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Analysis of Microgravity Space Experiments Space Shuttle Programmatic Safety Requirements

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Summary

This report documents the results of an analysis of microgravity space experiments space shuttle programmatic safety requirements and recommends the creation of a Safety Compliance Data Package (SCDP) Template for both flight and ground processes. These templates detail the programmatic requirements necessary to produce a complete SCDP. The templates were developed from various NASA centers' requirement documents, previously written guidelines on safety data packages, and from personal experiences. The templates are included in the back as part of this report.

Background

A Payload Safety Compliance Data Package (SCDP) is the culmination of a two-fold process: the completion of an experiment hazard analysis in combination with an assessment of the experiment's conformance to the technical safety requirements. This document presents the programmatic side of developing a SCDP with requirements levied by Johnson Space Center (JSC), Marshall Space Flight Center (MSFC), Goddard Space Flight Center (GSFC), and Kennedy Space Center (KSC). The discussion of hazard analysis techniques and technical safety requirements are beyond the scope of this document.

The National Space Transportation System (NSTS) Program requires a Flight and Ground SCDP for all payloads, including most microgravity space experiments, flying on the Space Shuttle. Typically, three or four iterations of the SCDP are required during the safety review process for an experiment The SCDP's are designated by Phases 0, I, II, and III, each having specific levels of detail and experiment maturity required. These specifics are delineated in NSTS 13830B. Once the initial package has been developed, reviewed, and approved, it serves as a foundation for the subsequent packages. It should be noted that phases may be combined, e.g Phase 0/I, and that additional instructions are provided for series or reflight payloads.

The SCDP provides information which identifies, evaluates, and details controls for all hazards associated with the experiment. The flight SCDP is utilized by the Payload Safety Review Panel (PSRP) at JSC to assure safety requirement compliance of the experiment. The flight SCDP must be approved by the PSRP before the experiment may be flown. The ground SCDP is utilized by the Ground Safety Review Panel (GSRP) at KSC to assure safety requirement compliance of the experiment. The ground SCDP must be approved by the Safety Panel before the experiment GSE arrives on site.

If the experiment is to be integrated into a specific carrier (such as Spacelab, Orbiter Middeck, or a Hitchhiker), it may be necessary to submit the SCDP to the center responsible for integration of that payload carrier. Specifically these are:

- Spacelab - MSFC
- GAS/Hitchhiker - GSFC
- Middeck - JSC
- Spacehab - Commercial

These centers may, at their discretion, use the experiment SCDP as is, or it may be used as input for a mission integrated SCDP (typical of Spacelab or Middeck payloads). Each center has its own SCDP requirements that go above and beyond those identified in NSTS 13830, and these are not always compatible or all-inclusive of the other center requirements. This SCDP template was created with the intention of integrating all centers' programmatic safety requirements into one document which would encompass all the needs of the Integration Centers, the PSRP, and/or the GSRP.

There are some discrepancies between the documents on whether the safety information should be presented in a combined flight and ground package, or separate packages. There will be no combination of the two packages using this format.

Process

The following documents were used as references in the analysis. The bolded document numbers and shortened titles are used as convenient references in the SCDP templates.

NSTS 13830B - "NSTS 13830B: Implementation Procedure for NSTS Payloads System Safety Requirements", Nov. 1989

NSTS 1700.7B - "NSTS 1700.7B: Safety Policy and Requirements for Payloads Using the Space Transportation System", Jan. 1989

KHB 1700.7B - "KHB 1700.7B. Space Shuttle Payload Ground Safety Handbook", Jan. 1989

JA-012D - "JA-012D: Payload Projects Office Payload Safety Implementation Approach", June 1988

GSFC Safety Handbook - "GAS Experimenter's Guide to the STS Safety Review Process and Data Package Preparation", Sept. 1993

JSC Payload Safety Class - "Payload Safety Review and Analysis Course, Section V: The Safety Data Package", Nov. 1993

JSC 26943 - "Guidelines for the Preparation of Payload Flight Safety Data Packages and Hazard Reports for Payloads using the Space Shuttle", Feb. 1995

From these documents a series of matrices were developed in order to compare the requirements of each document. A final set of matrices were created which displayed the SCDP section in relation to the reference documents listed above. This final set is attached as part of this report. From these matrices and the information found in the reference documents, the SCDP templates were developed. Additional experience based knowledge was added where appropriate.

Findings and Recommendations

A. Each NASA center has their own requirements for a SCDP. These are not always compatible or all-inclusive of the other centers requirements. Therefore, an integrated requirements package would be useful and more efficient for all of the centers. The differences between the center's packages were identified in the NOTES section of the SCDP.

B. These packages have been developed as templates for creating SCDPs. They are not and cannot be used in lieu of a hazard analysis (e.g. Preliminary Hazard Analysis (PHA), Fault Tree Analysis, Sneak Circuit Analysis, etc.). The hazard analysis is the basis from which the SCDP and in particular the hazard reports are drawn.

C. These SCDPs will be used at LeRC. It is recommended that they are distributed and used throughout all NASA centers. It is anticipated that the distribution will be through the NASA LeRC SAO homepage (http://ned_lerc.lerc.nasa.gov/osma_sao.html) on the World Wide Web. This would ensure consistency in the package format, as well as provide current information on the SCDP.

D. It is recommended that this effort is coordinated through the NASA SR&QA director meeting. This would ensure support by all NASA centers

Conclusion:

The following packages were derived from the process mentioned above. Using these templates, the SCDP development process can be made easier and more efficient. They will also decrease the panel review time due to the consistency of all of the packages.

Future plans include adding generic hazard report templates for each subsystem. These templates will add to the efficiency of the SCDP development. They are currently being produced by the LeRC SAO.

Flight Traceability Matrix

This matrix traces each section of the SCDP template to the six reference documents/guidelines which are listed by their official names on the previous page. The bolded titles in the left hand column represent the sections of the SCDP template The numbers listed relate which sections (if any) of the six documents/guidelines (listed at the top of the matrix) discuss the same topic as a particular SCDP section Therefore, this matrix can be used to further reference a specific section of the SCDP template

SCDP Section	NSTS 13830B	NSTS 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class	JSC 26943
Cover Page[1]						
Title Page					C 1	4 5
Preface					C 2	5 1 5 5 1
Action Items	5 3 2 5 4 1 a (8) 5.4 2 5 4 2 a 5 5 1 a (9) 5 5 2 5 5 2 a 5 5.2 f		5 0 6 1 2 2 6 1 3 2 6 1 4 1 9 0		C 13	5 5 4 1
Revision Page	5 1 5 5 3 2 a 5 4 2 b 5 5 2 b 5 6		5 0 6 1 1 2 6 1 2 2 6 1 3 2 6 1 4 1		C 2	4 4
Table of Contents					C 3	4 5 5 2
List of Figures and List of Tables				App D, pg D-1	C 16 C 17	5 3
Acronyms and Abbreviations				App D, pg D-1	C 15 c	5 4
Introduction					C 2	5 5
Mission Description	5 2 1 a (1) 5 3 1 a (1) 5 3 2 c 5 4 1 a (1) 5 5 1 a (1)		6 1 2 1 6 1 3 1		C 2 C 7	

SCDP Section	NSTS 13830B	NSTS 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class	JSC 26943
Experiment Overview	5 2 1 5 2 1 a (1) 5 2 2 b 5 3 1 a (1) 5 3.1 a.(5) 5 3 2 c 5 4 1 a (1) 5 4 1 a (5) 5 4 2 b 5 5 1 a (1) 5 5 1 a (5) 8.0	200 4b	6 1 1.1 6 1 2 1 6 1 3 1 7 0	App D, 1 0	C 2 C 7 C 8	5.5.2 5 7 5 9 5 13
Ground Safety Overview[2]				App D, 4 0	C.7	5.8
Safety Assessment				App D, 3 1	C 5	5 5 4
Subsystems[3]						
Detailed Subsystem Description	5 2 1 5 2 1 a (2) 5.2 2 c 5 3 1 a (2) 5 3 2 d 5 4 1 a (2) 5 4 1 a (6) 5 5 1 a (2) 5 5 1 a (7)		5 0 6 1 1.1 6 1.2 1 6 1 3.1	6 0 App D, 2 0	C 8	5 10
Subsystem Safety Assessment and Safety Features	5 3 2 e 5 4 2 c 5 5 2 c	301 305 2	5 0 6 1 4 1	App D, 3 1 App D, 3 1 1 App D, 3 2 App D, 3 3	C 8	5 11
Verification Summary						5 12

SCDP Section	NSTS 13830B	NSTS 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class	JSC 26943
Batteries			6 1 2.1 6 1 3.1 App A, pgs A11-(1-3)	7.0 7 1 App B, pgs B2-(1-10) App. D, pg D-1		(Part II, pgs 28-31) part of elec
Electrical Systems	5 3 1.1 5 4 1.1 5 5 1 1 App A		App. B, pgs. B1/1-(1-2), B1/2-(1-2)			Part II, pgs. 22-23, 24-31, 36-39, 60-61
Ionizing Radiation Subsystems	5 3 1.1 5 4 1 1 5 5 1 1 App A Fig 5-1		6.1 2 1 6 1 3 1 App A, pgs A1-(1-4)	App C, pgs C-(4-6), C-(9-10)		Part II, pgs 15-16
Materials Subsystem	5 3 1 1 5.4 1.1 5 5 1 1 App A		App B, pgs. B1/5-1, B1/6-1	6 0 App D, pg D-1		Part II, pgs 11-12 , 13-14, 32-35
Mechanical Systems	5 3.1 1 5 4 1 1 5 5 1 1 App A					Part II, pgs. 17-19, 21, 53-59
Non-ionizing Radiation Subsystem	5 4.1 1 5 5 1 1 App A		6 1.3 1 App. B, pg B1/3-1	App C, pg C-8		Part II, pgs. 40-42
Optical and Laser Subsystems			6 1 3 1	App C, pg C-7		Part II, pgs 24-25
Pressurized Subsystems	5 3 1 1 5 4 1 1 5 5 1 1 App A		6 1 3 1 6.1.4 1 App C, C3/2-(1-7)			Part II, pgs 43-46
Structures Subsystem	5.3 1 1 5 4 1 a (6) 5 4 1 1 5 5 1 a (7) 5 5.1 1		App B, pg B1/7-(1-2)	6 0 App B, pgs B1-(1-12) App D, pg. D-1		Part II, pgs 13-14, 17-19, 21, 47-52, 58-59

SCDP Section	NSTS 13830B	NSTS 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class	JSC 26943
	App A					
Applicability Matrix	5 2 1 a (3) 5 3 1 a (3) 5 4.1 a (3) 5 5.1 a (3) App. B, pgs. B-(1-5)		6.1 1 1 6 1 2 1 6 1 3.1 App A, pgs. A4-(1-5)	App C, pg C-1 App D, 3 1	C 9	
Hazard Report List/Status	5 1.4 5 3 1 1 5 4 1 1 5 5 1 1 App B, pg. B-4		6 1 1 1 6 1 2 1 6 1 3.1 6 1 4.1 pgs A3-(1-3)	App. C, pg C-2 App D, 3 1		Part II, 2 2
Hazard Reports	5 1 4 5 2 1 a (4) 5 2.1 1 5.2 2 e 5 3 1 a (4) 5 3 1 1 5.3 2.f 5 4 5 4.1 a (4) 5 4 1 1 5 4.2 d 5 5 1 a (4) 5 5 1 1 5 5 2 d 5 6 App A	200 4b 214 1 301 305 2	5 0 6 0 6 1 1 1 6 1.2 1 6 1 3 1 6 1 3 2 6 1 4 1 9 0 App A, pgs A2-(1-6)	6 0 App B, pgs B1-(10-11) pgs B2-(9-10) App C, pg C-3 App D, 3 1	C 8 C 10 C 14 C 15 a	4 5 Part II
NCR, Waivers, Deviations	5 4.2 c 5 5 1 a (6) 5 5.2 c 6 0 6 1 6 2	216 5 305 2c App. A App C, fig 2			C 6	5 5 4 2
Failures/Accidents Report	5 4 1 a (7) 5 5 1 a (8)	301 305 2d	6 1 3 1 6 1 4.1		C 12 C.15 c	

SCDP Section	NSTS 13830B	NSTS 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class	JSC 26943
Verification Tracking Log	5.5 1 a (11) 5 5.1 1 5 5 2 d 5 5 2 e 5.5 2 f App A, pg A-8 App C	214 2 305.2b 305 3	5.0 6 1.4.1 6 1 4.2 6 1 5 2		C.11	Part II, 2.3.9
Certificate of NSTS Payload	5.5.1 a (12) fig 5-2	304 App A App C, fig 3	6 1 4.1 6 1 4 2 9 0 fig 6-2		C 4	
Appendix A: Applicable Documents					C 2	5 6
Appendix B: Project Schedule	5 2 2 a 5 3 2.b				C 7	
Appendix C: Safety Analysis	5 1.6 5.3 5 4	301 App A		3 0	C 8	5 5 3
Definitions[4]					C 15 b	
TOPs[5]					C 15 d	5.5 4 3
FMEA[6]	5 1 6		5 0 6 1.2 1 6 1 3 1 9.0			

Notes:

1 - The Cover Page is a customary addition to the SCDP There are no requirements for this page

2 - The Ground Safety Overview has been omitted from the SCDP template There are no actual requirements for this section This information will be covered in the Ground SCDP

3 - This section was added to provide the reader with instructions on how to divide the package into subsystems

4 - The definition section has been omitted from the SCDP template There is only one reference and no actual requirements for this section

5 - The Technical Operating Procedures (TOPs) have been omitted from the Flight SCDP, however, they will be addressed in the Ground SCDP template

6 - The Failure Modes and Effects Analysis (FMEA) will not be included in the SCDP template This is considered a stand alone document

Ground Traceability Matrix

This matrix traces each section of the SCDP template to the five reference documents/guidelines which are listed by their official names on the previous page The bolded titles in the left hand column represent the sections of the SCDP template The numbers listed relate which sections (if any) of the five documents/guidelines (listed at the top of the matrix) discuss the same topic as a particular SCDP section. Therefore, this matrix can be used to further reference a specific section of the SCDP template

SCDP Section	NSTS 13830B	KHB 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class
Cover Page[1]					
Title Page					C.1
Preface					C 2
Action Items	5 3 2 5 4 1 b (8) 5 4 2 5 4 2 a 5 5 1 b (9) 5.5 2 5 5 2 a 5 5 2 f		5 0 6 2 4 1 9 0		C 13
Revision Page	5 1 5 5.3 2 a 5 4 2 b 5 5.2.b 5 6	3 4	5 0 6 2 4 1		C 2
Table of Contents					C 3
List of Figures and List of Tables				App D, pg D-1	C 16 C 17
Acronyms and Abbreviations				App D, pg D-1	C.15 c
Introduction					C 2
Mission Description	5 2.1.b (1) 5.3 1.b (1) 5 3.2 c 5 4 1 b (1) 5 5 1.b (1)		6 2 2 1 6 2 3 1		C 2 C.7

SCDP Section	NSTS 13830B	KHB 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class
Experiment Overview	5 2 1 5 2 1 b.(1) 5 2 2.b 5 3 1 b (1) 5 3 2 c 5 4 1 b (1) 5 4 2 b 5 5.1 b (1) 5 5 2 c 8 0		6 2.1.1 6.2 2 1 6 2 3 1	App D, 1.0	C 2 C 7 C 8
Ground Operations	5 2.1.b (3) 5 2 2 b 5 3 1 b (3) 5 3.2.c 5 4 1 b (3) 5 5.1 b (3)		6.2 1 1 6 2 2 1 6 2.3 1	App. D, 4 0	C 7
Safety Assessment				App D, 3 1	C 5
Subsystems[2]					
Subsystem Description	5 2 1.b (2) 5 2 2 b 5 3 1.b (2) 5 3 2 c 5 4 1 b (2) 5 4 1 b (6) 5 4 2 b 5 5 1 b (2) 5 5 1 b (7) 5 5 2 c	3 2 A	6 2.1 1 6 2.2 1 6 2 3 1	App D, 4 0	C 8
Subsystem Safety Assessment and Safety Features	5 3 2 e 5 4 2 c 5 5 2 c	4 0	5 0	App D, 3 1 App D, 3 1 1 App D, 3 2 App D, 3 3	C 8
Verification Summary[3]					

SCDP Section	NSTS 13830B	KHB 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class
Electrical Systems	5 3 1.1 5 4 1 1 5 5 1 1 App A	4 1 3.B.9 4 3 2 3 C	App. B, pgs B2/1-(1-2)		
Lifting/Handling	5 3 1 1 5 4 1 1 5 4 1 b (6) 5 5 1 1 5 5.1 b (7) App A	4 1 3 B 5 4 5 1 1.B	6 2 4.1 App B, pgs B2/2-(1-3)		
Materials	5 3 1 1 5 4 1 1 5 5 1 1 App. A	3 2 I 3 2 J 4 1 3 B 7 4 3 10 B 2		App D, pg D-3	
Pressure Systems	5.3 1 1 5 4 1 1 5 5 1 1 5 5 1 b (11) App. A	4 1 3 B 8	6 2 4 1 App B, pgs B2/3-(1-3)	App D, pg D-3	
Radiation	5 3 1 1 5 4.1 1 5 5 1 1 App A	3 2 D 4 1 3 B 6 4 3 4 1 E 4 3 4 1 F 1	6 2 2 1 6 2 3 1 App A, pgs. A5-(1-3), A6-(1-3), A7-(1-3), A8-(1-3) A9-(1-3), A10-(1-3)	App C, pgs C-7, C-9, C-10	

SCDP Section	NSTS 13830B	KHB 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class
Hazard Report List/Status	5 1.4 5.3 1.1 5 4 1 1 5 5 1 1 App. B, pg B-4		6 2 3 1 pgs A3-(1-3)	App C, pg C-2 App D, 3 1	
Hazard Reports and Supporting Data	5 1 4 5 2 1 b (4) 5 2.1 1 5 2 2 e 5 3 1 b (4) 5 3 1 1 5 3 2 f 5 4 5 4 1.b (4) 5 4 1 1 5 4.2 d 5 5.1.b (4) 5 5 1 1 5 5 2 d 5 6 App. A	3 2 E 3 3 2 3 3 3 1 E	5 0 6 0 6.2.1.1 6 2 2 1 6 2 3.1 6.2 4.1 9 0 App. A, pgs. A2-(1-6)	6 0 App C, pg C-3 App D, 3 1	C 8 C 10 C 14 C 15 a
NCR, Waivers, Deviations	5 4 2 c 5 5 1.b (6) 5 5 2 c 6 0 6 1 6 2	3 2 G 3 3 3 3 3 3 1 3 3.3 2 App C, 6 a-6 g			C 6
Failures/Accidents Report	5 4.1 b (7) 5 5 1 b (8)	3 2 F	6 2 3 1 6.2 4 1		C 12 C 15 c
Safety Verification Tracking Log	5 5 1 b (12) 5.5.1 1 5 5 2.d 5 5 2 e 5 5 2 f App A, pg A-8 App C		5 0 6.2 4 1		C 11

SCDP Section	NSTS 13830B	KHB 1700.7B	JA-012D	GSFC Safety Handbook	JSC Payload Safety Class
Certificate of NSTS Payload	5 5 1 b (13) fig 5-2		6 2 4 1 6 2 4 2 9.0 fig 6-2		C 4
List of Deliverable Items			6 2 2 1 6 2 3 1		
Appendix A: Applicable Documents					C 2
Appendix B: Project Schedules	5 2 2 a 5 3.2 b	3 2 B			C 7
Appendix C: Technical Operating Procedures (TOPs)	5 4 1 b(9) 5 5.1 b (10)	3 2 C 3 3 2 4.1 3 B 4 1 3 C 4 3 3 2 2 D 4 4 2 2 App C	6.2 3 1 6 2.4 1 6 2 4 2	App D, 4 0	C 15 d
Definitions[4]					C 15 b
FMEA[5]	5 1 6		5 0 9 0		

Notes:

1 - The Cover Page is a customary addition to the SCDP There are no requirements for this page

2 - This section was added to provide the reader with instructions on how to divide the package into subsystems

3 - This section was added because of requests from safety reviews There are no requirements for this page

4 - The definition section has been omitted from the SCDP template There is only one reference and no actual requirements for this section

5 - The Failure Modes and Effects Analysis (FMEA) will not be included in the SCDP template This is considered a stand alone document.

Flight Safety Compliance Data Package Template

Cover Page

Every SCDP begins with a cover page This page provides the title of the experiment, the phase of the data package, and the preparation date Often, this page is placed on a company letter head in order to identify the company or NASA center where the package was prepared This page can be arranged in any fashion The following page is an example of a typical cover page.

NOTE·

There are no requirements for this page

TITLE OF EXPERIMENT

PHASE __ FLIGHT SAFETY COMPLIANCE DATA PACKAGE

DATE

(Sample Cover Page)

Title Page

The title page provides necessary information about the package as well as the involved personnel. Similar to the cover page, the title page includes the experiment name, the phase of the data package, and the preparation date In addition, it provides the contract number and the signatures of the responsible personnel, which include the author(s), program manager, chief engineer, and the organization safety representative Included under the personnel signatures are their printed name, title, and affiliated company or NASA center A sample title page is provided for reference *NOTE Additional lines should be added for more than one preparer The signatures are interpreted as a concurrence of the SCDP*

NOTES

To avoid confusion, revision numbers have been excluded

JA-012D's cover page is the hazard list page and will be included in the hazard list section, NOT the title page

JSC 26943 refers to this page as the signature page

Information under the signature line and the phase number has been added

EXPERIMENT NAME

Phase __ Flight Safety Compliance Data Package

Date

Contract #:

Prepared By

_____

Name
Title
NASA Center or Company

Approved By

_____

Name
Program Manager
NASA Center

_____

Name
Chief Engineer
NASA Center

Concurred By

_____

Name
Title *(Organization Safety Representative)*
NASA Center

(Sample Title Page)

Preface

The preface is a brief paragraph which explains the requirements of the SCDP contract. This includes a statement of compliance with requirements specified in NSTS 1700.7B and a reference to the applicable documents appendix for supplementary compliance documents The preface also provides additional information about the responsible personnel including phone numbers and mailing addresses Furnishing the Payload Safety Review Panel (PSRP) with this information allows them to contact the responsible personnel in order to resolve technical issues and questions.

NOTES

JSC Payload Safety Class includes the statement of compliance with the requirements in the introduction and a list of all applicable documents This is covered in the preface which includes a reference to the applicable documents appendix. It also includes the reason why a SCDP needs to be submitted which is included in the preface as the requirements of the SCDP contract

The Forward and Purpose from JSC 26943 have been included in this paragraph The purpose of the hazard analysis and the desired result is included in the requirement of the SCDP contract

Action Items

The action items (AI), which evolve from safety panel reviews, are accounted for through an AI table An AI table is provided on the following page for reference This table numbers, lists, and provides information about a particular AI which includes its current status and closure rationale The AI number is assigned at safety reviews and can be obtained through the minutes of the meeting The current status is listed as either open or closed with a closure date The closure rationale explains the reasons for which the AI was accepted as being closed It is the responsibility of the SCDP developer to track all AIs to closure. All AIs must be closed by the PSRP prior to the Phase III Flight Safety Review to be considered complete A Phase 0 SCDP should have a blank AI table as a placeholder for future SCDP iterations, there will be no AIs since the Phase 0 SCDP is the first official version of the SCDP

NOTES:

The AI Number has been added in order to easily identify each AI The closure date has also been added as further information for the AI The explanations of each table header was added for clarification The AI section has been moved to the front of the package due to its importance

Action Items

AI Number	Action Item	Current Status (open/closed with closure date)	Closure Rationale

Revision Page

The revision page describes the significant alterations made to the SCDP after Phase II that occur due to action items, major engineering design changes, and/or control measure changes. Some of these changes are suggested by the engineers and designers and may be presented in ECRs (engineering change requests) All changes are assessed for safety, documented in the SCDP, and recorded in this table. It is not necessary to document insignificant editorial revisions As shown on the succeeding page, the revision page will include the following information the revision number, revision description, the location of the response data, and the revision date. The location of the response data is a listing of the page and paragraph number or hazard report number of the adjustment in the SCDP which resulted from the revision Hazard report alterations are to be referenced to the hazard report list/status page in order to avoid duplication of status A Phase 0 package will not contain a revision page since it is the first official copy of the SCDP *NOTE All significant revisions made to the SCDP will be identified by placing a bar in the right hand margin next to the altered paragraph or statement in the SCDP*

NOTES

NSTS 13830B details the safety assessment on changes to include effects on interfaces This is understood when saying that the changes should be assessed for their impact on the system's safety

The ECRs are only mentioned in JA-012D

There is no direct requirement for a revision page There are only references to changes and recording these changes. This table was created in order to help the safety engineer keep track of all of the changes

Revision Page

Revision Number	Revision Description	Response Data (pg. & paragraph # or hazard report #)	Revision Date

Table of Contents

The table of contents presents all of the section and subsection numbers, titles, and page numbers The pages between and including the preface and acronyms and abbreviations should be numbered with Roman numerals This excludes the cover and title pages, which are typically not numbered After the acronyms and abbreviations page, the pages should be numbered sequentially within each section This involves using a compound numbering system in which the first number represents the section number and the second number represents the page number in that particular section (i.e. pg. 1-5 is section 1, page 5) Using this technique, each section will begin on a new page This method easily allows for additional pages to be added per section without disrupting the complete numbering system All sections with Roman or Arabic numerals should appear in the table of contents. The total number of pages of the complete package should also be included to ensure the reader that he/she has received the complete package *NOTE The individual hazard reports will be separately listed elsewhere in the package and do not need to be listed by name here*

NOTES

The JSC Payload Safety Class suggested adding a letter to designate added pages. This is unnecessary if the compound numbering system is used The JSC Payload Safety Class also gives a choice of listing the hazard reports in the table of contents or at the beginning of the hazard report section The note above explains the use of the hazard report list found later in the package.

Further instructions on how to number the SCDP have been provided here for guidance

List of Figures and List of Tables

Following the table of contents is the list of figures and the list of tables These two separate lists follow the format of the table of contents and in effect look as though they are a part of it The figures and tables will have a separate compound numbering schemes similar to the page numbering system. The first number represents the section number and the second number represents the figure or table number in that particular section (i e figure 1-6 is section 1, figure 6)

NOTES:

Some of the documents discuss these together and some do not The information stated here was gathered from referencing previously written SCDPs

Acronyms and Abbreviations

This section is a list of all of the acronyms and abbreviations and their complete names used throughout the SCDP The list will stand as a reference for those not familiar with the terminology The following is a listing of common acronyms and abbreviations which are typically used in a SCDP This list is provided only as a reference for the preparer. This list should be altered and amended to reflect the appropriate acronyms and abbreviations for a particular project.

AC	Alternating Current
AI	Action Items
ASE	Airborne Support Equipment
CDMS	Command and Data Management System
DC	Direct Current
ECR	Engineering Change Request
EMI	Electrical Magnetic Interference
EVA	Extravehicular Activity
FMEA	Failure Modes and Effects Analysis
GAS	Get-Away-Special
GSFC	Goddard Space Flight Center
GFE	Government Furnished Equipment
GSE	Ground Support Equipment
ICD	Interface Control Document
JSC	Johnson Space Center
KSC	Kennedy Space Center
KHB	Kennedy Handbook
LeRC	Lewis Research Center
MDP	Maximum Design Pressure
MIP	Mandatory Inspection Point
MIUL	Material Identification Usage List
MLI	Multi-Layer Insulation
MPE	Mission Peculiar Equipment
MSFC	Marshall Space Flight Center
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NCR	Noncompliance Report
NHB	National Handbook
NSTS	National Space Transportation System
PGSC	Payload General Support Computer
PHA	Preliminary Hazard Analysis
PHR	Payload Hazard Report
POCC	Payload Operations Control Center
PSRP	Payload Safety Review Panel
SCDP	Safety Compliance Data Package
SH	Spacehab
SL	Spacelab
SRM&QA	Safety, Reliability, Maintainability, & Quality Assurance
SSP	Space Shuttle Program
STS	Space Transportation System
SVTL	Safety Verification Tracking Log

TBD	To Be Determined
TOP	Technical Operating Procedure

NOTES: (FOR ACRONYMS AND ABBREVIATIONS)

JSC 26943 calls the acronyms and abbreviations' complete name a definition. The word "definition" was excluded to avoid confusion

This list provided is not suggested in any document

Introduction

The introduction describes the format of the SCDP. A correlation is made between the progress of the experiment and the phase of the SCDP This informs the reader of the maturity of the experiment and SCDP The actual content of the SCDP depends on the phase Early phase packages contain considerably less information but exist as a base in which information can be added for a complete Phase III package This paragraph includes the approach taken to provide the information necessary for a package of the appropriate phase It should mention that the SCDP is broken into sections where each section represents a subsystem In each one of the sections is the subsystem description, subsystem safety features, subsystem's hazard report(s), and additional supporting data. The introduction should also include any other general information pertaining to the SCDP

NOTES

This introduction does not fit with the definition of introduction given in JSC Payload Safety Class The JSC document introduction is the payload and mission overview which will be covered in the experiment overview and the mission description, respectively The requirements which are satisfied by the SCDP are already covered in the preface (NSTS 1700 7B) and are also listed in the applicable documents section in the appendix The purpose of the hazard analysis and the desired results are also covered in the preface The JSC Payload Safety Class also addresses the description of the subsystems which is covered in the Subsystem Description of this package

JSC 26943 provides a generic statement which is covered in this paragraph

No other documents suggest this type of an introduction It is necessary in order to prepare the reader for the content of the SCDP Often, the overall payload and mission description is included under the introduction There are separate sections for both of these topics in this package

Mission Description

This section provides a description of the mission on which the experiment is to be flown. Included in the description is be the name of the mission, mission objectives, and mission characteristics. The mission objectives explain the purpose and goals of the mission.
The mission characteristics entail the launch location, launch date, launch window, attitude, mission duration, primary landing site, and payload configuration

NOTES

JSC Payload Safety Class included the mission objectives in the introduction The JSC document also included the payload objective and project schedules The payload objective will be included in the experiment overview and the project schedules have been placed in an appendix There is information in this section which may be on a mission schedule, such as the mission's launch date and launch window The JSC Payload Safety Class also includes ground operations which are not in this mission description The ground operations will be detailed in the Ground SCDP The flight operations are also discussed in the JSC Payload Safety Class's mission description This is covered in this package in the experiment overview

JA-012D includes the mission description with the payload description

NSTS 13830B has also included the mission description with the payload description

Experiment Overview

The experiment overview should be divided into several subsections which describe the payload, the experiment, the operational scenario, and Orbiter provided critical services and interfaces If an experiment is large in size and fairly complex it is common to consider it as a payload In this case, there will not be a separate description for the payload and the experiment since they are one and the same This section will change with the alteration of the design It is important to keep this information updated throughout the various phases of the SCDP *NOTE If the payload/experiment is to be reflown or is part of a series flight then refer to NSTS 13830B section 8 0 or JA-012D section 7 0 for complete instructions and also note this fact in this section.*

The payload description includes the payload name, its location on the STS, and the overall objectives of the payload A diagram of the location of the payload may be used to help explain the payload's location and its orientation on the STS

The experiment description addresses the objectives of the experiment and the experiment's overall design If the experiment is a GAS experiment then it is also necessary to identify the classification as either "B" or "C". *NOTE Reference the GSFC Safety Handbook, section 4 1, pg 9, for an explanation of the classification system* The overall design should mention all of the safety critical subsystems involved and reference the sections in the SCDP which describe each subsystem in detail The government furnished equipment (GFE) should be described along with an explanation of its use in relation to the experiment Illustrations and figures should be included to aid in the description of the system

The operational scenario provides a chronological explanation of the operation sequence This scenario should describe the experiment's operating procedures during all phases of flight from prelaunch to landing including abort and rapid-safing contingencies Any known crew procedures should also be included along with an explanation of necessary certifications for hazardous procedures. An operations timeline can be included to aid in the description of the operational scenario An example of an operations timeline is provided on the following page

The Orbiter provided critical services and the experiment-Orbiter interfaces should be identified and explained The Orbiter provided critical services include any monitoring or controlling of a potential hazard associated with the experiment These services must be identified as safety critical services Some common Orbiter provided critical services are structural/mechanical interfaces, environmental control, electrical power, and command and data management systems

NOTES (for Experiment Overview)

JSC Payload Safety Class covers the scope and purpose of the payload under the Introduction The scope and purpose of the payload will be addressed in the payload objectives and the experiment objectives The introduction also requires identification of the primary system, support systems, operational interfaces, and facilities These have all been moved to the experiment overview This document also includes the payload objective and flight operations under the mission description The detailed subsystem descriptions are also included in the payload/system description in the JSC document All detailed descriptions have been moved to the subsystem descriptions.

JSC 26943 has a separate scope section which has been included here It includes a list of all hardware items This will be covered in the description of the subsystems. This document also includes a section called ground operations. These will not be addressed in the flight SCDP They will be addressed in the ground SCDP The flight operations and the Orbiter provided critical services have been included under the experiment overview instead of under separate topics The Orbiter provided critical services section provides subsystems to include The JSC document describes each subsystem and repetitively tells the reader to describe each subsystem A simple list was added to this package in order to get the reader on the right track JSC 26943 also separates the payload description and the flight operations These have been combined in the experiment overview section

GSFC Safety Handbook includes the objectives of the experiment, the classification, conceptual descriptions, and operational scenarios These have been combined and included in this section

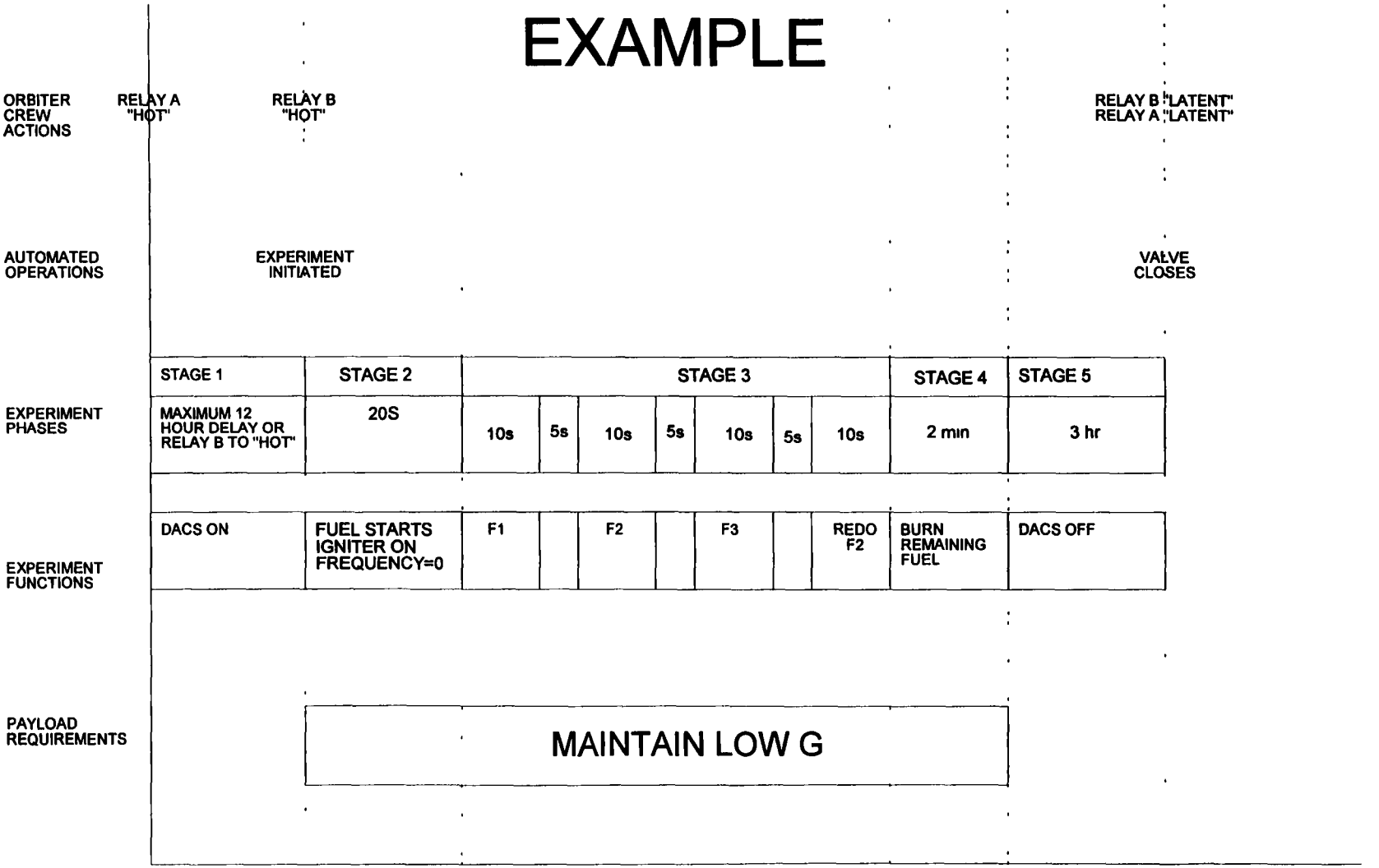
JA -012D suggests including block diagrams and line illustrations These are included in the illustrations and figures As the phases progress, this document stresses a fully developed description This will be covered in the subsystem description

NSTS 13830B asks for program milestone schedules This will be included in the appendix The Orbiter provided critical services have been included under the experiment overview instead of under a separate topic

NSTS 1700 7B also includes the Orbiter provided critical services in the hazard report

The payload description, experiment description, the operational scenario, and the Orbiter provided critical services and interfaces are all in one section. Noted above are the documents which separated some of these sections The payload location is included in the payload description No document actually calls out for the payload location

EXAMPLE



Note Timeline is not to scale

Relay B can be activated before the completion of STAGE 1 Relay B will then be deactivated 3 HR after Relay B is activated

Safety Assessment

The safety assessment gives a narrative summary of the safety analysis of the experiment and its interfaces The summary explains the approach and techniques used to analyze the experiment for hazards. Any assumptions made in order to analyze for hazards should be stated and explained. The maturity of the safety assessment depends on the maturity of the experiment; therefore, this section will be general for a Phase 0 package and will develop in detail for a Phase III package If the experiment is a GAS experiment then it is also necessary to rationalize the classification which was given in the experiment overview. *NOTE Reference the GSFC Safety Handbook, section 4 1, pg 9, for an explanation of the classification system* There should be a reference to the subsystem safety features for a detailed safety assessment of a particular subsystem The actual safety analysis may be included in Appendix C and should be referenced in this section

NOTES

JSC Payload Safety Class called this the Program Safety Status Summary The JSC document asks for safety concerns and noncompliance items. It also suggests a summary of all risks deemed acceptable by the approving agency and the corresponding program position This will be covered in the subsystem sections under safety features.

GSFC Safety Handbook asks for the results of the hazard analysis This is covered in the summary of the safety analysis.

Subsystems

This section is a narrative of the subsystems of the experiment which are discussed in the SCDP. The narrative explains that the SCDP is broken up into sections per experiment subsystem The subsystems which are included in the SCDP will be listed Each section contains a detailed subsystem description, subsystem safety assessment and safety features, and verification summary This section further explains what information can be found under each of these items as detailed below for reference

Subsystem Description·

This section will completely describe the subsystem including its layout, components, function, and planned operation. Diagrams and figures will be provided to illustrate the subsystem and its location within the experiment (These may be included in the Hazard Report section.)

Subsystem Safety Assessment and Safety Features

This section will provide a hazard assessment detailing the potential hazard sources associated with the particular subsystem References should be made to the appropriate hazard reports and their supporting data. Included in the assessment will be all of the safety features incorporated into the design Also, provide an explanation of all risks which are deemed acceptable by the approving agency and are to be supported by the experiment organization Additionally, a summary will be included which explains the safety controls of any eliminated hazards (those hazards in which a hazard report was found unnecessary). If applicable, diagrams and figures should be included to display and better explain any safety features (These may be included in the Hazard Report Section.)

Verification Summary

This section will describe the methods of verification used to assure that each hazard control meets its design specifications and intended performance levels The description of a particular test or analysis and its results will be provided along with references to the actual test or analysis report if applicable.

This SCDP template is divided into sections, each describing a specific subsystem, to illustrate the approach which should be taken The subsystems that follow are common subsystems found in space experiments which include Batteries, Electrical Subsystems, Ionizing Radiation, Materials Subsystems, Mechanical Subsystems, Non-ionizing Radiation Subsystems, Optical and Laser Subsystems, Pressure Subsystems, Structural Subsystems, and Miscellaneous Subsystems As described above, each subsystem section is divided into three separate sections in order to aid in the description of the subsystem and in assessing potential hazards This information is provided as a reference for use in developing an actual SCDP

NOTES

This section was added in order to assist the reader in preparing the subsystem divisions in the SCDP This was not suggested in any document, but will help the reader understand the format of the package The descriptions of each section under the subsystems was gathered from various documents.

13830 suggests several subsystems, but it also states that any convenient grouping may be used. The subsystems listed above are common to LeRC space experiments

Batteries:

Batteries:

- Includes any battery used throughout the experiment
- Includes all internal "button" batteries commonly found in computers or other small electronics
- Includes battery charging circuitry

Subsystem Description:

- Identify all batteries used in the experiment. Include manufacturer, model number, number of cells, cell or battery voltage, capacity, series or parallel arrangement, and a battery circuit diagram Complete the battery matrix.
- Provide diagrams of the location and the surrounding circuitry
- Description of operation

Safety Assessment Summary and Safety Features:

- Describe the battery box in which the battery is contained. Provide a drawing of the battery box ("Button" batteries may not have battery boxes)
- Describe the ventilation system used to vent the battery box Provide a diagram of the ventilation of the battery ("Button" batteries may not have ventilation)
- Describe control which protect against external shorts or their effects Reference or include applicable drawings
- Identify and describe all manufacturing controls that preclude internal shorting
- Specify what devices and procedures will limit the charging current, so as not to initiate or sustain an excessive outgassing or thermal runaway of secondary batteries.
- Identify monitors available
- Specify devices and procedures that are designed to limit effects of the current discharge or limit the discharge rate Specify failure tolerance of these systems

Verification Summary:

- Specify what techniques are used to verify that internal short protection is in place
- Summarize analyses to confirm adequate short protection is in place
- Specify how devices, procedures, monitors, etc , which protect against overcharging are to be qualified and verified
- Summarize how the implementation of controls to prevent cell reversal will be verified
- Summarize and refer to the verification analysis or test that verifies the safety margin between rupture, venting, and operating pressure for worst-case conditions
- Summarize and refer to thermal analysis that determined operating conditions
- Summarize verification analysis or demonstration test results that verify the required failure tolerance is maintained
- Summarize the results of the pressure test of the battery box.

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Provide diagrams of cell/battery construction
- Schematics of battery circuits identifying circuit protection features
- Schematics of control and monitoring circuits preventing cell reversal
- All necessary test reports which support the verifications listed

Electrical Subsystems:

Electrical Subsystem:

- Includes the control of potentially hazardous experiment functions
- Includes Electrical Power Distribution Systems (EPDS)
    - Starts at interface connector between the experiment and the Orbiter
    - Includes all electrical and electronic components· connectors, circuit breakers, fuses, cables and wiring, control circuit parts/components/elements, power systems, and power supplies
- Includes computer-controlled systems
- Includes all electronic safety inhibits
- May be referenced in other experiment subsystems
- Telemetry Systems

Subsystem Description:

- Provide a complete description of the experiment electrical subsystem Include the materials used for the various components
- Specify the function and operation of each major component or element and a definition of the experiment electrical interface requirements
- Provide schematics and block diagrams as appropriate
- Provide a brief description of any computer-based control systems utilized in the experiment design
- Identify whether the computer system is being used to actively process/command systems with a critical or catastrophic hazard potential
- If a computer is utilized solely to process/manipulated non-safety related data (e.g science data), state that the computer is not being used to actively inhibit, control, or monitor any experiment system which could possibly create a critical or catastrophic hazard
- Provide a list of all experiment safety critical systems being controlled by the computer
- Provide a summary of the service provided by the Orbiter general purpose computer such as the monitoring, storing, retrieving, or commanding of any experiment safety critical systems
- Provide a brief description of the hardware architecture including processors, redundant hardware components, and redundant computers
- Provide a diagram to show how the computer system interacts with the safety critical systems and components
- Provide a description of the electrical power used to enable the computer system

Safety Assessment Summary and Safety Features:

- Provide a description of the various types of inhibits and level used throughout the experiment
- Provide a description of the fault tolerance of all critical functions
- Provide a description of the protection of Orbiter circuitry that is powered by the experiment EPDS
- Provide a description of all safety features incorporated into the design of the EPDS This could include bonding, grounding, shielding, wire and fuse compatibility, isolation, compliance with conducted and radiated emissions requirements, wire routing, wire sizing, cable and wire physical protection, separation of safety critical circuits to the maximum extent possible, and shock protection

- Define the approach being used to verify independence of the computer system
- Describe how the experiment organization has instituted unique instruction sequences in the multiple-computer system software
- Describe the protection against under-voltage or over-voltage conditions

Verification Summary:

- Describe the inspection process used to verify that the safety features mentioned in the above section have been implemented properly.
- Describe the systems analysis and loads analysis which ensures that the proper load constraints are in place
- Summarize the testing process which verifies that proper grounding has been implemented Include the test parameters and reference the test plan

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Schematic diagrams indicating power source, wire sizes, circuit protection devices, wire temperature rating, etc.
- Inspection reports and close-out photographs (as requested)
- Document grounding and bonding techniques used
- Outline testing procedure and criteria

Ionizing Radiation Subsystems:

Ionizing Radiation:

- Radioactive material
- Equipment that emits ionizing levels of electromagnetic radiation

Subsystem Description:

- Identify all radioactive materials
- Complete JSC Form 44 for each radioactive material

Safety Assessment Summary and Safety Features:

- Describe the experiment procedures and/or the design used to ensure ionizing radiation levels and exposure of crew and equipment are minimized, in according with Federal licensing standards
- Describe any design provisions that prohibit release or displacement of radioactive material and subsequent contamination problems
- Specify and summarize fault tolerance to inadvertent operation
- Identify all inhibits, controls, and monitors available. Provide diagrams of controls and inhibits
- Summarize containment of ionizing radiation Provide diagrams indicating containment provisions.

Verification Summary:

- Summarize the review of the design, the containment analysis, and the operational hazard analysis
- Summarize and refer to the analysis to support fault tolerance of the design

Notes: The following information is needed for this section. As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- JSC Form 44 describing all uses of radioactive materials or radiation generators
- Schematics of controls and inhibits for operation of ionizing energy generators
- Diagrams indicating containment provisions

Materials Subsystems:

Materials Subsystem:

- Materials used in the construction of the experiment
- Materials used as experiment consumable (e.g experiment fluids and gases)
- Materials generated from the experiment operation/interaction (e g. exhaust fluids and gases)

Material Usage Description:

- Describe the payload in terms of the major uses of materials
- Provide a listing of the type and quantity of experiment consumable materials
- Provide a list of the materials generated from the experiment operations and/or potential interactions
- Provide a list of the any radioactive material or coatings used.

Safety Assessment Summary and Safety Features:

- Detail how the materials were selected (i e standards, requirements documents, testing, etc)
- Detail how the material selection inhibits stress corrosion
- Detail how the hazard level of the experiment was analytically derived
- Detail how the hazard level and quantities of the experiment generated materials were determined. (Mention the SMAC values for fluids)
- Detail how the hazard level of the radioactive sources was determined.

Verification Summary:

- Provide summary status report of the MIUL and number of MUA's generated
- Provide summary of offgas testing results
- Provide summary of experiment testing regarding experiment and exhaust gases and fluids

Notes: The following information is needed for this section. As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Materials Identification and Usage Listing (MIUL)
- Material Usage Agreement (MUA)
- Toxicology Analysis
- Flammability Analysis
- Ionizing Radiation Summary report
- O_2 Depletion Analysis
- Any material testing plan/results (i e corrosion, compatibility, structural, etc)

Mechanical Subsystems:

Mechanical Subsystem:

- Rotating Machinery. pumps, compressors, turbines, centrifuges, motors, disk drives
- Fasteners, lock pins, guide pins
- Doors, covers, screens, actuating mechanisms, latches

Subsystem Description:

- Include a description of these items and their operation
- Provide cutaway drawings showing design details.

Safety Assessment Summary and Safety Features:

- List hazards along with design features that mitigate the hazard
- Describe structural analysis and summarize appropriate margins.
- Describe the human factors engineering of these devices
- Describe the containment and tethering of these devices
- Describe the overspeed protection
- List any fracture critical parts
- Describe any redundant features

Verification Summary:

- Functional testing of the overspeed controls/ must-work mechanisms
- Inspection of as-built hardware.
- Summary of the structural analysis and/or test

Notes: The following information is needed for this section. As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Structural Analysis/Test
- Functional Test Reports
- As-built Hardware Inspection Reports
- Fracture Control summary
- Containment Analysis

Non-Ionizing Radiation Subsystems:
Electromagnetic Interference (EMI)
Radio Frequency (RF) Radiation

Non-Ionizing Radiation Subsystem:

Electromagnetic Interference (EMI):

- Generated from electronic equipment
- May be generated by the experiment/payload carrier
- Can be radiated and/or conducted
- Includes components that may be susceptible to EMI

Description:

- Describe the electrical systems which are suspected to generate radiated and/or conductive EMI
- Provide illustrations of these systems which reveal their relative location in respect to the complete experiment/payload

Summary of Safety Assessment and Safety Features:

- Compare the EMI generation and/or susceptibility of the experiment to the limits dictated by the payload-to-Orbiter/Carrier ICD (Interface Control Document)
- Describe any shielding provided for protection from EMI Include diagrams of the shielding. (Supporting Data)
- Describe the bonding/grounding designed and built into the electrical systems suspected to generate EMI Provide electrical schematics which illustrate the bonding/grounding included in the design (Supporting Data)

Verification Summary:

- Summarize the results of the system-level conductive and radiated EMI tests
- Summarize the results of the EMI susceptibility test
- Summarize the results of experiment circuit compatibility with the EMI environment specified in the ICD
- Relate all test values to the ICD EMI limits/levels for verification of compliance
- Refer to qualification procedures and reports for verification.

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Include schematics showing all shielding and/or electrical bonding/grounding. (from Safety Features section)
- Data/Reports showing potential EMI levels from the experiment relative to ICD limit levels
- Data/Report showing circuit compatibility with the EMI environment (EMI susceptibility) specified in the ICD.

Non-Ionizing Radiation Subsystem:

Radio Frequency (RF) Radiation:

- Generated from transmitter antenna systems

Description:

- Describe RF transmitter antenna system
- Include illustrations of the system and its location
- Define energy levels of the antenna in all modes of operation (high, low, etc)
- Define the minimum safe distances for EVA crew members during worst-case emissions
- Define the energy levels for experiment-to-experiment and experiment-to-carrier irradiations

Summary of Safety Assessment and Safety Features:

- NSTS 1700 7B defines radiation in excess of the ICD limits as a catastrophic hazard. Those below ICD limits are considered critical hazards
- Describe the electrical inhibits used to prevent a hazard.
- Describe each control for each inhibit and establish it independence
- Indicate how each inhibit is monitored. (Inhibit monitors are required if radiation levels exceed ICD limits be more than 6 dB)
- Describe ground/return leg inhibit and any RF commanding and encryption implemented
- Define the fault tolerance of the system electrical inhibits including Orbiter interfaces
- Include schematics/block diagrams showing electrical inhibits used to prevent inadvertent RF transmissions (Supporting Data)
- Define the zones of exclusion when the hazard is controlled by avoidance of the hazardous area.

Verification Summary:

- Specify how the electrical inhibits and controls were verified to withstand the expected shuttle environment
- Summarize the analysis that verifies the fault tolerance of the control system
- Refer to qualification procedures and reports for verifications

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Include schematics/block diagrams showing electrical inhibits used to prevent inadvertent RF transmissions (from Safety Features section)
- Include a table listing the electrical inhibits, when last cycled, and how verified
- Data/Reports showing potential RF levels from the experiment transmitters relative to ICD limit levels.

Optical and Laser Subsystems:

Optical and Laser Systems:

- Includes optical/laser components such as the laser source, the cable, surface mirrors and gratings, lenses, beam splitters and prisms.
- Includes lights, baffles, covers, lasers, and cameras

Subsystem Description:

- Describe any optical systems used in the experiment
- Describe any laser systems, include the type of laser, the laser class, and the function of the laser
- Define the laser's minimum/maximum energy output, the wavelength(s), pulse (with frequency) or continuous wave, and maximum permissible exposure levels for humans to the wavelength(s)/energy levels
- Provide drawings showing physical location and orientation of all optical and laser systems within the overall system

Safety Assessment Summary and Safety Features:

- Identify any operational or design safety features, such as baffling of light, containment of shatterable material, safe targets for lasers, and isolation of crew and the Orbiter from any hazardous fluids that are typically used with optical telescopes
- Specify the number and list the electrical/mechanical inhibits that prevent occurrence of the hazard
- Describe each control for each inhibit and establish its independence Indicate how each inhibit is monitored
- Describe ground/return leg inhibit and any RF commanding and encryption implemented
- Define the fault tolerance of the system electrical/mechanical inhibits including Orbiter interfaces
- Specify any interlocks to prevent operation unless a specific physical configuration is achieved
- Define the containment (mechanical, attenuation or dispersion) features of the system design to preclude crew exposure to laser emissions in excess of the allowable MPE
- Describe any mechanisms that require precision orientation to assure a safe optical path Describe the design features that assure operation only when the optical path is "safe"
- Describe any crew procedures used for hazard control

Verification Summary:

- Summarize analyses which verifies the fault tolerance Show how the analysis substantiates inhibit independence
- Summarize the testing process which verifies containment of laser emissions
- Summarize the testing process which verifies the interlock mechanisms
- Describe the inspection process used to verify that the safety features mentioned in the above section have been implemented properly.

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Include a table listing all laser sources, their energy, wavelength, pulse characteristics, dispersion characteristics, hazard classification, etc
- Schematics showing all inhibits, controls and monitors For any interlocks include a diagram indicating the interlock mechanism
- Drawing indicating the optical path(s). Indicate the containment feature around the optical path(s).
- Crew procedures used to control the hazard
- Containment Test Results.
- Interlock Mechanism Test Results

Pressure Subsystems:

Pressure Subsystem:

- Pressure vessels, lines and hoses, support members
- Valves, regulators, filters, fittings, bellows
- Instrumentation, components
- Sealed containers

Subsystem Description:

- Describe the purpose and planned operation of the subsystem
- Include a detailed system schematic.
- Provide functional schematics
- Provide cutaway drawings of major components
- Identify fluids and gases by name, identify quantities
- Categorize the hazard level posed by a gas/fluid release
- State the MDP and provide a basis for its determination
- Describe the scope of the pressure system as defined by the project (i e is the exhaust portion within the pressure system envelope?)

Safety Assessment Summary and Safety Features:

- Describe the basis for the systems MDP
- Provide a two fault analysis for determining the MDP
- Consider the worst case environmental conditions
- Consider a compatibility analysis of the pressure system components
- Provide listing of fracture critical components
- Consider failure of heaters
- Describe any use of software for pressure system operation and/or hazard control

Verification Summary:

- Provide summary of pressure system vibration testing pressurized at MDP
- Provide summary of proof testing results. (i.e NDE, flaw screening, etc.)
- Provide summary of leak testing results

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Include a table listing the fluid system components, their respective MDP's proof and burst pressures, and margins
- Summary table giving rational for usage of stress corrosion sensitive materials
- Include any materials testing done on pressure system components

Structural Subsystems:

Structural Subsystem:

- May consist of beams, plates, housings, brackets, braces, attachment fittings, structural fasteners
- Used to support experiment components
- Used to attach the experiment to the integrated payloads

Subsystem Description:

- Identify all major structural elements
- Provide diagrams identifying primary and secondary structures, front, top and side views
- Provide a listing of the materials used in the primary and secondary structure.

Safety Assessment Summary and Safety Features:

- List the safety and design requirements that were used as a basis of the design
- Describe how the maximum expected loads were determined
- Describe the method used or design features which will prevent fastener backoff from occurring

Verification Summary:

- Describe in detail the analysis and testing approach that will be used to demonstrate that the structural integrity of the payload will be maintained
- Describe the program for assuring that the fasteners used meet the design specifications and ensure that no counterfeit fasteners are used
- Describe what type of positive backoff protecting for threaded fasteners is used

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Summary table of stress corrosion sensitive materials
- Fracture Control Summary Report

Applicability Matrix

The applicability matrix is a standardized form from JSC (form 1090) It is provided on the following page for reference This form relates the hazard reports for a particular subsystem to the technical requirements in NSTS 1700.7B It is important to keep this form updated such that it reflects the current hazard reports in the SCDP Instructions for the proper completion of this form are given in NSTS 13830B, App B, pg. B-2 and JA-012D, App A, pg A4-2

NOTES:

The GSFC Safety Handbook has its own form called the GAS Payload Safety Matrix It provides less information It does not reference the requirements in NSTS 1700.7B

NSTS PAYLOAD SAFETY REQUIREMENTS APPLICABILITY MATRIX

PAYLOAD	DATE	PHASE	PAGE 1 OF 1

GENERAL REQUIREMENTS

NSTS 1700 7 REQUIREMENTS	200 GENERAL	201 HAZARDOUS FUNCTION	203 RETRIEVAL OF PAYLOAD	204 HAZARD DETECTION SAFING	205 CONT. RETURN/RAPID SAFING	206 FAILURE PROPAGATION	207 REDUNDANCY SEPERATION	211 DESTRUCT SYSTEMS	213.3 LIGHTING	214 VERIFICATION	215 HAZARDOUS OPERATION	216 SERIES HARDWARE	216 RELOWN HARDWARE	217 PLANNED EVA	218 PAYLOAD COMMANDING	220 CREW HABITABLE
PAYLOAD APPLICABILITY	X	X			X	X	X			X						

SPECIFIC PAYLOAD HAZARDS

PAYLOAD ELEMENT OR SYSTEM		202 1 SOLID PROPELLANT	202.2 LIQUID PROPELLANT	202.3 DEPLOYMENT/JETTISON	202 4 PLANNED EXTENSION	202.5 RF RADIATION	208 1,2 & 3 STRUCTURES	208 4 PRESSURE SYSTEMS	208.5 SEALED COMPARTMENTS	209 1 HAZARDOUS MATERIALS	209.2 FLAMMABLE MATERIALS	209.3 OFFGASSING MATERIALS	210 PYROTECHNICS	212.1 IONIZING RADIATION	212.2 NON-IONIZING RADIATION	212.3 LASERS	213 ELETRICAL SYSTEMS	213.2 BATTERIES	·219 FLAMMABLE ATMOSPHERES	20.2 HABITABILITY

	IMPLEMENTATION PERSONNEL	DATE	PAYLOAD ORGANIZATION PERSONNEL	DATE
PREPARED BY	______	______	______	______
REVIEWED BY	______	______	______	______
APPROVED BY	______	______	______	______

Hazard Report List/Status

The hazard report list/status provides a listing of the hazard reports and information on their status The form is shown on the following page The hazard report reference number is arbitrarily assigned to each hazard title on the list starting with number one and increasing sequentially. This number corresponds with the hazard report reference number on the applicability matrix (Refer to page 67 for an identification of the relationship between the hazard report, the applicability matrix and the hazard report list/status) The hazard report number is the number assigned to each hazard report and can be found in the upper right hand corner of the hazard report The hazard title is gathered from each hazard report. Alterations/comments refers to any change of a hazard report resulting from an action item and/or a change of design This column will provide updated information about each hazard report The status column should display whether the hazard report is open, closed, or has been deleted A hazard report is closed with the assessment of all hazard report related action items and with the completion of all verification methods This is the only complete listing of the hazard reports. It is important to keep this list updated and to provide the appropriate comments for bookkeeping purposes. *NOTE All changes of hazard reports will be identified by a bar in the right hand margin of the hazard report*

NOTES

NSTS 13830B requires form 1090A This form only asks for the matrix element reference number, the hazard report number, and the hazard title The payload (experiment), phase, and date are the same The page numbering was unnecessary since the pages will be numbered with respect to the complete package as described in the table of contents The title of this table has been changed from "NSTS Payload Safety Requirements Applicability Descriptive Data"

The GSFC Safety Handbook has a "GAS Hazard List" which provides the hazard group, hazard title, and applicable safety requirement The hazard group is not included The applicable safety requirements are covered in the applicability matrix. The payload (experiment) and the date are on this new form The subsystems are listed on the applicability matrix and can be traced back to there from the hazard report numbers.

JA-012D provides an "Experiment Safety Package Cover Sheet" which is actually a hazard report list/status page This page includes the experiment, payload, phase, date, and page numbers The payload is not necessary for this listing. The page numbers will follow the page numbers of the complete package as described in the table of contents The rest of the information is also provided on the new form The column titles are number, hazard title, remarks, disposition, and general comments. The remarks and general comments are combined into alterations/comments The disposition is the same as the status. There are also comments about hazard report status in the text of this document Assessing the changes of the hazard reports for impact to safety is covered in the revision page and does not need to be repeated here

Hazard Report List/Status

Experiment:	Phase:	Date:

Hazard Report Reference No.	Hazard Report No.	Hazard Title	Alterations/Comments	Status

Hazard Reports

This section contains the hazard reports which identify potential hazards of the subsystem, causes of the potential hazards, methods for controlling the hazards, and verifications of the control measures This information will be provided on the JSC Form 542B for hazard reports which is provided on the following page for reference. (Refer to page 53 for an identification of the relationship between the hazard report, the applicability matrix and the hazard report list/status.) *NOTE For instructions on the proper method of completing a hazard report form refer to NSTS 13830B, Appendix A, JA-012D, pages A2-1 to A2-6, or JSC 26943, Part II It is important to format the hazard reports identically for consistency and ease of reading Each hazard cause should be placed on one page with its corresponding controls and verifications* Along with the hazard reports will be all of the schematics, figures, reports, plans, etc. needed to provide a complete safety assessment of the potential hazards described in the hazard reports

The following hazard reports are considered common hazards for particular subsystems Other more unique hazards may be present in a subsystem and should be properly assessed for safety in the manner displayed in this package **It is important to realize that the hazard reports provided are not to be used as they exist in this package. They are to be used as a template only, and should be used to develop and document experiment-specific information.**

NOTES

The hazard report templates have not been inserted. LeRC Safety Assurance Office is currently working on developing these hazard reports.

The main changes to the hazard report form include the exclusion of the hazard group and the alteration of the signatures The hazard group was excluded to avoid confusion, since it was not adding needed information. The signatures were altered to include only the necessary signatures for the approval of the hazard report

EXPERIMENT FLIGHT HAZARD REPORT	NO	
EXPERIMENT	PHASE	
SUBSYSTEM	DATE	
HAZARD TITLE		
APPLICABLE SAFETY REQUIREMENTS	HAZARD CATEGORY	
		CATASTROPHIC
		CRITICAL
DESCRIPTION OF HAZARD		
HAZARD CAUSES		
HAZARD CONTROLS		
SAFETY VERIFICATION METHODS		
STATUS OF VERIFICATION		

APPROVAL	PHASE I	PHASE II	PHASE III
PREPARER			
PROJECT MANAGER			
INTEGRATION MANAGER			
PANEL CHAIRMAN			

Based on JSC Form 542B (rev Nov 82) NASA-JSC

EXPERIMENT FLIGHT HAZARD REPORT CONTINUATION SHEET	NO
EXPERIMENT	PHASE
HAZARD TITLE	DATE
HAZARD CAUSE	
HAZARD CONTROLS	
SAFETY VERIFICATION METHODS	
STATUS OF VERIFICATION	

Based on JSC Form 542B (rev Nov 82)

EXPERIMENT FLIGHT HAZARD REPORT

NO. ABC-HR-01

EXPERIMENT: ABC

PHASE. 0/1

SUBSYSTEM: Materials

DATE. 3/29/95

HAZARD TITLE: Use of Flammable Materials

APPLICABLE SAFETY REQUIREMENTS: NSTS 1700.7B, 209.2 Flammable Materials

	HAZARD CATEGORY
X	CATASTROPHIC
	CRITICAL

DESCRIPTION OF HAZARD:

Improper selection and use of materials in crew compartment cannot fire.

HAZARD CAUSES

1 Improper materials selection.

HAZARD CONTROLS.

1.1 Materials list will be selected in accordance with MSFC-HDBK-527F/JSC 09604, and where possible will have an "A" rating for flammability or will be tested in accordance with NHB 8060.1C.

SAFETY VERIFICATION METHODS

1.1.1 Materials list will be submitted to LaRC Materials Group for approval.

1.1.2 Flammability assessments will be performed as needed, if materials do not meet MSFC-HDBK-526F/JSC 09604 "A" rating requirements.

STATUS OF VERIFICATION

1.1.1 Open. Material List Approval Letter No. TBD.

1.1.2 Open Non-Conforming Materials Flammability Assessment Report No. TBD.

APPROVAL	PHASE I	PHASE II	PHASE III
PREPARED			
PROJECT MANAGER			
INTEGRATION MANAGER			
PANEL CHAIRMAN			

Hazard Report List/Status

Experiment: Phase: Phase 0/1 Date: 3/29/95

Hazard Report Reference	Hazard Report No.	Hazard Title	Alterations/Comments	Status
1	ABC-HR-01	Use of Flammable Materials		Open
2	ABC-HR-02	Structural Failure		Open
3	ABC-HR-03	Excessive EMI		Open

NSTS PAYLOAD SAFETY REQUIREMENTS APPLICABILITY MATRIX

PAYLOAD ABC DATE. 3/29/95 PHASE. 0/1 PAGE 1 OF 1

GENERAL REQUIREMENTS | SPECIFIC PAYLOAD HAZARDS

	NSTS 1700.7 REQUIREMENTS	200 GENERAL	201 HAZARDOUS FUNCTION	203 RETRIEVAL OF PAYLOAD	204 HAZARD DETECTION &AFING	206 CONT RETURN/RAPID &AFING	208 FAILURE PROPAGATION	207 REDUNDANCY SEPERATION	211 DESTRUCT SYSTEMS	213.3 LIGHTING	214 VERIFICATION	215 HAZARDOUS OPERATION	216 SERIES HARDWARE	216 REFLOWN HARDWARE	217 PLANNED EVA	218 PAYLOAD COMMANDING	220 CREW HABITABLE	202.1 SOLID PROPELLANT	202.2 LIQUID PROPELLANT	202.3 DEPLOYMENT/EJETTISON	202.4 PLANNED EXTENSION	202.5 RF RADIATION	208.1,2 &3 STRUCTURES	208.4 PRESSURE SYSTEMS	209.5 SEALED COMPARTMENTS	209.1 HAZARDOUS MATERIALS	209.2 FLAMMABLE MATERIALS	209.3 OFFGASSING MATERIALS	210 PYROTECHNICS	212.1 IONIZING RADIATION	212.2 NON-IONIZING RADIATION	212.3 LASERS	213 ELETRICAL SYSTEMS	213.2 BATTERIES	219 FLAMMABLE ATMOSPHERES
PAYLOAD APPLICABILITY		X	X				X			X																								
PAYLOAD ELEMENT OR SYSTEM	HAZARD REPORT REFENECE NO.																																	
MATERIALS																										1								
ELECTRICAL																													3					
STRUCTURES																						2												

IMPLEMENTATION PERSONNEL DATE PAYLOAD ORGANIZATION PERSONNEL DATE

PREPARED BY _____ _____ _____ _____

REVIEWED BY _____ _____ _____ _____

APPROVED BY _____ _____ _____ _____

Noncompliance Reports, Waivers, Deviations

The noncompliance report list provides information on all noncompliance reports which have been submitted to the PSRP A noncompliance report is necessary only when a safety requirement cannot be met The noncompliance is documented on JSC Form 542C which is provided on the following page for reference Justification must be given in the noncompliance report to conclude that an alternate method of design, procedures, configuration, etc has a comparable or higher degree of safety. If the noncompliance report is approved, the PSRP will issue a waiver (approved for one mission only) or a deviation (approved for multiple missions) All noncompliance reports must be closed before the Phase III safety review. A list of all submitted noncompliance reports and their status will be provided for easy reference. This list will state the noncompliance item with information about its acceptance or rejection. The list will track all noncompliance reports whether or not they have become waivers and deviations An example of the noncompliance report list is shown on a following page Also include in this section the actual noncompliance reports, waivers, and deviations *NOTE Detailed information on noncompliance reports, waivers, and deviations can be found in NSTS 13830B sections 6 0, 6 1, and 6 2 For reflown or series flights, waivered conditions must be corrected and deviations must be revalidated after each flight*

NOTES.

This table was suggested by JSC 26943 and NSTS 13830B

NSTS 13830B goes into much more detail on the process of completing and sending an NCR. This paragraph is to inform the preparer that a list and the reports are needed, it is not for the complete explanation of what a NCR is and how to fill it out and use it

JSC Payload Safety Class refers to this section as Non-compliant Items It suggests including a copy of the approving correspondence. This is unnecessary if the NCR are all signed

Payload Safety Noncompliance Report	**No.**	**Date:**
Title (brief reference to noncompliance)		
Payload Identification (Include reference to applicable payload element, subsystem, and/or component)		
Applicable Requirement		
Description of Noncompliance (Specify how the design or operation does not meet the safety requirement)		
Hazard or Hazard Cause (Include reference to Hazard Report)		
Reason Requirement Cannot be Fulfilled		
Rationale for Acceptance (Define the design feature or procedure used to conclude that the noncompliance condition is safe Attach applicable support data, i e drawings, test reports, analysis, etc)		

APPROVAL SIGNATURES

Payload Organization			**Date**
WAIVER APPROVAL		**DEVIATION APPROVAL**	
Effectivity		**Effectivity**	
STS Operator	**Date**	**STS Operator**	**Date**

JSC Form 542C (Rev Mar 83)

Noncompliance Report List

Noncompliance Item	Status

Safety Related Failures/Accidents

This section describes the safety related failures and accidents which have occurred during experiment processing, testing, and checkout. The description should include a summary of each failure/accident along with a safety assessment which identifies all impacts to the STS and/or other payloads and facilities This section will not appear in a SCDP until the experiment has begun processing, testing, and checkout activities which typically occurs after the Phase I safety review.

NOTES

The information about when this section appears in a SCDP was added for clarification Both NSTS 13830B and JA-012D do not discuss this topic until the phase II SCDP

JA-012D words this section slightly different

Safety Verification Tracking Log

The safety verification tracking log is used to record the status of the open safety verification items of the hazard reports The verification tracking log is a standardized JSC Form (no 764) and is provided on the following page for reference This form should be included in all phases of the SCDP and should be updated per each phase until all verifications are closed The goal is to have all verifications closed by the Phase III safety review, however, closure of verifications is required before flight. Instructions for completing the form can be found in NSTS 13830B, Appendix C. The page following the SVTL is provided to help show the relationship between the SVTL and a hazard report.

NOTES·

All of the information in the documents about the SVTL is covered in this paragraph or in the table itself

JA-012D refers to an Open Safety Items List which is a list of all open safety items requiring closure after the flight hardware is delivered The SVTL covers some of the same information along with the list of AI.

NSTS PAYLOAD FLIGHT
SAFETY VERIFICATION TRACKING LOG

Payload/Element	Date

Log No	Hazard Report Number	Safety Verification Number	Description (Identify Procedures By Number and Title)	Ground Operation(s) Constrained	Independent Verification Required (Yes/No)	Schedule Date	Completion Date	Method of Closure Comments

JSC Form 764 (Jul 89)

EXPERIMENT FLIGHT HAZARD REPORT		NO. ABC-HR-01
EXPERIMENT: ABC		PHASE: 0/1
SUBSYSTEM: Materials		DATE: 3/29/95
HAZARD TITLE: Use of Flammable Materials		
APPLICABLE SAFETY REQUIREMENTS: NSTS 1700.7B, 209.2 Flammable Materials	HAZARD CATEGORY	
	X	CATASTROPHIC
		CRITICAL

DESCRIPTION OF HAZARD:

Improper selection and use of material in crew compartment causes fire.

HAZARD CAUSES:

1 Improper materials selection.

HAZARD CONTROLS

1.1 Materials list will be selected in accordance with MSFC-HDBK-527F/JSC 09604, and where possible will have an "A" rating for flammability or will be tested in accordance with NHB 8060.1C.

SAFETY VERIFICATION METHODS:

1.1.1 Materials list will be submitted to LSRC Materials Group for approval.

1.2 Flammability assessments will be performed as needed, if materials do not meet MSFC-HDBK-527F/JSC 09604 "A" rating requirement.

STATUS OF VERIFICATION

1.1 Open Material List Approval Letter No. TBD.

1.1.2 Open Non-Conforming Materials Flammability Assessment Report No. TBD.

APPROVAL	PHASE I	PHASE II	PHASE III
PREPARER			
PROJECT MANAGER			
INTEGRATION MANAGER			
PANEL CHAIRMAN			

NSTS PAYLOAD FLIGHT SAFETY VERIFICATION TRACKING LOG

Experiment/Payload: ABC						DATE: 3/29/95		
Log No.	Hazard Report Number	Safety Verification Number	Description (Identify Procedures By Number and Title)	Ground Operation(s) Constrained	Independent Verification Required (Yes/No)	Schedule Date	Completion Date	Method of Closure Comments
1	ABC-HR-01	1.1.1	Materials list Approval Letter No. TBD	Open	Yes	4/95		
2	ABC-HR-01	1.1.2	Non-Conforming Materials Flammability Assessment report No. TBD	Open	No	4/95		

Certificate of NSTS Payload Safety Compliance

The Certificate of NSTS Payload Safety Compliance provides a formal approval from the payload organization payload manager stating that the experiment complies with all of the applicable requirements of NSTS 1700 7B This certificate is JSC Form 1114A which is provided on the following page for reference. It is typically prepared for the Phase III SCDP, but is required to be submitted along with the latest verification tracking log ten days prior to the Flight Readiness Review

NOTES

JA-012D has its own certificate which states safety compliance with NSTS 1700 7B and that the payload is prepared for integration. It also requires an open item's list which is similar to the SVTL The Open Items List is to provide a description of open safety items requiring closure after the flight hardware is delivered

The JSC Payload Safety Class requests a paragraph stating management approval and submission of the SCDP constitutes certification of the SCDP completeness, accuracy, and validity Also included is a statement of compliance with safety requirements The Certificate accomplishes this

Certificate of NSTS Payload Safety Compliance

For

_____

(Payload)

Payload Design and Flight Operations

The Payload Organization hereby certifies that:

(1) The payload is safe.

(2) The payload complies with all applicable requirements of NSTS 1700.7B, "Safety Policy and Requirements for Payloads using the National Space Transportation System."

List of approved Waivers/Deviations:

Approved: (Payload Organization Payload Manager)	**Date:**

JSC Form 1114A (May 89)

Appendix A: Applicable Documents

This section is a listing of all of the applicable safety related documents used to substantiate safety compliance in the SCDP It is important to use the current revisions of each document in the development of the SCDP This list should include each document's title, number, revision number or letter, and date The following list is provided for reference, documents should be added or deleted to this list depending on which were used The dates and the revision numbers or letters have not been provided due to the continuous revision of many documents, however, the current revisions of the documents should be listed

Applicable for all Experiments:

NSTS 13830	Implementation Procedure for STS Payloads System Safety Requirements
NSTS 14046	Payload Verification Requirements for the Space Shuttle Program
NSTS 18798	Interpretations of NSTS Payload Safety Requirements
NSTS 21000-IDD-MDK	Shuttle/Payload Interface Definition Document for Middeck Accommodations
NSTS 1700 7	Safety Policy and Requirements for Payloads Using the Space Transportation System
ICD 2-1-19001	Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 to NSTS 07700, Volume IV)

KSC:

KHB 1860 1	KSC Radiation Protection Handbook
KHB 1860 2	KSC Non-ionizing Radiation Protection Program

MSFC:

JA-012	Payload Projects Office Payload Safety Implementation Approach
JA-061	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Spacelab Payload Missions
JA-081	Payload Mission manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Partial Payload Missions
JA-276	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Orbiter Middeck Payload Missions
JA-418	Payload Flight Equipment Requirements for Safety-Critical Structures

JA-447	Mission Requirements on Facilities/Instruments/Experiments for Space Transportation Systems (STS) Attached Payloads (MROFIE)

GSFC:

---	GAS Experimenter's Guide to the STS Safety Review Process and Data Package Preparation

NOTES

The title of the document was added to the list because some documents do not have numbers This list has been generated as an example The majority of this list is from JA-012D, section 4 0

JSC Payload Safety Class suggests including this list in the introduction

Appendix B: Project Schedule

This section provides a schedule of all of the major design and safety reviews. This list should display the name of the review and its planned date. The dates should be updated if changes are made in the schedule. *NOTE For project schedule guidance, refer to JSC Payload Safety Class Module II, Section G, provided on the following pages*

NOTES

The JSC Payload Safety Class includes this in the mission description.

NSTS 13830B only discusses it in the review meetings, however, it is important to have it for reference

G. Schedule

Having seen the flow of activities and schedule of the integration process, let's consider how the safety process fits in Design of the payload will usually have progressed to some point before the approval for mission assignment is granted. That says that the safety process should be underway even before the payload has a flight assignment The two processes first come together with approval of the 1628 From that point they are running in parallel and are pegged together at milestones such as design reviews, readiness reviews, delivery to the launch range, processing points and launch

Figure II-1 depicts the overall flow and relationships of the payload design, integration, system safety and payload safety review processes. It should be clear from looking at the chart that the safety effort cannot wait until the integration process starts There is too much safety data required to support the PIP and ICD There is also too much design work done If the safety process is not started until the design is complete and hardware is being built, the cost of correcting hazards goes up tremendously. Remember, it is a lot less expensive to change a line on a piece of paper than it is to modify a piece of hardware

Figure II-3 looks at the relationships from another perspective The hazard reports form the basis for much of the activity that occurs during the integrated cargo development and control process

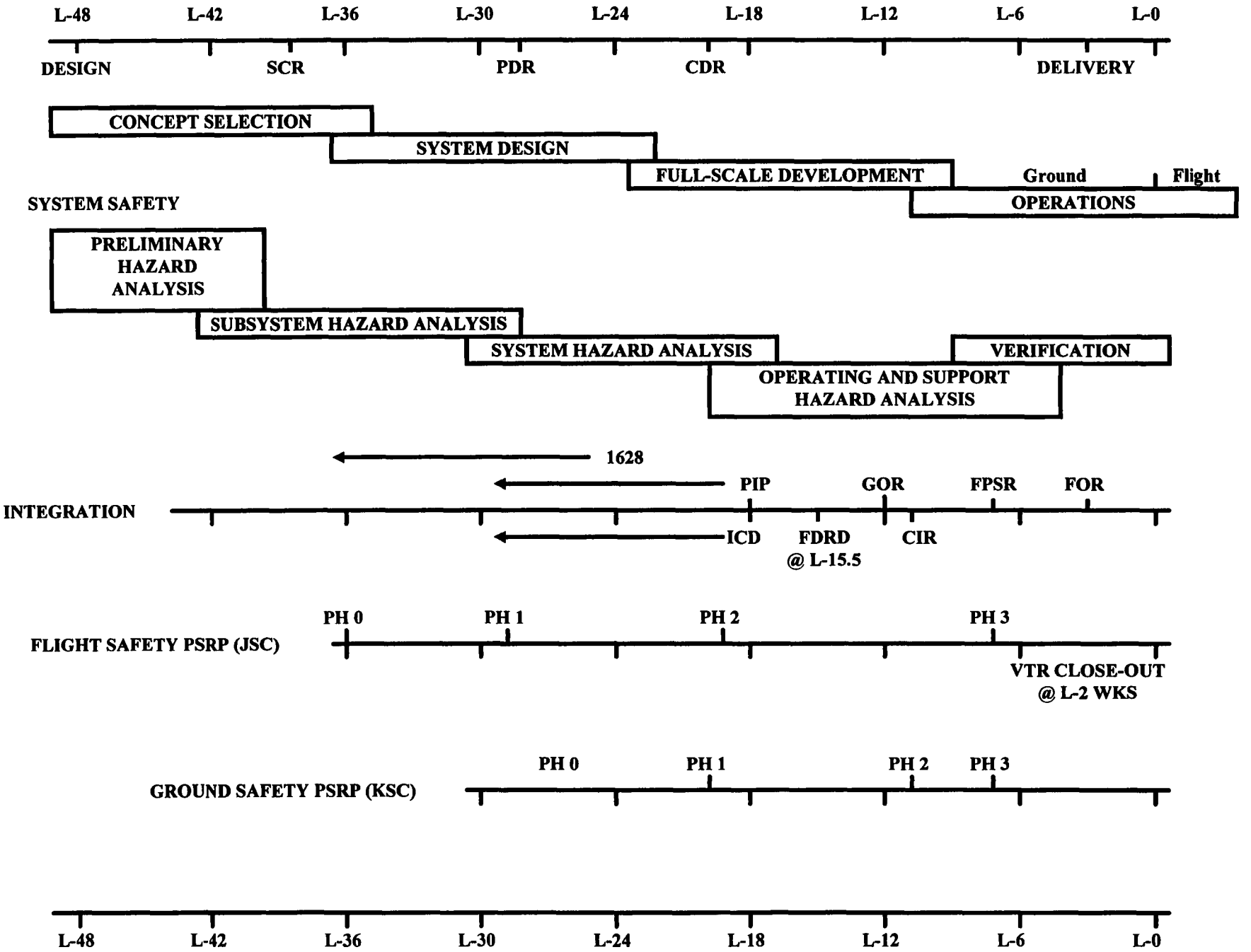


FIGURE II-1, DESIGN, SAFETY & INTEGRATION RELATIONSHIPS

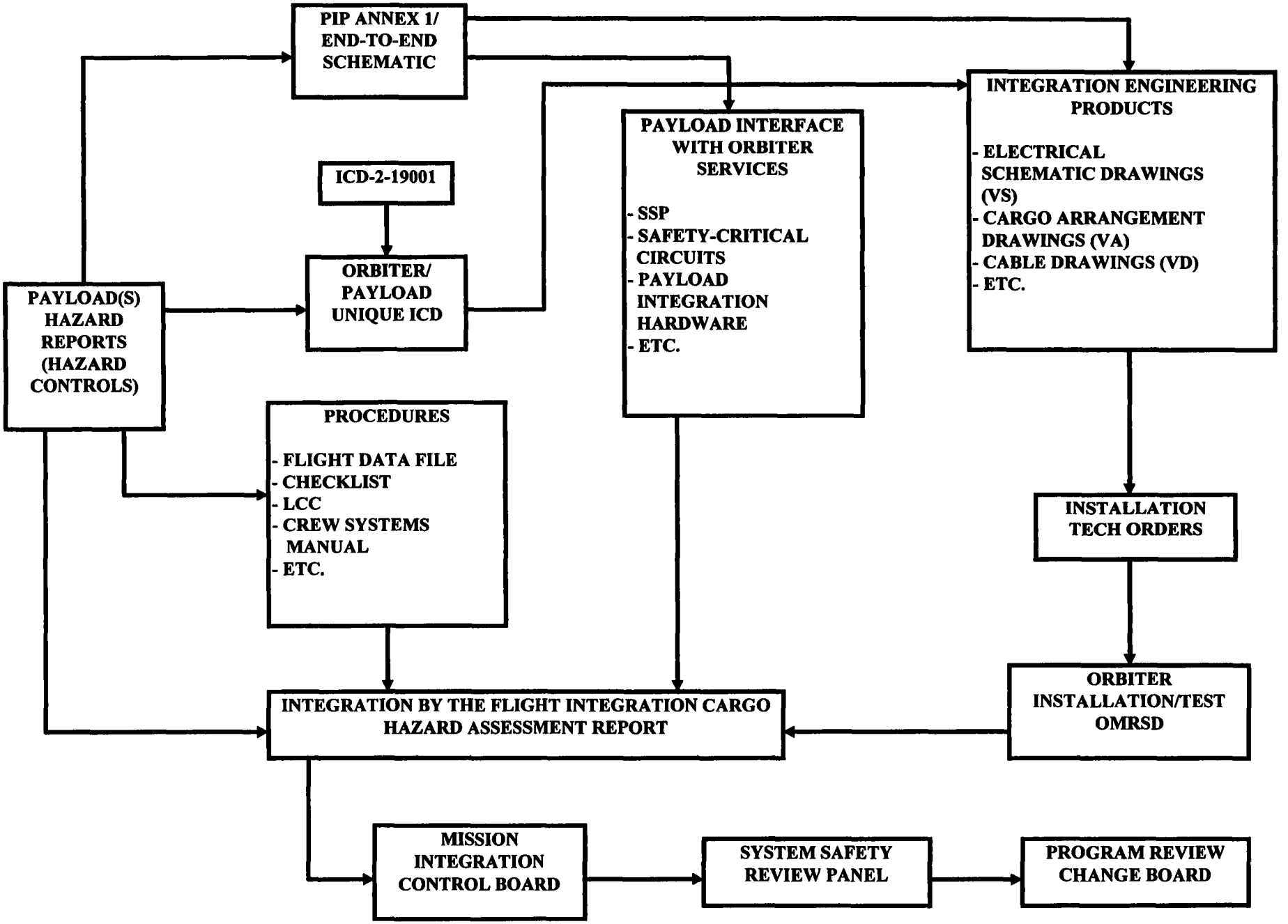


FIGURE II-3, INTEGRATED CARGO HAZARD CONTROL PROCESS

Ground Safety Compliance Data Package Template

Cover Page

Every SCDP begins with a cover page This page provides the title of the experiment, the phase of the data package, and the preparation date Often, this page is placed on a company letter head in order to identify the company or NASA center where the package was prepared This page can be arranged in any fashion The following page is an example of a typical cover page

NOTE

There are no requirements for this page

TITLE OF EXPERIMENT

PHASE __ GROUND SAFETY COMPLIANCE DATA PACKAGE

DATE

(Sample Cover Page)

Title Page

The title page provides necessary information about the package as well as the involved personnel Similar to the cover page, the title page includes the experiment name, the phase of the data package, and the preparation date In addition, it provides the contract number and the signatures of the responsible personnel, which include the author(s), program manager, chief engineer, and the organization safety representative Included under the personnel signatures are their printed name, title, and affiliated company or NASA center A sample title page is provided for reference *NOTE Additional lines should be added for more than one preparer The signatures are interpreted as a concurrence of the SCDP*

NOTES

To avoid confusion, revision numbers have been excluded

JA-012D's cover page is the hazard list page and will be included in the hazard list section, NOT the title page

Information under the signature line and the phase number have been added

EXPERIMENT NAME

Phase __ Ground Safety Compliance Data Package

Date

Contract #:

Prepared By

_____

Name
Title
NASA Center or Company

Approved By

_____

Name
Program Manager
NASA Center

_____

Name
Chief Engineer
NASA Center

Concurred By

_____

Name
Title *(Organization Safety Representative)*
NASA Center

(Sample Title Page)

Preface

The preface is a brief paragraph which explains the requirements of the SCDP contract This includes a statement of compliance with requirements specified in KHB 1700 7B and a reference to the applicable documents page for supplementary compliance documents The preface also provides additional information about the responsible personnel including phone numbers and mailing addresses Furnishing the GSRP with this information allows them to contact the responsible personnel in order to resolve technical issues and questions

NOTES

JSC Payload Safety Class includes the statement of compliance with the requirements in the introduction and a list of all applicable documents This is covered in the preface which includes a reference to the applicable documents appendix. It also includes the reason why a SCDP needs to be submitted which is included in the preface as the requirements of the SCDP contract.

Action Items

The action items (AI), which evolve from safety panel reviews, are accounted for through an AI table An AI table is provided on the following page for reference. This table numbers, lists, and provides information about a particular AI which includes its current status and closure rationale. The AI number is assigned at safety reviews and can be obtained through the minutes of the meeting The current status is listed as either open or closed with a closure date The closure rationale explains the reasons for which the AI was accepted as being closed It is the responsibility of the SCDP developer to track all AIs to closure All AIs must be closed by the GSRP prior to the Phase III Ground Safety Review to be considered complete. Often, AIs are prematurely closed prior to or at the Phase III Ground Safety Review with an understanding that they will be tracked through the SVTL (Safety Verification Tracking Log) and officially closed during processing by KSC Ground Safety personnel A Phase 0 SCDP should have a blank AI table as a placeholder for future SCDP iterations, there will be no AIs since the Phase 0 SCDP is the first official version of the SCDP

NOTES

The AI Number has been added in order to easily identify each AI. The closure date has also been added as further information for the AI The explanations of each table header was added for clarification The AI section has been moved to the front of the package due to its importance

Action Items

AI Number	Action Item	Current Status (open/closed with closure date)	Closure Rationale

Revision Page

The revision page describes the significant alterations made to the SCDP after Phase II that occur due to action items, major engineering design changes, and/or control measure changes Some of these changes are suggested by the engineers and designers and may be presented in ECRs (engineering change requests) All design changes are assessed for safety, documented in the SCDP, and recorded in this table It is not necessary to document insignificant editorial revisions As shown on the succeeding page, the revision page will include the following information the revision number, revision description, the location of the response data, and the revision date The location of the response data is a listing of the page and paragraph number or hazard report number of the adjustment in the SCDP which resulted from the revision Hazard report alterations are to be referenced to the hazard report list/status page in order to avoid duplication of status A Phase 0 package will not contain a revision page since it is the first official copy of the SCDP *NOTE All significant revisions made to the SCDP will be identified by placing a bar in the right hand margin next to the altered paragraph or statement in the SCDP*

NOTES

NSTS 13830B details the safety assessment on changes to include effects on interfaces This is understood by saying that the changes should be assessed for their impact on the system's safety

The ECRs are only mentioned in JA-012D

There is no direct requirement for a revision page There are only references to changes and recording these changes This table was created in order to help the safety engineer keep track of all of the changes

Revision Page

Revision Number	Revision Description	Response Data (pg. & paragraph # or hazard report #)	Revision Date

Table of Contents

The table of contents presents all of the section and subsection numbers, titles, and page numbers. The pages between and including the preface and acronyms and abbreviations should be numbered with Roman numerals This excludes the cover and title pages, which are typically not numbered After the acronyms and abbreviations page, the pages should be numbered sequentially within each section This involves using a compound numbering system in which the first number represents the section number and the second number represents the page number in that particular section (i e pg 1-5 is section 1, page 5) Using this technique, each section will begin on a new page. This method easily allows for additional pages to be added per section without disrupting the complete numbering system All sections with Roman or Arabic numerals should appear in the table of contents The total number of pages of the complete package is also included to ensure the reader that he/she has received the complete package. *NOTE The individual hazard reports will be separately listed elsewhere in the package and do not need to be listed by name here*

NOTES

The JSC Payload Safety Class suggested adding a letter to designate added pages This is unnecessary if the compound numbering system is used The JSC Payload Safety Class also gives you a choice of listing the hazard reports in the table of contents or at the beginning of the hazard report section. The note explains the use of the hazard report list found later in the package.

Further instructions on how to number the SCDP have been provided here for guidance

List of Figures and List of Tables

Following the table of contents is the list of figures and the list of tables These two separate lists follow the format of the table of contents and, in effect, look as though they are a part of it. The figures and tables have a separate compound numbering schemes similar to the page numbering system. The first number represents the section number and the second number represents the figure or table number in that particular section (i e figure 1-6 is section 1, figure 6)

NOTES

Some of the documents discuss these together and some do not The information stated here was gathered from referencing previously written SCDPs

Acronyms and Abbreviations

This section is a list of all of the acronyms and abbreviations and their complete names used throughout the SCDP The list will stand as a reference for those not familiar with the terminology The following is a listing of common acronyms and abbreviations which are typically used in a SCDP This list is provided only as a reference for the preparer. This list should be altered and amended to reflect the appropriate acronyms and abbreviations for a particular project

AC	Alternating Current
AI	Action Items
ASE	Airborne Support Equipment
CDMS	Command and Data Management System
DC	Direct Current
ECR	Engineering Change Request
ED	Experiment Developer
EGSE	Electrical Ground Support Equipment
EMI	Electrical Magnetic Interference
EVA	Extravehicular Activity
FMEA	Failure Modes and Effects Analysis
GAS	Get-Away-Special
GSFC	Goddard Space Flight Center
GFE	Government Furnished Equipment
GSCDP	Ground Safety Compliance Data Package
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSRP	Ground Safety Review Panel
ICD	Interface Control Document
JSC	Johnson Space Center
KHB	Kennedy Handbook
KSC	Kennedy Space Center
LeRC	Lewis Research Center
MDP	Maximum Design Pressure
MIP	Mandatory Inspection Point
MIUL	Material Identification Usage List
MLI	Multi-Layer Insulation
MPE	Mission Peculiar Equipment
MSDS	Material Safety Data Sheet
MSFC	Marshall Space Flight Center
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NCR	Noncompliance Report
NDI	Non-destructive Inspection
NHB	National Handbook
NSTS	National Space Transportation System
PGSC	Payload General Support Computer
PHA	Preliminary Hazard Analysis
PHR	Payload Hazard Report
POCC	Payload Operations Control Center
PSRP	Payload Safety Review Panel
SCDP	Safety Compliance Data Package
SH	Spacehab
SL	Spacelab
SRM&QA	Safety, Reliability, Maintainability, & Quality Assurance

SSP	Space Shuttle Program
STS	Space Transportation System
SVTL	Safety Verification Tracking Log
TBD	To Be Determined
TOP	Technical Operating Procedure

NOTES (FOR ACRONYMS AND ABBREVIATIONS)

This list provided is not suggested in any document

Introduction

The introduction describes the format of the ground SCDP A correlation is made between the progress of the experiment and the phase of the SCDP. This informs the reader of the maturity of the experiment and SCDP. The actual content of the SCDP depends on the phase Early phase packages contain considerably less information but exist as a base in which information can be added for a complete Phase III package. This paragraph includes the approach taken to provide the information necessary for a package of the appropriate phase It should mention that the SCDP is broken into sections where each section represents a subsystem In each one of the sections is the safety-critical subsystem description, subsystem safety assessment summary and safety features, and verification summary The introduction should also include any other general information pertaining to the SCDP. For instance, it is suggested to include a statement about the project schedules in the appendix since they are an important asset to the overall project

NOTES

This introduction does not fit with the definition of introduction given in JSC Payload Safety Class The JSC document introduction is the payload and mission overview which will be covered in the experiment overview and the mission description, respectively The requirements which are satisfied by the SCDP are already covered in the preface (KHB 1700 7B) and are also listed in the applicable documents section in the appendix. The purpose of the hazard analysis and the desired results are also covered in the preface. The JSC Payload Safety Class also addresses the description of the subsystems which is covered in the Subsystem Description of this package

No other documents suggest this type of an introduction It is necessary in order to prepare the reader for the content of the SCDP Often, the overall payload and mission description is included under the introduction There are separate sections for both of these topics in this package.

Mission Description

This section provides a description of the mission on which the experiment is to be flown Included in the description is the name of the mission, mission objectives, and mission characteristics The mission objectives explain the purpose and goals of the mission
The mission characteristics entail the launch location, launch date, launch window, attitude, mission duration, primary landing site, and payload configuration

NOTES

JSC Payload Safety Class included the mission objective in the introduction The JSC document also included the payload objective and project schedules The payload objective is included in the experiment overview and the project schedules have been placed in an appendix There is information in this section which may be on a mission schedule, such as the mission's launch date and launch window The JSC Payload Safety Class also includes flight operations which are not in this mission description. The flight operations will be detailed in the Flight SCDP The ground operations are also discussed in the JSC Payload Safety Class's mission description This is covered in this package in the ground operations section

JA-012D includes the mission description with the payload description

NSTS 13830B has also included the mission description with the payload description

Experiment Overview

The experiment overview should be divided into two subsections which describe the payload and the experiment If an experiment is large in size and fairly complex it is common to consider it as a payload. In this case, there will not be a separate description for the payload and the experiment since they are one and the same This section may change with the alteration of the design. It is important to keep this information updated throughout the various phases of the SCDP *NOTE If the payload/experiment is to be reflown or is part of a series flight then refer to NSTS 13830B section 8 0 or JA-012D section 7 0 for complete instructions and also note this fact in this section.*

The payload description should include the payload name, its location on the STS, and the overall objectives of the payload A diagram of the location of the payload may be used to help explain the payload's location and its orientation on the STS.

The experiment description addresses the objectives of the experiment and the experiment's overall design If the experiment is a GAS experiment then it is also necessary to identify the classification as either "B" or "C" *NOTE Reference the GSFC Safety Handbook, section 4 1, pg 9, for an explanation of the classification system* The overall design should mention all of the safety critical subsystems and their associated ground operational hazards References should be made to the flight SCDP for subsystem details

NOTES

This section has been altered from the flight SCDP The operational scenario and the Orbiter provided critical services and interfaces have been excluded. These topics are more detailed than is needed in a ground package The GSFC Safety Handbook and JSC Safety Office include the operational scenario, however, these documents do not require a separate ground SCDP, so naturally this would be included Both the JSC Safety Office and the JSC Payload Safety Class include the Orbiter provided critical services and interfaces in the SCDP. Neither of these documents differentiates between the flight and ground packages Therefore, there are sections included which are not necessary for both flight and ground SCDP. Some of the wording has been slightly changed, such as the referencing of the flight SCDP for subsystem details and the referencing of the section in the ground SCDP for GSE details By referencing the flight SCDP for the detailed subsystem description, it can be omitted in the ground SCDP The GSFC Safety Handbook and the JSC Safety Office both require this in the SCDP However, as mentioned above, both of these documents combine the ground and flight SCDP It is unnecessary to have the detailed subsystem descriptions in both packages

JSC Payload Safety Class covers the scope and purpose of the payload and the hardware under the Introduction The scope and purpose of the payload will be addressed in the payload objectives and the experiment objectives The introduction also requires identification of the primary system, support systems, operational interfaces, and facilities. These have all been moved to the experiment overview This document also includes the payload objective under the mission description The detailed subsystem descriptions are also included in the payload/system description in the JSC document All detailed descriptions have been moved to the subsystem descriptions.

GSFC Safety Handbook includes the objectives of the experiment, the classification, conceptual descriptions, and operational scenarios All of these except the operational scenario have been combined and included in this section as mentioned above

As the phases progress, JA -012D stresses a fully developed description of the complete experiment This will be covered in the subsystem description in which this section references the reader to the flight SCDP

The payload description and experiment description are combined into one section The payload location is included in the payload description No document actually calls out for the payload location

Ground Operations

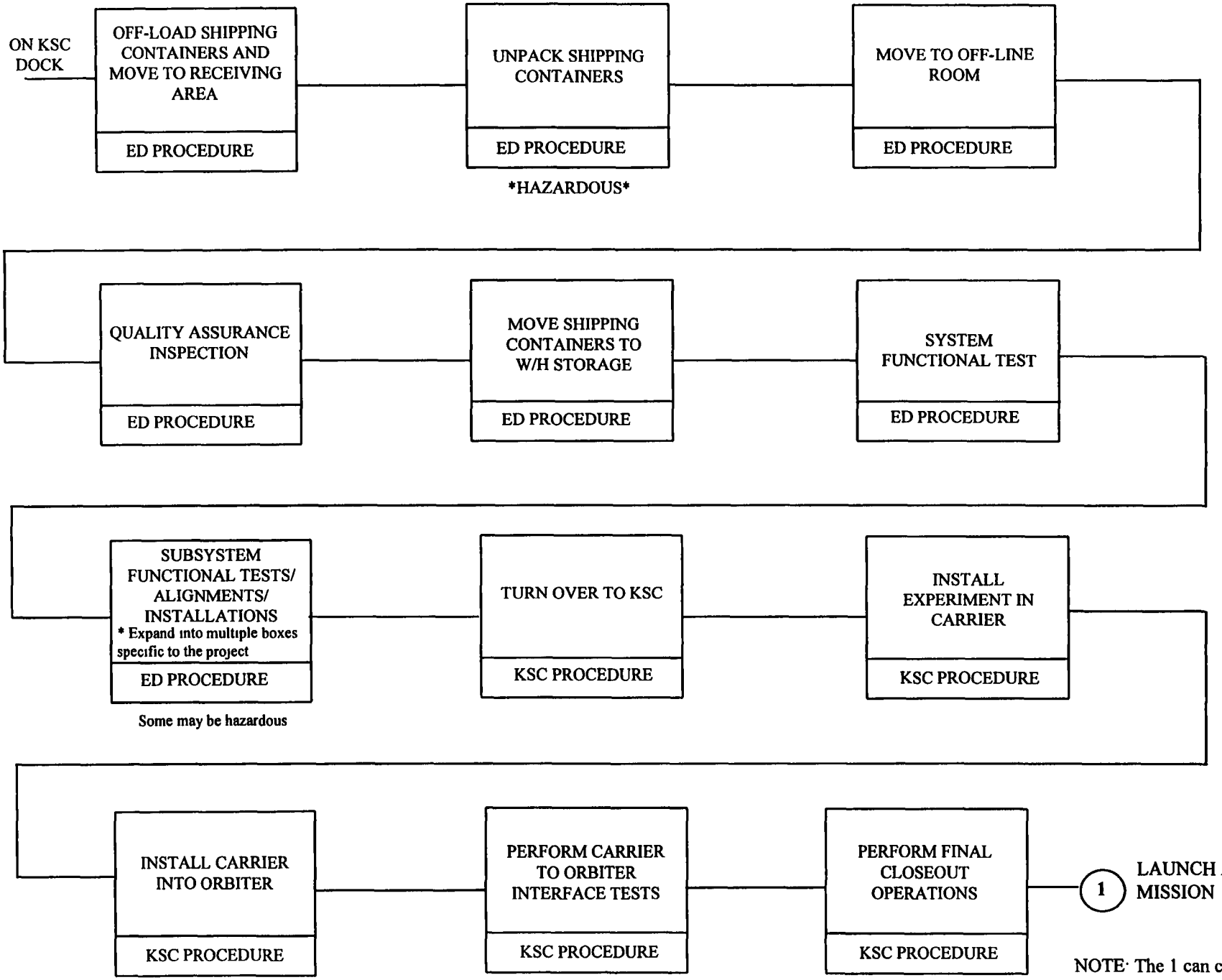
This section should briefly describe the ground support equipment (GSE) and reference the sections in the ground SCDP which provide further detail on each GSE and the associated subsystem Illustrations and figures should be included to aid in the description of the GSE Also include operations flow diagrams which reveal all of the planned ground operations in a flow chart orientation It is necessary to detail pre-flight, normal post flight, and contingency post flight in the ground operations flow diagrams. An example of a generic pre-flight operation flow diagram is provided on the following page. The 'ED' stands for Experiment Developers and signifies that they will be in charge of that particular procedure The operation flow diagram may expand onto multiple pages in which a numbering system should be used to follow the flow between pages

NOTES:

An operations flow diagram was added which is required in JA-012D. The example operations flow diagram is from a previously made ground package

This section was originally part of the Experiment Overview It has been separated for clarification of the material

JSC Payload Safety Class includes the ground operations under the mission description



EXAMPLE GROUND OPERATION FLOWCHART

NOTE: The 1 can continue the flowchart to the post-flight operations on a separate page

Safety Assessment

The safety assessment gives a narrative summary of the safety analysis of the GSE and its interfaces with the experiment and hazardous ground operation procedures The summary explains the approach and techniques used to analyze for hazards. Any assumptions made in order to analyze for hazards should be stated and explained The maturity of the safety assessment depends on the maturity of the experiment, therefore, this section will be general for a Phase 0 package and will develop in detail for a Phase III package There should be a reference to the subsystem safety assessment and safety features section for a detailed description of the safety features provided per GSE/TOPs.

NOTES

JSC Payload Safety Class called this the Program Safety Status Summary The JSC document asks for safety concerns and noncompliance items It also suggests a summary of all risks deemed acceptable by the approving agency and the corresponding program position This will be covered in the subsystem sections under safety features

GSFC Safety Handbook asks for the results of the hazard analysis This is covered in the summary of the safety analysis. It also asks for the rationale of the classification of the experiment. This is covered in the flight SCDP and is not necessary for the ground SCDP

Subsystems

This section is a narrative of the subsystems of the experiment which are discussed in the SCDP This narrative should explain that the SCDP is broken up into sections per experiment subsystem The subsystems which are included in the SCDP should be listed. Each section contains a subsystem description, subsystem safety assessment summary and safety features, and verification summary This section should further explain what information can be found under each of these items as detailed below for reference

Subsystem Description

This section will completely describe the ground support equipment (GSE) as well as the particular subsystem of the experiment with which it is associated. This description will include the GSE function and planned operation. If there is no GSE associated with a subsystem, but there are ground operations which are to be performed on the flight hardware, then this section will be used to describe the flight hardware and those relevant ground operations. All operations will be described in detail in the TOPs (Technical Operating Procedures) which should be referenced in this section and located in the appendix Operation flow diagrams, figures, and schematics will be provided to illustrate the GSE/flight hardware and its operation with respect to the experiment. (These may be included in the TOP or Hazard Report sections)

Subsystem Safety Assessment Summary and Safety Features

This section will provide a hazard assessment detailing the potential hazard sources associated with the GSE and/or subsystem of the experiment References will be made to the appropriate hazard reports in the Hazard Report Section Hazards associated with flight hardware may already be assessed through hazard reports in the flight SCDP. In this case, references will be made to the flight SCDP's hazard report. Included in the assessment will be all of the safety features incorporated into the design Also, provide an explanation of all risks which are deemed acceptable by the approving agency and are the responsibility of the experiment organization Additionally, a summary will be included which explains the safety controls of any eliminated hazards (those hazards in which a hazard report was found unnecessary) If applicable, diagrams and figures should be included to display and better explain any safety features (These may be included in the Hazard Report Section)

Verification Summary

This section will describe the methods of verification used to assure that each hazard control meets its design specifications and intended performance levels The description of a particular test or analysis and its results will be provided along with references to the actual test or analysis report if applicable

This SCDP template is divided into sections, each describing a specific subsystem, to illustrate the approach which should be taken The subsystems that follow are common subsystems associated with ground operations which include Electrical, Lifting/Handling, Materials, Pressure, and Radiation Subsystems. As described above, each subsystem section is divided into three separate sections in order to aid in the description of the ground operation and in assessing potential hazards This information is provided as a reference for use in developing an actual SCDP

NOTES

This section was added in order to assist the reader in preparing the subsystem divisions in the SCDP This was not suggested in any document, but will help the reader understand the format of the package The descriptions of each section under the subsystems was gathered from various documents

Electrical Subsystems:

Electrical Subsystem:

- Includes Electrical GSE
- Includes electrical hazards on the experiment that are exposed to the ground crew

Subsystem Description:

- Provide a description of the electrical GSE.
- Provide a description of the experiment's electrical components which may be exposed to the ground crew
- Provide schematics and block diagrams of non-commercial circuitry

Safety Assessment Summary and Safety Features:

- Describe the bonding/grounding and fusing provided in the circuitry
- Describe the voltage sources which are accessible to the ground crew (Must be under 30 V ac and/or 50 V dc)
- Describe the facility power phasing and EGSE power phasing
- List all COTS (Commercial off the Shelf) items List if they are UL rated or demonstrate conformance with NEC
- Reference all Electrical System Hazard Reports (See Hazard Report Section for hazard report templates)

Verification Summary:

- Describe the inspection process used to verify that the safety features mentioned in the above section have been implemented properly
- Summarize the testing process which verifies that proper grounding has been implemented. Include the test parameters and reference the test plan.

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Schematic diagrams indicating power source, wire sizes, circuit protection devices, wire temperature rating, etc
- Provide schematics of all exposed voltage sources
- Document grounding and bonding techniques used
- Procedures for tagging and lockout of control switches, circuit breakers, and mating/demating connectors

Lifting/Handling Subsystems:

Lifting/Handling Equipment:

- Includes all lifting and hoisting equipment
- Includes lifting devices such as slings, linkage, mechanisms, etc
- Includes support stands.

Subsystem Description:

- Provide a description of the lifting/handling equipment
- Provide diagrams as appropriate
- Provide a brief description of the use of the lifting/handling equipment in association with the experiment

Safety Assessment Summary and Safety Features:

- Reference any TOPs associated with the equipment Also state any specialized training needed for operation
- Describe any necessary tethering of the equipment
- Describe the personnel protective equipment necessary for use of the equipment.
- Describe how the maximum expected loads were determined
- Describe the process of tagging the appropriate equipment with the equipment identification, the most recent NDI and structural inspection dates, the next required periodic inspection dates, and the quality control stamp
- Reference Lifting/Handling Hazard Reports (See Hazard Report Section for hazard report templates)
- Describe the tipping analysis conducted on all appropriate GSE (i e movable carts, stands)
- Assess operations involving suspended loads.

Verification Summary:

- Summarize the structural analysis and testing done on all load bearing equipment
- Summarize the results of the dye penetrant or radiographic NDI (Completed annually for all load bearing hooks, shackles, eyebolts, etc)
- Describe the inspection process used to verify that the safety features mentioned in the above section have been implemented properly

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Structural analysis and testing report
- Dye penetrant or radiographic NDI report
- TOPs
- Inspection/verification reports

Materials Subsystems:

Materials Subsystem:

- Materials used as experiment consumables
- Materials used as experiment working fluids
- Materials generated from experiment operations that are handled during post-mission ground operations
- Materials used during ground processing, i e cleaning fluids, plastic films, .

Subsystem Description:

- Provide a listing of the type and quantity of experiment consumables
- Provide a list of the materials generated from the experiment operations
- Provide a list of all cleaning fluids
- Provide MSDS's sheets on all materials
- Provide a list of any radioactive material or coatings used

Safety Assessment Summary and Safety Features:

- Detail the hazard level of all materials
- Detail how the hazard level of the radioactive sources was determined
- Reference Materials Hazard Reports (See Hazard Report Section for hazard report templates)

Verification Summary:

- Provide flammability analysis for any combustible materials
- Provide toxicity assessment for all toxic fluids or gasses
- Provide radiation assessment for all radioactive sources

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Toxicology Analysis
- Flammability Analysis
- Ionizing Radiation Summary Report

Pressure Subsystems:

Pressure Subsystem:

- Pressure vessels, lines and hoses, support members
- Valves, regulators, filters, fittings
- Instrumentation, components
- Refer to Flight Hazards Reports and descriptions for flight hardware pressures systems

Subsystem Description:

- Describe the purpose and planned operation of the GSE
- Include a detailed system schematic showing relief valves and vents
- Provide information on fluid systems components markings
- Provide cutaway drawings of major components
- Identify fluids and gases by name, identify quantities
- Categorize the hazard level posed by a gas/fluid release
- State the GSE MOP and provide a basis for its determination

Safety Assessment Summary and Safety Features:

- Describe the basis for the GSE systems MOP
- Consider the worst case environmental conditions
- Provide listing of fracture critical components
- Consider failure of heaters
- Reference Pressure System Hazard Reports (See Hazard Report Section for hazard report templates)

Verification Summary:

- Provide summary of proof testing results
- Provide summary of leak testing results
- Provide copies of operations procedures

Notes: The following information is needed for this section As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate.

Supporting Data:

- Include a table listing the fluid system components, their respective MDP's proof and burst pressures, and margins
- Summary table giving rational for usage of stress corrosion sensitive materials

Radiation Subsystems:

Radiation:

- Includes both ionizing and non-ionizing sources
- Includes radioactive materials, radiation-producing equipment, lasers, and optical emitters.
- Radiation-producing equipment includes x-ray, devices, particle accelerators, radio frequency/microwave emitters, etc
- Optical emitters includes ultraviolet, infrared, and high intensity visible light sources

Subsystem Description:

- Provide a description of the radiation which may be exposed to the ground crew Include the quantity of radiation
- Describe any ventilation systems used in association with radioactive gases
- Describe any laser systems, include the type of laser, the laser class, and the function of the laser.
- Define the laser's minimum/maximum energy output, the wavelength(s), pulse (with frequency) or continuous wave, and maximum permissible exposure levels for humans to the wavelength(s)/energy levels.
- Provide diagrams to show the location of the radiation on/in the experiment.
- Complete applicable forms·
  - JSC 44· Ionizing Radiation Source Data Sheet
  - KSC 16-294NS Radiation Training and Experience Summary
  - KSC 16-295NS· Radiation Use Request/Authorization (Radioactive Materials)
  - KSC 28-34NS Radiation Use Request/Authorization (Ionizing Machine/Device)
  - KSC Form 16-450 Training and Experience Summary, Non-Ionizing Radiation Users
  - KSC 16-447· Laser/Optical Device Use Request/Authorization
  - KSC 16-451 Radio frequency/Microwave System Use Request/Authorization

Safety Assessment Summary and Safety Features:

- Describe any personnel protective equipment needed for ground operations
- Describe the containment of any radioactive materials
- Describe the qualifications/training needed for any operations
- Describe any radiation source shields, interlocks, fail-safe systems, and limit switches
- Reference Radiation Hazard Reports (See Hazard Report Section for hazard report templates)

Verification Summary:

- Describe the inspection process used to verify that the safety features mentioned in the above section have been implemented properly
- Document the use of GSE utilizing radioactive gases Include maintenance and checkout of the systems

Notes: The following information is needed for this section. As mentioned above, some of this information should be included with the descriptions and summaries while other information should be attached to the hazard reports and referenced where appropriate

Supporting Data:

- Forms listed in subsystem description section
- List of the equipment generation hazardous radiation
- Documentation of radioactive gases

Hazard Report List/Status

The hazard report list/status provides a listing of the hazard reports and information on their status The form is shown on the following page The hazard report number is the number assigned to each hazard report and can be found in the upper right hand corner of the hazard report The hazard title is gathered from each hazard report Alterations/comments refers to any change or alteration of a hazard report due to a change from an action item and/or a change of design This column will provide updated information about each hazard report. The status column should display whether the hazard report is open, closed, or has been deleted. A hazard report is closed with the assessment of all hazard report related action items and with the completion of all verification methods This is the only complete listing of the hazard reports It is important to keep this list updated and to provide the appropriate comments for bookkeeping purposes *NOTE All changes of hazard reports will be identified by a bar in the right hand margin of the hazard report*

NOTES

NSTS 13830B has form 1090A which is used for flight hazard reports This form only asks for the matrix element reference number, the hazard report number, and the hazard title The payload (experiment) , phase, and date are the same The page numbering was unnecessary since the pages will be numbered with respect to the complete package as described in the table of contents The title of this table has been changed from "NSTS Payload Safety Requirements Applicability Descriptive Data" There are also comments in the text about the status of hazard reports

The GSFC Safety Handbook has a "GAS Hazard List" which provides the hazard group, hazard title, and applicable safety requirement The hazard group is not included because we have taken this out of the hazard report The applicable safety requirements are covered in the hazard reports

JA-012D provides an "Experiment Safety Package Cover Sheet" which is actually a hazard report list/status page This page includes the experiment, payload, phase, date, and page numbers. The payload is not necessary for this listing The page numbers will follow the page numbers of the complete package as described in the table of contents The rest of the information is also provided on the new form The column titles are number, hazard title, remarks, disposition, and general comments. The remarks and general comments are combined into alterations/comments. The disposition is the same as the status There are also comments about hazard report status in the text of this document Assessing the changes of the hazard reports for impact to safety is covered in the revision page and does not need to be repeated here.

Hazard Report List/Status

Experiment:	Phase:	Date:

Hazard Report No.	Hazard Title	Alterations/Comments	Status

Hazard Reports

This section contains the hazard reports which identify potential hazards of the GSE/TOPs, causes of the potential hazards, methods for controlling the hazards, and verifications of the control measures This information will be provided on the JSC Form 542B for hazard reports which is provided on the following page for reference *Note For instructions on the proper method of completing a hazard report form refer to NSTS 13830B, Appendix A, JA-012D, pages A2-1 to A2-6, or JSC Safety Office, Part II It is important to format the hazard reports identically for consistency and ease of reading Each hazard cause should be placed on one page with its corresponding controls and verifications* Along with the hazard reports will be all of the schematics, figures, reports, plans, etc needed to provide a complete safety assessment of the potential hazards described in the hazard reports

The following hazard reports are considered common hazards for particular subsystems Other more unique hazards may be present in a subsystem and should be properly assessed for safety in the manner displayed in this package. **It is important to realize that the hazard reports provided are not to be used as they exist in this package. They are to be used as a template only, and should be used to develop and document experiment-specific information.**

NOTES

The hazard report templates have not been inserted. LeRC Safety Assurance Office is currently working on developing these hazard reports.

The main changes to the hazard report form include the exclusion of the hazard group and the alteration of the signatures The hazard group was excluded to avoid confusion, since it was not adding needed information The signatures were altered to include only the necessary signatures for the approval of the hazard report

EXPERIMENT GROUND HAZARD REPORT		NO	
EXPERIMENT		PHASE	
SUBSYSTEM		DATE	
HAZARD TITLE			
APPLICABLE SAFETY REQUIREMENTS		HAZARD CATEGORY	
			CATASTROPHIC
			CRITICAL
DESCRIPTION OF HAZARD			
HAZARD CONTROLS			
SAFETY VERIFICATION METHODS			
STATUS OF VERIFICATION			

APPROVAL	PHASE I	PHASE II	PHASE III
PREPARER			
PROJECT MANAGER			
INTEGRATION MANAGER			
PANEL CHAIRMAN			

Based on JSC Form 542B (rev Nov 82) NASA-JSC

EXPERIMENT GROUND HAZARD REPORT CONTINUATION SHEET	NO
EXPERIMENT	PHASE
HAZARD TITLE	DATE
HAZARD CAUSE	
HAZARD CONTROLS	
SAFETY VERIFICATION METHODS	
STATUS OF VERIFICATION	

Based on JSC Form 542B (rev Nov 82)

Noncompliance Reports, Waivers, Deviations

The noncompliance report list provides information on all noncompliance reports which have been submitted to the GSRP. A noncompliance report is necessary only when a safety requirement cannot be met. Noncompliance reports for KSC GSE are not needed in the GSCDP The noncompliance is documented on JSC Form 542C which is provided on the following page for reference Justification must be given in the noncompliance report to conclude that an alternate method of design, procedures, configuration, etc has a comparable or higher degree of safety If the noncompliance report is approved, the GSRP will issue a waiver (approved for one mission only) or a deviation (approved for multiple missions). All noncompliance reports must be closed before the Phase III safety review A list of all submitted noncompliance reports and their status will be provided for easy reference This list will state the noncompliance item with information about its acceptance or rejection. The list will track all noncompliance reports whether or not they have become waivers and deviations An example of the noncompliance report list is shown on a following page Also include in this section the actual noncompliance reports, waivers, and deviations *NOTE Detailed information on noncompliance reports, waivers, and deviations can be found in NSTS 13830B sections 6 0, 6 1, and 6 2 For reflown or series flights, waivered conditions must be corrected and deviations must be revalidated after each flight*

NOTES

This table was suggested by NSTS 13830B

NSTS 13830B goes into much more detail on the process of completing and sending an NCR This paragraph is to inform the preparer that a list and the reports are needed; it is not for the complete explanation of what a NCR is and how to fill it out and use it

JSC Payload Safety Class refers to this section as Non-compliant Items. It suggests including a copy of the approving correspondence This is unnecessary if the NCR are all signed

Payload Safety Noncompliance Report	**No.**	**Date:**
Title (brief reference to noncompliance)		
Payload Identification (Include reference to applicable payload element, subsystem, and/or component)		
Applicable Requirement		
Description of Noncompliance (Specify how the design or operation does not meet the safety requirement)		
Hazard or Hazard Cause (Include reference to Hazard Report)		
Reason Requirement Cannot be Fulfilled		
Rationale for Acceptance (Define the design feature or procedure used to conclude that the noncompliance condition is safe Attach applicable support data, i e drawings, test reports, analysis, etc)		

APPROVAL SIGNATURES

Payload Organization			**Date**
WAIVER APPROVAL		**DEVIATION APPROVAL**	
Effectivity		**Effectivity**	
STS Operator	**Date**	**STS Operator**	**Date**

JSC Form 542C (Rev Mar 83)

Noncompliance Report List

Noncompliance Item	Status

Safety Related Failures/Accidents

This section describes the safety related failures and accidents which involve GSE or other ground operations of safety-critical subsystems as well as those which have occurred during experiment processing, testing, and checkout The description should include a summary of each failure/accident along with a safety assessment which identifies all impacts to the STS This section will not appear in a SCDP until the experiment has begun ground operation processing, testing, and checkout which does not occur at KSC until after Phase III However, the GSE may have been used during flight hardware checkout at the developer's site Any failures or accidents associated with GSE there may be documented here.

NOTES

The information about when this section appears in a SCDP was added for clarification. Both NSTS 13830B and JA-012D do not discuss this topic until the phase II SCDP

JA-012D words this section slightly different

Safety Verification Tracking Log

The safety verification tracking log (SVTL) is used to record the status of the open safety verification items of the hazard reports. The SVTL is a standardized JSC Form (no 764) and is provided on the following page for reference This form should be included in all phases of the GSCDP and should be updated per each phase until all verifications are closed The goal is to have all verifications closed by the Phase III safety review, however, closure of verifications is required before GSE use at KSC Instructions for completing the form can be found in NSTS 13830B, Appendix C. The page following the SVTL is provided to help show the relationship between the SVTL and a hazard report

NOTES

All of the information in the documents about the SVTL is covered in this paragraph or in the table itself

JA-012D refers to an Open Safety Items List which is a list of all open safety items requiring closure after the flight hardware is delivered. The SVTL covers some of the same information along with the list of AI

NSTS PAYLOAD GROUND
SAFETY VERIFICATION TRACKING LOG

Experiment/Payload	Date:

Log No	Hazard Report Number	Safety Verification Number	Description (Identify Procedures By Number and Title)	Ground Operation(s) Constrained (Procedure #)	Independent Verification Required (Yes/No)	Schedule Date	Completion Date	Method of Closure Comments

JSC Form 764 (Jul 89)

EXPERIMENT GROUND HAZARD REPORT	NO. ABC-GHR-01
EXPERIMENT: ABC	PHASE: III
SUBSYSTEM: Electrical	DATE: 3/29/95
HAZARD TITLE: Ignition of Flammable Materials	
APPLICABLE SAFETY REQUIREMENTS KHB 1700.7B: 4.3.2 Electrical	HAZARD CATEGORY X CATASTROPHIC CRITICAL
DESCRIPTION OF HAZARD: Ignition of flammable materials resulting in injury to personnel and/or damage to flight/ground equipment.	
HAZARD CAUSES: 1 Inadequate circuit protection causes fire.	
HAZARD CONTROLS 1 1 GSE uses proper fuses or current limiters with respect to wire size in accordance with the requirements of NSTS 18798 (TA-92-038) and will not induce overload into teh Orbiter other GSE, or facility electrical systems.	
SAFETY VERIFICATION METHODS 1.1 Inspection. Review and approve design of GSE wire sizing and fuses.	
STATUS OF VERIFICATION 1.1 Open. Inspection Report # TBD.	

APPROVAL	PHASE I	PHASE II	PHASE III
PREPARER			
PROJECT MANAGER			
INTEGRATION MANAGER			
PANEL CHAIRMAN			

NSTS PAYLOAD GROUND SAFETY VERIFICATION TRACKING LOG

Experiment/Payload: ABC DATE: 3/29/95

Log No.	Hazard Report Number	Safety Verification Number	Description (Identify Procedures By Number and Title)	Ground Operations(s) Constrained (Procedure #)	Independent Verification Required (Yes/No)	Schedule Date	Completion Date	Method of Closure Comments
1	ABC-GHR-01	1 1 1	Inspection Report # TBD	5	Yes	4/95		

Certificate of NSTS Payload Safety Compliance

The Certificate of NSTS Payload Safety Compliance provides a formal approval from the payload organization payload manager stating that the GSE and ground operations comply with all of the applicable requirements of KHB 1700.7B This certificate is JSC Form 1114A which is provided on the following page for reference It is typically prepared for the Phase III SCDP, but is required to be submitted along with the latest SVTL 30 days prior to delivery Any flight verifications still open must be accompanied with a rationale for acceptance

NOTES

JA-012D has its own certificate which states safety compliance with NSTS 1700 7B (KHB 1700.7 refers to this) and that the payload is prepared for integration It also requires an open item's list which is similar to the SVTL The Open Items List is to provide a description of open safety items requiring closure after the flight hardware is delivered

The JSC Payload Safety Class requests a paragraph stating management approval and submission of the SCDP constitutes certification of the SCDP completeness, accuracy, and validity Also included is a statement of compliance with safety requirements The Certificate accomplishes this

Certificate of NSTS Payload Safety Compliance

For

_____

(Payload)

GSE Design and Ground Operations

The Payload Organization hereby certifies that:

(1) The payload is safe.

(2) The payload complies with all applicable requirements of KHB 1700.7B, "Space Shuttle Payload Ground Safety Handbook."

List of approved Waivers/Deviations:

Approved: (Payload Organization Payload Manager)	**Date:**

JSC Form 1114A (May 89)

List of Deliverables

This section will provide a complete list of all items of the experiment which will be delivered to the integration facility This includes all equipment which supports the servicing, checkout, and integration of the experiment A list of deliverables table is provided on the following page The information required for this table includes the part number, the item name, the manufacturer/vendor, the destination, and the disposition. The destination box should be completed with "on-line", "off-line", or a specific room. On-line refers to shuttle interface processing while off-line implies processing elsewhere The disposition column should be completed with an "X" in the appropriate subsection The 'ED' stands for Experiment Developer and in this case, signifies that the Experiment Developer will be bringing this item with him/her as backup This item will be returning with the Experiment Developer if it is not needed. The other choices of disposition are for items which planned to be stored and items which are considered flight hardware This list will verify that all parts have arrived to the integration facility

NOTES:

This is only found in JA-012D This document suggests that this list confirms the completeness of the safety analysis This document also references the Operations and Integration Agreement.

List of Deliverables

No.	Item	Manufacturer	Destination	Disposition		
				ED	Storage	Flight

Appendix A: Applicable Documents

This section is a listing of all of the applicable safety related documents used to substantiate safety compliance in the SCDP It is important to use the current revisions of each document in the development of the SCDP This list should include each document's title, number, revision number or letter, and date. The following list is provided for reference, documents should be added or deleted to this list depending on which were used The dates and the revision numbers or letters have not been provided due to the continuous revision of many documents, however, the current revisions of the documents should be listed

Applicable for all Experiments:

NSTS 13830	Implementation Procedure for STS Payloads System Safety Requirements
NSTS 14046	Payload Verification Requirements for the Space Shuttle Program
NSTS 18798	Interpretations of NSTS Payload Safety Requirements
NSTS 21000-IDD-MDK	Shuttle/Payload Interface Definition Document for Middeck Accommodations
NSTS 1700 7	Safety Policy and Requirements for Payloads Using the Space Transportation System
KHB 1700 7	Space Shuttle Payload Ground Safety Handbook
ICD 2-1-19001	Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 to NSTS 07700, Volume IV)

KSC:

KHB 1860 1	KSC Radiation Protection Handbook
KHB 1860 2	KSC Non-ionizing Radiation Protection Program

MSFC:

JA-012	Payload Projects Office Payload Safety Implementation Approach
JA-061	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Spacelab Payload Missions
JA-081	Payload Mission manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Partial Payload Missions
JA-276	Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on STS Orbiter Middeck Payload Missions

JA-418	Payload Flight Equipment Requirements for Safety-Critical Structures
JA-447	Mission Requirements on Facilities/Instruments/Experiments for Space Transportation Systems (STS) Attached Payloads (MROFIE)

GSFC:

---	GAS Experimenter's Guide to the STS Safety Review Process and Data Package Preparation

NOTES

The title of the document was added to the list because some documents do not have numbers The majority of this list is from JA-012D, section 4 0

JSC Payload Safety Class suggests including this list in the introduction Instead of including it, it was referenced it in the Preface

Appendix B: Project Schedules

This section provides a schedule of all of the major ground safety reviews along with a timeline schedule of all activities associated with launch site processing The ground safety review schedule should display the name of the ground review and its planned date These dates should be updated if changes are made in the schedule *NOTE For project schedule guidance, refer to JSC Payload Safety Class Module II, Section G, provided on the following pages* The launch site processing timeline should include planned dates for handling, storage, assembly, servicing, and checkout operations which are to occur at KSC

NOTES·

The JSC Payload Safety Class includes this in the mission description

NSTS 13830B only discusses it in the review meetings, however, it is important to have it for reference

KHB 1700.7B requests a launch site safety plan This has been added to this section and is referenced in the introduction

G. Schedule

Having seen the flow of activities and schedule of the integration process, let's consider how the safety process fits in Design of the payload will usually have progressed to some point before the approval for mission assignment is granted. That says that the safety process should be underway even before the payload has a flight assignment The two processes first come together with approval of the 1628 From that point they are running in parallel and are pegged together at milestones such as design reviews, readiness reviews, delivery to the launch range, processing points and launch.

Figure II-1 depicts the overall flow and relationships of the payload design, integration, system safety and payload safety review processes It should be clear from looking at the chart that the safety effort cannot wait until the integration process starts There is too much safety data required to support the PIP and ICD There is also too much design work done If the safety process is not started until the design is complete and hardware is being built, the cost of correcting hazards goes up tremendously Remember, it is a lot less expensive to change a line on a piece of paper than it is to modify a piece of hardware.

Figure II-3 looks at the relationships from another perspective The hazard reports form the basis for much of the activity that occurs during the integrated cargo development and control process

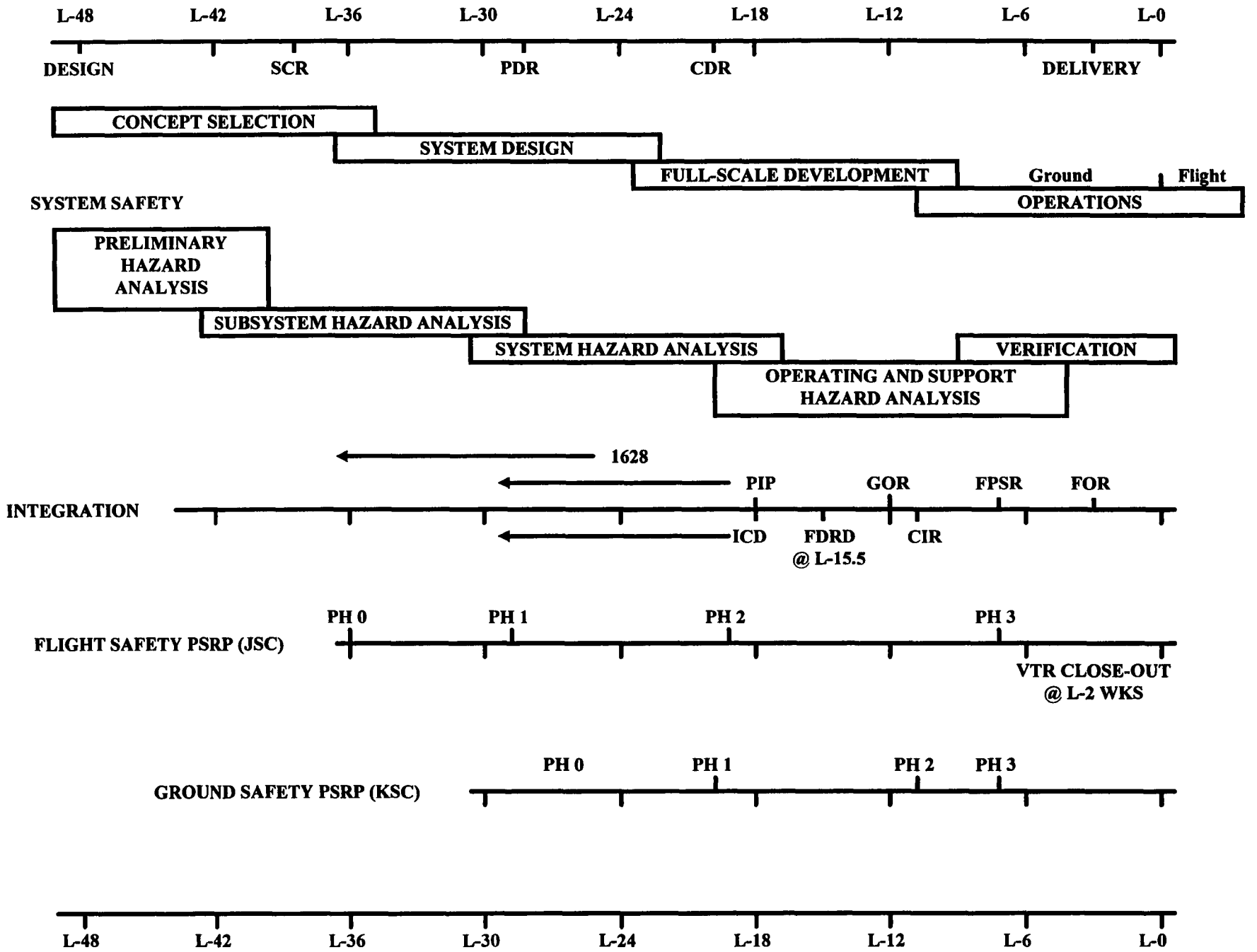


FIGURE II-1, DESIGN, SAFETY & INTEGRATION RELATIONSHIPS

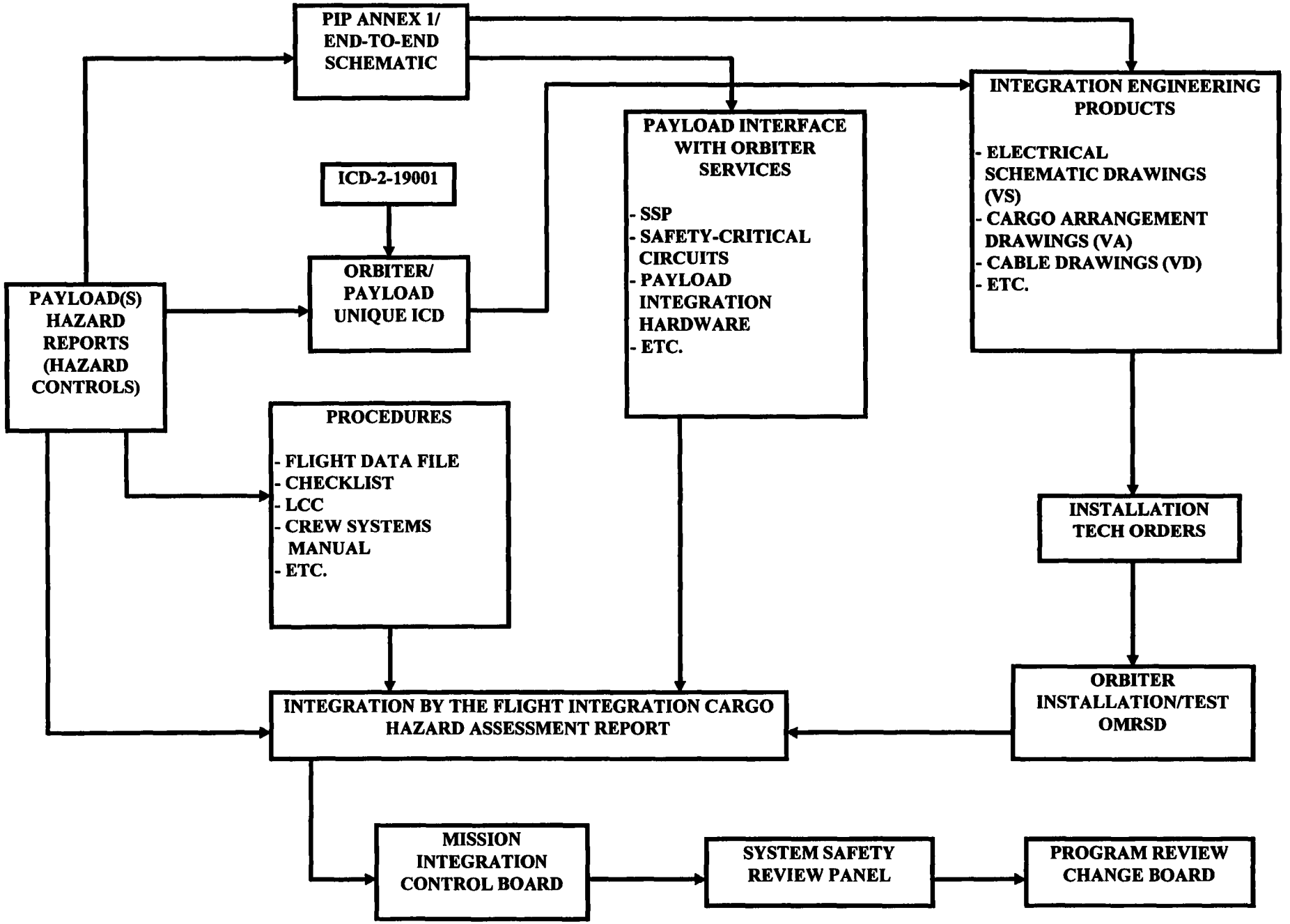


FIGURE II-3, INTEGRATED CARGO HAZARD CONTROL PROCESS

Appendix C: TOPs

This appendix provides a list of all the TOPs associated with the experiment. It can also be used to track all of the TOPs through completion An example table is displayed on the following page The hazard report number is the number assigned to each hazard report and can be found in the upper right hand corner of the hazard report The hazard report control number refers to a particular control on the hazard report for which the TOP is written A procedure title and procedure number is assigned for each TOP The sequence affected is a brief description of the hazard control which is associated with the TOP The facility in which the procedure will be performed and the date in which it will be completed are also included on the table A draft version of this list is necessary for the Phase II GSCDP The final list should be presented in the Phase III GSCDP

NOTES This table has been added for reference purposes There are no requirements for this table It is from KSC

Hazard Controls Incorporation In Operational Procedures

Hazardous Procedure Information Log For _____
(Payload Customer)

HR Number	HR Control Number	Procedure Title	Procedure Number	Sequence(s) Affected (Hazard Controls)	Facility Used In	Use Date

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13. ABSTRACT (*Maximum 200 words*)

This report documents the results of an analysis of microgravity space experiments space shuttle programmatic safety requirements and recommends the creation of a Safety Compliance Data Package (SCDP) Template for both flight and ground processes. These templates detail the programmatic requirements necessary to produce a complete SCDP. The templates were developed from various NASA centers' requirement documents, previously written guidelines on safety data packages, and from personal experiences The templates are included in the back as part of this report.

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