstrated by firing a production cartridge in a nut having a separation cross section that is 115% of the maximum allowable cross section. The margin requirement shall be demonstrated on each production lot. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. This test should be performed under the minimum allowable flight loading conditions that can exist at the time of functioning of the frangible nut. The SRB/ASRB frangible nut (MLP hold down) shall demonstrate margin with a separation cross section that is 110% of the maximum allowable cross section.

3.6.21 Guillotines and Cutters

When severing electrical wires with a guillotine or cutter, the possibility of electrical shorting during and/or after operation shall be considered and appropriate protection shall be provided. A performance margin shall be demonstrated by either firing a production cartridge (charge) in the device and cutting at least 115% of the target material or by using a cartridge 85% (by weight) of the minimum allowable charge with a 100% target material. The device shall not fragment when fired with 115% (by weight) of the maximum output charge. For dual blade devices this capability (no fragmentation) shall be demonstrated with 115% (by weight) of the nominal output charge installed in each blade and both blades fired simultaneously.

3.6.22 Safety and Arming (S/A) Devices

The following requirements apply to S/A devices utilized in conjunction with ordnance functions on the Space Shuttle launch vehicle.

a. The ignition train within the device shall begin with two NSI-1s.

b. The ignition train will perform its desired function when one or both of the initiators are fired with the S/A device in the armed position.

c. The S/A device shall, by means of a mechanical barrier, prevent propagation of the ignition train when one or both of the initiators are fired with the S/A device in the safe position. The barrier shall rotate a minimum of 90° between the S&A positions.

d. The S/A device shall be capable of remote positioning from safe-to-arm and arm-to-safe through simplex command and control circuits and simplex actuation devices.

e. The S/A device shall provide remote simplex electrical position indication. The position indicator switches shall be attached to or directly actuated by the mechanical barrier.

f. The S/A device shall provide direct visual position indication in both the safed and armed positions. The armed indication will not be visible unless the device is in such a position that the ordnance train in it will propagate past the mechanical barrier.

g. A partially “armed” S/A device shall be capable of remote electrical arming and safing.

h. The S/A device shall incorporate a positive mechanical linkage to maintain the device in either full “armed” or “safed” position. Electrical arming and both electrical and mechanical safing shall be capable of overriding this mechanical linkage.

i. When installed through an RSRM bulkhead, the S/A device shall be provided with a mechanical lock pin which, when manually installed, will prevent rotation of the barrier. The pin may be installed while the device is in any position between full “safe” and full “arm” and will return the device from any position to the “safe” position without passing through the “arm” position. S/A devices which do not penetrate RSRM bulkheads do not require a lock pin but shall be provided with a means of being manually disconnected from the downstream pyrotechnic train and of being manually moved to the “safe” position.

j. The S/A device mechanical lock pin (when required) shall not be removable when the “arm” command circuit is energized, but can be removed after de-energizing.

k. The S/A device shall prevent manual arming.

l. The electric initiators or the entire S/A device shall be separable from the remainder of the ordnance train.

m. The S/A device shall be environmentally sealed so that the leak rate will not exceed 1.0 X 10-2 scc/sec of helium with a differential pressure of 15 psi.

n. The S/A device electrical power requirements and electrical connectors shall meet the requirements specified by the procuring agency.

3.7 LIFE AND AGE CONTROL

3.7.1 Design Life (Age Life)

3.7.1.1 Definition

The design life (also known as age life) is the life over which a pyrotechnic component is designed to perform its intended function.

3.7.1.2 Age Life

The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Testing (DLAT) is performed.

3.7.1.2.1 NSI and Solid Rocket Motor (SRM) SRM Ignition Initiator (SII) Age Life

The life of the NSI-1 and the SII shall be 10 years from the date of manufacture. Reference Paragraph 3.7.1.3 for age life extension testing requirements for the NSI and SII.

3.7.1.3 Age Life Testing

Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The method by which age

life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using Preflight Verification Testing (PVT) or lot acceptance procedures. Each age life test shall consist of a minimum of five units each. The tests shall be performed at specific intervals until the minimum design life of ten years is reached. The intervals shall commence with tests at four years, and shall be repeated at seven and ten years from the original component DLAT. For LSC, MDF, and LSC/MDF assemblies, the interval shall commence at four years, and shall be repeated seven and ten years from the original MDF or LSC cord acceptance test date. No four-year or seven-year age life testing is required for NSIs and SIIs. For extension of NSI and SII age life beyond ten years, Paragraph 3.7.1.3.4 applies.

3.7.1.3.1 Functional Testing of Samples from the Lot

The preferred method of performing age life testing is by functional testing of samples from the production lot. Lot samples shall be randomly chosen when practical. Each age life test shall consist of a minimum of five units each.

Deviation/Waiver 123 is applicable to Paragraph 3.7.1.3.1.
Refer to the Deviations/Waivers Section in front of the document.

3.7.1.3.1.1 Environmental Conditioning

Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable NASA design center.

3.7.1.3.2 Functional Testing of Recoverable Flight Units

Recoverable flight units are acceptable for age life samples.

3.7.1.3.3 Evaluation of Flight/Ground Performance

Flight/ground performance may be used for age life extension if no degradation of performance of a device can be verified:

SRB components - frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold

RSRM component - nozzle severance LSC

Ground components - bonnet thruster and hydrogen burn igniters

Pyrotechnic component flight/ground performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The

performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The responsible NASA design center shall identify, perform and evaluate any teardown and disassembly of the test articles.

3.7.1.3.4 Age Life Testing Beyond 10 Years

Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test.

3.7.1.3.5 Age Life Testing of LSC

Sub-length LSCs manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing.

3.7.1.3.6 Age Life Testing of Linear Charge Assemblies

Multiple production lots of linear charge assemblies (e.g., CDF assemblies, x-cord, etc.) whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots.

3.7.1.4 Certification

The age life shall be tracked from the date of the DLAT of the loaded component, except for the NSI/SII where the age life shall be tracked from the manufacturing date. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. In the case of components containing explosive cord, the age life shall be tracked from the date of the original explosive cord acceptance test. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

3.7.1.5 25-Year Life Age Life of Orbiter Pyrotechnic Components Containing HNS

The following Orbiter pyrotechnic components containing HNS are exempted from their 10-year age life and shall have a 25-year age life assigned. Age life extension tests shall be performed at 4, 7, and 15 years.

OVERHEAD WINDOW CREW ESCAPE

Pyrotechnic Device	Part Number
Through Bulkhead Initiator	MC325-0004-0003
Through Bulkhead Initiator	MC325-0004-0023
Flexible Confined Detonating Cord	MC325-0004-0128 through MC325-0004-0139
Flexible Confined Detonating Cord	MC325-0004-0141 through MC325-0004-0152
Shielded Mild Detonating Cord	MC325-0004-0728 through MC325-0004-0750
Shielded Mild Detonating Cord	MC325-0004-0763 through MC325-0004-0765
X-Cord Assembly	MC325-0027-0001
Expanding Tube Assembly (XTA)	MC325-0027-0003
Outer Window Severance Assy	MC325-0027-0005
Inner Window Severance Assy	MC325-0027-0006

SIDE HATCH CREW ESCAPE

Pyrotechnic Device	Part Number
Flexible Confined Detonating Cord	MC325-0004-2001 through MC325-0004-2011
Flexible Confined Detonating Cord	MC325-0004-2013
Shielded Mild Detonating Cord	MC325-0004-2050 through MC325-0004-2073
Shielded Mild Detonating Cord	MC325-0004-2075 through MC325-0004-2077
Shielded Mild Detonating Cord	MC325-0004-2079 through MC325-0004-2085
Shielded Mild Detonating Cord	MC325-0004-2088 through MC325-0004-2090
Through Bulkhead Initiator	MC325-0004-2092
Shielded Mild Detonating Cord	MC325-0004-2093
Shielded Mild Detonating Cord	MC325-0004-2095 through MC325-0004-2098
Shielded Mild Detonating Cord	MC325-0004-2099 through MC325-0004-2100
Collar Severance (XTA)	MC325-0040-0001 through MC325-0040-0002
Hinge Severance (LSC)	MC325-0043-0001 through MC325-0043-0002
Hinge Severance (LSC)	MC325-0043-0004 through MC325-0043-0005
Hinge Severance (LSC)	MC325-0043-0012
Vent Severance	MC325-0044-0001

3.8 ENVIRONMENTS

3.8.1 Mission Environments

Pyrotechnic devices and systems loaded with the nominal charge and without the redundant charge, if applicable, shall perform as specified for the particular device or system during and after exposure to any combination of the Shuttle flight environmental conditions for that device/system required by NSTS 07700, Volume X - Book 2, Flight and Ground System Specification, Environment Design, Weight and Performance, and Avionics Events, for the equivalent duration of the device or system age life.

3.8.1.1 Mission Cycles

Pyrotechnic devices not normally expended on each mission shall be exposed to repeated vibration, shock, humidity, and thermal cycling environments to qualify the device for repeated mission usages. These environments shall be consistent with the planned number of missions projected during the installed life of the device or for the planned remove and replace interval.

3.8.2 Natural and Induced Environments

Pyrotechnic devices shall be designed to withstand, without damage or impairment of performance, as a minimum, the environments in MIL-STD-810, Environmental Test Methods and Engineering Guidelines, required by the item specification.

3.8.3 Transportation Environments

Pyrotechnic devices shall be designed to permit their transportation in accordance with NHB 6000.1, Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment and Associated Components, or NPG 6000.1, Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment and Associated Components.

3.8.4 Unique Pyrotechnic Requirements

3.8.4.1 Drop Test

Pyrotechnic loaded devices shall be capable of being dropped from a height of six feet minimum without firing as a result of the drop. The device shall be fired after the drop and shall meet the DLAT firing performance characteristics unless obvious damage, which occurs during the drop, compromises the functional reliability of the device. Obvious damage is any condition which would be identified during normal pre-installation inspection.

NOTE: The RSRM S&A device is exempt from this requirement.

3.8.4.2 Forty-Foot Drop

Pyrotechnic loaded devices shall not create a safety or disposal hazard as a result of a drop from a height of 40 feet.

NOTE: The RSRM S&A device is exempt from this requirement.

3.8.4.3 Auto-Ignition

Explosive materials selected shall not auto ignite when subjected to 50 °F above the maximum expected thermal exposure for which the device is designed. The device shall be exposed to that temperature for a minimum of one hour. The device is not required to function afterwards. Devices loaded with PETN should not be tested higher than 275 °F regardless of the margin above the maximum expected thermal exposure.

3.8.4.4 Eighty-Five Percent Minimum Energy Test

Each pyrotechnically loaded device shall be capable of performing its function with 85% of the energy output expected from a device loaded with the minimum allowable charge weight. Because of the difficulty in downloading some devices to 85% of the minimum charge weight, increased thickness of target material or increased fracture area is the required method of meeting this requirement in those cases. Suggested methods of meeting this requirement for the following types of pyrotechnic devices are provided as a guide. Other methods are acceptable if adequate technical justification is provided. This requirement must be satisfied during qualification testing.

3.8.4.4.1 Linear Shaped Charge

Margin can be demonstrated by the severance of 115% of the thickness of the material to be severed in actual use or verification of a 15% penetration margin by the use of a suitable test target material. Material thickness of 115% or penetration margin of 15% is required.

3.8.4.4.2 Thru-Bulkhead Devices

Proper transfer across the bulkhead shall be demonstrated by loading the donor and acceptor charge by the force method only, using 85% of the minimum allowable explosive charge weight in each cavity.

3.8.4.4.3 Frangible Devices

3.8.4.4.3.1 Frangible Devices

A 15% margin shall be demonstrated in a manner dependent on the design of the device. Frangible devices shall be capable of the required performance with a production cartridge/charge. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. This test should be performed under the minimum allowable loading conditions that can exist at the time of functioning of the frangible device.

3.8.4.4.3.2 Frangible Nuts

The margin shall be demonstrated by firing a production cartridge in a nut having a separation cross section that is 115% of the maximum allowable cross section. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. The margin requirement shall be demonstrated on each production lot. This test should be performed under the minimum allowable flight loading conditions that can exist at the time of functioning of the frangible nut. The SRB/ASRB frangible nut (MLP hold down) shall demonstrate margin with a separation cross section that is 110% of the maximum allowable structural cross section.

3.8.4.4.4 Mild Detonating Fuse

When an MDF is used to fracture a structural element, this requirement may be demonstrated by downloading the MDF to 85% of the minimum allowable charge weight or by increasing the structural element to 115% of the maximum allowable size.

3.8.4.4.5 Pressure Actuated Devices

Pressure actuated devices must be capable of the required performance with a single cartridge loaded with 85% of the minimum allowable charge weight. If multiple cartridges are used to achieve redundancy, this requirement must be satisfied using a single 85% cartridge.

Deviation/Waiver 111 is applicable to Paragraph 3.8.4.4.5.
Refer to the Deviations/Waivers Section in front of the document.

3.8.4.4.6 Guillotines/Cutters

The performance margin shall be demonstrated by firing a guillotine/cutter with a cartridge/charge loaded to the minimum allowable weight in the device and cutting at least 115% of the target material, or by loading the cartridge/charge to 85% of the minimum allowable weight and cutting the maximum allowable target material.

3.8.4.4.7 Detonation/Energy Transfer Devices

Devices that have the sole function of transferring detonation/energy within a pyrotechnic system are exempt from this requirement. This exemption includes delay fuses and columns.

3.8.4.5 One Hundred Fifteen Percent Maximum Energy Test

Each pyrotechnically loaded device shall be capable of performing its function with 115% of the energy output expected from a device loaded with the maximum allowable charge weight. The following types of devices must meet this requirement without structural failure. This requirement must be satisfied during qualification testing. Devices should not be specifically fabricated to permit 115% overload if internal dimensions of the device do not permit overloading. Other suitable methods may be applied such as adding powder into the firing cavity, increasing the web thickness in frangible devices, or the thickness of the target plate for LSCs.

3.8.4.5.1 Thru-Bulkhead Devices

Proper transfer across the bulkhead must be demonstrated by loading the donor and acceptor charge by the force method only using 115% of the maximum allowable charge weight in each cavity. There shall be no leakage through the bulkhead after this test. The Thru-Bulkhead Initiator (TBI) bulkhead critical design dimensions shall not be altered to accommodate overloading of explosives (e.g., machining of a special device to permit accommodation of 115% load in donor or acceptor cavities). Other suitable methods of testing bulkhead strengths shall be applied (e.g., booster pellets or hydraulic pressure).

If leakage after firing will not compromise system performance or safety, this requirement is waived.

3.8.4.5.2 Pressure Actuated Devices

Pressure actuated devices must be capable of the required performance with a cartridge loaded with 115% of the maximum allowable charge weight. If multiple cartridges are used to achieve redundancy, this requirement must be satisfied with both cartridges loaded to 115% of the maximum allowable charge weight. The cartridges must be fired simultaneously during the performance of this test.

3.8.4.5.3 Mild Detonating Fuse

When an MDF is used to fracture a structural element and containment of the detonation products is a part of the design, this requirement must be satisfied. The MDF must be loaded with 115% of the maximum allowable charge weight for this test. The structural element and the containment method must be the minimum allowed by the design.

3.8.4.5.4 Detonation/Energy Transfer Devices

Devices that have the sole function of transferring detonation/energy within a pyrotechnic system are exempt from this requirement. This exemption includes delay fuses and columns.

3.9 TRACEABILITY AND IDENTIFICATION

3.9.1 Traceability

All pyrotechnic devices shall be traceable by lot (reference Paragraph 3.12.1) and serial number. Components and materials which are not susceptible to serialization, such as percussion primers, shall be traceable by lot.

3.9.2 Identification of Product

Pyrotechnic devices shall be durably and legibly marked in accordance with MIL-STD-130, Identification Marking of U.S. Military Property, where feasible. Shipper identification tags shall show all information required by the purchase order.

3.9.3 Lot Designators

Each lot of pyrotechnic devices shall be identified by a three-letter designator (e.g., AAA, AAB...) which shall not be repeated for any part numbers. Production lot designator shall not begin with the letters D, I, O, Q, U, X, and Z. The letters I, O, Q, and Z shall not occupy any lot designator position. The letters D and X are reserved for development and non-Shuttle hardware use. The letter U is reserved to designate qualification lot hardware.

3.9.4 Color Coding

Color coding of pyrotechnic devices shall be in accordance with the following requirements of JSCM 8080, Standard P-7.

a. All loaded devices procured for testing, not intended for flight, shall be color coded BLUE, at the supplier facility.

b. All inert (non-loaded) devices procured (not intended for flight) shall be color coded RED, at the supplier facility.

c. Any lot certified device subsequently found to be discrepant shall be submitted to the Material Review Board (MRB). If the board finds the device “not acceptable for flight”, the device shall be color coded BLUE by the inspecting agency and dispositioned in accordance with the MRB instructions. Information pertaining to all problem areas requiring MRB action and resulting MRB dispositions shall be transmitted to the cognizant NASA Project Office.

d. Flight operational units shall be the natural color of the body material (stainless steel, aluminum, etc.).

3.10 (DELETED)

3.11 WEIGHT

Each cartridge shall be weighed individually just prior to loading, weighed after the loading of each charge in the manufacturing sequence, and as a completed cartridge. Detail procedures to ensure that the specified charge weight is present in the completed pyrotechnic device shall be specified in manufacturing procedures approved by the appropriate NASA design center. Representative items such as insulation/isolation discs, spacers, and closures can be used in determining the appropriate tare weight. All incremental weights shall be recorded in the manufacturing records. Energy transfer devices (Confined Detonating Cord [CDC], CDF and MDF, etc.) are exempt from this requirement.

3.12 PRODUCTION LOT REQUIREMENTS

The requirements of this paragraph pertain to all lots beginning with the qualification lots of the various devices and assemblies and include all lots intended for manned flight use.

3.12.1 Production Lot

Each piece part, component, subassembly, or device shall be of the same design, construction, material heat or melt lot and heat treat lot fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. The single lot control requirements of nonexplosive components used in a lot of devices shall be determined, documented and approved by the cognizant Project Office. Factors such as component function in end item performance and effectiveness of destructive tests in screening defective components shall be considered in establishing single lot control requirements. Only one lot of each explosive or pyrotechnic material shall be used in a lot of explosively loaded components or devices. Only one lot of explosively loaded components, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

Deviations/Waivers 73 and 74 are applicable to Paragraph 3.12.1.
Refer to the Deviations/Waivers Section in front of the document.

3.12.2 Lot Size

Each lot shall be sized to include flight, flight spares, test article, age life samples and PVT parts for a selected number of vehicles, plus parts necessary for other uses when

required. Specific direction from the NASA Program Office is required for deviations from these sizing requirements with respect to quantity of PVT and flight spare units. In determining lot size consideration shall be given to:

a. Life of the part and component thereof in order to prevent life expiration prior to the last scheduled use of the lot.

b. Economic benefits of large quantity procurement.

c. Potential cost and schedule impact of a lot-associated failure.

3.12.3 Quantity Started

The number of units in a lot at the start of manufacture shall be limited to parts required for delivery (reference Paragraph 3.12.2) and attrition in manufacturing and acceptance testing. The lot shall not include extra units that are not required as part of the purchase order fulfilling the NASA requirement.

3.12.4 Extra Units

3.12.4.1 NASA ID Control

The NASA or element contractor part number and lot number identifying Space Shuttle units shall be removed from any units which the manufacturer sells or disposes of outside the NASA certification system. Original serial numbers may be retained.

3.12.4.2 Disposition of NSI-1

At the completion of lot acceptance of each lot of cartridge assemblies, the cartridge supplier shall account for, and dispose of, all NSI-1 received for the manufacture of that cartridge lot by one of the following methods:

a. Delivery to customer as an integral component of a cartridge assembly.

b. Return of acceptable parts to the NASA stock from which received (units surplus to the manufacturing operation).

c. Ship to NASA JSC, Attn: EP6 (units rejected or damaged or disassembled from cartridges).

3.13 CONTAMINATION CONTROL

Proper contamination requirements will be observed at all times. Particular care will be taken to assure that there is no contamination of explosive materials on the mating surfaces at the time of assembly. In all assembly operation involving explosively loaded

parts, positive protective measures shall be taken to assure that potentially degrading fluids, moisture, or other contaminants are not trapped and/or sealed into assemblies. To prevent contamination of the explosive material(s) with liquids, the supplier's applicable manufacturing procedures shall specify that each device shall be completely dry prior to sealing and that no liquids are to be utilized for cleaning or sealing preparation after installation of the explosive materials and prior to sealing. The procedures shall specify that the immediate area of explosive operations shall be free of such liquids as methanol, freon solvents, oils, and alcohol. In the event that spillage of explosive material necessitates cleaning of the loading area with liquids, all parts shall be removed from the area until cleaning is completed, the area is completely dry, and the liquids have been removed. If liquids are used to clean a loaded unit after sealing and prior to leak testing, any unit that fails leak testing shall not be reworked but shall be rejected.

3.14 (DELETED)

3.14.1 (Deleted)

4.0 VERIFICATION

This section delineates the activities (analyses and tests) to be performed in order to verify that the item to be developed or offered for acceptance conforms to the requirements of this specification. The verification requirements are categorized as development, acceptance, and qualification. Development includes those activities required to support the design process. Acceptance assures the quality of the deliverable product. Qualification results in assurance that the design will satisfy all specified design requirements. Data from development and acceptance test programs may be used to support qualification requirements provided that appropriate test rigor is applied. Analysis includes appraisal of design features (e.g., transportability, parts standardization) that do not require tests.

4.1 GENERAL REQUIREMENTS

The supplier shall use the following general requirements in developing a certification program. Each performance and design requirement specified herein shall be verified by test or analysis. The general philosophy of the testing programs should focus on establishing performance capabilities in the presence of critical material properties and dimensional extremes within specification limits. Performance of certification tests using nominal materials, dimensions, and processes has not proven adequate for pyrotechnic systems.

4.1.1 Development Testing

Testing performed with minimum rigors and controls to verify a design approach. Development tests should incorporate variations in critical dimensions and properties to probe the expected limits allowable by the appropriate specifications.

4.1.2 Qualification Tests

Qualification tests shall be structured to verify the full range of the design requirements under specified environments as required by Paragraph 3.8.1.

4.1.2.1 Redundancy in Design

Where redundancy in design exists, each redundant mode shall be verified during qualification.

4.1.2.2 Acceptance Testing of Qualification Specimens

All qualification test specimens shall be processed through specific nondestructive lot acceptance testing prior to qualification test.

4.1.3 Off-Limit Testing

Testing performed that is not a component or system design or certification requirement, as defined by the applicable specification, is considered off-limits. Off-limits testing when performed should be included in the development tests and not a part of the qualification requirements. Margin demonstration tests, that are included in the certification requirements, are not considered off-limits.

4.2 DEVELOPMENT TESTS

Development tests encompass standard laboratory tests to support material selection and engineering evaluations of hardware for the purpose of acquiring a data base to establish confidence that the hardware will meet specification requirements. Those tests used to satisfy a qualification requirement must meet the following criteria:

Predeclaration	The intent to use the test for certification is declared prior to conducting the test.
Configuration	Production configuration or approval (where allowed) for differences.
Facilities	Certified
Inspection	Required
Test requirement/ procedure/pass-fail criteria	Formally approved
Acceptance, prefunctional and postfunctional test	Required
Documentation	Submittal of configuration description, failure reports, and test methods and results.

4.3 ACCEPTANCE

The acceptance requirements shall be satisfied by test or analysis. Acceptance tests shall be performed on all units presented for certification and destructive lot acceptance units that support the certification. The acceptance requirements shall be documented and a test procedure approved prior to testing.

4.4 QUALIFICATION

Qualification requirements must be individually defined for each component or assembly considering its function, complexity, redundancy, design, and maintenance requirements. These requirements can be satisfied by test or analysis.

4.4.1 Qualification by Tests

Testing is the basic method to be used in the qualification of flight hardware and Ground Support Equipment (GSE). Such tests shall be used to determine that the hardware is capable of performing its required operational functions in the known or anticipated environmental conditions. These tests will be designed to subject samples of the hardware to the worst case environments and stresses anticipated. Hardware requiring qualification by test, which is produced to identical design requirements by several manufacturing sources, shall be qualified, by test, for each source. Those environmental tests or stress conditions that would not be affected by a new vendor's process or procedure need not be repeated by test.

4.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration and manufactured under the same production process as the flight hardware, unless differences are adequately documented and are judged to be acceptable by the certifying agency. The qualification hardware must come from a single lot.

4.4.1.2 Test Sequences and Environments

Environments and test sequences shall be considered by each element contractor and identified in a test plan and shall be subject to approval by the NASA Project Office associated with the procurement. Testing shall include both natural and induced environments anticipated during the operational cycles. Combined environments shall be used when necessary and practical. Every natural and induced environment which may be imposed during a hardware item's operational life and which can detrimentally affect the item's performance, strength, or life shall be included in the test program.

4.4.1.3 Qualification Tests Unique to Pyrotechnics

4.4.1.3.1 Mission Cycle Life Testing

Pyrotechnic devices not normally expended on each mission shall be qualified to appropriate multiple mission environments which represent the number of mission cycles expected prior to hardware change out and replacement as specified in Paragraph 3.8.1. The number of cycles performed shall be consistent in quantity and magnitude with the projected environmental excursions expected for the duration of hardware installation.

4.4.1.3.2 Drop Test

Pyrotechnic loaded devices shall be capable of being dropped from a height of six feet minimum plus six inches minus zero upon a steel plate (1/2 inch minimum) without firing as a result of the drop. The device shall meet the performance requirements described in Paragraph 3.8.4.1. A minimum of three test samples shall be dropped. One unit each will be dropped in each of the three mutually perpendicular axes.

4.4.1.3.3 Forty-Foot Drop Test

When this test is specified for a device by the Element Project Office, a single test specimen shall be dropped from a height of 40 feet plus six, minus zero inches. The impact surface shall be a steel plate (minimum thickness of three inches) backed up by a minimum of 24 inches of reinforced concrete. The impact orientation of the test specimen with the plate shall be within 10° of that which is determined (by analysis) to be the most sensitive. Reference MIL-STD-331, Fuze and Fuze Components, Environmental and Performance Test for.

4.4.1.3.4 Auto-Ignition Test

Auto-ignition tests are to be performed to a temperature level 50° F minimum above the maximum expected temperature of the pyrotechnic device in question. Temperature rise rate of the test article and dwell time at maximum temperature shall be derived from the expected exposure cycles of the pyrotechnic device in question. The auto-ignition test temperature for PETN loaded devices shall be limited to 275° F maximum.

4.4.1.3.5 Eighty-Five Percent Minimum Energy Test

The device shall be functioned in accordance with the requirements of Paragraph 3.8.4.4. Where multiple explosive components exist within a device, all components must be downloaded simultaneously.

EXCEPTIONS:

a. Use of Hinge Severance Assembly (P/Ns MC 325-0043-0001, -0002, -0004 and -0005, L/N WAA) without having met the requirements of the 85% minimum energy test, is allowable for STS-31 and STS-35 and subs.

b. The NSI and NASA Standard Detonator (NSD).

4.4.1.3.6 One-Hundred Fifteen Percent Maximum Energy Test

The device shall be functioned in accordance with the requirements of Paragraph 3.8.4.5. Where multiple explosive components exist within a device, each component must be uploaded simultaneously. The NSI and NSD are exempt from this requirement.

4.4.2 Qualification by Similarity

Qualification by similarity is acceptable provided all following conditions are met:

a. Engineering evaluation reveals that design differences between the item being qualified and the previously qualified similar item are acceptable and will have no deleterious effect on integrity and performance.

b. The previously qualified similar item was designed and qualified for equal or higher environmental stress levels and time durations than those known or anticipated for the item being qualified.

c. The item being qualified was fabricated by the same manufacturer as the similar item using the same processes, materials, and quality control methods.

d. Documentation is provided which assures that qualification by similarity is adequate. The submitted documentation should include as a minimum, the test specification/test procedure/test report of the item to which similarity is claimed, a description of the differences between the items and the rationale for qualification by similarity.

4.4.3 Qualification by Analysis

Qualification by analysis is limited to those situations in which it is not feasible or cost effective to qualify by other methods. Such analysis shall be documented to an extent sufficient to provide for an independent evaluation of the results of the analysis. Analysis may be used for those requirements for an alternate source vendor when testing is not required by Paragraph 4.4.1

4.5 LOT ACCEPTANCE AND LOT CERTIFICATION

This activity pertains to the acceptance testing and flight certification of individual production lots of pyrotechnic devices.

4.5.1 General

Acceptance tests shall be performed on each lot of pyrotechnic devices.

4.5.1.1 Test Plans and Procedures

All acceptance testing shall be performed in accordance with approved detailed test plans and procedures. Specific acceptance and rejection criteria, as well as details of test fixtures, equipment, instrumentation, and other matters adequate to permit duplication of testing by other facilities, such as the launch site, shall be included.

Deviation/Waiver 100 is applicable to Paragraph 4.5.1.1. Refer to the Deviations/Waivers Section in front of the document.

4.5.1.2 Radiography

Neutron radiography (N-ray) and X-radiography (X-ray) shall be considered for use in acceptance of all pyrotechnic devices. Since they are generally supplementary to each other, both techniques shall be used where practical and useful. Mandatory radiography for loaded devices are specified in Paragraphs 4.5.2.4 and 4.5.3.2.

4.5.1.3 Examination of Product

Each end item assembly shall be examined and the subassembly/component manufacturing records shall be reviewed to verify that the materials, explosive charges, design, construction, dimensions, workmanship, and marking comply with the requirements of drawings and this and other applicable specifications. Parts having defects usually shall be rejected on an individual basis.

4.5.1.4 DLAT Sample Size

The number of parts to be destructively tested from variously sized lots of pyrotechnic devices shall be as follows:

a. Loaded pyrotechnic devices which contain an integral pyrotechnic charge. The number of parts to be fired in DLAT shall be 10% of the lot or 10 units minimum whichever is greater. Lot size equals the final number of units which are presented for formal lot acceptance. Fractional sample sizes 0.5 and above shall be rounded upward and sizes below 0.5 shall be rounded downward.

b. Inert pyrotechnic devices which do not contain an explosive component but are functioned by a separable cartridge. The number of parts to be fired from various lots of inert pyrotechnic devices shall be established by the project office based on the criteria in Paragraph 4.5.1.5

4.5.1.5 Acceptance Tests for Inert Pyrotechnic Devices

Each unit of the lot shall be subjected to a proof load test and a minimum of two units shall be subjected to an ultimate load test. For SRB inert pyrotechnic devices, the proof load requirement applies only to the forward and aft separation bolts and the holddown frangible nut. Additional acceptance tests for inert pyrotechnic devices may be accomplished by one of the following methods:

a. Devices that can be functionally verified by the application of pneumatic pressure at an appropriate level of assembly or when completed may be accepted as a lot without a pyrotechnic DLAT firing. This approach requires that each unit in the lot function at an acceptable pressure and then be reassembled

maintaining the components as a set. Components that are normally degraded during the functioning must be replaced. If other components are degraded the pressure test must be repeated. These tests may be performed at an appropriate level of assembly.

b. Devices that cannot be functionally verified as specified in Subparagraph a. because the unit would be destroyed must be accepted by pyrotechnic DLAT firings. The DLAT sample size shall not be less than two units.

c. Frangible devices shall be accepted by a minimum of five pyrotechnic DLAT firings. These firings shall demonstrate the required performance margin in a manner dependent on the design of the device. Frangible nuts shall demonstrate the required performance margin with a single production cartridge/charge if dual cartridges/charges are used. The cartridges used to activate these frangible devices shall have met the acceptance requirements of Paragraph 4.5.1.4.

4.5.1.6 Current/Time to Peak Performance Measurements

The data obtained in each destructive test for pressure generating cartridges shall have actual firing current and output pressure versus time recorded.

4.5.1.7 Detonation Performance Measurements

Detonating cartridges shall utilize a dent block acceptance criteria as delineated in MIL-STD-331. Detonating cord shall utilize pass/fail criteria delineated in the respective procurement specification such as detonation velocity, target material thickness, swell cap expansion, explosive jet penetration, etc.

4.5.1.8 Environmental Testing

Appropriate environmental acceptance testing shall be considered for each pyrotechnic device, either as a nondestructive test on the entire lot or as conditioning on the destructive test samples only.

4.5.1.9 Test Equipment, Setup, and Procedures

A detailed acceptance test procedure shall be prepared for each pyrotechnic device. This procedure shall cover the details of both nondestructive and destructive testing. All test fixtures and equipment required to perform acceptance testing shall be identified and detailed instructions for the use of all equipment shall be included. Redundant instrumentation shall be used to minimize loss of data. Specific accept/reject criteria shall be established for each required test. Examples of all forms required for documentation of test results shall be included. JSCM 8080, Standard G-18 is applicable.

4.5.2 Cartridge, Booster, Detonators, Initiators, Etc., Acceptance Tests

Prior to delivery and as a condition of acceptance the supplier shall conduct nondestructive tests on each device submitted for lot acceptance and destructive tests on a random sample of the lot (reference Paragraph 4.5.1.4) as specified in the table below. Acceptance tests need not be limited to those listed below:

ACCEPTANCE TESTS

Test	Applicable Paragraph
Examination of Product	4.5.2.2
Leakage Test	4.5.2.3
Radiography Test	4.5.2.4
Verification of NSI-1 Characteristics	4.5.2.5
Insulation Resistance (@50 VDC)	4.5.2.5.3
Destructive Performance Tests	4.5.2.6

Sequence of testing shall be specified by the element contractor except that the firing of the lot sample shall be conducted last and all units of this sample shall have undergone all other tests prior to firing.

4.5.2.1 General

Any cartridge found to be defective in any nondestructive test shall be rejected. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2. Detonating cartridges shall be fired with a test indentation fixture in accordance with MIL-STD-331. Neither the device nor the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

Deviation/Waiver 101 is applicable to Paragraph 4.5.2.1.
Refer to the Deviations/Waivers Section in front of the document.

4.5.2.2 Verification of Explosive Weight

In addition to the requirements of Paragraph 4.5.1.3, a weight verification shall be performed on each device per Paragraph 3.11. Verify the device weight and include the manufacturing weight records in the data package.

4.5.2.3 Leakage Tests

4.5.2.3.1 Helium Test

The indicated leak rate for loaded, hermetically sealed pyrotechnic device shall not be greater than 1 X 10 E-6 cc/second of helium when measured at one atmosphere differential pressure at laboratory ambient temperature. Testing shall be in accordance with MIL-STD-202, Test Methods for Electronic and Electrical Component Parts, Method 112, Seal, or a procedure approved by the the procuring agency/center. Environmental (dust) seals are exempt from this requirement.

4.5.2.3.2 Gross Leak Test

A visual inspection shall serve to reject defective units which could have a gross leak. Visually inspect each unit prior to performing the helium leak test (reference Paragraph 4.5.2.3.1) using a 10 X minimum magnification. Cracks, inclusions or voids shall be cause for rejection.

4.5.2.4 Radiography

4.5.2.4.1 X-Ray Test

When specified in the procurement specification, all devices shall be X-rayed in accordance with MIL-STD-453, Inspection, Radiographic, or ASTM E1742, Standard Practice for Radiographic Examination, to verify compliance to the assembly drawing, to determine that there are no missing or improperly oriented details and to verify that there are no foreign objects or materials present. The views shall be perpendicular to the longitudinal axis, and the number of views shall be the minimum number required to obtain the necessary required information. Two negatives shall be made of each view. The procuring agency shall establish the requirement for retention of radiographs.

4.5.2.4.2 N-Ray Test

When specified in the procurement specification, each device shall be subjected to N-ray examination in one view in accordance with JSC 20431, NASA JSC Neutron Radiography Specification, to verify that the pyrotechnic mixture is present and properly oriented in accordance with the applicable assembly drawing. Also, there shall be no missing or improperly oriented details and no foreign objects or materials present. The procuring agency shall establish the requirement for radiographic copies and who should retain a permanent file for the original copy. When external finishes, adhesives, potting materials, etc., would reduce the resolution of the N-ray negative, the radiograph shall be made prior to the application of such materials. Devices loaded with loose powder shall be N-rayed in an attitude which reveals column height.

4.5.2.5 Verification NSI-1 Characteristics

4.5.2.5.1 Bridgewire Resistance Test

The bridgewire resistance of the NSI-1 in each cartridge shall be measured and recorded. The measured resistance shall be 1.05 (plus or minus 0.10) ohms at laboratory ambient temperature. Test current shall be limited to 0.02 ampere for a maximum of one minute. The applied voltage shall not exceed 1.0 volt when the measuring circuit is terminated in an open circuit.

4.5.2.5.2 Staking Verification

Verify acceptance data pack contains documentary evidence that the NSI-1 installed in the device is the correct configuration (dash number) for the type of device being delivered. The NSI-1 dash number is controlled in the baseline documentation for the device. The dash number is electroetched on the flange of each NSI-1.

4.5.2.5.3 IR Tests

NSI-1 IR tests shall be performed on the DLAT sample at 250 VDC using a megohmmeter. The measured value shall be 2.0 megohms minimum and any part failing this test shall be rejected and a replacement part shall be selected for the DLAT sample. IR tests on other cartridges in the lot shall be performed at 50 VDC maximum.

4.5.2.5.4 NSI-1 Lot Certification Verification

The flight certification of all NSI-1 used in the cartridge lot shall be verified by reference to the parts and serial numbers listed in the appropriate NSI-1 lot certificate supplied for the NSI-1 lot(s).

4.5.2.6 Destructive Performance Test

4.5.2.6.1 General

The firing stimulus to the NSI-1 shall be applied by the Standard Firing Unit (SFU) (Rockwell International P/N C77-0833), Initiator Firing Unit (IFU) (NASA P/N SED26100128-301), Pyrotechnic Initiator Controller (PIC) (Model GSE-01) or Constant Current Pulse Generator (E & R Development Company Model PS-11). The firing mode shall be that which will be experienced in flight; i.e., capacitor discharge or constant current. In the constant current mode the SFU or PS-11 Constant Current Generator shall be set at 5 amperes and in the capacitor discharge mode the SFU shall be set at 30 volts. The PIC and IFU may be used for capacitor discharge firing and will

provide an output from a 680 μf capacitor charged to approximately 40 VDC. For cartridges which are intended to be fired in flight in either mode, the acceptance sample shall be appropriately divided and part fired in each mode. The pressure/time trace for each firing shall be recorded using a NASA approved and calibrated data system.

4.5.2.6.2 Test Bomb Configuration Control

Detail drawings of test bombs shall be prepared and shall be approved by the element contractor and NASA review team representatives. The actual bomb shall be inspected and stamped to assure complete compliance with drawing requirements. Each bomb shall be permanently identified with part number and serial number. Before and after each series of tests, such as acceptance or qualification, the volume shall be measured and compared with the original volume. The allowable maximum volume shall be established for each bomb and the bomb shall be replaced or reworked, if appropriate, when this limit is exceeded. The bomb shall be cleaned and visually inspected after each firing. The data shall indicate the part, serial number, and actual volume of the bomb used.

CAUTION: Preservatives, water and cleaning solvents may influence the output pressure in closed bomb tests if not removed properly.

4.5.2.6.3 Cartridge Ports

The cartridge ports in test bombs shall duplicate the ports used in the specific Shuttle application.

4.5.2.6.4 Pressure Transducers

Each test bomb shall utilize a minimum of two pressure transducers and they shall be standardized to the greatest extent possible to minimize inventory requirements at the contractor, suppliers, and launch sites. The test bomb transducer ports shall be in accordance with the transducer manufacturer's recommendations and completely defined on the test bomb drawing. The installation requirements for the transducer shall be described in detail in the applicable test procedure.

4.5.2.7 Cartridge Body Proof Pressure

Verify requirements that were established in Paragraph 3.6.18.1a.

4.5.3 Explosive Trains Acceptance Tests

Explosive trains (LSC, CDF, MDF, CDC, Shielded Mild Detonating Cord [SMDC], Flexible Confined Detonating Cord [FCDC]), assemblies, and charge holders.

4.5.3.1 General

The provisions of Paragraph 4.5.1.3 shall be applicable to these assemblies and components. Additional acceptance tests shall be performed at the levels of assembly shown below:

CDF/MDF/FCDC/SMDC

Nondestructive Tests	Core Charge	Explosive Train Assy Level
X-ray	Yes	Yes
N-ray	No	Yes

Destructive Tests	Core Charge	Explosive Train Assy Level
Core Weight	Yes	No
Bending	Yes	No
Detonation Velocity	Yes	No
Performance	No	Yes
Initiation	No	Yes

LSC

Nondestructive Tests	Core Charge	Explosive Train Assy Level
X-ray	Yes	Optional
N-ray	No	Optional

Destructive Tests	Core Charge	Explosive Train Assy Level
Core Weight	Yes	No
Detonation Velocity	Yes	No
Penetration	Yes	Yes
Performance	Yes	Yes
Initiation	No	Yes

4.5.3.2 Radiography

4.5.3.2.1 X-Ray Tests

When specified, all explosive train and charge holder assemblies shall be X-rayed in accordance with MIL-STD-453 or ASTM E1742 to verify compliance with the assembly drawing, to determine that there are no missing or improperly oriented details and to assure that there are no included foreign objects, materials, or unacceptable voids. Each train and charge holder assembly shall be radiographed in at least one view perpendicular to the longitudinal axis and two negatives shall be made of this view. The

procuring agency shall establish the requirement for radiographic copies and who should retain a permanent file for the original copy.

4.5.3.2.2 Neutron Radiographic Test

All explosive trains except as specified in Paragraph 4.5.3.1, shall be examined by N-ray per JSC 20431 to verify that the pyrotechnic charge components are present and properly oriented in accordance with the applicable drawings. Also, there shall be no missing or improperly oriented details, and no included foreign objects, materials, or unacceptable voids. Each train shall be radiographed in one view along the longitudinal axis. The procuring agency should establish the requirement for radiographic copies and who should retain a permanent file for the original copy. When external finishes, adhesive potting materials, etc., would reduce the resolution of the radiograph, the radiograph shall be made prior to the application of these materials.

4.5.3.3 Core Charges (MDF, CDF, CDC and LSC)

As a minimum, core charges shall be tested as specified herein.

4.5.3.3.1 Core Weight

Test samples shall be cut from each tube of detonating cord. Each sample shall be a three-inch minimum length. For core weights 250 grains per foot or larger, one-inch minimum samples shall be taken instead of three-inch samples. Samples shall be from each end of each tube and at other specified intervals. Maximum intervals of 30 feet are preferred, providing the manufacturing lengths permit. Each manufacturing length shall have core weight samples taken from both ends.

LSC/cord core weight samples exceeding the tolerance identified in the end item procurement specification shall result in rejection of either the LSC/cord 100 feet minimum on either side of the failed sample or a manufacturing length on either side of the failed sample, whichever is less.

4.5.3.3.2 Bending

When the application includes bends, bend tests shall be performed as a part of qualification and lot acceptance. Test samples shall be cut from each tube of detonating cord. Each test sample shall be 15 inches minimum length. One sample shall be from each end of each production run and at other specified intervals. Maximum intervals of 30 feet are preferred. A bend radius of five cord diameters or less, measured to the center of the cord, constitutes a bend. These tests shall be performed prior to determining the detonation velocity in accordance with Paragraph 4.5.3.3.3.

4.5.3.3.3 Detonation Velocity

The detonation velocity shall be measured with an electronic time-interval meter or similar equipment. The detonation velocity shall be established for each component that

uses HNS, RDX, HMX, or PETN. The established detonation velocity shall have a tolerance sufficient to detect unacceptable performance. When a lot of CDC, CDF, MDF, or LSC contains multiple tubes, only the tube from which the failed detonation velocity sample is taken shall be rejected. The number and location of detonation velocity samples required for a lot of CDC, CDF, MDF, or LSC shall be established by the responsible NASA design center.

Deviation/Waiver 72 is applicable to Paragraph 4.5.3.3.3.
Refer to the Deviations/Waivers Section in front of the document.

4.6 THREAD INTERCHANGEABILITY REVIEW COMMITTEE

A NASA representative from MSFC and JSC, appointed by the Chair, Shuttle Pyrotechnic Working Group (SPWG), shall review each pyrotechnic device for thread interchangeability. An engineering drawing, showing thread form and size, shall be submitted to the Chair, SPWG, for each new threaded pyrotechnic device. This review shall be completed prior to the Critical Design Review (reference Paragraph 5.1).

4.6.1 Thread Sizes for Pyrotechnic Devices Used on the Space Shuttle Program (SSP), MSFC

SRB/ARSB COMPONENTS

Part Name	Part Number	Thread Size	
CDF Assembly	10314-0001-XXX	5/8-18UNF-3B	
CDF Manifold	10312-0001-XXX	5/8-18UNF-3A	9/16-18UNF-3B R&L
CDF Pressure Cartridge	10319-000X-XXX	9/16-18UNF-3A	5/8-18UNF-3A
CDF Initiator	10308-000X-XXX	9/16-18UNF-3A	5/8-18UNF-3A
RSS S&A Device	10311-0001-XXX	9/16-18UNF-3A	5/8-18UNF-3B
(3 1/2) Frangible Nut Booster Cartridge	10307-0001-XXX	7/8-14UNF-3A	9/16-18UNF-3B
(3 1/2") Frangible Nut	10306-0001-XXX	7/8-14UNF-3B	3.50-8
	(N-Butt modified per HDBK H-28, Part III, 1969)		
NSI Pressure Cartridge	10303-0001-XXX	1.875-12UNJ-3A	
Forward Separation Bolt	10301-0001-XXX	3.4575-12UNFS-3A	1.875-12UNJ-3B
Aft Separation Bolt	10302-0001-XXX	4.75-6UNJS-3A	1.875-12UNJ-3B
Nose Cap Thruster	10304-0001-XXX	1/2-20UNJF-3B	1.312-12UNJ-3B
Nose Cap Thruster Pressure Cartridge	10305-0001-XXX	5/8-18UNF-3A	1.312-12UNJ-3A
Frustum Separation Assy	10310-000X-XXX	5/8-18UNF-3A	
Parachute Release Nut	10309-00XX-XXX	9/16-18UNF-3B	1.25-12UNJF-3B
SRB Destruct System	10313-000X-XXX	5/8-18UNJF-3A	
CDF/CDF Connectors	10183-0010-XXX	9/16-18UNF-3B	
NSD/CDF Connector Block	10183-0008-XXX	9/16-18UNF-3B	5/8-18UNF-3A
RSRM S&A Device	1U52295-0X	3/8-24UNJF-3B	
RSRM Nozzle Severance Ring Segment	1U52700-0X	9/16-18UNF-2B	

EXTERNAL TANK COMPONENTS

Part Name	Part Number	Thread Size
CDF Assembly	10315-000X-XXX	5/8-18UNF-3B
Separation Bolt, Disconnect	PD5000020-0XX	3/8-24UNJF-3A Umbilical
External Tank, Destruct System	PD5000016-0XX	5/8-18UNJF-3A
Tumble Valve Pressure, Cartridge	PD5000011-00X	9/16-18UNJF-3A

4.6.2 Thread Sizes for Pyrotechnic Devices Used on the SSP, JSC

ORBITER

Part Name	Part Number	Thread Size
Main Landing Gear Pressure Cartridge	SKD26100102-301	1.625-12UNJ-3A
RMS Retractor Pressure Cartridge	SKD26100104-301	.4375-20UNJF-3A
Drag Chute Mortar Pressure Cartridge	SKD26100138-301	2.000-16UNJ-3A
Drag Chute Retractor Pressure Cartridge	SKD26100134-201	.8125-16-UNJ-3A
Common Cartridge	SKD26100105-301	.6250-18UNJF-3A
Nose Gear Extension Thruster Pressure Cartridge	SKD26100100-301	1.0000-12UNJF-3A
Nose Gear Emergency Uplock Release Pressure Cartridge	SKD26100101-301	1.000-16UNJ-3A
NASA Standard Detonator	SEB26100094-201RH	.5625-18UNF-3A-RH
NASA Standard Detonator	SEB26100094-202LH	.5625-18UNF-3A-LH
NASA Standard Initiator	SEB26100001	.3750-24UNJF-3A
Hazardous Gas Sampler Pressure Cartridge	SKD26100112-201	.5625-18UNJF-3A
(2 1/2 ” Nut) Detonator Booster	SKD26100099-401	.8750-9UNJC-3A
Shear Bolt Pressure Cartridge	SKD26100098-301	1.125-12UNJF-3A
Side Hatch Thruster Pressure Cartridge	SKD26100123-201	1.625-18UNEF-3A
SPDS Thruster Cartridge	SKD26100131-401	.5000-20UNJF-3A
RSRM Initiator	SED26100107-301	.3750-24-UNJF-3A
RSRM Initiator	SED26100107-302	.3750-24-UNJF-3A

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5.0 CONFIGURATION AND PROCESS CONTROL

Element contractors shall establish and maintain effective and detailed control of the configuration, manufacturing processes, materials, QA, acceptance, and qualification of all pyrotechnic devices used in the Shuttle vehicle. This responsibility shall not be delegated. For new devices and for those devices carried over from other programs which require requalification, the control baseline shall be the first production lot acquired for Shuttle use. Control of the baseline and all changes thereto shall be maintained as long as the device is used in the SSP, and shall include all contractor/subcontractor/supplier documents, equipment, facilities, instrumentation, etc., related to the design, manufacturing, acceptance, and qualification of the device. QA shall satisfy the provisions of NSTS 5300.4(1D-2) or NHB 5300.4(1C), as appropriate. The control baselines and all changes thereto shall require approval of the NASA project offices, and shall be implemented through a system of reviews as described below. Inert hardware intended for mockup, fit check, or training use does not require phase reviews.

5.1 REVIEWS

A Phase I Baseline Review shall be conducted for each device to establish the control baseline. A Phase II Production Review shall be held for each production lot of each device except as indicated in Paragraph 5.3. A Phase III Lot Acceptance/Certification Review shall be conducted on each lot of qualified pyrotechnic devices prior to shipment from the supplier. Each review shall be conducted by a team representing engineering, QA, and, when appropriate, Reliability organizations of the element contractor and the NASA Project Office. Representatives of the integrating contractor shall be included at the discretion of the NASA Project Office. Each review shall include documents, equipment, facilities, etc., necessary to establish the baseline, control changes, or acceptance, as appropriate.

5.2 PHASE I, BASELINE REVIEWS

A Phase I Baseline Review shall be conducted for each device to be used in the SSP. For new devices and those devices from other programs which require qualification for Shuttle use, the review shall precede the start of manufacture of the qualification lot or the first Shuttle lot for carry over devices. The review items shall include, but not be limited to, all drawings (devices, bombs, fixtures, tools, and packaging), specifications (procurement, special process, materials, etc.), procedures (acceptance, and quality plan), instructions (manufacturing and processing), parts list, development test program data for new devices and the qualification test data/history for carry over devices. The Phase I Review shall result in authorization to proceed with the manufacturing of piece parts following closeout of open review items. The authorization to proceed with device assembly shall be approved by the Phase II Production Review (reference Paragraph 5.3) as follows:

a. Prior to loading of explosive loaded components/devices.

b. Prior to assembly of non-loaded components/devices which use separate components/devices containing the operating charge.

5.2.1 Control Documentation

Following the Phase I Baseline Review, the element contractor shall establish a record set of all approved documents related to the device. This set shall be updated after each Phase II Production Review and shall consist of the following:

a. One copy of each document comprising the baseline.

b. One copy of each revision/change to each document annotated to show the lot effectivity of the change/revision.

c. One copy of the minutes of each production review, including action/open items and their closeout documentation, and one copy of all production review waivers.

d. A lot effectivity matrix of all changes/revisions to all documents.

e. A reference listing of all qualification reports, failure/anomaly reports and their corrective actions.

f. Other material or listings appropriate for a complete history of the device as it may affect Shuttle use.

g. Acceptance test procedures.

These documents shall be maintained in the record set or otherwise be readily available for a minimum of 10 years.

5.2.2 List of Controlling Documents

Each element contractor shall publish a single, comprehensive document listing all controlling documents in the record set for each device. The information for each listed document shall include the issuing organization, document number and title, current revision and date, and the lot effectivity history of each document listed. Pages shall be revised when a listed document is changed or deleted, or when a new controlled document is added.

5.3 PHASE II, PRODUCTION REVIEWS

A Phase II Production Review shall be conducted prior to the start of manufacture of each production lot of each device. The review shall assure adequate evaluation and

control of all proposed changes to the baseline and/or last production lot, including the potential effect of the changes upon the qualification status of the device. If required, delta qualification tests shall be defined. The review shall also consider any proposed personnel changes and the current certification of personnel. If there is an interval of less than one year between the acceptance of the last lot and the start of manufacture of the next lot of the same device, and where the last and new lots will be identical in all respects including manufacturing, acceptance and QA, a production review for the lot is not required.

5.3.1 Manufacturing

Production lot manufacture shall be constrained by the closeout of open items as required by Paragraphs 5.2. and 5.3.

5.4 PHASE III, LOT ACCEPTANCE/CERTIFICATE REVIEWS

The Phase III Lot Acceptance/Certificate Review will be conducted prior to issuing a lot certificate, as described in Paragraph 5.4.3. A Phase III Review Team shall consist of NASA and element contractor, if applicable, engineering and SR&QA personnel who have detailed knowledge of the specific device. The STS Project Offices shall be allowed to delegate the performance of the Phase I, II, III reviews to contractor personnel. NASA direct-support contractor personnel may serve as Phase III Review Team members, in lieu of the NASA team members, if so delegated by cognizant NASA personnel. The RSRM ignition S&A device may be certified after delivery to KSC.

Procedure for delegation of authority in the acceptance/certification of flight pyrotechnic devices:

a. Prepare detailed pyrotechnic device agenda for each pyrotechnic device or lot as applicable. This agenda will contain as a minimum the following:

    1. A comparison of baseline record with supplier drawing package, specifications, procedures, and instructions to assure compliance.

    2. A comparison of as-built configuration with verified baseline.

    3. A comparison of supplier drawing and purchase order configuration and requirements to receiving inspection records and certification to assure compliance.

    4. A procedure for the identification and resolution of failures, nonconformances, discrepancies, and anomalies.

    5. A verification of the non-destructive and destructive test requirements based on acceptance test and/or qualification test procedures.

    6. Specify the Acceptance Data Package requirements.

b. Establish a Pyrotechnic Acceptance Team as required to support the reviews of flight pyrotechnic devices. This team will include membership, with alternates, from both engineering and QA disciplines who have detailed technical knowledge of the specific devices under review.

c. Provide copies of the pyrotechnic device agenda to the SPWG for review.

5.4.1 Lot Acceptance Data Information

The supplier shall make the following data, as a minimum, available for review by the Phase III review team.

a. Operational/manufacturing records (travelers).

b. Purchase orders.

c. Rework information/inspection records.

d. Operating time logs.

e. Element contractor specifications and drawings.

f. Subcontractor specifications and drawings including tooling and test fixtures.

g. Approved change notices, engineering orders, etc., pertaining to drawings and specifications.

h. Drawings of the pyrotechnic device and test fixtures, as required.

i. Element contractor/subcontractor acceptance test procedures and test records.

j. One set of radiographs, as applicable.

k. Comparison of the baseline qualified configuration to the as-built configuration.

l. Any other information the Phase III Review Team may wish to use for the assessment of the quality and reliability of each pyrotechnic device.

Deviation/Waiver 71 is applicable to Paragraph 5.4.1.
Refer to the Deviations/Waivers Section in front of the document

5.4.2 Lot Acceptance Data Package

The Lot Acceptance Data Package shall be submitted to the element contractor only and shall include the following applicable items as a minimum:

a. Certified acceptance reports including the date of manufacture of the devices (and the NSI-1 installed) and the lot number(s) of the explosive material(s) utilized.

b. Certified list of all piece parts by drawing revision number and receiving inspection records. Total lot quantities and/or serial numbers to provide lot production/rejection traceability.

c. Documented final inspection records including X-ray negatives and N-ray negatives of each part in the lot if required by the procurement specification. Copies of the N-ray and X-ray certifications prepared by the performing vendor listing serial numbers of parts radiographed.

d. A copy of the lot acceptance firing data or other performance parameters which may include pressure/time traces with tabulated values, detonation velocity, delay time, or dent block testing.

e. Material tensile strength test results, requirements, and proof pressure test results, with the performing vendor's certification.

f. Statement certifying the formula for the charge is the same as that used for manufacture of the qualification lot. Caloric test data for the current powder lot/batch.

g. Lot certification of the NSI-1 lot used and a marriage list of serial numbers of devices in the lot with each mating NSI-1. Shipping data on the NSI-1 used in device manufacture.

h. Weight data for each device in accordance with Paragraph 3.11.

i. Copies of all nondestructive lot acceptance test data which will show leak test information, bridgewire resistance reading, and any other applicable information.

j. Copies of all failure and corrective action records including MRB waivers/deviations. Current information shall include copies of all descriptive information such as discrepancy reports, squawk sheets, material review records, rejection reports, etc., pertaining to discrepant hardware for the subject lot in review. This information shall include all reports covering discrepancies from receiving inspection records for piece parts inclusive to end item testing prior to shipment.

k. A copy of the explosive classification. The supplier of each pyrotechnic device shall be responsible for obtaining the explosive classification for that device from the Department of Transportation (DOT). A copy of each such classification shall be furnished to the appropriate element contractor, the NASA Project Office, or the integrating contractor.

l. A copy of the Competent Authority Approval. The supplier of each pyrotechnic device shall be responsible for obtaining the Component Authority Approval

letter for that device from the U.S. DOT. A copy of each letter, as it applies, shall be furnished to the appropriate element contractor, the NASA Project Office, or the integrating contractor.

m. A copy of the Material Safety Data Sheet (MSDS). The supplier of each pyrotechnic device shall be responsible for preparation of the MSDS on the current Occupational Safety and Health Act form designated for that device being presented for certification. A copy of each such data sheet shall be furnished to the appropriate element contractor, the NASA Project Office, or the integrating contractor.

n. Lot certificate (reference Paragraph 5.4.3).

o. Receiving inspection records of piece parts.

p. Vendor certification records pertaining to material traceability from raw stock.

5.4.3 Lot Certificate

A lot certificate shall be issued for each lot of pyrotechnic devices. The certificate shall be signed by appropriate element contractor engineering and QA representatives and shall be approved by the cognizant NASA QA representative and the Pyrotechnics Subsystem Manager, or equivalent. As a minimum each lot certificate shall contain the following:

a. The lot identification, date of manufacture of the end items and date of the DLAT.

b. Each acceptable flight part in the lot by serial number.

c. The serialized marriage or assembly of all major pyrotechnically loaded components at each level of assembly.

d. The lot and serial number of pyrotechnically loaded components and subassemblies.

e. The end item shelf life expiration date based on the completion date of destructive lot acceptance testing. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

f. For devices containing integral NSI-1, such as cartridges, the bridgewire resistance of each NSI-1 shall be recorded. The recorded value shall be transcribed from the appropriate NSI-1 lot certificate.

g. Deviations/Waivers (list numbers on face of certificate and attach copy to certificate).

5.5 QA SURVEYS

QA surveys will be conducted on an annual basis to evaluate the contractor's compliance to the contractual quality requirements. Each survey shall include examination of operation and documentation system to determine compliance with established requirements. This includes the examination of articles and material to verify the effectiveness of the contractor's quality system. A summary of the survey results shall be documented including problem areas discovered, recommendation for timely correction and prevention of deficiencies, and recommendation for follow-up action. These surveys will be conducted annually in conjunction with a Phase II review. To minimize the impact of the number of surveys, all involved NASA centers and affected Space Shuttle contractors may perform the surveys on a joint basis.

5.5.1 Procurement Surveys

The contractor shall schedule and conduct surveys of their major subcontractors to determine compliance with requirements. A schedule shall be prepared in matrix form and shall include all planned surveys for one year. The schedule shall be maintained throughout the duration of the contract.

5.6 DOCUMENTATION RETENTION

Element contractors shall retain lot acceptance data on all pyrotechnic devices for a minimum of 10 years from date of manufacture of the lot, or until the lot has been depleted if the shelf life has been extended beyond 10 years, to assure its availability for failure investigations. Suppliers shall not destroy lot manufacturing records and acceptance data without prior approval from the appropriate element contractor.

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6.0 PRESERVATION, PACKAGING, AND DELIVERY

6.1 GENERAL

Preservation, packaging, and delivery of pyrotechnics shall be in compliance with NHB 6000.1 or NPG 6000.1, MIL-STD-2073-1, Standard Practice for Military Packaging, NSTS 07700, Volume XII, Program Logistics and Supportability Requirements, and as prescribed herein. MIL-STD-2073-1 may be used in lieu of MIL-STD-2073, DOD Material, Procedures for Development and Application of Packaging Requirements, or MIL-P-116, Methods of Preservation. Depending on the mode of transportation, one or more of the following apply:

a. For military air shipments: AFJMAN 24-204, Preparing Hazardous Materials for Military Air Shipments

b. For commercial shipments: CFR, Title 49 Code of Federal Regulations (Parts 100 through 199), Department of Transportation, and IATA DGR, International Air Transport Association Dangerous Goods Regulations Manual

JSCM 8080, Standard G-13, is applicable.

6.2 PREPARATION FOR DELIVERY

6.2.1 Electrostatic Protection

When grounding of pyrotechnic devices will be accomplished during all phases of packaging, transportation, storage and handling, these devices shall be packaged in conductive materials which provide protection from static electric charges. Conductive packaging materials shall have a maximum surface resistivity of 3x10 to the 4th power ohms per square. A nonconductive outer barrier is acceptable for packaging if a conductive inner barrier with a grounding path through all nonconductive exterior barrier material is provided. When grounding of pyrotechnic devices will not be accomplished during all phases of packaging, transportation, storage and handling, these devices shall be packaged in antistatic materials to prevent generation of static charges by triboelectrification. Antistatic packaging materials shall have a surface resistivity greater than 1x10 to the 9th power ohms per square, but less than 1x10 to the 14th power ohms per square. Specified surface resistivities of packaging materials shall be maintained at all levels of humidity when tested as defined in ASTM D257, Standard Test Methods for DC Resistance or Conductance of Insulating Materials; or the materials shall be certified in accordance with MIL-STD-2073 or MIL-STD-2073-1. The NSI-1, with installed Faraday cap, is exempt from this requirement. JSCM 8080, Standard P-4 is applicable.

6.2.1.1 Faraday Caps

A Faraday cap, SEB26100060-301 or JSC approved equivalent, shall be affixed to all NSI-1 and NSI-based cartridges during shipment.

6.2.2 Preservation, Packaging, and Packing

Materials for preservation, packaging, and packing of pyrotechnic devices shall be selected in accordance with MIL-STD-794, Parts and Equipment, Procedures for Packaging of, or MIL-STD-2073-1.

6.2.2.1 Methods of Preservation

Methods of preservation for pyrotechnic devices shall be selected in accordance with the Level B requirements of MIL-STD-794 and accomplished in accordance with MIL-P-116 or MIL-STD-2073-1.

6.2.2.2 Monitoring Devices

Unit packages shall have desiccant and humidity indicators per MIL-P-116, Method II, or MIL-STD-2073-1, Method 50. Card type humidity indicators per MS20003 will be used inside the package. Through-the-container-wall humidity indicators per MIL-I-26860, Indicator, Humidity, Plug, Color Change, will not be used unless approved by the procuring agency. Except for the humidity indicators, monitoring and recording devices are not required.

6.2.3 Marking

The containers shall be indelibly marked in a legible manner in such a way that the marking shall not become damaged when the containers are opened. The marking shall provide the following information:

Lot Number _____

Part Name _____

Part Number _____

Supplier _____ Date of Manufacture _____

6.2.4 Shipping Containers

Shipping containers shall be designed and constructed so as to meet the requirements of regulatory tariffs from the Department of Transportation, CFR Title 49, or AFJMAN 24-204, depending on the mode of transportation.

6.2.4.1 Container Design Requirements (Structural)

Preservation, packaging, and packing shall be designed to withstand, as a minimum, the Level B requirements of MIL-STD-794 or MIL-STD-2073-1, as defined in FED-STD-101, Preservation, Packaging and Packing Materials: Test Procedures.

6.2.4.2 Reusable Containers

Where analysis indicates a requirement for reusable containers, maximum practical utilization shall be made of standard off-the-shelf, low cost metal or plastic containers. A reusable NSI shipping container (KSC container L0 70,000047) is available from code TV-MSD-23 (KSC).

6.2.4.3 Marking of Shipping Containers

Shipping containers shall be marked in accordance with MIL-STD-129, Standard Practice for Military Marking, and shall include the suppliers' standard marking for address and precautionary handling. All container markings shall meet the applicable requirements of CFR, Title 49 or AFJMAN 24-204, depending on the mode of transportation. Attach copy of DD250 or DD1149 and MSDS to outside of shipping container.

6.2.5 External O-Rings

External O-rings may be shipped installed or in a separate package. Installed O-rings shall not be lubricated unless exempted in this paragraph. The O-ring for the piston of the Nose Gear Extension Thruster, NASA P/N SKD26100100-205 is exempt from this requirement.

6.3 SHIPMENT

6.3.1 Data Accompanying Shipments

One reproducible copy of the lot flight certificate shall accompany each shipment from the manufacturer to the vehicle installation site. Additionally, all "M" lot NSIs shipped from the manufacturer to destinations other than JSC must be accompanied by a lot certificate. Also, a letter of Competent Authority Approval applied for by the manufacturer and issued by the DOT shall be included in the shipment, as well as the applicable MSDS for the hazardous material contained within the device. All pyrotechnic devices identified with a Shuttle program part, lot or serial number, are subject to these provisions. The RSRM Ignition S&A Device may be shipped to KSC without a lot certificate.

6.3.2 Report of Shipment

The supplier shall forward to the Transportation Officer of the using facility (test or installation site) a report of shipment for each shipment. This report shall be sent by

electrical communication and shall arrive prior to the estimated arrival of the shipment and shall include the name of the shipper, items shipped, item classification, date of shipment, mode of transportation, name of carrier, shipping document or waybill identification, and the estimated time of arrival of the shipment.

6.3.2.1 Eastern Test Range

All shipments of Class A, B, or C explosives coming to KSC will be sent to the following address:

Shuttle Transportation Manager, NASA
LC-39 Logistic Facility
Building K6-1547
Kennedy Space Center, FL 32899

Mark For:
Chief, Pyro Section
TV-MSD-23 861-3652
Launch Complex 39
Ordnance Storage Facility, Bldg, K7-506

Notify: (Name) _____ (Phone) _____

Prior to shipping explosives to KSC, the cognizant contractor will be notified by telephone. Information should include devices being shipped, mode of transportation, carrier, class, expected arrival time.

Chief, Freight Traffic Office
Don DeSlover (305) 867-3240
AP-SAT-21A

6.3.2.2 Western Test Range

To Be Determined.

6.4 RECEIPT, STORAGE, AND HANDLING

Receipt, storage, and handling requirements and procedures shall be the responsibility of each user facility utilizing pyrotechnic components and/or assemblies. The Faraday cap shall remain installed on the NSI-1 or all applicable devices except when being tested or installed in a test fixture or flight vehicle. JSCM 8080, Standard E-11 is applicable.

7.0 LAUNCH SITE OPERATIONS

7.1 PREFLIGHT VERIFICATION TESTING

A destructive performance test shall be performed at the launch site (or a test facility approved by the appropriate Element Project Office) on one sample from each lot of explosively loaded devices or assemblies scheduled for their initial flight installation. The lot of devices shall initially be shipped to the launch site as required by Paragraph 6.2. If the PVT is to be performed at a location other than the launch site, a sample of the lot shall be shipped in turn from the launch site to the test location (reference Paragraph 6.2). The PVT is performed to assure that no degradation from handling, shipment, or storage has occurred which would result in unacceptable flight performance of that lot. The PVT can be performed as late as possible prior to flight use of the lot. PVT shall be repeated on an annual basis following the initial test. Shelf life extension tests (reference Paragraph 3.7.1) at four and seven years shall be substitutions for the PVT. PVT shall be performed without induced environmental exposure until 10 years of life is reached. The criteria for device performance shall be the same as that for the original DLAT. The test equipment, set-up, instrumentation, firing stimulus, procedures, etc., shall duplicate those of DLAT insofar as practical. JSCM 8080, Standard P-2 is applicable.

Exceptions to the PVT requirement are the following:

a. SRB range safety system

b. SRB recovery system

c. ET range safety system

d. Ground Umbilical Carrier Plate (GUCP) Separator Assembly

e. Crew escape energy transfer system, overhead window severance system and side hatch system

f. TSM disconnect system

g. Hydrogen gas sampler

h. Payload bay vent severance system

i. Orbiter/ET separation system

j. Remote Manipulator System (RMS) jettison system

k. Ku-band antenna jettison system

l. Landing gear uplock and extension system

m. Drag chute system

n. Orbiter fire extinguishing system

o. SRB/ET separation system

p. SRB Booster Separation Motors (BSM) ignition system

q. RSRM ignition system

r. SRB/MLP separation system

The annual PVT shall be performed on any newly designed explosively loaded device not used in a pyrotechnic system which is exempted from PVT. For pyrotechnic devices that contain electrical or electronic circuitry, a simulator which contains only the pyrotechnic portion of the device may be used for PVT and shelf life extension testing.

7.2 PREINSTALLATION CHECKOUT

All pyrotechnic items shall receive the following preinstallation checkout.

7.2.1 Flight (Lot) Certification

Verify by part number, lot number and serial number that each item being kitted for flight is identified on a flight certification.

7.2.2 Age Life

At the time of hardware kitting (explosive devices chosen for flight), verify by lot and serial number that age life of those chosen will not be exceeded during the scheduled Shuttle flight.

7.2.3 Visual Examination

Perform visual examination for damage or degradation.

7.2.4 NSI-1 and Faraday Cap Inspection and Cleaning

When required, the NSI-1 and Faraday cap shall be cleaned as follows.

CAUTION: Provide operator protection.

a. Using a 10X magnifier, visually inspect the parts for foreign material such as hair, lint, metal particles or films, flakes of epoxy, plating or body material, or products of corrosion.

b. If contaminated blow connector end of NSI-1 and Faraday cap out with gaseous nitrogen and re-examine.

c. If contamination is still present, dip a camel hair brush in methanol or freon TF and clean contaminated surfaces.

d. Blow connector and cap dry with gaseous nitrogen and re-examine.

7.2.4.1 O-Ring Cleaning

When required, clean the electrical connector O-ring with gaseous nitrogen or freon TF, but do not immerse O-ring in freon TF. Examine for damage such as nicks or cuts and contamination. If the O-ring is acceptable, replace in the initiator (connector end). If the O-ring is damaged, install new O-ring (Parker Number 3-903, Compound S595-50, AMS 3302, Parker Number 3-903, Compound S613-60, AMS 3303) or JSC approved equivalent.

7.2.4.2 Bridgewire Resistance

Verify that the bridgewire resistance is 1.05 ± 0.10 ohms and is within 0.05 ohms of the value recorded on the appropriate lot certification. The resistance shall be measured with the Initiator Resistance Measuring Equipment (IRME) (NASA P/N SAD38111063/ Rockwell International P/N C72-1109) or the Initiator Resistance Measurement Unit (IRMU) (P/N SED26148100). All units which fail to meet this requirement shall be documented on a problem report. Lots with units varying more than 0.05 ohms shall be evaluated independently. A new baseline resistance can be established when the vendor resistance measurements for the lot is determined to be incorrect.

7.2.4.3 Insulation Resistance

NSI-1 IR tests shall be performed at 250 VDC per Paragraph 4.5.2.5.3 on each flight, spare, and PVT NSI-1 and NSI based cartridge. Parts failing to meet the 2.0 megohm minimum requirement shall be rejected on an individual basis and replacement parts re-kitted. Hardware kitted for flight shall be subjected to the 250 VDC insulation test prior to kitting one time only. If retest is required, 50 VDC shall be used on a component.

7.3 INSTALLATION AND CHECKOUT

For electrically initiated pyrotechnic systems, perform stray voltage checks, circuit resistance check (after all flight connections are made including NSI-1 connections) and high energy squib simulator checks using the appropriate onboard, built in, test or GSE equipment, or that listed below. JSCM 8080, Standards G-3 and E-11 are applicable.

Stray Voltage Tester (C72-1127)

NSI-1 Load Simulator

Pyro Checkout Module (C72-1138)

7.3.1 Pyrotechnic Circuit Shield Resistance Verification

The resistance of the circuit shields shall be measured between the connector shell and the pyrotechnic cartridge before connecting the circuit connector to the NSI-1.

7.3.2 Pyrotechnic Firing Circuit Resistance

The allowable firing circuit resistance for each circuit shall be established and specified in the applicable test and checkout procedure.

7.3.3 Arming and Firing Stimulus Verification

The capability of the firing system to deliver the required firing stimulus to the NSI-1 shall be verified by simulated NSI-1 firing on each firing circuit.

7.3.4 Pyrotechnic Firing Circuit Stray Voltage

Stray voltage at each pyrotechnic connector shall not exceed 0.05 VAC RMS or 0.05 VDC. Stray voltage with PICs armed shall not exceed .05 VAC at each pyro connector between line and ground when loaded with a 1 ohm resistor.

7.3.5 Procedures

Detailed procedures shall be established and published for the installation and checkout of all pyrotechnics. These procedures shall include appropriate safety warnings and controls. JSCM 8080, Standard G-18 is applicable.

7.3.6 Temporarily Installed Hardware

All temporarily installed devices and hardware such as caps, plugs, covers, support bracketry, protective plates etc., shall be cerise red in color and/or shall have cerise red streamers attached to ensure that they are easily identified under casual observation. Inert non-flight pyrotechnic devices shall be gloss red in color per JSCM 8080, Standard P-7, and/or shall have streamers attached. All temporarily installed hardware and streamers shall be logged on and off the flight elements unless tracked by some other system. Before closeout of any vehicle, the log and area tracking system shall be inspected to ensure that all temporarily installed hardware has been removed.

7.3.7 O-Ring Lubrication

Minimum lubrication shall be used prior to final installation of devices in the vehicle.

7.3.8 Equipment Calibration

Calibration shall be accomplished in accordance with MIL-STD-45662, Calibration System Requirements, ANSI/NCSL Z450-1, Calibration Laboratories and Measuring and Test Equipment - General Requirements, or equivalent.

7.4 DISPOSITION OF REJECTED PARTS

Pyrotechnic devices which are removed from flight status subsequent to lot certification shall be shipped from the installation site or destroyed as directed by the design organization. All rejected parts shall be color coded blue per Paragraph 3.9.4 immediately after the rejection decision.

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8.0 ELECTRICAL CIRCUIT REQUIREMENTS

8.1 GENERAL

Pyrotechnic circuits and power sources shall meet the requirements of Paragraph 3.1. The design of all pyrotechnic electrical circuits associated with pyrotechnic devices shall require approval of the Space Shuttle Project Office. JSCM 8080, Standards E-1, E-3, E-4, E-7, E-8, E-9, E-11, E-14, E-16, E-17, E-19, G-8, M/P-2, M/P-7, M/P-18, M/S-3, P-1, and P-6 are applicable.

8.1.1 Firing Control System

The pyrotechnic firing control system includes all electrical circuits for arming and firing of pyrotechnic devices, including logic, monitoring, and checkout circuits.

8.1.2 Failure Propagation

Failures shall not propagate from one system to another.

8.1.3 Test Points

The capability to verify the redundancy of all pyrotechnic circuits and elements shall be provided.

8.1.4 Pin Shorting

To prevent the possibility of premature firing resulting from short circuits between pins, pyrotechnic circuits shall not share pins in multipin connectors with other load carrying circuits.

8.1.5 Malfunction

Malfunction and inadvertent operation of control circuits caused by extremes of ground and flight environments shall be avoided by protective design features. JSCM 8080, Standard G-8 is applicable.

Deviation/Waiver 58 is applicable to Paragraph 8.1.5. Refer to the Deviations/Waivers Section in front of the document.

8.2 FIRING CIRCUITS

The firing circuit for an EED shall consist of that portion of the firing control system which is isolated and which carries the initiator firing current. A separate firing circuit shall be provided for each EED.

8.2.1 Circuit Characteristics

To prevent adverse effects of common mode currents, each EED shall be supplied by a balanced, shielded, twisted-pair line. The line shall not be connected directly to vehicle structure and will be isolated from vehicle direct current returns through a minimum of 100k ohms resistance. Voltage breakdown from the balanced two-wire line to vehicle structure or direct current return shall be greater than 1500 VAC RMS at a frequency of 60 Hertz.

8.2.2 Fusistors

Fusible resistors (fusistors) shall be provided only where necessary to prevent high current surges during EED firing and to limit current and interrupt flow in the event of a post firing short in the EED.

8.2.3 Wire Routing

Firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electrical control, Radio Frequency (RF) transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

Deviation/Waiver 57 is applicable to Paragraph 8.2.3.
Refer to the Deviations/Waivers Section in front of the document.

8.2.4 Arm/Disarm Indicator Circuits

Arm/disarm indicator circuits are required and shall be hardwired for mission critical functions, or the indicator circuits shall be at least as reliable as the operational firing circuits. These circuits shall be isolated from firing circuits.

8.2.5 Crimping and Soldering

Crimping is the preferred method of making pyrotechnic circuit connections. Soldering, if used, shall conform to the requirements of NHB 5300.4(3A-1), Requirements for Soldered Electrical Connections, NHB 5300.4(3A-2), Requirements for Soldered Electrical Connections or NASA-STD-8739.3, Soldered Electrical Connections.

8.2.6 Pyrotechnic Initiator Controller

The following PIC part numbers shall be used to fire all NSI in the Shuttle system with the exception of the Shuttle range safety system, ET tumble valve, and the H_2 gas sampler which shall be fired by other means.

Orbiter	PIC MC450-0018-0004, MC450-0018-0005, MC450-0018-0007, and/or MC450-0018-0008
SRB/ET	PIC MC450-0018-0006, MC450-0018-0007, and/or MC450-0018-0008
Ground PIC (GSE) System	PIC MC450-0018-0007, and/or MC450-0018-0008

8.3 ARMING AND FIRING

8.3.1 Switches

Control circuit arm switches, firing switches, command receiver power switches (if used), and arm and disarm position control switches shall be capable of being locked or safed in the OFF (disarm) position and shall be located in a common area accessible to the crew. JSCM 8080, Standard G-30 is applicable.

8.3.1.1 Protection

Firing circuit switching devices shall be protected as required to prevent inadvertent operation or degradation by high voltage spikes or reverse voltages caused by transients due to load switching, RF interference, lightning, etc. NSTS 07636, Lightning Protection, Test and Analysis Requirements, and JSCM 8080, Standard E-15 are applicable.

8.3.1.2 Safing

Safing of firing circuits shall be accomplished by removal of the arm command. This shall cause the capacitor bank voltage to decrease to a value of 1.5 VDC maximum in less than 15 seconds. The discharge time with any one failed circuit element shall be less than 30 seconds.

8.3.2 Arming Circuits

Control circuits shall include an arming circuit which is energized by a separate signal or action prior to the initiation of the firing signal.

8.3.3 Electrical S&A Devices

Electrical safing and arming shall provide means for interrupting the firing circuit between the firing switches and the NSI-1. It may be remotely or locally controlled but must provide means for monitoring the status both remotely and locally. Control of the interrupter shall be separate and independent from all other command and/or control systems in the vehicle.

8.3.4 Timing Circuits

Timing circuits used as logic for firing pyrotechnic devices shall be designed to be fail-safe. The primary failure mode shall not result in an unsafe condition.

8.4 ELECTROMAGNETIC COMPATIBILITY

8.4.1 Shielding

The firing circuit from the current source shall be twisted, shielded pairs. Good RF shielding practices; e.g., multiple shield grounding, no opening in shields and RF type shield termination, shall be used. Shields shall be grounded to vehicle structure through the EED connector and body. JSCM 8080, Standards P-3 and E-24 are applicable.

8.4.2 Electrical Bonding

Electrical pyrotechnic circuit elements shall be bonded in accordance with class “R” bonding (2.5 milliohms) per NSTS 37330, Paragraph 3.3.5.

8.5 CHECKOUT EQUIPMENT

Carry-on checkout equipment for use at the launch site shall be minimized. Provisions shall be made in the circuitry to allow for verification of the test requirements specified in Paragraph 7.3.

9.0 GOVERNMENT AND ELEMENT CONTRACTOR FURNISHED MATERIAL AND EQUIPMENT

9.1 GENERAL

The requirements and procedures of this section pertain to materials and equipment supplied by the NASA and to equipment supplied by one element contractor to another.

9.1.1 Pre-Existing Equipment

Special emphasis shall be placed upon a source of supply which is experienced in the design, fabrication, and testing for the procurement and supply of pre-existing equipment which is accepted for Shuttle use. NASA retains the right to approve the sources selected. NASA may provide some or all of this equipment to the affected element contractors through appropriate contractual action as GFE.

9.1.2 New Equipment

New devices developed for one element and subsequently used in other elements, including modifications of pre-existing devices, shall be procured or obtained in the manner indicated in Paragraph 9.1.1.

9.2 GFE AND GOVERNMENT FURNISHED MATERIAL (GFM)

A NASA source shall be in accordance with NSTS 07700, Volume VI, Flight Support Equipment (FSE) Management.

9.2.1 NSI-1, NSI-1 Output O-Ring, RSRM/Standard Initiator (SI) and NSD

The NSI-1, SEB26100001, NSI Output O-ring, the SRM/SI, SED26100107 and the NSD, SEB26100094, shall be supplied by JSC to all Shuttle users. JSC shall maintain at least a dual supply source capability for the NSI and NSD. The NSI-1 and NSI Output O-ring will be made available for non-Shuttle U.S. Government use subject to the provision in Paragraph 9.2.1.3.

9.2.1.1 Forecasts of Shuttle Requirements

Each element contractor shall submit an annual 5-year forecast of NSI-1 and NSD requirements to the appropriate NASA Project Office which shall review the contractor forecast, and requirements for other, noncontractor use (e.g., MSFC in-house Shuttle use) and forward the overall element forecast to the Flight Engineering and Vehicle Management Office for approval and inclusion in the JSC budgetary estimates. Each forecast is due on November 1, and shall include the estimated requirements for the

next five government fiscal years. The first two years of each forecast shall be by fiscal quarters and the remainder by year. Detailed justification for the first year requirements shall be included. NASA Form 558 shall be used. The following assumptions shall be used in estimating requirements:

a. Preflight verification testing of each flight lot of NSI-1 and NSDs used as independent units, cartridges, and other assemblies containing integral charges will be conducted on the basis of one device from each flight lot per year.

b. Each flight and backup lot of cartridges and independently installed NSI-1 and NSDs will be delivered to the installation site six months prior to the first scheduled use of the lot.

c. No reserve of NSI-1 or NSDs for contingencies shall be included.

9.2.1.2 Requests for Shipments (Shuttle Use Only)

Each element contractor shall submit a request for specific shipments of NSI-1 and NSDs to the appropriate NASA Project Office which shall review the request, add requests for other required shipments, and forward the combined requests to the Flight Engineering and Vehicle Management Office. Each request shall include detailed shipping information. (Upon approval by the Flight Engineering and Vehicle Management Office, these requests will be the basis for JSC configuration and shipping direction to the NSI-1/NSD stock manager [the supplier] and for planning and revising program reserves.) Consignees for NSI-1/NSD shipments shall be the cartridge manufacturers, the installation sites (for independently-installed NSI-1/NSD) or the test sites (for NSI-1/NSD to be used in development tests), as appropriate.

9.2.1.3 Non-Shuttle GFE Requirements

The NSI-1 and NSI output O-ring can be made available for non-Shuttle U.S. Government projects outside of the SSP. Non-U.S. Government requirements are not supported. The NSD is not available as GFE outside of the SSP. Availability of the NSI-1 and NSI output O-ring is subject to the following conditions:

a. Written request shall be made to the Flight Engineering and Vehicle Management Office, with a copy to JSC Code EP5, 24 months prior to desired delivery. The request shall include the name of the program, contact name and phone number, quantity of units desired, configuration, and destination for shipping purposes. Conditional acceptance and an estimate of costs will be provided in 60 days.

b. Full funding shall be provided no later than 12 months prior to desired delivery date. Funds shall be provided by an intra-government funds transfer. Transfer

of travel funds may be required for manufacturing coverage by JSC engineering and quality personnel. Funding cannot be directly accepted from U.S. government contractors. Requests for less than 1,000 units are subject to accumulation of sufficient orders to process manufacture of at least 1,000 units. Final acceptance of requests and establishment of a delivery date are subject to the above conditions.

c. Final shipment of GFE shall be made on an agency to agency property transfer.

9.2.1.4 Accountability

NSI-1 and NSD are accountable by part, lot, and serial number and are supplied for the specific use stated in the Request for Shipment (reference Paragraph 9.2.1.2). Project offices and element contractors are responsible for assuring the NSI-1 and NSD are used only for authorized U.S. Government purposes. Upon receipt of a shipment from NASA stock, the accountability is transferred from the NASA stock manager (the supplier) to the consignee. Cartridge manufacturers receiving NSI-1 are accountable for the NSI-1 until dispositioned as indicated in Paragraph 3.12.4.2.

9.2.2 Faraday Caps

Each NSI-1 is shipped from NASA stock with an installed Faraday cap, SEB26100060-301, or an equivalent protective device which is reusable. Each site accumulating these caps (e.g., cartridge manufacturers, installation, and test sites) shall periodically ship the accumulated caps to JSC/Energy Systems Test Branch, for appropriate inspection, refurbishment, and reissue to suppliers.

9.2.3 NASA Equipment

NASA equipment such as the IRME, the IRMU, the SFU, the PS-11 Constant Current Pulse Generator, the IFU, and the PIC Model GFE-01, shall be supplied by JSC to Shuttle users on as required basis. JSC shall maintain and perform calibrations subject to the provision in Paragraph 9.2.3.1.1.

9.2.3.1 Initiator Resistance Measuring Equipment

The IRME, P/N SAD38111063 (C72-1109) or IRMU (P/N SED26148100) are digital ohmmeters designed for very accurate measurement of the bridgewire resistance of the NSI-1. The use of this equipment is required only during preinstallation testing of the NSI-1 and NSI-1 based cartridge assemblies and in lot acceptance testing of the NSI-1. The IRME or IRMU shall be GFE from JSC. One IRME or IRMU shall be located at each NSI-1 supplier and one at each facility where NSI-1/cartridges are installed in flight vehicles.

9.2.3.1.1 Calibration

The IRME or IRMU requires field calibration prior to each use. Field calibration shall be performed in accordance with the IRME manual using the IRME calibration resistor. The calibration resistor shall be calibrated by a JSC approved laboratory or returned to JSC for calibration. A calibration sticker with the control number and recall date shall be attached to the calibration resistor.

9.2.3.2 Standard Firing Unit

The SFU (R-I Model C77-0833) is a portable firing unit provided GFE to all NASA centers, contractors, and their appropriate subcontractors and suppliers for conducting ground test of pyrotechnic devices and systems in which the NSI-1 is used. The unit provides for firing the NSI-1 in either the capacitor discharge or constant current firing mode. It is capable of firing up to 10 NSI-1s simultaneously in the capacitor discharge mode and one unit in the constant current mode. The SFU shall be GFE from NASA/JSC, and shall be recalibrated annually by an approved NASA/JSC source. The SFU may be used to fire NSI-1s at the device or system level during qualification, acceptance and system level tests. The capacitor discharge channels must be used with voltage selector set at 30 volts. Each channel to be used must have a voltage recording monitor connected to the SFU current monitor output. Prior to the actual firing or series of firings of NSI-1s, proper function of the SFU shall be demonstrated by connecting the output cable(s) to a one ohm dummy load(s) and recording the voltage at the current monitor output connector during the test firing into the dummy load(s).

9.2.3.2.1 Calibration

The SFU shall be calibrated annually. In order to maintain configuration control, repairs and internal adjustments shall be made by NASA/JSC personnel only. Test laboratory field calibration may be performed in accordance with JSC 17849, Contractor Calibration Procedure for GFE SFU, Model C72-0833. If the SFU meets the requirements specified in JSC 17849, the calibration recall date may be extended for one year. The field calibration shall be witnessed by the government quality representative. The government quality representative shall stamp and date sheets of the JSC 17849 and place a new calibration recall date on the unit calibration sticker.

9.2.3.3 PS-11 Constant Current Pulse Generator

The PS-11 Constant Current Pulse Generator is a commercial constant current pulse generator manufactured by E & R Development Company, Palos Verdes, CA. It may be used to fire the NSI-1 at the device or system level during qualification, acceptance, and system level tests when the constant current mode is specified.

9.2.3.3.1 Calibration

The PS-11 Constant Current Generator is to be calibrated by an approved calibration laboratory using equipment traceable to the National Institute of Standards and Technology. Calibration to be performed in accordance with the manufacturer's recommendations.

9.2.3.4 Initiator Firing Unit

a. NASA P/N SED26100128-301. The IFU (-301) is a portable firing unit provided as GFE by JSC. It provides a firing stimulus from a capacitor bank of 680 microfarads and a circuit tester to verify firing circuit continuity. The charging voltage for the capacitor bank is fixed at 40 ±1.0 VDC. The IFU (-301) may be used to fire the NSI-1 at the device or system level during qualification, acceptance, and systems test when the capacitor discharge mode is specified.

b. NASA P/N SED26100128-303. The IFU (-302) is a portable firing unit provided as GFE by JSC. It provides a firing stimulus from capacitor banks of either 680 microfarads or 1000 microfarads and a charging voltage of 5 to 45 ±0.2 volts Direct Current (DC) in 5 volt increments. It also provides a circuit tester to verify the firing circuit continuity. The IFU (-302) may be used to fire the NSI-1 at the device or system level during qualification, acceptance, and systems level tests when the capacitor discharge mode is specified.

9.2.3.4.1 Calibration

The IFUs (-301 and -302) shall be returned to JSC/Energy Systems Test Bunch, annually for preventive maintenance and calibration. The calibration shall be performed in accordance with approved procedures and shall be verified by SR&QA.

9.2.3.5 PIC Model GFE-01

The PIC Model GFE-01 is a flight type device packaged for use as GFE. The PIC has a capacitor bank of 680 microfarads. The capacitors are charged to 37-40 volts DC when connected to an external 28 ±1.0 VDC power supply. The PIC may be used to fire the NSI-1 at the device or system level during qualification, acceptance, and system level tests when the capacitor discharge mode is specified.

9.2.3.5.1 Calibration

The PIC requires no calibration; however, it shall be tested prior to each firing or series of firings by connecting a one ohm dummy load resistor into the output circuit and test firing the PIC into this circuit. The current through the circuit is to be recorded on the data system and the data evaluated to ensure proper operation of the PIC prior to beginning the test firing of the NSI-1 or NSI-1 initiated device.

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10.0 FAILURE AND ANOMALY INVESTIGATION AND REPORTING

10.1 GENERAL

Each NASA Space Shuttle Project Office and element contractor shall establish a controlled, closed-loop documentation technique for recording, investigating/analyzing, reporting, verifying, correcting, and feeding back information and data on problems and nonconformances (discrepancies) pertaining to pyrotechnic devices and assemblies. Project offices and contractors shall ensure that the reporting and corrective action systems of subcontractors and supplier conform hereto.

10.2 APPLICABILITY

The requirements herein are applicable to all NASA and contractor/supplier organizations and activities which manufacture, assemble, test, install, or otherwise handle Space Shuttle pyrotechnics. They are applicable to flight equipment, launch essential GSE, and other GSE the malfunction of which could create a safety hazard or induce defects into flight equipment. Spares and flight-configured equipment used as test articles are also subject to these requirements.

10.3 EFFECTIVITY

The requirements herein shall be effective with the start of acceptance testing of the qualification lots except that problems which occur prior to that time and which will, or have the potential to, adversely affect safety, contribute to the delay of a scheduled event or which result in a design change shall also conform to these requirements.

10.3.1 DR Trending

After final acceptance of pyrotechnic devices, all unit rejection nonconformances, such as: X-ray, N-ray, dimensional, leakage, bridgewire resistance, IR, and staking, shall be reported for DR trending to the appropriate NASA Space Shuttle Engineering Office on the identifying agency's nonconforming discrepancy report. Nonconformances related to fail to fire, or output which are out of specification, or nonconformances which have been identified as requiring recurrence control shall be reported as problems in accordance with Paragraph 10.5.

10.4 INVESTIGATIONS AND ANALYSES

Each problem shall be investigated and/or analyzed to determine its cause and to establish and implement corrective action which will prevent its recurrence. The type and extent of each investigation/analysis will depend on the nature of the specific problem; however, each investigation and analysis shall be covered by a written plan which is approved by the appropriate NASA Project Office prior to its implementation.

10.4.1 Action Upon Problem Occurrence

When a problem occurs in a test, all testing shall be immediately suspended and, consistent with safety to personnel and equipment, no actions shall be taken which would disturb or alter the test setup as it exists at the time of problem occurrence. The problem shall be reported as specified below and a plan of action shall be prepared and approved by the appropriate project office. Only then may the investigation of the problem proceed, unless specific authorization for interim action has been issued by the appropriate NASA Project Office.

10.5 REPORTING

Problems as defined in Paragraph 10.3.1 will be reported in accordance with the criteria specified in NSTS 08126, Problem Reporting and Corrective Action (PRACA) System Requirements.

10.5.1 Immediate Reports

These reports, which are the initial notification of the existence of a problem, shall be forwarded within 24 hours of detection or occurrence for each NASA center, contractor, or subcontractor/supplier. Transmission shall be by the most expeditious means available (i.e., telecopier, telephone, courier, etc). The contents of the report shall include the items shown in Table 10.1, Column A.

10.5.2 Subsequent and Follow-Up Reports

These documented reports shall contain the additional information shown in Table 10.1, Column B, and shall be forwarded within five days of problem occurrence/identification. Existing report forms are acceptable provided that all data elements are included. These reports shall be updated as necessary.

10.5.3 Problem Resolution (Closeout and Explanation) Reports

These reports shall document the following:

a. Successful efforts to determine the cause of the problem and corrective actions which have been implemented to prevent recurrence, or

b. Unsuccessful efforts to determine the cause of the problem and information and rationale which provide assurance as follows:

    1. Occurrence of the problem during a mission can be tolerated, and/or

    2. Procedures have been formulated and implemented which will nullify the effects of the problem.

Initial resolution reports shall be submitted within 21 days of the immediate report of the problem and shall contain the elements shown in Table 10.1, Column C. These reports shall be updated at appropriate intervals as problem explanations are accomplished and until final resolution of the problem and implementation of final corrective action.

10.6 OPEN PROBLEMS LIST

This list, published by the Problem Assessment Engineering Office at JSC, includes all reported problems which have not been closed and the data elements shown in Table 10.1, Column D. This list will be initiated one week after accumulation of 10 or more reportable problems. It will be published monthly until the beginning of qualification/ certification testing and weekly thereafter. Supplemental lists will be provided to support specific tests and flight/launch events/milestones.

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TABLE 10.1
PROBLEM REPORT/LIST DATA ELEMENTS

	Data Element	Report (*) A	B	C	D
1.	Date of occurrence	X	X	X	X
2.	Location of article at time of occurrence	X	X	X	
3.	Test or operation being performed at time of occurrence	X	X	X	X
4.	Prevalent conditions at time of occurrence	X	X	X	X
5.	Nonconforming article: part number and name, manufacture, lot, and serial number	X	X	X	X
6.	Contractor deliverable item description	X	X	X	
7.	Indication as to whether nonconformance is a failure or an unsatisfactory condition	X	X	X	X
8.	Symptom of nonconformance	X	X	X	X
9.	Brief narrative description of nonconformance, including comparison of actual with expected event or result	X	X	X	X
10.	Criticality with respect to mission effects	X	X	X	X
11.	Cause of nonconformance, if known	X		X	X
12.	Contract number	X	X	X	
13.	Subsystem affected	X	X	X	
14.	Uniquely identifiable report number		X	X	X
15.	Next higher assembly: part, lot and serial number, manufacturer		X	X	
16.	Indication of whether problem is due to a design deficiency or manufacturing inconsistency		X		
17.	Test document number		X	X	
18.	Time cycle in use		X	X	
19.	Planned date of dispositioning		X		
20.	All end items that may be affected by the problem		X		X
21.	Problem action center number				X
22.	End item on which nonconformance occurred, if applicable				X
23.	Indication of whether nonconformance is design or manufacturing oriented, as available			X	X
24.	Analysis results, including laboratory test results, as available			X	X
25.	Corrective action, as available			X	X

(*) A - Immediate Report
B - Followup Report
C - Problem Resolution (Closeout and Explanation) Report
D - Open Problem List

TABLE 10.1
PROBLEM REPORT/LIST DATA ELEMENTS - Concluded

	Data Element	Report (*) A	B	C	D
26.	Estimated closeout date				X
27.	Actual closeout date				X
28.	Effort made to determine cause of nonconformance (explanation)			X	
29.	Date of disposition			X	
30.	Problem report numbers and dates relating to the same problem			X	X
31.	Previous history of nonconforming article			X	
32.	Explanation rationale			X	
33.	Assurance that explanations using redundancy as rationale and/or alternate modes of operation as one of the elements does not negate each other			X	
34.	Date when last test prior to mission is to be performed; statement as to whether nonconformance is detectable during mission			X	
35.	Effect on mission if nonconformance recurred and recommended operational workaround procedures			X	
36.	Vehicle effectivity of problem closeout or corrective action (for pyrotechnic devices give lot designator)			X	

(*) A - Immediate Report
B - Followup Report
C - Problem Resolution (Closeout and Explanation) Report
D - Open Problem List

11.0 DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

The definitions, abbreviations, and acronyms herein shall be applicable and standard to the pyrotechnics subsystems of the Space Shuttle System and Program.

Acceptance Testing - Tests to determine that a part, components, subsystem, or system is capable of meeting performance requirements prescribed in purchase specification or other documents specifying what constitutes the adequate performance capability for the item in question.

Acceptor - An explosive component which conducts a detonation impulse from a preceding detonating component usually called a donor.

Apex Thickness - Sheath thickness of LSC at apex of vee angle.

Arm/Disarm Device - A device to make (arm) and break (disarm) electrical continuity from the firing controller to the EED.

ASRB - Advanced Solid Rocket Booster.

Assessment - A verification method employing inspection and/or review of design techniques to verify design features which are impossible to verify by test methods. Features such as finishes, tolerances, bonding, identification and traceability, safety wiring, warning and servicing labels, bill of materials, etc., are applicable.

Booster - An explosive charge augmenting the initiating component of an explosive train to cause ignition or detonation of the main explosive charge or to increase the output of the assembly.

Bridgewire - A resistance wire incorporated into an EED to convert electrical energy into heat to cause ignition of the pyrotechnic material.

Brisance - The shattering power of an explosive as distinguished from its total work capacity.

Bruceton Analysis - A method of sensitivity testing to estimate the mean of the distribution and, less accurately, the standard deviation from a limited number of samples. In this test the level of variable applied depends upon the results of the previous test.

Cartridge - A separable device loaded with propellant or high explosive.

CDF - Confined Detonating Fuse.

CEI - Contact End Item.

Certification - Consists of qualification tests, major ground tests, and other tests and analysis required to determine that the design of hardware from the component through the subsystem level meets requirements.

a. Certification by testing is the process of conducting tests which normally are considered qualification tests plus specific additional tests of components and subsystems and higher levels of assemblies required to certify that the hardware design meets established design requirements. Certification testing does not generally include development, piece-part qualification, acceptance, or checkout tests except where such tests are specifically identified as required for certification.

b. Certification by Analysis

    1. Analysis performed to satisfy certification objectives when testing under simulated mission conditions is not feasible or cost effective, or the need exists to extrapolate test data beyond the performed test points.

    2. Analysis performed to show that an article is similar or identical in design, manufacturing process, and quality control to another that has been previously certified to equivalent or more stringent criteria.

Charge Holder - An assembly consisting of an explosive train permanently mounted in a holder (usually metallic) designed for vehicle installation. The train may be one intended for structural separation or a transfer charge.

Circuit Interrupter - A device used for interruption of electrical circuits usually by means of an internal piston which, by its motion, breaks the contacts between the pins and pin sockets.

Closed Bomb - A fixed volume chamber used for testing the pressure/time characteristics of pressure cartridges.

Confined Detonating Cord (CDC) - A detonating cord surrounded by a flexible sheath of plastic, fiber fabric, or combination thereof that confines the effects of the explosive core. Generally used for energy transfer between multiplexed components in a pyrotechnic system.

Core Charge - A high explosive material contained in a suitably configured sheath, usually of metal. A generic term for both MDF and LSC. The basic component of an explosive train as defined herein.

CR - Change Request.

DC - Direct Current.

Delay Column - The component of a delay element which introduces a controlled time delay in the functioning of a series of explosive events. It consists of a tube of length

primarily dependent upon the burning rate of the delay material being used and the time delay required. Sometimes the column consists of a “priming” material at one end to initiate the delay material and a relay charge at the output end to transfer an impulse and augment the output to a succeeding element in the train.

Delay Element - An assembly that consists of an initiating element at one end, a delay column in the middle and a base charge at the terminal end to transfer an impulse to the next succeeding element in the train.

Detonation - The extremely rapid chemical decomposition (explosion) of a material in which the reaction front advances into the reacted material at greater than sonic velocity.

Detonator - A pyrotechnic device capable of initiating detonation in a subsequent high explosive component.

Development Testing - Testing performed with minimum rigors and controls to verify a design approach.

Dielectric Testing - A resistance test utilizing alternating current.

DLAT - Destructive Lot Acceptance Testing

DOD - Department of Defense.

Donor - An explosive component that conducts a detonation impulse out of a detonating charge into a succeeding high explosive charge usually called an acceptor.

DOT - Department of Transportation.

Dud, Dudded - The destruction of the operating or functioning capability of a device; for example, a cartridge or other device which will not function upon receipt of the prescribed initiating stimulus.

EED - Electro Explosive Device (e.g., the NSI-1).

Electrical Circuit Safe/Arm - A device which electro-mechanically interrupts the firing circuit between the initiator and the final firing control device and which provides additional safety from premature firing. (Reference Arm/Disarm).

Element Contractor -

Orbiter - United Space Alliance (Houston Operations)/Johnson Space Center (procuring authority)
SRB - United Space Alliance (Florida Operations)
RSRM ATK Launch Systems
ET - Lockheed Martin
Launch/Ground Systems - United Space Alliance (Florida Operations)

EMI - Electromagnetic Interference.

End Coupler - An integral acceptor and/or donor charge built into the end(s) of an explosive train.

ET - External Tank.

Explosive - A generic term which includes deflagrating, detonating, and pyrotechnic materials.

Explosive Batch - A specific quantity of an explosive material resulting from a single continuing process of manufacturing.

Explosive Bolt - A bolt that is intended to be fractured at a predetermined point by a contained or inserted explosive charge for the purpose of releasing a load.

Explosive Lot - A specific traceable quantity of an explosive material resulting from a one-time blending or mixing of one or more batches, all of which were prepared within a short time period.

Explosive Train - An assembly of MDF or LSC sealed at both ends, either with or without end couplers or boosters.

Fail Safe - System design which after a single functional failure is still capable of performing its required function. Premature firing is excluded as a failure.

Faraday Cap - The cap applied to the connector end of the NSI-1 to provide an EMI shield to prevent inadvertent firing from RF sources. This cap does not short out the bridgewire.

FCDC - Flexible Confined Detonating Cord.

GFE - Government Furnished Equipment.

GFM - Government Furnished Material.

GSE - Ground Support Equipment.

GUCP - Ground Umbilical Carrier Plate.

HMX - Cyclotetramethylenetetranitramine; a secondary explosive color - white.

HNS - Hexanitrostilbene; a secondary explosive. Color - buff to pale yellow.

IFU - Initiator Firing Unit.

Igniter Cartridge - A pyrotechnic device designed to initiate burning of a fuel mixture or a propellant.

Indentation Fixture - Steel witness block used in MIL-STD-331 (Test 301.1) dent test.

Inert Device - A pyrotechnic device which contains no explosive, pyrotechnic or chemical agent.

Initiator - The primary stimulus component in all pyrotechnic devices and systems.

Installation - The assembly of a pyrotechnic device into a vehicle or another assembly in a manner such as to permit removal or disassembly; e.g., a cartridge installed into a mortar or a guillotine into a vehicle.

IR - Insulation Resistance.

IRME - Initiator Resistance Measuring Equipment.

IRMU - Initiator Resistance Measurement Unit.

Ku-band - 10.9 to 35 Gigahertz per Second.

L/N - Lot Number.

Lead Azide - A sensitive primary explosive. Color - white.

Locked-Shut Test - A test of a device designed to operate with an expanding gas volume (e.g., piston type thruster) in which the moving parts (e.g., pistons) are restrained from movement so that the initial volume remains unchanged and a high over-pressure results. This test demonstrates that the device will not rupture or fragment with restraint on the piston. Testing is performed with redundant charges firing simultaneously, when appropriate.

Lot Certificate - A NASA approved document pertaining to a specific lot of a specific pyrotechnic device which lists all specific serialized parts in the lot that are certified for flight vehicle installation. It is prepared on the basis of manufacturing and acceptance data and represents the status of each device at the time of the certification activity and is not changed as listed devices are used or subsequently undergo a flight worthiness change.

LSC - Linear Shaped Charge. A metal tube containing a core of high explosive, formed into a “V” or chevron shape to produce a cutting jet.

Marriage - The assembly of components, such as the NSI-1, into a cartridge or an explosive train into a charge holder, in a manner intended to be permanent.

MDF - Mild Detonating Fuse. A metal tube containing a core of high explosive usually of circular or similar cross-section.

MRB - Material Review Board.

MSDS - Material Safety Data Sheet.

N-ray - Neutron radiography.

NSD - NASA Standard Detonator.

NSI - NASA Standard Initiator.

NSI-1 - NASA Standard Initiator, Type 1 (previously designated as the Standard Manned Space Flight Initiator [SMSI] and the Single Bridgewire Apollo Standard Initiator [SBASI]).

Off-Limits Testing - Those tests designed to evaluate device performance during or after exposure to environments which are more severe than those predicted for mission use.

P/N - Part Number.

Percussion - A method of initiating a pyrotechnic charge by an intentional sudden pinching or crushing of the explosive material, as between a blunt firing pin and an anvil.

PETN - Pentaerythrite Tetranitrate. A secondary explosive more sensitive than RDX or HNS. Color - white.

PIC - Pyrotechnic Initiator Controller IFU (-301 and -302) IFUs.

Piggyback - The practice of backing up one LSC with another by placing one LSC on the back of the LSC performing the cutting such that the liner of the backup charge is in contact with the back side of the cutting charge.

PRCB - Program Requirements Control Board.

PRCBD - Program Requirements Control Board Directive.

Preinstallation Test - A nondestructive test, or series of tests, performed on a pyrotechnic device prior to its installation in a flight vehicle or test fixture.

Primary Explosive - An explosive material that is very sensitive to heat, impact, and friction as initiating mechanisms. Includes azides, fulminates, etc. Often used as one of the first elements in an explosive train. Example: lead azide

Production Lot - A group of new production components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time.

PS-11: Constant Current Pulse Generator Model PS-11.

psi - pounds per square inch.

PVT - Preflight Verification Test. A firing test performed at the launch site on a sample of the flight lots installed on a vehicle. Tests may be time, vehicle or mission based.

Pyrotechnic Material - A mixture of chemicals designed to produce heat, gas, pressure, or shock.

Pyrotechnics - The generic term used throughout the SSP in lieu of “ordnance” to avoid the connotation of weaponry as in “pyrotechnic systems.” “Pyrotechnic devices” include all devices and assemblies containing, or operated/actuated by, propellants and/or

explosives including items such as initiators, detonators, S&A devices, cartridges, separation bolts and nuts, pin pullers, linear separation systems, guillotines, valves, disconnects, transfer assemblies, TBIs, shaped charges, mortars, circuit interruptors, dimple motors, but specifically excepting large rocket motors.

QA - Quality Assurance.

Qualification Test - A test structured to certify that design requirements have been met.

Random Sample - A sample selected without bias or prejudice.

RDX - Cyclotrimethylenetrinitramine. A secondary explosive. Color - white.

Receptor - Reference “Acceptor”.

Recommended Firing Current - A current recommended to be applied to an EED to cause initiation of the explosive charge and which provides a margin over the “all- fire” current stimulus. Specified as 5.0 amperes minimum for the NSI-1.

Redundancy

Single - A single-redundant system is one which will sustain one failure of an assembly/component and still retain the capability of performing the intended function. This level of redundancy is attained by adding one like assembly/component to the system. For example, if one battery is required to provide a source of firing current, one additional battery provides single-redundancy of the current source and the batteries are said to be redundant.

Dual - A dual-redundant system is one which will sustain two failures of one assembly/component and still retain the capability of performing the intended function. Such a system is frequently termed “fail operational/fail-safe”. This level of redundancy is attained by adding two like assemblies/components to the system. For example, if one battery is required to provide a source of firing current, two additional batteries provide dual-redundancy of the current source and the batteries are said to be dual-redundant.

Design - Design redundancy exists when redundant devices are of different designs, usually having different failure modes. For example, if an umbilical is severed by either a guillotine or an LSC, both mounted so as to perform the function, the severing system is both device redundant and design redundant.

RF - Radio Frequency.

RFI - Radio Frequency Interference.

RITOL - Pentaerythritol Tetranitrate (Per Picitinny Arsenal Technical Report #1740, Revision 1, Properties of Explosives of Military Interest).

RMS - Remote Manipulator System.

RSRM - Reusable Solid Rocket Motor.

RTV - Room Temperature Vulcanizing.

S&A - Safe and Arm.

S/A Device - A mechanical device for interrupting an explosive train (safe) when required to be in the unarmed condition and aligning the train so as to render it operative (armed) when required to be ready to fire.

scc - standard cubic centimeters.

Secondary Explosive - Explosive materials that are relatively insensitive to heat or impact and must be initiated by a suitable primary explosive or another secondary explosive. Secondary explosives are generally more brisant and more powerful than primary explosives; synonymous with “high explosive”.

Sensitivity - The characteristics of an explosive or component which express its susceptibility to initiation by externally applied energy. May apply to electrical, shock, or other stimuli.

Severance Target - Witness specimen used for evaluating performance of a detonating cutting charge such as MDF or LSC.

SFU - Standard Firing Unit.

SI - Standard Initiator.

SII - SRM Ignition Initiator.

SMDC - Shielded Mild Detonating Cord.

SSP Organization

Associate Administrator, Office of Space Flight (NASA Headquarters)
Space Shuttle Program Office (JSC)
Space Shuttle Vehicle Engineering Office (JSC)
Shuttle Project Office (KSC)
Shuttle Project Office (MSFC)
External Tank Project Office (MSFC)
Solid Rocket Booster Project Office (MSFC)
Reusable Solid Rocket Motor Project Office (MSFC)

SPWG - Shuttle Pyrotechnic Working Group.

Squib - A general term usually meaning any one of many EEDs such as NSI-1.

SR&QA - Safety, Reliability and Quality Assurance.

SRB - Solid Rocket Booster.

SRM - Solid Rocket Motor.

SRM Ignition Initiator (SII) - An NSI with a unitized wide body flange to accommodate the sealing requirements of the RSRM S&A device.

SRM Initiator - An initiator designed specifically for installation into the SRM S&A device and used for ignition of the SRBs for the Space Shuttle. Commonly referred to as the SII by the MSFC.

SSP - Space Shuttle Program.

SSPO - Space Shuttle Program Office (NASA).

Standoffl - The distance between the base of a shaped charge liner and the target material.

STS - Space Transportation System.

Test Bomb - A chamber into which cartridges are test fired to establish or verify performance characteristics such as the output pressure vs. operating time. These fixtures have a fixed, known volume (see also “closed bomb” and “vented bomb”).

Thru-Bulkhead Initiator (TBI) - An explosive initiator that provides a detonation transfer via a shock wave through an integral bulkhead without rupturing the bulkhead. Explosive material is packed intimately in cavities on both sides of the bulkhead.

Transfer Charge - A sealed assembly containing explosives designed to provide an alternate explosive path between explosive trains as in an elongated container containing bulk explosive to bridge the gap between two end-to-end positioned trains.

TSM - Tail Service Mast.

VAC - Vacuum.

VDC - Volts, Direct Current.

Vented Bomb - A closed bomb with an orifice to control venting of the gas pressure to the atmosphere.

X-ray - X radiography.

SYMBOLS

μf - microfarad.

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12.0 INDEX

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APPENDIX A

ARCHIVED DEVIATIONS/WAIVERS

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APPENDIX A

ARCHIVED DEVIATIONS/WAIVERS

1.0 PURPOSE AND SCOPE

The purpose of this appendix is to retain those Deviations/Waivers rescinded as a result of the STS 51-L accident and retired due to the expiration of effectivity.

1.1 RESCINDED DEVIATIONS/WAIVERS

The Deviations/Waivers contained in this section were approved prior to STS-51L. Any of these Deviations/Waivers that apply to future Space Shuttle missions must be resubmitted with appropriate rationale for SSP approval and reinstatement.

ARCHIVED DEVIATIONS/WAIVERS AUTHORIZED FOR REQUIREMENTS CONTAINED IN THIS DOCUMENT

1. REQUIREMENT: Paragraph 3.4.1.2 specifies the only connector configurations authorized for use in pyrotechnic systems shall be NBS 9E8-2SE, -2SF, -2SG, and -2SH. The use of other configurations and the use of the right-angle connectors shall require the specific approval of the SSPO. The four configurations above are restricted from use in non-pyrotechnic circuits in the vicinity of installed NSI-1.

WAIVER: Use right angle cable connectors NBS 8GE 8-2SE in lieu of connectors NBS 9E8-2SE to mate with the ET/SRB strut NSIs.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S03346R1, 4/14/77) and S40019R3, dated 8/26/87.

2. REQUIREMENT: Paragraph 3.5.9 specifies tensile coupons shall be required from component parts exposed to operating pressures and/or primary structure. The supplier shall establish and the NASA Project Office shall approve the minimum acceptance criteria of the above material properties at the baseline review.

Failure to meet these minimum acceptance criteria shall be cause for rejection of the component parts associated with those test coupons.

WAIVER: This requirement is waived for lot WAA, Nose Gear Extension Thruster Cartridge, MC325-006-0003, only.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S03798, 5/20/77) and S40019R3, dated 8/26/87.

3. REQUIREMENT: Paragraph 7.3 specifies that for electrically initiated pyrotechnic systems, a circuit resistance check will be performed after all flight connections are made.

DEVIATION: A circuit resistance check will not be required on the ET tumble system pyrotechnic valve fire circuit after the Orbiter/ET interface connectors have been mated.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S00833F, 9/14/77) and S40019R3, dated 8/26/87.

4. REQUIREMENT: Paragraph 3.5.3.1 specifies that the use of reclaimed high explosive material is prohibited.

WAIVER: Reclaimed MIL-R-398 (Type A) RDX may be used in the 10A00462 CDF manifold.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S05212, 11/29/78) and S40019R3, dated 8/26/87.

5. REQUIREMENT: Paragraph 3.6.18.1 specifies that all propellant operated devices be proof tested to 1.2 times the maximum anticipated operating pressure.

DEVIATION: The forward ET attach bolt housing and cartridge shall be subjected to a proof pressure of 31,500+ 1000 psi (0.5 MOP) for 35 seconds. The maximum allowable permanent set for the top surface of flight bolt housing is 0.006". Any flight part exceeding this permanent set will be rejected. A dye penetrant inspection of the bolt housing and cartridge will be conducted after the housing shall be ultra sonically inspected and 100% dimensionally checked to the manufacturing drawing.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S05349, 3/7/79) and S40019R3, dated 8/26/87.

6. REQUIREMENT: Paragraph 3.6.18.1 specifies that all propellant operated devices be proof tested to 1.2 times the maximum anticipated operating pressure.

WAIVER: This requirement is waived for all qualification and production units for the SRB Project Thruster Pressure Cartridge (10A00459).

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S37114R1, 10/11/79) and S40019R3, dated 8/26/87.

7. REQUIREMENT: Paragraph 3.6.18.1 specifies that all propellant operated devices be proof tested to 1.2 times the maximum anticipated operating pressure.

WAIVER: This requirement is waived for all qualification and production units for the SRB Project Nose Cap Thruster (10A00458).

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S37115R1, 10/11/79) and S40019R3, dated 8/26/87.

8. REQUIREMENT: Paragraph 8.2.3 specifies that firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electrical control, RF transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

DEVIATION: For the Orbiter vehicle, firing circuits may be routed in bundles with other circuits classified as Low Level Instrumentation (ML) as long as dedicated pyro connectors are provided at each interface.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S03794, 7/18/77) and S40019R3, dated 8/26/87.

9. REQUIREMENT: Paragraph 4.5.1.4 specifies that 10% (or 10 units minimum) from each lot be fired in destructive lot acceptance tests.

WAIVER: The destructive test sample size for the Tail Service Mast Bonnet Thrusters shall be as follows:

Lot Size*	Sample Size**
1 - 9	3
91 - 150	10 plus 11.7% of quantity above 90
151 - 280	17 plus 9.2% of quantity above 150
281 - 500	29 plus 8.2% of quantity above 280
501 - 1200	47 plus 4.3% of quantity above 500
1201 - 3200	77 plus 2.3% of quantity above 1200

* Lot size equals sample size plus usable units.

** Fractional sample sizes 0.5 and above shall be rounded upward and sizes below 0.5 shall be rounded downward.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13110, 4/4/80) and S40019R3, dated 8/26/87.

10. REQUIREMENT: Paragraph 3.4.1.1 specifies use of the MSFC connector 40M38298 shall be used throughout the Space Shuttle to connect firing circuits to the NSI-1.

WAIVER: The external tank tumble valve shall use a MSFC connector 40M38298 modified with a MMC/Denver ST81D141 coupling ring.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S05769, 3/30/80) and S40019R3, dated 8/26/87.

11. REQUIREMENT: Paragraph 3.4.1 specifies that the NASA Standard Initiator, Type I (NSI-1), JSC/SEB26100001, shall be the standard Electro Explosive Device (EED) for the Space Shuttle and shall be provided as Government Furnished Equipment (GFE) to all users by the Johnson Space Center (JSC), and shall conform to JSC/SKB26100066.

WAIVER: This requirement is waived for the gas sampler application. The selected valve is qualified using an initiator developed for use on the Gemini Program.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S02227AR3, 7/1/80) and S40019R3, dated 8/26/87.

12. REQUIREMENT: Paragraph 7.1 specifies annual destructive performance testing for each lot of explosively loaded devices or assemblies at the launch site.

DEVIATION: For lots flown from VAFB, shipment of test articles to KSC for destructive testing is authorized.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S14559, 2/25/81) and S40019R3, dated 8/26/87.

13. REQUIREMENT: Paragraph 3.6.4 specifies that all devices be sealed to protect explosive materials from contaminants and exposure to vacuum environment.

WAIVER: This waiver allows the initiator closure disk on the “Fire #1” initiator (gas sampler) to be removed and replaced with an epoxy seal to prevent valve damage and leaks caused by the stainless steel closure disk.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S14895, 2/10/81) and S40019R3, dated 8/26/87.

14. REQUIREMENT: Paragraph 3.6.18.1 specifies that all components exposed to operating pressure shall be capable of withstanding an internal proof pressure of 1.2 times the maximum operating pressure without permanent deformation or leakage.

WAIVER: This waiver allows that a vent hole be drilled into the gas sampler valve body subsequent to the manufacturers hydrostatic tests.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S14895, 2/10/81) and S40019R3, dated 8/26/87.

15. REQUIREMENT: Paragraph 3.6.18.1 specifies that all components exposed to operating pressure shall be capable of withstanding an internal proof pressure of 1.2 times the maximum operating pressure without permanent deformation or leakage.

WAIVER: This waiver allows for the out casing of the TSM Bonnet Thrusters to be pressure tested during refurbishment prior to final assembly.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13110C, 3/20/81) and S40019R3, dated 8/26/87.

16. REQUIREMENT: Paragraph 3.5.8 requires separation of dissimilar metals which tend toward active electrolytic or galvanic corrosion.

WAIVER: The use of copper sheath to contain the HMX explosive and the swaging of anodized aluminum end fittings, using an adhesive between the copper and the aluminum end fittings, on the Linear Shaped Charges is authorized for STS-2 and subs.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13703B, 9/7/81) and S40019R3, dated 8/26/87.

17. REQUIREMENT: Paragraph 8.2.1 specifies that firing lines be isolated from vehicle direct current returns through a minimum of 100K ohms resistance. Voltage breakdown from the balanced two-wire line to vehicle structure or direct current return shall be greater than 1500 VAC RMS at a frequency of 60 Hertz.

WAIVER: For STS-2 and subs, the ET RSS actuation system circuit isolation shall be a minimum of 2 megohms at 1500 VDC.

The ET Tumble Valve actuation system circuit isolation shall be a minimum of 100 megohms at 500 VDC.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13703B, 9/7/81) and S40019R3, dated 8/26/87.

18. REQUIREMENT: Paragraph 8.2.3 specifies that firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electric control, RF transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

WAIVER: The requirement for isolation of the firing circuit wiring and all other current carrying circuits for the ET Tumble System is waived for STS-2 and subs.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13703B, 9/7/81) and S40019R3, dated 8/26/87.

19. REQUIREMENT: Paragraph 8.2.4 specifies that arm/disarm indicator circuits be isolated from firing circuits.

WAIVER: The requirement for isolation between the arm/disarm indicator circuits and the firing circuit for the ET Tumble System is waived for STS-2 and subs.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S13703B, 9/7/81) and S40019R3, dated 8/26/87.

20. REQUIREMENT: Paragraph 6.3.1 specifies that one reproducible copy of the lot certificate shall accompany each shipment from the manufacturer to a vehicle installation site and shall constitute the only acceptance data provided to the consignee. Additionally, all “M” lot NSIs shipped from the manufacturer to destinations other than JSC must be accompanied by a lot certificate. All pyrotechnic devices identified with Shuttle Program part, lot or serial numbers are subject to these provisions.

DEVIATION: Nozzle severance pyrotechnic parts (Lot AAB) may be shipped installed on STS-5 and STS-6 SRM nozzle exit cones prior to completion of flight certification. Qualification and flight certification will be completed prior to flight.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S67665, 5/18/82 and S67665A, 7/27/82) and S40019R3, dated 8/26/87.

21. REQUIREMENT: Paragraph 6.3.1 specifies that one reproducible copy of the lot certificate shall accompany each shipment from the manufacturer to a vehicle installation site and shall constitute the only acceptance data provided to the consignee. Additionally, all “M” lot NSIs shipped from the manufacturer to destinations other than JSC must be accompanied by a lot certificate. All pyrotechnic devices identified with Shuttle Program part, lot or serial numbers are subject to these provisions.

WAIVER: For STS-6, this requirement is waived for shipment of the emergency egress window pyrotechnic devices MC325-0027-0002 (S/N 17610-00002, LOT WAA), MC325-0027-0005 (S/N 17610-00003, LOT WAA), and MC325-0027-0006 (S/N 17610-0001, LOT WAA) prior to their flight certification.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S21520 3/20/82) and S40019R3, dated 8/26/87.

22. REQUIREMENT: Paragraph 6.3.1 specifies that one reproducible copy of the lot certificate shall accompany each shipment from the manufacturer to a vehicle installation site and shall constitute the only acceptance data provided to the consignee. Additionally, all “M” lot NSIs shipped from the manufacturer to destinations other than JSC must be accompanied by a lot certificate. All pyrotechnic devices identified with Shuttle Program part, lot or serial numbers are subject to these provisions.

WAIVER: For STS-6, this requirement is waived for shipment of the following emergency egress pyrotechnic transfer system components prior to their flight certification:

SMDC Lines Assemblies

P/N	LOT NO.
MC325-0004-0728 thru MC325-0004-0735	17610-WAN
MC325-0004-0728 thru MC325-0004-0745	17610-WAN
MC325-0004-0748 thru MC325-0004-0750	17610-WAN
MC325-0004-0763 thru MC325-0004-0765	17610-WAN

CDC Line Assemblies

P/N	LOT NO.
MC325-0004-0128 thru MC325-0004-0139	17610-WAF

Thru Bulkhead Initiator

P/N	LOT NO.
MC325-0004-0003	17610-WAD
MC325-0004-0023	17610-WAD

Time Delay

P/N	LOT NO.
MC325-0004-0300	17610-WAE

AUTHORITY: Level II PRCBDs S21391, dated 12/9/72 (Reference S21521, 7/30/82) and S40019R3, dated 8/26/87.

23. REQUIREMENT: Paragraph 6.3.1 specifies that one reproducible copy of the lot certificate shall accompany each shipment from the manufacturer to a vehicle installation site and shall constitute the only acceptance data provided to the consignee. Additionally, all “M” lot NSIs shipped from the manufacturer to destinations other than JSC must be accompanied by a lot certificate. All pyrotechnic devices identified with Shuttle Program part, lot or serial numbers are subject to these provisions.

DEVIATION: SRM initiators (P/N SED26100107-301, LOT HWA) with backup rings may be shipped for installation into the S and

A's to support STS-6 and QM5 firing prior to completion of flight certification.

AUTHORITY: Level II PRCBDs S21391, dated 12/9/82 (Reference S21602, 7/29/82) and S40019R3, dated 8/26/87.

24. REQUIREMENT: Paragraph 4.5.3.2.2 specifies that all explosive trains shall be examined by neutron radiograph per Rockwell/SD Specification MT0501-505 to verify that the pyrotechnic charge components are present and properly oriented in accordance with the applicable drawings, that there are no missing or improperly oriented details and that there are no included foreign objects, materials, or unacceptable voids. Each train shall be radiographed in one view along the longitudinal axis; the original negative shall be submitted per 5.4.2 and a copy shall be retained in the permanent files of the supplier. When external finishes, adhesive potting materials, etc., would reduce the resolution of the radiograph the radiograph shall be made prior to the application of these materials.

WAIVER: This waiver allows, for STS-15 and subs, the use of Thiokol Specification STW7-3132 (P/N 1U52306, Lot No. AAD and subs) for neutron radiography of SRM nozzle severance ring segments.

AUTHORITY: Level II PRCBDs S20792A, dated 2/3/83 and S40019R3, dated 8/26/87.

25. REQUIREMENT: Paragraph 7.2.4.2 specifies that the bridgewire resistance is 1.0 (plus or minus .10) ohms and is within .05 ohms of the value recorded on the appropriate lot certification, using the Initiator Resistance Measuring Equipment (IRME).

WAIVER: This waiver allows, for STS-8, the use of Thiokol ordnance low current circuit tester for bridgewire resistance measurement (1.05 + 0.10 ohms) of SRM LSC initiator.

AUTHORITY: Level II PRCBDs S77949, dated 6/6/83 and S40019R3, dated 8/26/87.

26. REQUIREMENT: Paragraph 7.1 specifies an annual destructive performance test shall be performed at the launch site on each lot of

explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB range safety system, (b) SRB recovery systems, (c) ET range safety system (d) ET tumble valve system, (e) crew escape, (f) tail service mast disconnect system, (g) H_2 gas sampler to assure that no deterioration from handling or shipment has occurred which would result in unacceptable flight performance of that lot....

WAIVER: This waiver allows, for STS-7 only, the use of GUCP pressure cartridges from Lot 13-34920 that have not been annually tested.

AUTHORITY: Level II PRCBDs S87080, dated 6/10/83 and S40019R3, dated 8/26/87.

27. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage) specifies that the design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years.

WAIVER: For the Centaur Project/Payload, Centaur Super Zip Program, the requirement for a substantiated shelf life of 10 years is relaxed to 5 years. LMSC has no actual test data to substantiate a life greater than 5 years although a detailed analysis of the design, material and packaging of LMSC pyrotechnics would indicate a probable shelf life in excess of 10 years.

AUTHORITY: Level II PRCBDs S10111, dated 1/3/85 and S40019R3, dated 8/26/87.

28. REQUIREMENT: Paragraph 5.4 PHASE III, LOT ACCEPTANCE/ CERTIFICATE REVIEWS. The Phase III review shall be conducted after the pyrotechnic devices have been manufactured and presented to the customer for acceptance...

WAIVER: This waiver, for STS 51-C only, allows use of pyrotechnics from Lot AAA (S/Ns 21, 22 and 24) which have been

reviewed by Phase III after pyrotechnic loading, but not before end item assembly.

AUTHORITY: Level II PRCBDs S31524, dated 1/7/85 and S40019R3, dated 8/26/87.

29. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. A lot certificate shall be issued for each lot of pyrotechnic devices. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager, or equivalent...

WAIVER: This waiver allows, for STS 51-C only, use of end item and pyrotechnic devices from Lot AAA (S/Ns 21, 22 and 24) which have been certified by the appropriate element contractor engineering and quality assurance representatives only.

AUTHORITY: Level II PRCBDs S31524, dated 1/7/85 and S40019R3, dated 8/26/87.

30. REQUIREMENT: Paragraph 5.4 PHASE III, LOT ACCEPTANCE/ CERTIFICATE REVIEWS. The Phase III review shall be conducted after the pyrotechnic devices have been manufactured and presented to the customer for acceptance...

WAIVER: This waiver allows use of pyrotechnics from Lot AAA (S/Ns 19, 20, 21, 22, 23, 25 and 26) which have been reviewed by Phase III after pyrotechnic loading, but not before end item assembly.

AUTHORITY: Level II PRCBDs S31524A, dated 2/13/85 and S40019R3, dated 8/26/87.

31. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. A lot certificate shall be issued for each lot of pyrotechnic devices. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager, or equivalent...

WAIVER: This waiver allows use of end item and pyrotechnic devices from Lot AAA (S/Ns 19, 20, 21, 22, 23, 25 and 26) which have been certified by the appropriate element contractor engineering and quality assurance representatives only.

AUTHORITY: Level II PRCBDs S31524A, dated 2/13/85 and S40019R3, dated 8/26/87.

32. REQUIREMENT: Paragraph 7.1 PREFLIGHT VERIFICATION TESTING (PVT). An annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB range safety system, (b) SRB recovery systems, (c) ET range safety systems, (d) ET tumble valve system, (e) crew escape, (f) Tail Service Mast Disconnect System (g) H_2 Gas Sampler to assure that no deterioration from handling or shipping has occurred which would result in unacceptable flight performance of that lot...

WAIVER: This waiver allows, for STS 51-C only, the use of NSI pressure cartridges from Lot AAE that have not been tested within the past year.

AUTHORITY: Level II PRCBDs S90469, dated 1/7/85 and S40019R3, dated 8/26/87.

33. REQUIREMENT: Paragraph 7.1 PREFLIGHT VERIFICATION TESTING (PVT). An annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies... This test shall be performed as late as possible prior to flight use of the lot and shall be repeated annually until the lot is expended...

WAIVER: The requirement for annual pyro verification testing of L/N MNE is waived through 3-88.

AUTHORITY: Level II PRCBDs S66251, dated 3/19/85 and S40019R3, dated 8/26/87.

34. REQUIREMENT: Paragraph 9.2.1.1 Forecasts of Requirements. a. Life of the NSI-1: 10 years from date of manufacture. Life of NSI-1 based cartridges: 10 years from date of manufacture of NSI-1 or cartridge, whichever is earliest.

Life of the NSD: 10 years from date of manufacture.

WAIVER: The 10 years age life for NSI installed in the Orbiter fire suppression system is extended 3 years for L/Ns MNE and MCB.

AUTHORITY: Level II PRCBDs S66251, dated 3/19/85 and S40019R3, dated 8/26/87.

35. REQUIREMENT: Paragraph 5.4 PHASE III, LOT ACCEPTANCE/ CERTIFICATE REVIEWS. The Phase III review will be conducted prior to issuing a lot certificate... A Phase III review team shall consist of NASA engineering and NASA quality assurance personnel who have detailed knowledge of the specific device.

WAIVER: This waiver allows use of 3.5 frangible nuts from Lot AAC (S/Ns 289, 290, 292, 294, 295, 296, 298, 299, 301, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334) which have not been reviewed by a complete Phase III team.

AUTHORITY: Level II PRCBDs S90913, dated 5/13/85 and S40019R3, dated 8/26/87.

36. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of 3.5 frangible nuts from Lot AAC (S/Ns 289, 290, 292, 294, 295, 296, 298, 290, 292, 294, 295, 296, 298, 299, 301, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334) which have not been reviewed by a complete Phase III team.

AUTHORITY: Level II PRCBDs S90913, dated 5/13/85 and S40019R3, dated 8/26/87.

37. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATE REVIEWS. The Phase III review shall be conducted after the pyrotechnic devices have been manufactured and presented to the customer for acceptance.

WAIVER: This waiver allows use of pyrotechnics from Lot AAA (S/Ns 34, 35, 36, 37 and 39) which have been reviewed by Phase II after pyrotechnic loading, but not before end item assembly.

AUTHORITY: Level II PRCBDs S31524B, dated 6/20/85 and S40019R3, dated 8/26/87.

38. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of end item and pyrotechnic devices from Lot AAA (S/Ns 34, 35, 36, 37, and 39) which have been certified by the appropriate element contractor engineering and quality assurance representatives only.

AUTHORITY: Level II PRCBDs S31524B, dated 6/20/85 and S40019R3, dated 8/26/87.

39. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATE REVIEW. The Phase III review will be conducted prior to issuing a lot certificate. A Phase III review team shall consist of NASA engineering and NASA quality assurance personnel who have detailed knowledge of the specific device.

WAIVER: This waiver allows use of 168 confined detonating fuse initiators from Lot AAK, S/Ns 1786 thru 2054 which have not been reviewed by a complete Phase III team.

AUTHORITY: Level II PRCBDs S90437C, dated 6/24/85 and S40019R3, dated 8/26/87.

40. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of confirmed detonating fuse initiators from Lot AAK S/Ns 1786 thru 2054 which have not been reviewed by a complete Phase III team.

AUTHORITY: Level II PRCBDs S90437C, dated 6/24/85 and S40019R3, dated 8/26/87.

41. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATE REVIEW specifies the Phase III lot acceptance/certificate review will be conducted prior to issuing a lot certificate... A Phase III review team shall consist of NASA engineering and NASA quality assurance personnel who have detailed knowledge of the specific device.

WAIVER: This waiver allows the following pyrotechnics lots be used.

PART NO.	PART NAME	LOT NO.	SERIAL NO.	QUANTITY
10308-0003-801	CDF INITIATOR	AAL	2070 thru 2203	99
10302-0001-801	AFT SEPARATION BOLT	AAJ	477 thru 509	20
10302-0001-801	AFT SEPARATION BOLT	AAK	511 thru 579	47
10302-0001-801	AFT SEPARATION BOLT	AAL	583 thru 661	60
10304-0001-801	NOSE CAP THRUSTER ASSY	AAF	337 thru 467	115
10303-0001-801	NSI PRESSURE CARTRIDGE	AAJ	1434 thru 1708	240
10305-0001-801	THRUSTER PRESSURE CARTRIDGE	AAL	504 thru 698	148
10314-0001-XXX	CDF ASSY	AAT	4325 thru 4535	178
10314-0001-XXX	CDF ASSY	AAS	4083 thru 4324	203
10307-0001-801	FRANGIBLE NUT BOOSTER	AAB	336 thru 636	242

AUTHORITY: Level II PRCBDs S91307, dated 7/24/85 and S40019R3, dated 8/26/87.

42. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. A lot certificate shall be issued for each lot of pyrotechnic devices. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of the following pyrotechnics component lots list.

PART NO.	PART NAME	LOT NO.	SERIAL NO.	QUANTITY
10308-0003-801	CDF INITIATOR	AAL	2070 thru 2203	99
10302-0001-801	AFT SEPARATION BOLT	AAJ	477 thru 509	20
10302-0001-801	AFT SEPARATION BOLT	AAK	511 thru 579	47
10302-0001-801	AFT SEPARATION BOLT	AAL	583 thru 661	60
10304-0001-801	NOSE CAP THRUSTER ASSY	AAF	337 thru 467	115
10303-0001-801	NSI PRESSURE CARTRIDGE	AAJ	1434 thru 1708	240
10305-0001-801	THRUSTER PRESSURE CARTRIDGE	AAL	504 thru 698	148
10314-0001-XXX	CDF ASSY	AAT	4325 thru 4535	178
10314-0001-XXX	CDF ASSY	AAS	4083 thru 4324	203
10307-0001-801	FRANGIBLE NUT BOOSTER	AAB	336 thru 636	242

AUTHORITY: Level II PRCBDs S91307, dated 7/24/85 and S40019R3, dated 8/26/87.

43. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATION REVIEWS. The Phase III review will be conducted after the pyrotechnic devices have been manufactured and presented to the customer for acceptance.

WAIVER: This waiver allows use of pyrotechnics from Lot AAA (S/Ns 41, 42, 43, 44 and 45) which have been reviewed by Phase II after pyrotechnic loading, but not before end item assembly.

AUTHORITY: Level II PRCBDs S31524C, dated 8/29/85 and S40019R3, dated 8/26/87.

44. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of end item and pyrotechnic devices from Lot AAA (S/Ns 41, 42, 43, 44 and 45) which have been certified by the appropriate element contractor engineering and quality assurance representatives only.

AUTHORITY: Level II PRCBDs S31524C, dated 8/29/85 and S40019R3, dated 8/26/87.

45. REQUIREMENT: Paragraph 8.2.3 Wire Routing. Firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits.

WAIVER: The requirement for separate routing for firing circuit wiring is waived for STS 51-I, ET-21, only.

AUTHORITY: Level II PRCBDs S90833, dated 8/21/85 and S40019R3, dated 8/26/87.

46. REQUIREMENT: Paragraph 8.2.4 Arm/Disarm Indicator Circuits. Arm/Disarm indicator circuits are required... These circuits shall be isolated from firing circuits.

WAIVER: The requirement for separate wiring for the Arm/Disarm indicator circuits is waived for STS 51-I, ET-21, only.

AUTHORITY: Level II PRCBDs S90833, dated 8/21/85 and S40019R3, dated 8/26/87.

47. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATE REVIEWS. The Phase III review will be conducted prior to issuing a lot certificate. A Phase III review team shall consist of NASA engineering and NASA quality assurance personnel who have detailed knowledge of the specific device.

WAIVER: This waiver allows use of 3.5 frangible nuts from Lot AAD (S/Ns 000347 thru 000385) and Lot AAE (S/Ns 000398 thru 000440) which have not been reviewed by a complete Phase III team.

AUTHORITY: Level PRCBDs S90913A, dated 6/19/85 and S40019R3, dated 8/26/87.

48. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows use of 3.5 frangible nuts from Lot AAD (S/Ns 000347 thru 000385) and Lot AAE (S/Ns 000398 thru 000440) which have not been reviewed by a complete Phase III team.

AUTHORITY: Level II PRCBDs S90913A, dated 6/19/85 and S40019R3, dated 8/26/87.

49. REQUIREMENT: Paragraph 5.4 PHASE III LOT ACCEPTANCE/ CERTIFICATION REVIEWS. The Phase III review will be conducted after the pyrotechnic devices have been manufactured and presented to the customer for acceptance.

WAIVER: This waiver, for STS 61-C only (S/N 33), allows use of pyrotechnics from Lot AAA which were subjected to Phase III review after pyrotechnic loading, but not before end item assembly.

AUTHORITY: Level II PRCBDs S91465, dated 12/5/85 and S40019R3, dated 8/26/87.

50. REQUIREMENT: Paragraph 5.4.3 Lot Certificate. The certificate shall be signed by appropriate element contractor engineering and quality assurance representatives and shall be approved by the cognizant NASA quality assurance representative and the Pyrotechnics Subsystem Manager or equivalent.

WAIVER: This waiver allows, for STS 61-C only (S/N 33), use of end item and pyrotechnic devices from Lot AAA which have been certified by the appropriate element contractor engineering and quality assurance representatives only.

AUTHORITY: Level II PRCBDs S91465, dated 12/5/85 and S40019R3, dated 8/26/87.

1.2 RETIRED DEVIATIONS/WAIVERS

The Deviations/Waivers contained in this section have been removed from the list of active Deviations/Waivers because of expiration of effectivity.

51. REQUIREMENT: Paragraph 3.6.2, Installation, Replaceability, Maintainability, and Interchangeability, specifies that installation of all components and subsystems shall be controlled by detailed procedures specifying step-by-step details, including techniques and the equipment to be used for inspection. Provisions shall be made for design tolerances and buildups such that items having the dimensions and characteristics permitted by the item specification or drawing are interchangeable without selection or departure from the specified equipment performance. Appropriate warnings pertaining to the fragility and hazardous nature of pyrotechnic devices shall be incorporated into all assembly and installation procedures. Wherever practicable, but consistent with the provisions of Paragraph 3.6.1.2, the loaded pyrotechnic device (e.g., NSI-1 or cartridge assembly) shall be designed to be accessible for inspection and/or changeout. Duplication of thread sizes on cartridges shall be avoided to prevent installation of and incorrect cartridge. Where appropriate, adjacently located cartridges shall utilize the NSI-1 connector indexing technique (Paragraph 3.4.1.1) to prevent errors in electrical connector installations. Pyrotechnic devices shall not be installed in the proximity of heat sources that could case ignition or degradation of the pyrotechnic components.

WAIVER: The constraint on duplication of thread sizes on cartridges is waived, for STS-26 and subs, for CDF pressure cartridges (10319-0002-801 and 802, all serial numbers) and CDF initiators (10308-0003-801, all serial numbers).

AUTHORITY: Level II PRCBD S92329, dated 2/5/88.

52. REQUIREMENT: Paragraph 8.2.3, Wire Routing, specifies that firing circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electrical control, RF transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

DEVIATION: For the Orbiter vehicle, firing circuits may by routed in bundles with other circuits classified as low level instrumentation (ML) as long as dedicated pyro connectors are provided at each interface.

AUTHORITY: Level II PRCBD S03422C, dated 6/18/88.

53. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies that a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: This waiver allows use of delay cutter assemblies of lot AAF (all serial numbers) which have different blends of SOS-285, ignition charge for SRBs BI-029 thru BI-999.

AUTHORITY: Level II PRCBD S92305, dated 5/4/88.

54. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies that a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: This waiver allows use of delay cutter assemblies of lot AAG (all serial numbers) which have different blends of SOS-285, ignition charge for SRBs BI-029 thru BI-999.

AUTHORITY: Level II PRCBD S92305A, dated 5/4/88.

55. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies that a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: This waiver allows use of reefing line cutter blades installed in lots AAF thru AAM (all serial numbers) for SRBs BI-029 thru BI-999.

RATIONALE: Destructive Lot Acceptance Testing (DLAT) verified the Kevlar cutting capability of all heat treat lots used within lot AAF and AAG. Additionally, tensile testing of each heat treat log and 100% RC inspection of all heat treated blades provides the necessary assurance that the blades meet engineering process requirements. It is recommended that the single lot requirement for blades be waived for lots AAF and AAG.

Based on the proceeding acceptance rationale, it is recommended that the single lot requirement for blades also be waived for lots AAH, AAJ, AAK, AAL and AAM.

EFFECTIVITY: BI-029 thru BI-999

AUTHORITY: Level II PRCBDs S92305B, dated 5/4/88 and S92305E, dated 5/22/89.

56. REQUIREMENT: Paragraph 3.6.18.1, General, (a) specifies that for this type of device a separable cartridge assembly is preferred over

an integral charge for safety, ease of installation and replacement, and to allow flexibility of installation scheduling during prelaunch operations. All components exposed to operating pressure shall be capable of withstanding the following pressures:

a. An internal proof pressure of 1.2 times the maximum operating pressure without permanent deformation or leakage. The maximum operating pressure shall be defined as the highest measured operating pressure from a minimum of 5 firings using nominal cartridge load. This requirement must be demonstrated on all qualification and production hardware.

WAIVER: This waiver allows use of the reefing line cutter assemblies in lots AAA thru AAG (all serial numbers) for SRBs BI-029 thru BI-999.

AUTHORITY: Level II PRCBD S92305C, dated 5/4/88.

60. REQUIREMENT: Paragraph 3.1, RELIABILITY, specifies all pyrotechnic devices and systems shall comply with the applicable provisions of Paragraph 3.5.1, NSTS 07700, Volume X. All devices whose functions are required for the safe recovery of Orbiter vehicle and crew shall not be less than fail-safe. Crew and mission criticality shall be the primary consideration in redundancy requirements. Elimination of single

failure points is the primary reliability consideration in the design of pyrotechnics. Each redundant path shall be verified by test. Reliability shall comply with the provisions of NHB 5300.4 (1D-2).

WAIVER: The ET tumbling system shall not require redundant valves and associated electrical circuits for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

61. REQUIREMENT: Paragraph 3.4.1, NASA Standard Initiator, specifies use of the MSFC connector 40M38298 shall be used throughout the Space Shuttle to connect firing circuits to the NSI-1.

WAIVER: The ET tumble valve shall use a MSFC connector 40M38298 modified with a MMC/Denver ST81D141 coupling ring for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

62. REQUIREMENT: Paragraph 3.5.8, Dissimilar Metals, specifies dissimilar metals which tend toward active electrolytic or galvanic corrosion when in direct contact with each other shall not be used in application requiring direct contact. JSCM 8080-63 defines dissimilar metals.

WAIVER: An epoxy sealant/adhesive may be applied, to the copper sheath during the swaging of the aluminum end fittings on the linear shaped charges for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

63. REQUIREMENT: Paragraph 7.3, INSTALLATION AND CHECKOUT, specifies installation and checkout for electrically initiated pyrotechnic systems perform stray voltage checks, circuit resistance check (including circuit resistance after all flight connections are made, including NSI-1 connections) and high energy squib simulator checks using the appropriate onboard, built-in, test or GSE equipment, or that listed below. JSCM 8080-7 and 85 are applicable.

- Stray Voltage Tester (C72-1127)

- NSI-1 Load Simulator

- Pyro Checkout Module (C72-1138)

WAIVER: A circuit resistance check will not be required on the ET tumble system pyrotechnic valve fire circuit after the Orbiter/ET interface connectors have been mated for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

64. REQUIREMENT: Paragraph 8.2.1, Circuit Characteristics, specifies circuit characteristics to prevent adverse effects of common mode currents, each EED shall be supplied by a balanced,

shielded, twisted-pair line. The line shall not be connected directly to vehicle structure and will be isolated from vehicle direct current returns through a minimum of 100K ohms resistance. Voltage breakdown from the balanced two-wire line to vehicle structure or direct current return shall be greater than 1500 VAC RMS at a frequency of 60 hertz.

WAIVER: The ET RSS firing circuit and the ET tumble valve firing circuit (armed condition) shall not be required to meet the voltage breakdown requirement (1500 VAC to vehicle structure) as specified in NSTS 08060 Paragraph 8.2.1. The tumble system and RSS EED circuits shall meet 100 megaohms isolation resistance at 500 VDC.

The tumble valve firing circuit (safe condition) shall not be required to meet the minimum 100K ohms isolation from direct current returns prior to the arm command as specified in NSTS 08060 Paragraph 8.2.1. The tumble system shall be connected to structure through a 10K ohms static bleed resistor switched out of the circuit when the system is armed for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

65. REQUIREMENT: Paragraph 8.2.3, Wire Routing, specifies fire circuit wiring shall be routed separately (in separate trays or conduit) from all other current carrying circuits including electrical power, electrical control, RF transmission lines, and monitoring circuitry. Circuits routed through a single multicircuit connector do not satisfy this requirement.

Paragraph 8.2.4 specifies arm/disarm indicator circuits are required and shall be hardwired for mission critical functions, or the indicator circuits shall be at least as reliable as the operational firing circuits. These circuits shall be isolated from firing circuits.

WAIVER: The tumble valve actuation system circuit wiring shall be routed within cable trays and shall not be separate from all other circuits for ET-23, ET-27 thru ET-29 and ET-31 thru ET-999.

AUTHORITY: Level II PRCBD S40732F, dated 6/24/88.

66. REQUIREMENT: Paragraph 4.5.1.4, Destructive Test Sample Size, specifies as follows:

The number of parts to be fired from variously sized lots of loaded pyrotechnic devices shall be 10% of the lot or 10 units minimum.

a. Lot size equals number of units presented for lot acceptance tests.

b. Fractional sample sizes 0.5 and above shall be rounded upward and sizes below 0.5 shall be rounded downward.

WAIVER: Destructive Test Sample Size: For STS-26 and subs, the sample size for the tail service mast bonnet thruster shall be as follows:

Lot Size*	Sample Size**
1 - 9	3
10 - 24	3
25 - 49	3
50 - 90	5
91 - 150	10 plus 11.7% of quantity above 90
151 - 280	17 plus 9.2% of quantity above 150
281 - 500	29 plus 8.2% of quantity above 280
501 - 1200	47 plus 4.3% of quantity above 500
1201 - 3200	77 plus 2.3% of quantity above 1200

* Lot size equals sample size plus usable units

** Fractional sample sizes 0.5 and above shall be rounded upward and sizes below 0.5 shall be rounded downward.

AUTHORITY: Level II PRCBD S13110E, dated 8/29/88.

67. REQUIREMENT: Paragraph 3.7.1, Shelf Life (Ground Storage), specifies the design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these

same intervals for appropriate inspection if required by the responsible design organization. Performance tests shall be conducted at the launch site using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The requirement for comparison of test data with previous lot acceptance test data on CDF assemblies, P/N 10A00455, Lot AAD is waived for ET-23 and ET-28.

AUTHORITY: Level II PRCBD S40732L, dated 8/12/88.

68. REQUIREMENT: Paragraph 8.2.6, Pyrotechnic Initiator Controller (PIC), specifies PIC, ME450-0018-XXXX, shall be used to fire all NSI in the Shuttle Vehicle except the tumble and the H2 gas sampler.

MC450-0018: 3.1.2.1.1.3 Arm Duration. The duration of the arm command shall be 1.0 seconds minimum, and shall be maintained 5 milliseconds, minimum after both fire commands have been issued.

WAIVER: This waiver will allow the use of the software sequence that is in the current flight subsystems software requirements document (STS83-0026B) that removes the arm command one ET SEP sequence cycle, 160 milliseconds prior to issuing the fire command. The MEC retains the arm command for 140 $\pm$ 14 milliseconds, and the associated PICs introduce their own delay of up to 3.5 milliseconds, before the fire commands are executed. The worst case delay between cessation of the PIC arm command (PIC capacitor charging) and PIC firing is therefore 37.5 milliseconds.

This sequence would be used in the following contingency abort scenario: (1) Failure of 2 SSMEs, and (2) Failure to activate the nominal automatic ET separation sequence due to the failure of an ET feed valve to close, and (3) Activation

of the manual separation sequence for STS-26 thru STS-999/OI-8B only.

AUTHORITY: Level II PRCBD S41299, dated 8/12/88.

69. REQUIREMENT: Paragraph 3.12.1, Production Lot, specifies that a group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: This waiver allows use of CDF sleeves (Part Numbers 10314-001-101 thru 10314-001-135) consisting of two heat lots (AAK and AAL) of material.

AUTHORITY: Level II PRCBD S92305D, dated 8/29/88.

70. REQUIREMENT: Paragraph 3.6.18.1, General, specifies that for this type of device a separable cartridge assembly is preferred over an integral charge for safety, ease of installation and replacement, and to allow flexibility of installation scheduling during prelaunch operations. All components exposed to operating pressure shall be capable of withstanding the following pressures:

a. An internal proof pressure 1.2 times the maximum operating pressure without permanent deformation or leakage. The maximum operating pressure shall be defined as the highest measured operating pressure from a minimum of 5 firings using nominal cartridge load. This requirement must be demonstrated on all qualification and production hardware.

WAIVER: This waiver exempts, STS-26 and Subs, the tail service mast bonnet thrusters from the proof pressure test during original manufacture and refurbishment and allows the use of units on hand at KSC and units on order from the vendor at the time of waiver initiation (including new and refurbished units) to be used for ongoing STS launches.

A KSC safety review has concluded that the Shuttle is protected from debris resulting from possible rupture of the TSM thruster during the retraction internal by the TSM structure, the TSM purge curtains, and the TSM bonnet and has determined damage to the Orbiter/ET/SRM to be a noncredible failure.

AUTHORITY: Level II PRCBD S13110D, dated 9/2/88.

76. REQUIREMENT: Paragraph 7.1, PREFLIGHT VERIFICATION TESTING (PVT), specifies an annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB Range Safety System, (b) SRB Recovery Systems, (c) ET Range Safety System, (d) ET Tumble Valve System, (e) Crew Escape, (f) Tail Service Mast Disconnect System, and (g) H2 Gas Sampler to assure that no deterioration from handling or shipment has occurred which would result in unacceptable flight performance of that lot. This test shall be performed as late as possible prior to flight use of the lot and shall be repeated annually until the lot is expended. Tested lots shall be scheduled for installation during the following year. PVT shall be performed without prior environment exposure. The criteria for device performance shall be the same as for lot acceptance of the device. The test articles shall have been stored at the installation site or under the same environmental conditions. The test equipment, setup, instrumentation, and procedures shall duplicate those of lot acceptance testing insofar as practicable. The firing stimuli used for these tests shall be the SFU. JSC 8080-105B is applicable.

WAIVER: The above requirement is waived for the CDF Initiators (P/N 10308-0003-801, Lot AAN, all S/Ns) for STS-26 and subs.

AUTHORITY: Level II PRCBD S92329A, dated 9/10/88.

77. REQUIREMENT: Paragraph 3.6.18.1, General, specifies for this type of device a separable cartridge assembly is preferred over an integral charge for safety, ease of installation and replacement, and to allow flexibility of installation scheduling during prelaunch operations. All components exposed to operating pressure shall be capable of withstanding the following pressures:

b. An internal burst pressure of 1.25 times the proof pressure level as determined in 3.6.18.1a without structural failure (burst).

WAIVER: The above requirement is waived for the forward separation bolts for STS-26 and subs.

AUTHORITY: Level II PRCBD S95023, dated 9/10/88.

78. REQUIREMENT: Paragraph 4.1.2, Qualification Test, specifies that qualification tests shall be structured to verify the full range of the design requirements under specified environments as required by Paragraph 3.8.1.

WAIVER: The above requirement is waived for the overall Side Hatch Crew Escape System (SHCES, P/N V070-553411-001), the Thruster Assembly (P/N MC325-0041-0001) and the Cartridge Assembly (MC325-0041-0002) for STS-26 thru STS-32, STS-36 and STS-31.

AUTHORITY: Level II PRCBDs S76233, dated 9/10/88; S076233R1, dated 2/16/90 and S076233R3, dated 3/26/90.

79. REQUIREMENT: Paragraph 4.4.1.3.5, 85% Minimum Energy Test. When this test is specified, the device shall be functioned with a single charge or explosive load representing 85% by weight of the minimum allowable charge. Where multiple explosive components exist within an assembly, each component may be downloaded individually and tested in conjunction with nominal loads in the other components or a single test may be performed where all components are downloaded simultaneously.

WAIVER: The above requirement is waived for the hinge severance assembly (P/Ns MC325-0043-0001, -0002, -0004 and -0005, L/N WAA) for STS-26 thru STS-32 (November 1989).

AUTHORITY: Level II PRCBDs S76233D, dated 9/10/88 and S076233T, dated 2/13/90.

80. REQUIREMENT: Paragraph 3.6.18.1c, General, specifies that propellant gas operated devices shall be capable of the required performance with a single cartridge loaded with 85% (by weight of each pyrotechnic element) of the minimum allowable charge. This may be demonstrated by downloading the elements individually or collectively. Simulated, inert cartridges shall be installed in the redundant cartridge port(s) when demonstrating this capability. If multiple cartridges are used to achieve the required redundancy, each device shall be capable of the required performance with 85% (by weight) of the minimum allowable charge. The 85% single cartridge requirement must be demonstrated in qualification testing. When downloaded cartridges are not available, as in the case of the NSI-1 or a cartridge carried over from a prior program, other suitable methods to satisfy the intent of this requirement may be employed.

Paragraph 3.8.4.1, Eight Foot Drop, specifies that pyrotechnic loaded devices shall be capable of performing its function after being dropped from a height of eight feet.

Paragraph 3.8.4.2, Forty Foot Drop, specifies that pyrotechnic loaded devices shall not create a safety or disposal hazard as a result of a drop from a height of forty feet.

Paragraph 3.8.4.3, Auto Ignition, specifies that explosive and pyrotechnic materials selected shall not auto ignite when subjected to temperatures up to +275° F for a period of 5 minutes. The component is not required to function after exposure to this temperature.

WAIVER: This waiver allows use of RSRM S&A devices with out-of-specification conditions for STS-26 and STS-27.

AUTHORITY: Level II PRCBD S94991, dated 9/27/88.

81. REQUIREMENT: Paragraph 3.4.1.2, Authorized Configurations, specifies that the only connector configurations authorized for use in pyrotechnic systems shall be NBS 9E8-2SE, -2SF, -2SG, and -2SH. The use of other configurations and the use of right-angle connectors shall require the specific approval of the SSPO. The four configurations above are restricted from use in non-pyrotechnic circuits in the vicinity of installed NSI-1.

WAIVER: The above requirement is waived, for STS-26 and subs, to allow use of the NBS6G connector at the SRB holddown posts.

AUTHORITY: Level II PRCBD S041230V, dated 9/28/88 and S041062B, dated 4/5/93.

82. REQUIREMENT: Paragraph 7.2.1 Lot Certification. Verify by lot and serial number that each item is lot certified.

WAIVER: The above requirement is waived to allow use of H2 burn igniters, P/N 51-1151-1.

RATIONALE: Approve waiver of NSTS 08060, Paragraph 7.2.1, contingent upon successful completion of igniter testing at KSC. Shortage of LH2 pre-burn igniters would prevent scrub turn-around if abort occurs after T-10 seconds.

EFFECTIVITY: STS-28

AUTHORITY: Level II PRCBD S50728, dated 6/29/89.

83. REQUIREMENT: Paragraph 7.2.2 Age Life. Verify by lot and serial number that age life will not be exceeded during the Shuttle flight.

WAIVER: The above requirement is waived to allow use of H2 burn igniters, P/N 51-1151-1.

RATIONALE: Approve waiver of NSTS 08060, Paragraph 7.2.2, contingent upon successful completion of igniter testing at KSC. Shortage of LH2 pre-burn igniters would prevent scrub turn-around if abort occurs after T-10 seconds.

EFFECTIVITY: STS-28

AUTHORITY: Level II PRCBD S50728, dated 6/29/89.

84. REQUIREMENT: Paragraph 9.2.1.1 Forecasts of Requirements. Each element contractor shall submit an annual 2-year forecast of NSI-1 and NSD requirements to the appropriate NASA Project Office which shall review the contractor forecast, and requirements for other, noncontractor use (e.g., MSFC in-house Shuttle use) and forward the overall element forecast to the SSPO for approval and inclusion in the JSC budgetary estimates. Each forecast is due in the SSPO on November 1, and shall include the estimated requirements for the next 7 government fiscal years (e.g., due November 1, 1975, for GFY 1977-1983). The first 2 years of each forecast shall be by fiscal quarters and the remainder by year. Detailed justification for the first year requirements shall be included. NASA Form 558 shall be used. The following assumptions shall be used in estimating requirements:

a. Life of the NSI-1: 10 years from date of manufacture. Life of NSI-1 based cartridges: 10 years from date of manufacture of NSI-1 or cartridge, whichever is earliest.

   Life of the NSD: 10 years from date of manufacture.

WAIVER: The above requirement is waived to allow use of H2 burn igniters, P/N 51-1151-1.

RATIONALE: Approve waiver of NSTS 08060, Paragraph 9.2.2.1a, contingent upon successful completion of igniter testing at KSC. Shortage of LH2 pre-burn igniters would prevent scrub turn-around if abort occurs after T-10 seconds.

EFFECTIVITY: STS-28

AUTHORITY: Level II PRCBD S50728, dated 6/29/89.

85. REQUIREMENT: Paragraph 3.12.1 Production Lot. A group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: The above requirement is waived to allow use of NASA Standard Initiator (NSI) Lot MDF to be tested and certified as a single lot.

RATIONALE: NASA Standard Initiator Lot MDF contains two lots of header assemblies. Partitioning the NASA standard initiators with different header assemblies would require reidentification of initiator lot number and additional lot acceptance testing.

EFFECTIVITY: NSI Lot MDF

AUTHORITY: Level II PRCBD S76233M, dated 10/5/89.

86. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The four year design shelf life test requirement for explosively loaded pyrotechnic devices is waived for the SRM Linear Shaped Charge (LSC) Lot AAE for STS-31 thru STS-34 and STS-36.

RATIONALE: LSC Lot AAE performed satisfactorily on the following flights:

FLIGHT NUMBER	DATE FLOWN	DEMONSTRATED SHELF LIFE	
STS-26 (360L001)	29 SEP 1988	3 YRS	9 MOS
STS-27 (360L002)	02 DEC 1988	3 YRS	11 MOS
STS-29 (360L003)	13 MAR 1989	4 YRS	3 MOS
STS-30 (360T004)	04 MAY 1989	4 YRS	5 MOS
STS-28 (360H005)	08 AUG 1989	4 YRS	8 MOS

LSC Lot AAE performed satisfactorily on QM-7 and QM-8.

Thiokol lab tests included 10 year old LSC assemblies with 40 year old RDX which demonstrated acceptable penetration and end-to-end propagation.

Based on testing, age degradation of RDX explosive could only result in failure to fire, which would occur after SRB separation. This FMEA/CIL failure mode is Criticality 3.

EFFECTIVITY: STS-32, STS-33, STS-34, STS-31 and STS-36

AUTHORITY: Level II PRCBDs S83081, dated 10/13/89 and S083081R1, dated 1/25/90.

87. REQUIREMENT: Paragraph 7.1 PREFLIGHT VERIFICATION TESTING (PVT). An annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB range safety system, (b) SRB recovery systems, (c) ET range safety system, (d) ET tumble valve system, (e) crew escape, (f) Tail Service Mast Disconnect System (g) H_2 Gas Sampler to assure that no deterioration from handling or shipment has occurred which would result in unacceptable flight performance of that lot. This test shall be performed as late as possible prior to flight use of the lot and shall be repeated annually until the lot is expended. Tested lots shall be scheduled for installation during the following year. PVT shall be performed without prior environment exposure. The criteria for device performance shall be the same as for lot acceptance of the device. The test articles shall have been stored at the installation site or under the same environmental conditions. The test equipment, setup, instrumentation, and procedures shall duplicate those of lot acceptance testing insofar as practicable. The firing stimuli used for these tests shall be the SFU. JSC 8080-105B is applicable.

WAIVER: The above requirement is waived for the SRB CDF initiators (P/N 10308-0003-801, lot AAK, all S/Ns) for STS-31, STS-35, STS-37 thru STS-999.

RATIONALE: The 810 psig pressure would have no effect on the CDF initiators' ability to withstand the BSM operating pressure. Stress and fracture mechanics analyses (USBI-ANAL-70-88) show positive margins and no fracture problems when analyzed at the 7500 psig burst test requirement of 10SPC-0032 (over 3 times Maximum Expected Operating Pressure (MEOP) of the BSM).

The BSM would not be affected structurally by the "Over Pressure" initiator. The output pressure of the initiators is freely vented from the igniter adapter and the igniter. The excess pressure of the initiator would not make a measurable increase in pressure of the BSM, (calculated to be less than one PSI). This does not create any negative margins per BSM stress analysis BPC-ANAL-66-87.

The 810 psig pressure from the initiator would not have a deleterious effect on the ignition of the BSM igniter. The initiator propels fiery particles into the BSM ignition mix. This mix is held captive by a perforated, .120 inch thick steel plate. The burning magnesium and copper from the initiator penetrate the BKN03 pellets and ignite them while the gases escape through the plate into the igniter.

EFFECTIVITY: STS-31, STS-35, STS-37 thru STS-999

AUTHORITY: Level II PRCBD S092329B, dated 4/5/90.

88. REQUIREMENT: Paragraph 3.5.3.1 High Explosive Materials. The use of reclaimed high explosive materials is prohibited. The number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements; when used, lead azide shall be encapsulated or otherwise isolated from organic materials. All high explosives except HNS may be furnished by the contractors and procured to the following specifications:

Material	Specification
HMX	MIL-H-45444
RDX	MIL-R-398
PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225B

HNS shall be Government Furnished Material (GFM) supplied by JSC to WS5003.

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command; requests for such letters shall be forwarded to the appropriate NASA Project Office for action.

WAIVER: The above requirement is waived to allow certification of PETN explosive material to MIL-P-387, Revision C for lots AAN and AAP.

RATIONALE: Suppliers are currently certifying the PETN to MIL-P-387, Revision C.

EFFECTIVITY: BI-038

AUTHORITY: Level II PRCBD S083859, dated 5/4/90.

89. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The seven year design shelf life test requirement for nose landing gear uplock release thruster pressure cartridge is waived for Part Number SKD26100101-301, lot HNC for STS-35.

RATIONALE: Review of data from 2 test firings in October 1990 and previous PVT and age life tests show no age effects on performance.

EFFECTIVITY: STS-35

AUTHORITY: Level II PRCBD S086233G, dated 11/1/90.

90. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The seven year design shelf life test requirement for nose gear extension thruster pressure cartridges is waived for Part Number SKD26100100-301, lot Hay for STS-35 and STS-38.

RATIONALE: PVT and age life tests on lot Hay have shown no age effects since manufacture in October 1983. Lot Hay has supported last 11 flights with no anomalies.

EFFECTIVITY: STS-35 and STS-38

AUTHORITY: Level II PRCBD S086233H, dated 11/1/90.

91. REQUIREMENT: Paragraph 7.1 PREFLIGHT VERIFICATION TESTING (PVT). An annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB range safety system, (b) SRB recovery systems, (c) ET range safety system, (d) ET tumble valve system, (e) crew escape, (f) Tail Service Mast Disconnect System (g) H_2 Gas Sampler to assure that no deterioration from handling or shipment has occurred which would result in unacceptable flight performance of that lot. This test shall be performed as late as possible prior to flight use of the lot and shall be repeated annually until the lot is expended. Tested lots shall be scheduled for installation during the following year. PVT shall be performed without prior environment exposure. The criteria for device performance shall be the same as for lot acceptance of the device. The test articles shall have been stored at the installation site or under the same environmental conditions. The test equipment, setup, instrumentation, and procedures shall duplicate those of lot acceptance testing insofar as practicable. The firing stimuli used for these tests shall be the SFU. JSC 8080-105B is applicable.

WAIVER: Preflight verification testing for nose gear extension thruster pressure cartridge is waived for Part Number SKD26100100-301, lot Hay for STS-35 and STS-38.

RATIONALE: No inventory exists to support preflight verification testing required in October 1990. PVT and age life tests on lot Hay have shown no age effects since manufacture in October 1983. Lot Hay has supported last 11 flights with no anomalies.

EFFECTIVITY: STS-35 and STS-38

AUTHORITY: Level II PRCBD S086233H, dated 11/1/90.

92. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The shelf life test requirement for manipulator arm release retractor pressure cartridge is waived for part number SKD26100104-301, lot HTJ for OV-103, Flight 12 thru OV-103, Flight 15.

RATIONALE: One of five lot HTJ cartridges tested by KSC per OMI V9015 resulted in a peak pressure of 5,120 psig. The SKD26100104-301 pressure cartridge peak pressure limits are 5,018 to 3,050 psig. The measured peak pressure will not affect performance of the retractor in its intended function. A positive margin exists for expected operational peak pressures against the proof pressure test level for the retractor and cartridge housings.

EFFECTIVITY: OV-103, Flight 12 thru OV-103, Flight 15

AUTHORITY: Level II PRCBD S086233J, dated 2/1/91.

93. REQUIREMENT: Paragraph 3.12.1 Production Lot. A group of components, devices, or assemblies of the same design, construction,

and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. Only one lot of each component shall be used in the manufacture of a lot of devices. Similarly, only one lot of each explosively loaded component, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: The above requirement is waived for use of booster assemblies used in CDF assembly lots ABC, ABD (non-flight), ABE, ABF, ABG, and ABH.

RATIONALE: Booster assemblies, ensign bickford P/N 202095, were not all manufactured in a continuous process. However, the component parts are from a single material lot. The booster assemblies were all made using single lots of explosive and metal shells and the procedure was identical for all assemblies. The booster assembly manufacturing processes are simple and 100% verifiable.

CDF assembly lot acceptance testing for lots ABC, ABD (non-flight), ABE, ABF, ABG, and ABH included firing test of 261 CDF assemblies. These lot acceptance test assemblies represent all 35 CDF numbers. Since the booster assembly is assembled to each end of the CDF assembly, there were 522 boosters verified to be functionally acceptable. There were 572 CDF assemblies flown from these lots on 10 out of the last 13 flights.

EFFECTIVITY: CDF lots ABC, ABD (non-flight), ABE, ABF, ABG, and ABH

AUTHORITY: Level II PRCBD S092155A, dated 2/14/91.

94. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing.

WAIVER: The shelf life of frustum separation assembly lots AAN, AAP, AAR and AAS using sublength test LSCS manufactured with lots AAS since all four assembly lots used the same linear shaped charge.

RATIONALE: Lots AAN, AAP, AAR and AAS frustum separation assemblies (including detonator subassemblies) were all made from the same production run of LSC. Shelf life testing on units from any of these lots is representative of all four lots.

EFFECTIVITY: BI-049

AUTHORITY: Level II PRCBD S077725, dated 2/22/91.

95. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as single lot and the test results shall apply to each of the production lots.

WAIVER: The above requirement is waived to allow use of Orbiter vent severance assemblies, Part Number MC325-0044-0001, lot WAA.

RATIONALE: The four year age life of MC325-0044-0001, lot WAA expires at the end of September 1991. No test hardware exists to extend the life of lot WAA. The rational for waiver is that the Hexanitrostilbene-II (HNS), lot S-3980, installed in the side hatch crew escape system Shielded Mild Detonating Cord (SMDC), and the hatch hinge cutters are common to lot WAA installed in P/N MC325-0044-0001. Successful testing of samples from the above component lots verifies acceptability of HNS-II lot S-3980, thru August of 1994.

EFFECTIVITY: OV-103, Flight 13 and 14, OV-104, Flight 10 thru 12, OV-102, Flight 12 thru OV-102, Major MOD-2 (not to extend past August 31, 1994).

AUTHORITY: Level II PRCBD S086136, dated 8/28/91 and Space Shuttle PRCBD S086136R1, dated 2/12/92.

96. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as single lot and the test results shall apply to each of the production lots.

WAIVER: The ten year design storage life requirement for explosively loaded pyrotechnic devices is waived for overhead window crew escape system for the components and lots listed below for OV-103, Flight 14, and OV-104, Flight 11 and 12:

MC325-0004-01XX, Lot WAF
MC325-0004-07XX, Lot WAN
MC325-0004-0023, Lot WAD
MC325-0027-0005, Lot WAA
MC325-0004-0003, Lot WAD

RATIONALE: Testing performed on pyrotechnic components which share the same Hexanitrostilbene-I (HNS) and HNS-II lots as the above flight lots and which were manufactured prior to the above flight lots has shown no evidence of degradation due to age. Additional testing performed on hardware manufactured prior to the flight components and containing the same HNS lots as the flight hardware has proven that the hardware did not degrade due to age combined with the qualification thermal environments.

EFFECTIVITY: OV-103, Flight 14, OV-104, Flight 11 and 12

AUTHORITY: Level II PRCBD S086137, dated 10/9/91.

97. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as a single lot and the test results shall apply to each of the production lots.

WAIVER: The above requirement is waived to permit use of SRM Linear Shaped Charge (LSC) lot AAE for STS-42 and STS-45.

RATIONALE: Previous full-scale motor tests utilizing LSC which performed below minimum performance requirements and below performance requirements of lot AAE lot acceptance testing demonstrate that lot AAE LSC will successfully sever the STS-42 (360T020) LH (A) and RH (B) and STS-45 (360T021) RH (B) flight aft exit cones.

The performance margin of the LSC exceeds the margin requirements specified in NSTS 08060. Lot AAE LSC have performed successfully on 19 RSRM flights including STS-44 (360T019) on November 24, 1991. The use of lot AAE LSC is a Criticality 3 failure/reuse issue only and is not a flight safety concern.

EFFECTIVITY: STS-42 and STS-45

AUTHORITY: Level II PRCBD S052607, dated 1/6/92.

98. REQUIREMENT: Paragraph 7.1 PREFLIGHT VERIFICATION TESTING (PVT). An annual destructive performance test shall be performed at the launch site on each lot of explosively loaded devices or assemblies (with the exception of explosively loaded units used in the (a) SRB range safety system, (b) SRB recovery systems, (c) ET range safety system, (d) ET tumble valve system, (e) crew escape, (f) Tail Service Mast Disconnect System (g) H_2 Gas Sampler to assure that no deterioration from handling or shipment has occurred which would result in unacceptable flight performance of that lot. This test shall be performed as late as possible prior to flight use of the lot and shall be repeated annually until the lot is expended. Tested lots shall be scheduled for installation during the following year. PVT shall be performed without prior environment exposure. The criteria for device performance shall be the same as for lot acceptance of the device. The test articles shall have been stored at the installation site or under the same environmental conditions. The test equipment, setup, instrumentation, and procedures shall duplicate those of lot acceptance testing insofar as practicable. The firing stimuli used for these tests shall be the SFU. JSC 8080-105B is applicable.

WAIVER: Drag chute components will not have been subjected to a PVT prior to STS-49. The components and lots involved are shown below.

Part Number	Description	Lot Number
MC325-0052-0002	Retractor Pressure Cartridge	WAA
MC621-0076-0003	Pilot Mortar Cartridge	WAB
MC621-0076-0011	Reefing Line Cutter	WAA

RATIONALE: The above components have been subjected to shipping exposure as part of acceptance test. Each of the above items is required to be subjected to neutron radiography prior to performance of destructive lot acceptance testing. Each device was packaged and shipped to the neutron radiography facility in shipping containers prior to performance of destructive testing.

The above items have been shown to be resilient when exposed to handling through exposure to qualification random vibration levels and/or drop tests.

Three MC621-0076-0011 reefing line cutters, lot WAA, have been exposed to an 8-foot drop test as part of qualification as defined in CR No. 44-621-0076-0011B. The three reefing line cutters successfully fired following the eight foot drop tests.

Twelve MC621-0076-0003 mortar pressure cartridges, lot WAB, have been subjected to random vibration per CR No. 44-621-0076D and subsequently fired in mortars. All of the mortar pressure cartridges produced successful results. In addition, three MC621-0076-0003 mortar pressure cartridges, lot WAB, have been subjected to an 8-foot drop test as part of qualification as defined in CR No. 44-621-0076D. The three mortar pressure cartridges were subsequently fired in vented bombs and were found to meet acceptance criteria.

Six MC325-0052-0002 retractor pressure cartridges, lot WAA, were subjected to random vibration while installed into the attach-jettison mechanism during qualification tests as delineated in CR No. 44-325-0052-0001B. The retractor pressure cartridges were subsequently fired into the attach-jettison mechanism with successful results.

Based upon the successful firings of the above items following environments and/or handling tests, the requirement to perform PVT prior to flight usage of the lots in question can be waived.

PVT is planned next year on the above items.

EFFECTIVITY: Pyro lots WAA and WAB for STS-46, STS-47, STS-49 thru STS-56, not to extend past April 1, 1993

AUTHORITY: Space Shuttle PRCBD S086361, dated 4/22/92.

99. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as single lot and the test results shall apply to each of the production lots.

WAIVER: The above requirement is waived to permit use of the side hatch thruster pressure cartridges (P/N MC325-0041), lot WAB, with test results from only 4 test firings.

RATIONALE: All 5 firings were successfully completed. No data was recorded on firing No. 4 due to a pretrigger of the oscilloscope. Test results from the 4 firings were analyzed and demonstrated the functional reliability of lot WAB. Data from 4 of the 5 firings was well within the test pass/fail criteria. The unit for which no data was recorded fired with no anomalies observed during the post closed bomb inspection.

EFFECTIVITY: STS-46, STS-47, STS-50 thru STS-999

AUTHORITY: Space Shuttle PRCBD S086329, dated 5/14/92.

102. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as single lot and the test results shall apply to each of the production lots.

WAIVER: The above requirement is waived to permit use of the Tail Service Masts (TSM) bonnet thruster, P/N 79K22641-1, Lot No. EAD S/Ns 49, 50, 51, 54, 55 and 56.

RATIONALE: PYRO devices are designed for a ten year shelf life. Lot EAD was manufactured in August 1988. Thirty thrusters

from Lot EAD have been used on the last 15 Shuttle flights with no anomalies. The units are stored at the OSF in sealed desiccant containers until approximately two weeks prior to launch. They are not exposed to environmental cycling (thermal vacuum or vibration) until launch when they are expended. The bonnet thruster is used in Tail Service Mast where it would have no impact on Shuttle performance.

EFFECTIVITY: STS-47, STS-52 and STS-53

AUTHORITY: Space Shuttle PRCBD S086482, dated 9/2/92.

103. REQUIREMENT: Paragraph 3.7.1 Shelf Life (Ground Storage). The design storage life of explosively loaded pyrotechnic devices shall be 10 years from date of manufacture to vehicle installation. The design shelf life shall be demonstrated in appropriate, realtime test programs at 4 and 7 years of age. At each of the two test dates, a minimum of 5 units shall be selected from available certified lot(s) and performance tested. The test data shall be compared to that obtained in previous lot acceptance for evidence of performance degradation. Additional units may be disassembled at these same intervals for appropriate inspection if required by the responsible design organization. Performance tests may be conducted at the launch site, supplier's facility or other appropriate test sites using PVT or lot acceptance procedures. The design organization shall be responsible for performing and evaluating any required disassembly.

Sublength linear charges manufactured in a lot of production hardware may be used for shelf-life evaluation. These charges shall be stored in the same manner and at the same location as the flight hardware. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf-life tested as single lot and the test results shall apply to each of the production lots.

WAIVER: The above requirement is waived to permit the use of the Linear Shaped Charge (LSC) lot AAF on RSRM 360X023, 360L028 thru 360X039, for BI-055 thru BI-067.

RATIONALE: The LSCs from lot AAF failed the lot acceptance tests for the four year performance demonstration.

Previous full-scale motor tests demonstrate lot AAF LSCs will successfully sever flight Aft Exit Cones (AECs). Lot AAF performed successfully on all previous uses (14 RSRMs). This is a splashdown/reuse issued only and not a flight issue.

EFFECTIVITY: BI-055 thru BI-067

AUTHORITY: Space Shuttle PRCBD S052607A, dated 12/2/92.

104. REQUIREMENT: Paragraph 3.4.1.2 Authorized Configurations. The only connector configurations authorized for use in pyrotechnic systems shall be NBS 9E8-2SE, -2SF, -2SG and -2SH. The use of other configurations and the use of right-angle connectors shall require the specific approval of the SSPO. The four configurations above are restricted from use in non-pyrotechnic circuits in the vicinity of installed NSI-1.

WAIVER: The above requirement is waived to allow for the use of NBS6GE8-2SE or NBS6E8-2SE connectors for mating to NASA Standard Initiators (NSIs).

RATIONALE: Suspect PRs have been written and dispositioned for PMRB approval to use-as-is with the following rationale:

1) Physical connection of PIC cable connector to NSI will carry the shield to ground.

2) Surrounding structure will provide adequate RFI shielding at the NSI connection.

3) At least two “GO” PIC resistance tests will be performed to verify that the ordnance device is intact.

EFFECTIVITY: STS-56

AUTHORITY: Space Shuttle PRCBD S011556N, dated 4/5/93.

105. REQUIREMENT: Paragraph 3.4.1.1 Mating Electrical Connector. MSFC Connector 40M38298 shall be used throughout the Space Shuttle to connect firing circuits to the NSI-1. Connector indexing configurations are shown in the NASA JSC control

drawing, NASA Standard Initiator SLB26100052 and the sketch below. JSCM 8080-3 is applicable.

WAIVER: The above requirement is waived to allow use of the NBS6GE type connectors in the ET vent arm umbilical, ET T-0 static lanyard, H2 burn and TSM release PYRO firing line cables.

RATIONALE: The type NBS6G is an RFI grounded connector and differs from the type NBS9G in that it does not have an RFI backshell. Sufficient shield grounding exists using the type NBS6G and is verified during OMI testing. The shield is further protected from RFI/EMI intrusion by virtue of the installation location being surrounded by structural steel and the launch pad Lightning Protection System.

EFFECTIVITY: STS-55 and STS-56

AUTHORITY: Space Shuttle PRCBD S011556P, dated 4/5/93.

106. REQUIREMENT: Paragraph 3.4.1.2 Authorized Configurations. The only connector configurations authorized for use in pyrotechnic systems shall be NBS 9E8-2SE, -2SF, -2SG, and -2SH. The use of other configurations and the use of right-angle connectors shall require the specific approval of the SSPO. The four configurations above are restricted from use in the non-pyrotechnic circuits in the vicinity of installed NSI-1.

WAIVER: The above requirement is waived to allow use of NBS6GE type connectors in the ET vent arm umbilical, ET T-0 static lanyard, H2 burn and TSM release PYRO firing line cables.

RATIONALE: The type NBS6G is an RFI grounded connector and differs from the type NBS9G in that it does not have an RFI backshell. Sufficient shield grounding exists using the type NBS6G and is verified during OMI testing. The shield is further protected from RFI/EMI intrusion by virtue of the installation location being surrounded by structural steel and launch pad Lightning Protection System.

EFFECTIVITY: STS-55 and STS-56

AUTHORITY: Space Shuttle PRCBD S011556P, dated 4/5/93.

107. REQUIREMENT: Paragraph 3.4.1.2 Authorized Configurations. The only connector configuration authorized for use in pyrotechnic systems shall be NBS 9E8-2SE, -2SF, -2SG, and -2SH. The use of other configurations and the use of right-angle connectors shall require the specific approval of the SSPO. The four configurations above are restricted from use in the non-pyrotechnic circuits in the vicinity of installed NSI-1.

WAIVER: The above requirement is waived to allow use of the NBS6CE8 or the NBS6E8 type connector in place of the NBS9E8 connector on the Solid Rocket Booster holddown posts for STS-55 only.

RATIONALE:

1) Physical connection of PIC cable connector to NSI will carry the shield to ground.

2) HDP blast container is installed over the NSI connection, providing superior RFI shielding.

3) At least two GO PIC resistance tests will be performed to verify that ordnance is intact.

EFFECTIVITY: STS-55

AUTHORITY: Space Shuttle PRCBD S093510H, dated 4/19/93.

108. REQUIREMENT: Paragraph 3.9.3 Lot Designators. Each lot of pyrotechnic devices shall be identified by a three-letter designator (e.g., AAA, AAB...) which shall not be repeated for any part numbers. Production Lot designator shall not begin with the letters D, I, O, Q, U, X, and Z. The letters I, O, Q, U, and Z shall not occupy any lot designator position. The letters D and X are reserved for development and non-Shuttle hardware use.

WAIVER: The above requirement is waived for booster shells lot AAJ linear shaped charges for external tank.

RATIONALE: The rework effort would provide a substantial cost avoidance, while assuring no reduction in flight safety. The effort would require cutting one end of the existing LH2 LSCs back, making the new configuration identical in length to present LO2 LSCs, and then installing a booster shell in the cut end. Ample powder and materials from the original lot

build (AAJ) are available from the supplier for manufacture of booster shells and reworked LSCs. Configuration accountability/traceability of the reworked LH2 LSCs will be maintained by serial numbers.

Test articles will be made from the existing LH2 LSCs to support the verification of the rework acceptance testing, the four year shelf life and seven year shelf life extension testing.

EFFECTIVITY: Non Flight Specific

AUTHORITY: Space Shuttle PRCBD S060042D, dated 6/26/93.

109. REQUIREMENT: Paragraph 3.12.1 Production Lot. Each piece part, component, subassembly, or device shall be of the same design, construction, material heat or melt lot and heat treat lot fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. The single lot control requirements of nonexplosive components used in a lot of devices shall be determined, documented and approved by the cognizant Project Office. Factors such as component function in end item performance and effectiveness of destructive tests in screening defective components shall be considered in establishing single lot control requirements. Only one lot of each explosive or pyrotechnic material shall be used in a lot of explosively loaded components or devices. Only one lot of explosively loaded components, such as MDF, shall be used in the manufacture of a lot of the next higher assembly, such as explosive trains. This restriction shall apply to all successive levels of assembly, including the final acceptance level but shall not apply to NSI-1 lots integrally installed (married) into cartridge assemblies.

WAIVER: The above requirement is waived for booster shells lot AAJ linear shaped charges for external tank.

RATIONALE: The rework effort would provide a substantial cost avoidance, while assuring no reduction in flight safety. The effort would require cutting one end of the existing LH2 LSCs back, making the new configuration identical in length to present LO2 LSCs, and then installing a booster shell in the

cut end. Ample powder and materials from the original lot build (AAJ) are available from the supplier for manufacture of booster shells and reworked LSCs. Configuration accountability/traceability of the reworked LH2 LSCs will be maintained by serial numbers.

Test articles will be made from the existing LH2 LSCs to support the verification of the rework acceptance testing, the four year shelf life and seven year shelf life extension testing.

EFFECTIVITY: Non Flight Specific

AUTHORITY: Space Shuttle PRCBD S060042D, dated 6/26/93.

113. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the device but the age life limit shall be tracked from the date of the DLAT of the oldest explosively loaded component. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Repetition of all lot

acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any teardown and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 15 year life assigned: shielded mild detonating cord, Part Numbers MC325-0004-0728 through MC325-0004-0765, Part Numbers MC325-0004-2051 through MC325-0004-2090, and Part Numbers MC325-0004-2093 through MC325-0004-2100; flexible confined detonating cord Part Numbers MC325-0004-0128 through MC325-0004-0139; inner window severance assembly Part Number MC325-0027-0006. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

WAIVER: The above requirement is waived to permit the use of the Orbiter Overhead Window Crew Escape SystemTime Delay, P/N SKD26100115-300, Lot HEA.

RATIONALE: The two time delays which failed acceptance requirements did produce high order output and met the performance objective of propagating detonation onto the receiving cord.

Additional time to function will retain inner window closed for longer periods of time (581 vs. 490 milliseconds) while outer window is jettisoned.

The five test articles were subjected to a repeat of thermal qualification environments prior to the functional tests. The thermal test was 25 cycles from +160° F to -65° F.

EFFECTIVITY: STS-59, STS-60 and STS-62 thru STS-71

AUTHORITY: Space Shuttle PRCBD S086861, dated 1/21/94.

114. REQUIREMENT: Paragraph 4.5.2.1 General. Any cartridge found to be defective in any nondestructive test shall be rejected. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2. Detonating cartridges shall be fired with a test indentation fixture in accordance with MIL-STD-331. Neither the device nor the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

WAIVER: The above requirement is waived to permit the use of the Hydrogen Burn Igniters, P/N 51-1151-2, Lot AAM, for STS-65. Two units failed to meet the minimum burn time duration of 8 seconds +4/-0 seconds at 150° F as required by Specification 80K50593, Paragraph 3.3.1.

RATIONALE: The hydrogen burn igniters receive fire commands at T-9.8 to T-9.7. The main engines ignite at T-6.6 to T-6.2 seconds. A 3.6 second burn time of the hydrogen burn igniters would provide sufficient time for all three main engines to start.

Launch commit criteria will not allow a launch if ambient temperature exceeds 99° F for greater than 30 minutes.

There are two hydrogen burn igniters per engine arranged around the base of the Orbiter. Each set of igniters projects hot zirconium particles towards the center of each main engine with a considerable amount of overlap provided to the other engines.

Compared to previous lots, this lot of igniters has a faster burn rate. Tests performed by the vendor indicate that the reason for this is a change in the supplier of the zirconium. Zirconium is not longer available from the previous vendor.

EFFECTIVITY: STS-65 (Lot AAM)

AUTHORITY: Space Shuttle PRCBD S060445, dated 2/4/94.

115. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.). The age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier’s facility or other appropriate test facility using PVT or lot acceptance procedures. Flight

performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: flangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component; nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any teardown and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as the used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 15 year life assigned: shielded mild detonating cord, Part Numbers MC325-0004-0728 through MC325-0004-0765, Part Numbers MC325-0004-2051 through MC325-0004-2090, and Part Numbers MC325-0004-2093 through MC325-0004-2100. Flexible confined detonating cord Part Numbers MC325-0004-0128 through MC325-0004-0139, inner window severance assembly Part Number MC325-0027-0006. The shelf life of the NSI/SII shall not be

considered in determining the shelf life expiration date for the end item.

WAIVER: The above requirement is waived to permit the use of P/N SKD26100105-301, Lot HBR pressure cartridges for the four year age life extension test.

RATIONALE: The SKD26100105-301 cartridge is used in the Ku-band release nut, Ku-band guillotine, and RMS type-I guillotine which were subjected to single 85% charge weight cartridge firings during qualification. The maximum pressure expected from the qual lot 85% cartridges is approximately 4156 psi in a closed bomb. Lot HBR produces higher pressure than the 85% cartridges which were successful. Lot HBR will perform its design function. In addition, the cartridges are redundant in each application.

EFFECTIVITY: P/N SKD26100105-301 lot HBR (not to extend past June 1997)

AUTHORITY: Space Shuttle PRCBD S064489, dated 11/8/95.

116. REQUIREMENT: Paragraph 3.6.20.2 Frangible Nuts. The margin shall be demonstrated by firing a production cartridge in a nut having a separation cross section that is 115% of the maximum allowable cross section. The margin requirement shall be demonstrated on each production lot. If multiple cartridges/ charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. This test should be performed under the minimum allowable flight loading conditions that can exist at the time of functioning of the frangible nut. The SRB/ASRB frangible nut (MLP hold down) shall demonstrate margin with a separation cross section that is 110% of the maximum allowable cross section.

WAIVER: The above requirement shall be waived to permit use of lot AAN of SRB frangible nuts (MLP hold down). During lot acceptance test, one of two test nuts clamshelled enough to release the hold down stud, but failed to separate into two pieces. The two test nuts were manufactured to 110% of the maximum allowable cross section.

RATIONALE: The remaining nine nuts of the lot sample were remachined to 110% of the largest outer web represented in the lot. All

nine nuts were successfully tested. These nine nuts represented 109.8% of the maximum outer web dimension allowed by drawing.

Functional testing 10% of a lot (or ten nuts minimum) provides confidence that variations in nut and booster performance are represented.

The frangible nuts use redundant booster cartridges to separate. Only one booster cartridge is used during the lot acceptance functional test.

EFFECTIVITY: STS-83 thru STS-93 and STS-95 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062H, dated 6/27/97.

117. REQUIREMENT: Paragraph 3.8.4.4.3.2 Frangible Nuts. The margin shall be demonstrated by firing a production cartridge in a nut having a separation cross section that is 115% of the maximum allowable cross section. If multiple cartridges/charges are used to achieve redundancy, this requirement must be satisfied using a single cartridge/charge. The margin requirement shall be demonstrated on each production lot. This test should be performed under the minimum allowable flight loading conditions that can exist at the time of functioning of the frangible nut. The SRB/ASRB frangible nut (MLP hold down) shall demonstrate margin with a separation cross section that is 110% of the maximum allowable structural cross section.

WAIVER: The above requirement shall be waived to permit use of lot AAN of SRB frangible nuts (MLP hold down). During lot acceptance test, one of two test nuts clamshelled enough to release the hold down stud, but failed to separate into two pieces. The two test nuts were manufactured to 110% of the maximum allowable cross section.

RATIONALE: The remaining nine nuts of the lot sample were remachined to 110% of the largest outer web represented in the lot. All nine nuts were successfully tested. These nine nuts represented 109.8% of the maximum outer web dimension allowed by drawing.

Functional testing 10% of a lot (or ten nuts minimum) provides confidence that variations in nut and booster performance are represented.

The frangible nuts use redundant booster cartridges to separate. Only one booster cartridge is used during the lot acceptance functional test.

EFFECTIVITY: STS-87 thru STS-93 and STS-95 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062H, dated 6/27/97.

118. REQUIREMENT: Paragraph 4.5.2.1 General. Any cartridge found to be defective in any nondestructive test shall be rejected. The number of cartridges to be subjected to destructive testing from various lot sizes shall be in accordance with Paragraph 4.5.1.4. Failure of any device to meet performance requirements shall be cause for lot rejection. Pressure cartridges shall be fired in closed or vented test bombs as appropriate to their specific application per Paragraph 4.5.2.6.2. Detonating cartridges shall be fired with a test indentation fixture in accordance with MIL-STD-331. Neither the device nor the NSI shall fracture, except for the portion immediately surrounding the detonating charge.

WAIVER: The above requirement is waived to allow use of lot AAC SRB nose cap thruster pressure cartridges.

RATIONALE: During destructive Lot Acceptance Testing (LAT), one of ten pressure cartridges (S/N 2000249) produced a pressure versus time curve which was outside allowable boundaries.

An anomaly resolution team was assembled to investigate the failure. The team concluded that the most probable cause of the failure of S/N 2000249 was poor inhibiting of the outer diameter of the propellant grain. Analyses, assuming no inhibitor on the outer diameter of the propellant grain, show no significant effect on their performance of the nose cap ejection system.

EFFECTIVITY: BI-098 thru BI-101

AUTHORITY: Space Shuttle PRCBD S092194, dated 6/9/98.

119. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that

the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight.

Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any tear-down and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 15 year life assigned: shielded mild detonating cord, Part Numbers MC325-0004-0728 through MC325-0004-0765, Part Numbers MC325-0004-2051 through MC325-0004-2090, and Part Numbers MC325-0004-2093 through MC325-0004-2100; flexible confined detonating cord Part Numbers MC325-0004-0128 through MC325-0004-0139; inner window severance assembly Part Number MC325-0027-0006. The shelf life of the NSI/SII shall not be considered in determining the shelf life expiration date for the end item.

WAIVER: The above requirement is waived to extend the use of the inner window severance assembly, P/N MC325-0027-0006, S/N 1716100004 for a total of 19 years.

RATIONALE: New GFE Expanding Tube Assembly (XTA) replacement hardware was erroneously scrapped by supplier and replacement hardware will be available in 14 months.

Explosive cord loaded with same type of explosive (HNS) showed no degradation in performance when tested at 29 years.

Accelerated testing of HNS shows no performance degradation in at least 50 years.

Detonation propagation test on March 6, 1998 of XTA from the same lot as presently installed in OV-104 showed no degradation in performance.

EFFECTIVITY: OV-104, Flight 21 thru Flight 24

AUTHORITY: Space Shuttle PRCBDs S061062A, dated 9/21/98 and S061062AR1, dated 11/17/98.

120. REQUIREMENT: Paragraph 4.4.1 Qualification by Tests. Testing is the basic method to be used in the qualification of flight hardware and GSE. Such tests shall be used to determine that the hardware is capable of performing its required operational functions in the known or anticipated environmental conditions. These tests will be designed to subject samples of the hardware to the worst case environments and stresses anticipated. Hardware requiring qualification by test, which is produced to identical design requirements by several manufacturing sources, shall be qualified, by test, for each source. Those environmental tests or stress conditions that would not be affected by a new vendor's process or procedure need not be repeated by test.

WAIVER: The above requirement is waved for the SRB parachute time delay reefing line cutters on lot ABJ due to three units failing to meet the time delay requirements:

S/N 2004255 and S/N 2004462 - Fired at ambient temperature had a delay time of 12.03 seconds and 8.91 seconds, respectively. Allowable range is 9.40 to 11.49 seconds.

S/N 2004425 - Fired at high temperature had a delay time of 11.49 seconds. Allowable range is 9.12 to 11.15 seconds.

RATIONALE: Worst case effect of time delay failures is parachute overload during development. The actual effect based on load analysis is no effect on parachute safety margins.

EFFECTIVITY: STS-100, STS-102, STS-104, STS-106 thru STS-999

AUTHORITY: Space Shuttle PRCBD S041062L, dated 5/1/00.

121. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended

function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to

meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any tear-down and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 25-year life assigned.

WAIVER: The above requirement is waived to extend the use of 12 SRB drogue parachute reefing line cutters, P/N 10320-0001-802, S/N 2003501 thru 2003505, 2003493A thru 2003498A, and 2003500A without performing the shelf life extension test.

RATIONALE: The twelve SRB drogue parachute reefing line cutters are four years from destructive lot acceptance test and require age life test. There are no remaining reefing line cutters available from this lot to support a shelf life extension test.

Functional test of previous lots (Lots ABC tested in 1994, Lot ABD in 1996 and ABH in 1998) of seven second delay cutters were within specification limits and did not show any shifts due to age deterioration. All three lots were manufactured using the same lot of delay mixture.

The greatest variation in average delay time from the LAT firings above was added to the 3-sigma variation to give the worst case time delay that could be expected. This variation of 1.402 seconds or 20.6% of 6.813 seconds is less than the allowable ± 22%. Therefore, the use of these cutters will not result in any increase of drogue parachute loads.

EFFECTIVITY: BI-102 thru BI-104

AUTHORITY: Space Shuttle PRCBD S041062M, dated 8/28/00.

122. REQUIREMENT: Paragraph 3.7.1 Design Life. The life over which a pyrotechnic component is designed to perform its intended function. The design life of explosively loaded pyrotechnic devices shall be a minimum of 10 years from the date that the Destructive Lot Acceptance Test (DLAT) is performed. The flight certification document shall denote the manufacturing date as marked on the component but the age life shall be tracked from the date of the DLAT of the loaded component. In the case of those components containing multiple pyrotechnic elements that are controlled by the responsible NASA design center (primers, initiators, delay trains, booster charges, etc.), the age life shall be tracked from the date of the DLAT of the component without regard to the DLAT of the pyrotechnic elements. Age life tests shall demonstrate that the performance characteristics continue to meet the lot acceptance criteria without significant degradation. The tests shall be performed at specific intervals until the minimum design life of 10 years is reached. The intervals shall commence with tests a maximum of 4 years from the original DLAT and again at 7 and 10 years. Extension of age life beyond 10 years shall require testing every year until significant performance degradation is identified or insufficient quantities remain for test. Each age life test shall consist of a minimum of five units each. Environmental conditioning shall be performed on test units. The extent of environmental conditioning shall be the responsibility of the applicable design organization. Devices removed and replaced every flight shall be functioned at the temperature environment(s) demonstrated in DLAT at a minimum. Recoverable flight units are acceptable for age life samples. Age life performance tests may be conducted

at the launch site, supplier's facility or other appropriate test facility using PVT or lot acceptance procedures. Flight performance may be used for age life extension if no degradation of performance of a device can be verified (SRB components: frangible nut booster cartridge, frustum separation LSC, CDF assembly, and CDF manifold; RSRM component: nozzle severance LSC). Pyrotechnic component flight performance in systems in which proper operation of an individual device can be verified may be used to extend the age life of the lot. The performance of devices from the same lot on multiple Shuttle flights may be used to meet the five-firing minimum requirement. When performance from multiple Shuttle flights is used, the age life of a lot shall be extended based on the date of the earliest flight. Pyrotechnic component flight performance in redundant systems in which proper operation of an individual device can not be verified shall not be used to extend age life. The means by which age life may be extended on a specific component (functional testing of samples from the lot, functional testing of recovered flight units, and/or evaluation of flight performance) shall be established by the responsible NASA design center. Repetition of all lot acceptance tests is not required for shelf life testing. The responsible design organization shall identify, perform and evaluate any teardown and disassembly of the test articles. Sub-length linear charges manufactured in a lot of production hardware may be used for shelf life evaluation. The target material shall be the same as that used for lot acceptance testing. Multiple production lots of linear charge assemblies whose explosive cord has been manufactured in one continuous cord production run may be shelf life tested as a single lot and the test results shall apply to each of the production lots. The following Orbiter components are exempted from the post 10 year age life test requirements and shall have a 25-year life assigned.

WAIVER: The above requirement is waved to extend the use of the SRB main parachute 10-second and-17 second delay reefing line cutters, P/N 10320-0001-803, Lot ABG, and 10320-0001-805, Lot ABF without performing the shelf life extension test.

RATIONALE: These SRB main parachute delay reefing line cutters are four years from destructive lot acceptance test and require age life test. There are no remaining reefing line cutters available from these lots to support a shelf life extension test.

The pertinent requirements to evaluate for deterioration due to age are:

a. The cutters must sever the Kevlar reefing lines.

b. The delay times must be within ± 22% of nominal over all temperature ranges.

c. Delay time variance must be within 10% of average at a given temperature.

The performance parameters can be measured using flight data from the SRB Data Acquisition System (DAS) and post-flight inspection. The DAS is located in the forward skirt and records accelerations including those associated with main parachute deployment and disreef. The DAS also has a video camera with the main parachutes in the field of view on selected flights. Using the acceleration data with the parachute video, the actual deployment and disreef times can be accurately measured for each parachute. Data was collected on five flights. Lot ABF delays ranged from 16.47 to 17.93 seconds with a target of 17 seconds. Lot ABG delays ranged from 9.96 to 10.54 with a target of 10 seconds. All delay times were within 5.5% of average and nominal (target) values, meeting the 10% and 22% requirements defined in (b) and (c). All Lot ABF and ABG cutters flown have successfully actuated. All Kevlar reefing lines completely severed.

EFFECTIVITY: BI-102 thru BI-105

AUTHORITY: Space Shuttle PRCBD S041062N, dated 8/28/00.

124. REQUIREMENT: Paragraph 3.5.3.1 High explosive materials. The use of reclaimed high explosive materials is prohibited. The number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be

limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials and copper and copper containment alloys. All high explosives may be furnished by the contractors and procured to the following specifications:

Material	Specification
HNS	WS 5003
HMX	MIL-H-45444
RDX	MIL-R-398
PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command. Requests for such letters shall be forwarded to the appropriate NASA Project Office for action. Each lot of high explosive shall be analyzed for conformance to the applicable military specification requirements. This analysis shall be performed upon receipt at the suppliers facility or prior to loading of the first pyrotechnic device lot using this explosive material lot. The analysis will be performed by a laboratory or test facility different than the facility which provided the original explosive manufacturer's test report. Test results shall be compared with the original test report for evidence of significant degradation which could impact the functional performance or shelf life of the affected pyrotechnic devices. Independent analysis of high explosive materials shall be repeated at five year intervals or prior to loading of the next lot of explosive devices until the life is expended or the high explosive lot is no longer used for loading of NASA pyrotechnic devices. In the event the pyrotechnic device supplier wishes to utilize test methods different from those described in the applicable military specification to satisfy the independent analysis requirement, detailed test procedures shall be prepared and submitted to the appropriate NASA center and prime contractor, if required, for approval.

WAIVER: PETN Kit 8730 (CDF assembly Lots ABS, ABT, ABV, ABW, and ABY) is waived for minimum nitrogen content (17.38%) during the 5-year independent analysis.

RATIONALE: PETN Lot 8730 was successfully tested during the original analysis 5 years ago. During the recent 5-year independent analysis, this PETN lot failed to meet the minimum nitrogen content requirement (17.5% minimum, reference MIL-P-387C, Paragraph 3.2). Nitrogen test results were 17.38%, all other requirements were met. Subsequently, margin testing was conducted on 24 CDF assemblies representing Lots ABV, ABW and ABY. The tests successfully demonstrated detonation propagation at 8 times the maximum design gap (0.432 inch air gap between ends of CDF assemblies). These tests provide confidence that initiation sensitivity and CDF output have not been compromised. In addition, 1083 CDF assemblies have successfully functioned in flight. There have been approximately 300 CDF assemblies successfully ground tested. All have used PETN Lot 8730. There have been no detonation propagation failures. Critical functions are redundant.

EFFECTIVITY: BI-106

AUTHORITY: Space Shuttle PRCBD S041062U, dated 3/7/01.

125. REQUIREMENT: Paragraph 3.5.3.1 High explosive materials. The use of reclaimed high explosive materials is prohibited. The number and types of high explosives in the Space Shuttle system shall be minimized. HNS, HMX, and RDX are the preferred high explosive materials. Lead azide use shall be limited to those applications where it has been demonstrated that a less sensitive material will not meet the reliability requirements. When used, lead azide shall be encapsulated or otherwise isolated from organic materials and copper and copper containment alloys. All high explosives may be furnished by the contractors and procured to the following specifications:

Material	Specification
HNS	WS 5003
HMX	MIL-H-45444
RDX	MIL-R-398

PETN	MIL-P-387
Lead Azide	MIL-L-3055 (Type I)
Lead Azide RD-1333	MIL-L-46225

A NASA letter of certification is required for contractors to procure RDX directly from the U.S. Army Armament Command. Requests for such letters shall be forwarded to the appropriate NASA Project Office for action. Each lot of high explosive shall be analyzed for conformance to the applicable military specification requirements. This analysis shall be performed upon receipt at the suppliers facility or prior to loading of the first pyrotechnic device lot using this explosive material lot. The analysis will be performed by a laboratory or test facility different than the facility which provided the original explosive manufacturer's test report. Test results shall be compared with the original test report for evidence of significant degradation which could impact the functional performance or shelf life of the affected pyrotechnic devices. Independent analysis of high explosive materials shall be repeated at five year intervals or prior to loading of the next lot of explosive devices until the life is expended or the high explosive lot is no longer used for loading of NASA pyrotechnic devices. In the event the pyrotechnic device supplier wishes to utilize test methods different from those described in the applicable military specification to satisfy the independent analysis requirement, detailed test procedures shall be prepared and submitted to the appropriate NASA center and prime contractor, if required, for approval.

WAIVER: The minimum nitrogen content for superfine PETN Lot 8730 is waived for Lot ABS, ABT, ABV, ABW, ABY, and ACA CDF assemblies installed on STS-100 as follows:

Part Number, Serial Number and Lot Number Matrix

Part Number	Serial Number	Lot Number
10314-0001-101	2014226	ABW
10314-0001-101	2014227	ABW
10314-0001-102	2012750	ABT
10314-0001-102	2012751	ABT
10314-0001-103	2012765	ABT

10314-0001-103	2012766	ABT
10314-0001-104	2012776	ABT
10314-0001-104	2012777	ABT
10314-0001-105	2012922	ABV
10314-0001-105	2012923	ABV
10314-0001-106	2012937	ABV
10314-0001-106	2012938	ABV
10314-0001-107	2012951	ABV
10314-0001-107	2012952	ABV
10314-0001-108	2012971	ABV
10314-0001-108	2012972	ABV
10314-0001-109	2012988	ABV
10314-0001-109	2014306	ABW
10314-0001-110	2013003	ABV
10314-0001-110	2013004	ABV
10314-0001-111	2014328	ABW
10314-0001-111	2014329	ABW
10314-0001-112	2013038	ABV
10314-0001-112	2013039	ABV
10314-0001-113	2013060	ABV
10314-0001-113	2013061	ABV
10314-0001-114	2012447	ABS
10314-0001-114	2013076	ABV
10314-0001-115	2013099	ABV
10314-0001-115	2013100	ABV
10314-0001-116	2013116	ABV
10314-0001-116	2013117	ABV
10314-0001-117	2013137	ABV
10314-0001-117	2013138	ABV
10314-0001-118	2013154	ABV
10314-0001-118	2013155	ABV
10314-0001-119	2013172	ABV
10314-0001-119	2013173	ABV
10314-0001-120	2013185	ABV
10314-0001-120	2013186	ABV

10314-0001-121	2013204	ABV
10314-0001-121	2013205	ABV
10314-0001-122	2013226	ABV
10314-0001-122	2013227	ABV
10314-0001-128	2012799	ABT
10314-0001-128	3000288	ACA
10314-0001-129	2012817	ABT
10314-0001-129	3000301	ACA
10314-0001-140	2014193	ABY
10314-0001-140	2014194	ABY
10314-0001-141	2014213	ABY
10314-0001-141	2014214	ABY

RATIONALE: PETN Lot 8730 was successfully tested during the original analysis 5 years ago. During the recent 5-year independent analysis, this PETN lot failed to meet the minimum nitrogen content requirement (17.5% minimum, reference MIL-P-387C, Paragraph 3.2). Nitrogen test results were 17.38%, all other requirements were met. Subsequently, margin testing was conducted on 12 CDF assemblies representing Lot ACA, and on 24 CDF assemblies representing Lots ABV, ABW, and ABY. The tests successfully demonstrated detonation propagation at 8 times the maximum design gap (0.432 inch air gap between ends of CDF assemblies). These tests provide confidence that initiation sensitivity and CDF output have not been compromised. In addition, 1,135 CDF assemblies have successfully functioned in flight. There have been approximately 300 CDF assemblies successfully ground tested. All have used PETN Lot 8730. There have been no detonation propagation failures. Critical functions are redundant.

Lots ABS and ABT CDF assemblies that were not represented in March, 2001 margin tests have been stored the same way as Lots ABV, ABW, and ABY. The storage environment is benign, the CDFs are sealed in desiccated bags. There have been no problem reports associated with CDF assembly storage. The PETN nitrogen content is a material issue rather than a CDF lot manufacturing issue. Therefore,

margin testing of Lots ABV, ABW, and ABY is representative of Lots ABS and ABT.

EFFECTIVITY: BI-107

AUTHORITY: Space Shuttle PRCBD S041062W, dated 3/28/01.