AOD 33890
Basic PCN 1

WB-57 User's Guide

Aircraft Operations Division

February 2002

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

Verify that this is the correct version before use.

WB-57 User's Guide

February 2002

Basic PCN 1

Approved by

Original Signed By:

Robert J. Naughton
Chief, Aircraft Operations Division

Change Record

Rev.	Date	Document OPR/ Custodian/Extension Alternate/Extension	Description
Basic	August 2001	CC5/Gary Ash/49651	Initial Release
Basic PCN 1	February 2002	CC5/Gary Ash/49651	Change bar denotes changes on Page 18.

Table of Contents

1 GENERAL NASA WB-57 AIRCRAFT INFORMATION 7
1.1 Aircraft Description 7
1.2 Payload Integration Locations 8
1.3 Payload Environment Information 9
1.4 Data Processing and Recording 9
1.5 Payload Control 9
1.6 Voice Communications 11
1.7 Data Communications 11
1.8 Electrical Interface 11
1.9 WB-57 Deployment Information 11
2 PAYLOAD DESIGN REQUIREMENTS 14
2.1 Aircraft/Payload Integration 14
2.1.1 Pallet Integration 15
2.1.2 Wing Pod Integration 15
2.1.3 Nose Cone Integration 16
2.1.4 Aft Fuselage/Tail Cone Integration 17
2.2 Payload Structural Design 17
2.2.1 Crash Load Requirements for Pallet, Nose Cone, and Aft Fuselage Payloads 18
2.2.2 Crash Load Requirements for Wing Pod Payloads 18
2.2.3 Payload Weight Restrictions 19
2.2.4 Structural Materials 19
2.2.5 Structural Fasteners 19
2.2.6 Welding 20
2.3 Pressure/Vacuum Systems 20
2.4 Electrical Interface 20
2.4.1 Electrical Interface Panel 20
2.4.2 Auxiliary Power Panels 24
2.4.3 RS232 Navigation Data Recorder Output 25
2.4.4 RS232 Time Channel Data Format 26
2.4.5 ARINC 429 GPS Output To Payload Areas 26
2.4.6 ARINC 429 INS Output to Payload Areas 27
2.5 Overboard Vent 27
2.6 Lasers 28
2.7 Payload Fail-Safing 28
2.8 Hazardous Materials 28
2.9 Researcher Tools and Support Equipment 28
2.10 Spill Control 28
2.11 Electromagnetic Interference (EMI) 29
2.12 Cleaning, Stowing, and Repairing Equipment for Flight 29
2.13 Touch Temperature for Research Hardware 29

3 PAYLOAD DATA PACKAGE REQUIREMENTS 30
3.1 Cover Page 31
3.2 Quick Reference Data Sheet 31
3.3 Table of Contents 32
3.4 Proposed Mission Profile and Flight Schedule 32
3.5 Payload Description 32
3.6 Structural Analysis 32
3.7 Pressure/Vacuum Systems 33
3.8 Laser Systems 33
3.9 Hazard Analysis Report Guidelines 33
3.10 Ground Support Requirements 35
3.11 Hazardous Materials 35
3.12 Material Safety Data Sheets 36
3.13 Mission Procedures 36

4 USER REQUEST & MISSION ARRANGEMENTS 38
4.1 Flight Request Procedure 38
4.2 Funding 39
4.3 Badging Requirements 39
4.3.1 U.S. Citizens 39
4.3.2 Permanent Resident Aliens ("Green Card" Holders) 39
4.3.3 Foreign Nationals and Foreign Representatives 39
4.4 Timeline 40

5 TEST OPERATIONS 41
5.1 Pre-Flight 41
5.2 In-Flight 42
5.3 Post-Flight 42
5.4 Post-Mission 42

6 Ground Facilities 43
6.1 WB-57 Program Office 43
6.2 Building 994 Computer Network Access, Printers, and Phones 44
6.3 Payload Equipment and Material Storage 44
6.4 Shipping and Receiving 45
6.5 Forklifts and Hoists 45
6.6 Hand Tools 45

7 SAFETY 46
7.1 Johnson Space Center Requirements 46
7.2 Aircraft Operations Division Requirements 46
7.3 WB-57 Program Office Requirements 47

List of Figures

Figure 1. WB-57 Aircraft Dimensions 7
Figure 2. Typical WB-57 Payload Integration Locations 8
Figure 3. Backseat - Right Side Console Configuration 10
Figure 4. Backseat - Forward Console Configuration 10
Figure 5. Domestic Deployment Sites 12
Figure 6. International Deployment Sites 13
Figure 7. Typical WB-57 Payload Integration Locations 14
Figure 8. WB-57 3 ft. Pallet 15
Figure 9. WB-57 Wing Pod 16
Figure 10. WB-57 Nose Cone 16
Figure 11. WB-57 Axis Configuration for Crash Loads 18
Figure 12. Typical Experiment Interface Panel 20
Figure 13. Power and Status Simplified Schematic 21
Figure 14. Pinout Receptacles J1 through J5 22
Figure 15. Pinout Receptacles J6 through J10 23
Figure 16. Pinout Receptacles J11 and J12 23
Figure 17. Typical Auxiliary Power Panel 24
Figure 18. Building 994 - WB-57 Payload Laboratory 43
Figure 19. Building 994 High Bay Work Area 44
Figure 20. Building 994 Toolbox 45

1 GENERAL NASA WB-57 AIRCRAFT INFORMATION

This guide is our attempt to give you the information necessary to make your work with us easier, safer, and less expensive. We have outlined various categories of information that have been important in the past. The procedures that we require prior to flight are necessary to ensure the safety of our and your people and all the associated equipment. We will be happy to work with you to make your time with us as pleasant and productive as possible.

1.1 Aircraft Description

NASA Johnson Space Center (JSC) operates two WB-57 aircraft out of Ellington Field – Houston, Texas. The WB-57 is a mid-wing, long-range aircraft capable of operation for extended periods of time from sea level to altitudes well in excess of 60,000 feet. Two crewmembers are positioned at separate tandem stations in the forward section of the fuselage. The pilot station contains all the essential equipment for flying the aircraft. The aft or sensor operator station contains both navigational equipment and controls for the operation of the payloads and payload support systems located throughout the aircraft. Figure 1 gives the basic aircraft dimensions for the WB-57. During normal conditions the WB-57 can remain aloft for approximately 6.5 hours. Maximum crosswind component for takeoff and landing is 15 knots. Minimum runway length and width, respectively, is 7000 ft. x 150 ft. (at sea level). Contact the WB-57 Program Office (reference Section 4.1) for any further inquiries on aircraft operation parameters.

Performance and Capabilities

Aircraft Ceiling:	Well in Excess of 60,000 ft.	True Air Speed at 60,000+ feet:	~410 knots (Max Mach .8)
Maximum Flight Duration:	Approximately 6.5 hours	Max. True Air Speed at Sea Level:	190 knots
Range:	Approximately 2,500 miles	Minimum Runway Dimensions:	7000 ft. x 150 ft. (sea level)
Max Gross Weight:	63,000 pounds	Maximum Crosswind Component:	15 Knots
Maximum Payload Weight:	6,000 pounds	Air to Ground Communications:	UHF, VHF, HF, & SAT Phone
Wing Surface Area:	2,000 square feet	Payload Power Options:	110V 400Hz 3 Phase
Engine Thrust:	15,500 pounds per TF-33 engine		110V 60Hz Single Phase
			28VDC

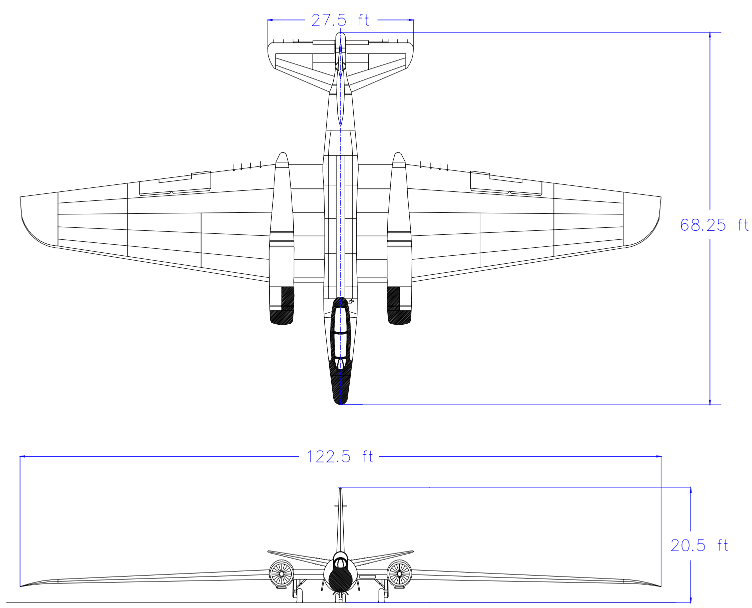


Figure 1. WB-57 Aircraft Dimensions

1.2 Payload Integration Locations

The WB-57 aircraft can carry up to 6000 lbs. of payload. Typical payload integration locations are detailed in Figure 2. The WB-57 employs a pallet system in the main fuselage area. The pallet system consists of interchangeable pallet modules. Pressurized and unpressurized pallets are available. The pallet system will carry a total of 4000 lbs. including pallet weight. Lighter, smaller weight payloads can also be carried in the aft fuselage, in the tail and tailcone, wing pods, wing hatches, and/or in the nose cone.

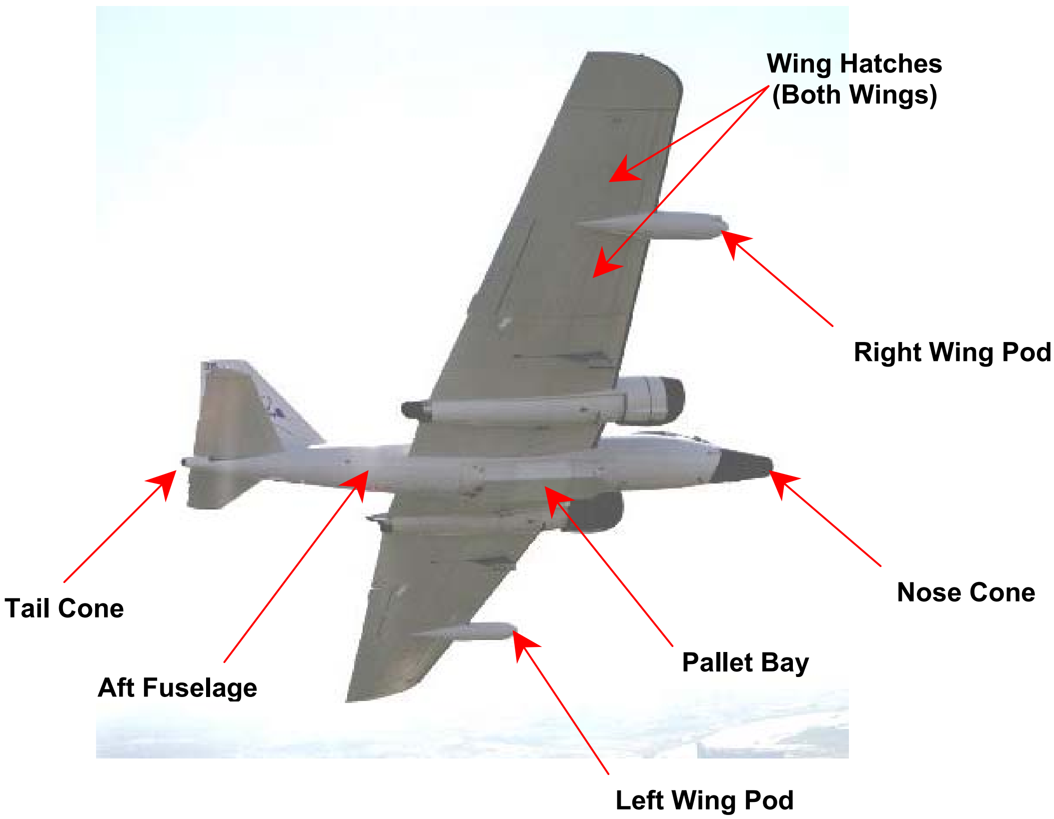


Figure 2. Typical WB-57 Payload Integration Locations

For integration economy, pallets, wing pods, and nose cones are available for shipment to a researcher's facility. The modular feature of the pallets, wing pods, and nose cones allow for sensor development, integration, checkout, and maintenance away from the aircraft.

The WB-57 has been modified to provide a standardized electrical interface for payload integration, power, and payload control operations. The standard interface permits the aircraft to carry multiple payloads at the same time.

1.3 Payload Environment Information

Payload integration locations are typically unpressurized; however, the bleed-air pressurization system, if required, provides pressure (5 psig) to the nose cone compartment and pressurized pallet compartments.

Vibration levels within the WB-57 during flight are quite low. Levels during ground operations are somewhat higher, especially in the low frequency range. Contact the WB-57 program for specific vibration data.

Temperature levels in payload compartments vary according to flight profile and ambient air conditions; however, tarmac temperatures in the summer can reach as high as 140^{o} F (60^{o} C) and temperatures at high altitude drop to as low as -120^{o} F (-84^{o} C). Water condensation in Houston, Texas is very likely upon descent to landing. The WB-57 does possess the capability for payload cooling operations prior to taxi and heating operations for payloads during flight. Contact the WB-57 Program Office for specific temperature data.

1.4 Data Processing and Recording

The WB-57 does not typically provide an on-board processor and/or recorder for sensor payloads. On-board processing would be considered part of the sensor payload. Aircraft attitude, navigational data (GPS and inertial), ambient flight path atmospheric conditions, and precise timing is recorded throughout the flight on the WB-57 Nav Data Recorder. This data stream is also available to aircraft payloads for data processing/recording.

1.5 Payload Control

Switches on the rear cockpit control panels are available to control power to experiments. The switch is simply an On/Off switch. Once power is provided to the instrument, payload operations should be handled internally. The configuration of the backseat station is shown in Figures 3 and 4. For payloads that are not totally automated, contact the WB-57 Program Office for suggestions on payload control options.

For optical payloads, a Pointing and Tracking System (PTS) is available. Contact the WB-57 Program Office for detailed information on the PTS and the associated computer systems.

Figure 3. Backseat - Right Side Console Configuration

Figure 4. Backseat - Forward Console Configuration

1.6 Voice Communications

The WB-57 is equipped with SAT Phone, UHF, VHF, and HF radios for flight crew use in communication with payload personnel on the ground.

1.7 Data Communications

The WB-57 provides a video/digital telemetry link to a fixed receiver at Ellington Field – Houston, TX. Contact the WB-57 Program Office for details.

1.8 Electrical Interface

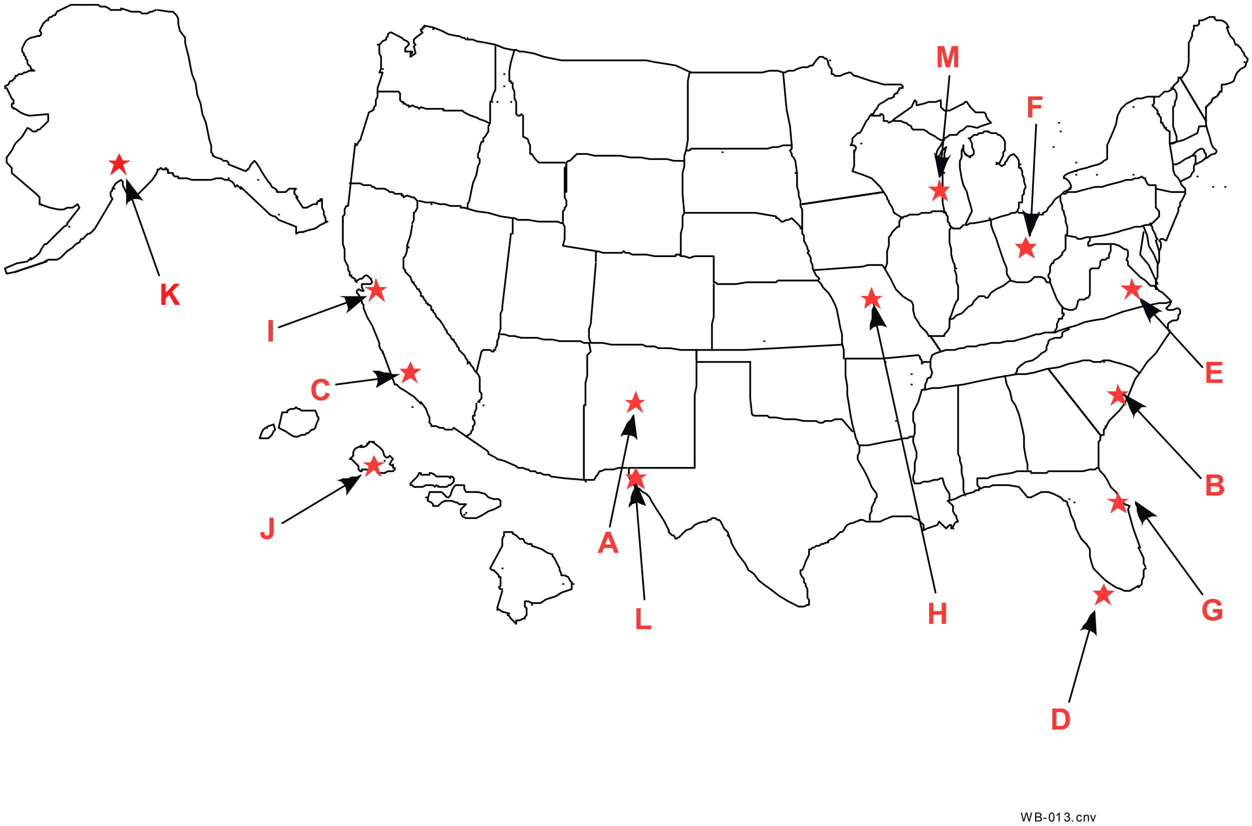
Payloads installed in the aircraft have the following power options:

- 115VAC-400HZ, 3 phase
- 115VAC-60 HZ, single phase
- 28 VDC

These power options are conveniently available at all typical payload integration locations through installed power panels. Connections to aircraft power panels are through standard Mil Spec connectors. Internal data bus connections are also available for payloads. WB-57 data busses provide IRIG timing, inertial reference system and various aircraft parameters to the payload data processor/recorder (reference Chapter 2 for detailed information on electrical interfaces).

1.9 WB-57 Deployment Information

NASA Johnson Space Center has two WB-57's based at Ellington Field – Houston, Texas. If necessary, the WB-57 can be deployed to both domestic and international locations. A site survey will be performed by the WB-57 Program Office to assess remote site support facilities, logistics support, runway parameters, meteorological/operational issues, and if located outside the U.S., foreign government permission. Export control laws will need to be addressed for foreign deployments. Contact the WB-57 Program Office with any inquiries about remote site deployments. See Figures 5 and 6 for some examples of remote sites the WB-57 has been deployed.



A. Albuquerque, New Mexico

B. Charleston, South Carolina

C. Edwards Air Force Base, California

D. Key West, Florida

E. Langley Air Force Base, Virginia

F. Wright-Patterson Air Force Base, Ohio

G. Kennedy Space Center, Florida

H. Whiteman Air Force Base, Missouri

I. NASA Ames, San Francisco, California

J. Hickham Air Force Base, Hawaii

K. Elmendorf Air Force Base, Alaska

L. El Paso, Texas

M. Milwaukee, Wisconsin

Figure 5. Domestic Deployment Sites

A. Kwajalein

B. San Jose, Costa Rica

C. Panama City, Panama

D. Montevideo, Uruguay

E. Ottawa, Canada

Figure 6. International Deployment Sites

2 PAYLOAD DESIGN REQUIREMENTS

This chapter provides a detailed description of payload design specifications that must be met before a payload is approved for flight on the WB-57. Retain all documentation throughout the design process so that it may be presented later in the flight approval process. The safety guidelines presented in this section are the minimum required. We encourage you to take steps to exceed these guidelines when practical, while keeping overall payload weight and drag to a minimum.

2.1 Aircraft/Payload Integration

Payloads proposed for flight on the WB-57 should consider provisions for safe and efficient aircraft integration operations. All payloads must be designed to fit, without aircraft interference, into its designated location on the aircraft, and must meet all design guidelines specified in this chapter (i.e. structural, electrical, etc.). Accurate weight and CG locations must be determined for all payloads, and provisions made for service coils (slack) for electrical connections and/or overboard vent lines. Reference the picture below to view typical WB-57 payload integration locations. If necessary, other payload integration locations are available. Contact the WB-57 Program Office with any integration inquiries.

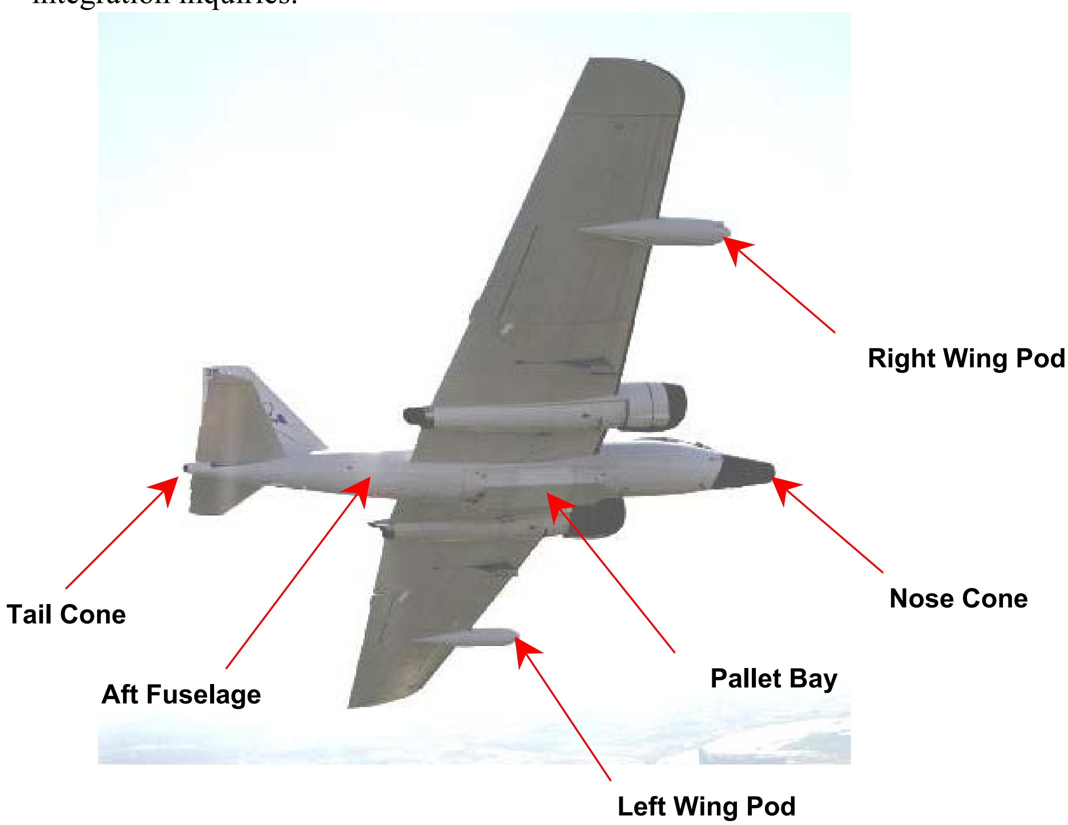


Figure 7. Typical WB-57 Payload Integration Locations

2.1.1 Pallet Integration

Payloads can be integrated by use of WB-57 pallets (contact the WB-57 Program Office for detailed design information on pallets). Pallets are located mid-fuselage on the belly of the airplane. They come in 3 ft. or 6 ft. sizes (measured longitudinally along the aircraft), pressurized or unpressurized configurations, and have convenient power panels located in close proximity to mounting locations. Pressurized pallets are pressurized to cockpit pressure (approximately 5 psig). All pallets have detachable casters for use during ground operations and standard inlet holes available for payload inlets. Modifications to pallets are allowed with WB-57 Program Office approval. Pallets are available for shipment to researcher laboratories for payload design purposes.

Note: 3 ft. and 6 ft. pallets can be installed on the airplane in multiple configurations so long as the 12 feet of allotted space in the pallet bay is not exceeded (e.g. two 3ft. pallets may be installed with one 6 ft. pallet, or two 6 ft. pallets may be installed with no 3 ft. pallets, or four 3 ft. pallets may be installed with no 6 ft. pallets).

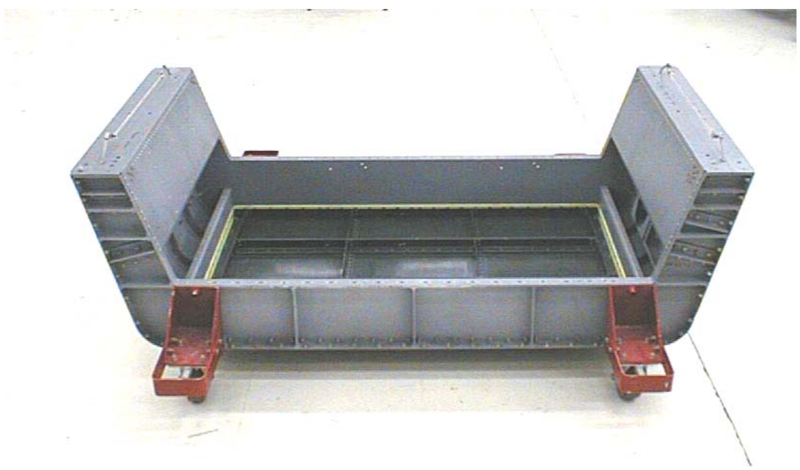


Figure 8. WB-57 3 ft. Pallet

2.1.2 Wing Pod Integration

Payloads can be integrated in WB-57 wing pods (contact the WB-57 Program Office for detailed design information on wing pods). Wing pods are located outboard of the engines and have convenient power panels located in close proximity to their mounting location. They come in one size and are unpressurized. Wing pod rigs/carts are available at Ellington Field for use during ground operations and installation/removal procedures. Wing pods are available for shipment to researcher laboratories for payload design purposes. Inlet holes are available on all wing pods. Wing pod modifications are allowed with WB-57 Program Office approval.

Figure 9. WB-57 Wing Pod

2.1.3 Nose Cone Integration

Payloads can be integrated in the WB-57 nose cone (contact the WB-57 Program Office for detailed design information on nose cones). The nose cone comes in one size and has convenient power panels located in close proximity to its mounting location. It can be either pressurized or unpressurized. When pressurized, the nose cone is pressurized at cockpit pressure (approximately 5 psig). A nose cone rig is available at Ellington Field for use during ground operations and installation/removal procedures. Nose cones are available for shipment to researcher laboratories for payload design purposes. Inlet holes are available on the nose cone. Modifications to nose cones are allowed with WB-57 Program Office approval.

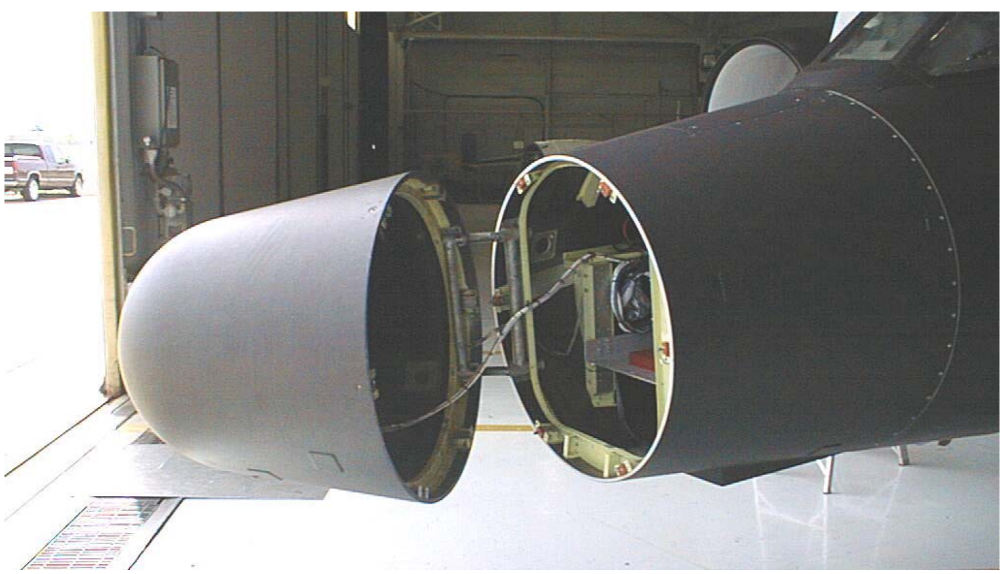


Figure 10. WB-57 Nose Cone

2.1.4 Aft Fuselage/Tail Cone Integration

Payloads can be integrated in the WB-57 aft fuselage (contact the WB-57 Program Office for detailed design information on the WB-57 aft fuselage). The aft fuselage is located within the body of the airplane from mid-wing to the tail cone, and is unpressurized. Standard inlet holes are available on the aft fuselage. Aft fuselage modifications are allowed with WB-57 Program Office approval.

2.2 Payload Structural Design

WB-57 payloads must comply with the following structural design requirements and provide documented proof of compliance via the Payload Data Package (reference Chapter 3). Sound structural design practice should be used to result in payloads that meet the WB-57 Program Office strength requirements and optimum payload weight. Structural designs should allow for ease of aircraft integration, payload maintenance, and replacement of components, when required. Structures are to be designed with both design and crash load cases in mind. Design and crash loads for the WB-57 are defined as follows:

Design Loads

Design loads are the **maximum** loads figured to occur during normal payload operation. Design loads must not yield any part of the structure; therefore, a positive safety margin must exist when using documented material yield strengths as the allowable load in safety margin calculations. In addition, a minimum factor of safety of 1.5 must exist when design loads are compared with documented material **ultimate** strengths.

Crash Loads

Crash loads are the loads estimated to occur during a high impact incident on the airplane. Crash loads may result in damage, distortion, and some local yielding, but the structure must not experience a catastrophic failure (i.e. come loose from its mount). These loads are specified in the following sections in terms of the mounting location of the payload, the magnitude of deceleration experienced, and the direction of the deceleration. For example, specified per Section 2.2.1, payloads mounted in a pallet must be able to withstand 3 g's in the forward direction, 1.5 g's in the aft direction, etc. Each load direction should be analyzed independent of the other load cases.

Documented material ultimate strengths are to be used as the maximum allowable loads throughout all safety margin calculations. Throughout this analysis, positive safety margins must exist throughout the entire payload structure as well as in the hardware used to mount the payload to the airplane. Structural crash load requirements for the various payload integration locations will be described in the direction vectors specified per Figure 11.

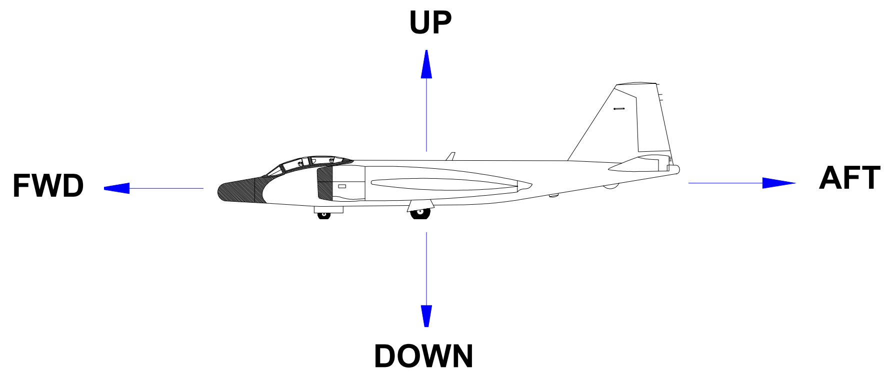


Figure 11. WB-57 Axis Configuration for Crash Loads

2.2.1 Crash Load Requirements for Pallet, Nose Cone, and Aft Fuselage Payloads

All equipment (i.e. fasteners, individual components, frames, and full assemblies) mounted in pallets, the nose cone, and aft fuselage must be designed to withstand the following crash loads during all flight configurations. Documented ultimate strengths are to be used as the allowables in safety margin calculations.

- Forward: 3.0 g's (ultimate)
- Aft: 1.5 g's (ultimate)
- Up: 2.0 g's (ultimate)
- Down: 4.5 g's (ultimate)
- Lateral: 1.5 g's (ultimate)

2.2.2 Crash Load Requirements for Wing Pod Payloads

All equipment (i.e. fasteners, individual components, frames, and full assemblies) mounted in wing pods must be designed to withstand the following crash loads during all flight configurations. Documented ultimate strengths are to be used as the allowables in safety margin calculations.

- Forward: 3.0 g's (ultimate)
- Aft: 1.5 g's (ultimate)
- Up: 3.0 g's (ultimate)
- Down: 6.0 g's (ultimate)

- Lateral: 1.5 g's (ultimate)

2.2.3 Payload Weight Restrictions

Overall payload weight should be kept to a minimum when all other payload design requirements have been satisfied. The list below outlines maximum payload weight limits for the various payload integration locations. For all locations that are CG dependent, contact the WB-57 Program Office for more information on allowable CG/weight envelopes. **Note: the weights listed below pertain to payload only weights. You do not have to include the weight of the pallet, nose cone, wing pod, etc.**

- 3 ft. Unpressurized Pallet Payload: 825 lbs. (1000 lbs. max including pallet)
- 3 ft. Pressurized Pallet Payload: Contact WB-57 Program Office
- 6 ft. Unpressurized Pallet Payload: 1600 lbs. (2000 lbs. max including pallet)
- 6 ft. Pressurized Pallet Payload: 1225 lbs. (2000 lbs. max including pallet)
- Nose Cone Payload: 600 lbs.
- Aft Fuselage Payload: *CG dependent
- Wing Pod Payload: *280 lbs. maximum, CG dependent

* Contact the WB-57 Program Office for documented CG/Weight envelopes for aft fuselage and wing pod payloads.

2.2.4 Structural Materials

Materials used in a payload structural design must have documented allowable strengths. Typical materials used in structural design are aluminum, steel, and stainless steel. If non-metallic materials are utilized, some restrictions apply. Researchers must provide documentation that the non-metallic items are non-flammable and that they will not support combustion. The researcher is also required to supply the WB-57 Program Office with MSDS sheets, via the Payload Data Package (reference Chapter 3), for the non-metallic materials being used.

2.2.5 Structural Fasteners

Fasteners utilized in structural designs must be of an aerospace grade (AN, MS, NAS, etc.) or equivalent, and must possess documented fastener strengths. Common fasteners used in payload structures include bolts, screws, rivets, nut plates, etc. Proper fastener installation must be practiced at all times by using correct fastener sizes, spacing (e.g. E/D edge margins no less than 2.0), torque loads, locking hardware (e.g. safety wire, lock washers, lock nuts, etc.), and rivet bucking procedures. **No. 8 size threaded fasteners (or smaller)** are not considered sufficiently sized fasteners for structural purposes. Only use #10 size (.190 inches in diameter) fasteners or larger when selecting fasteners for load bearing structure. Threaded fasteners must have threads engaged sufficiently. This requires at least two threads to be visible beyond the locking nut or nut plate. Do not oversize threaded fasteners as well. If more than four threads are exposed, a shorter grip length should be selected.

2.2.6 Welding

Structural welds must be performed in accordance with Society of Automotive Engineers (SAE) standard AMS-STD-2219. Contact the WB-57 Program Office for more information on welding.

2.3 Pressure/Vacuum Systems

All pressure/vacuum systems proposed for flight and/or ground use must comply with Johnson Space Center Document JHB 1710.13B. Contact the WB-57 Program Office for a copy.

2.4 Electrical Interface

2.4.1 Electrical Interface Panel

The interface panel (Figure 12) links the payload to the aircraft electrical system, the sensor operator control panel, and the aircraft data system. Interface panels are located in all typical payload integration areas.

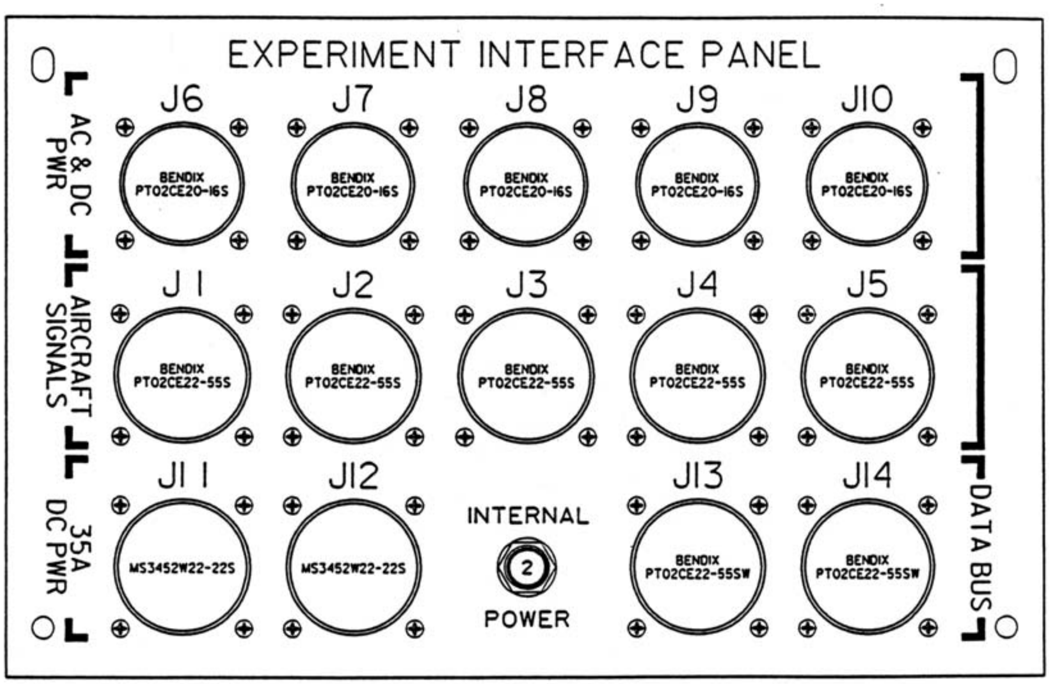


Figure 12. Typical Experiment Interface Panel

Switches on the control panel operate up to five payloads in each payload area with the exception of the pallet bay. There are ten control switches for the pallet bay corresponding to fwd and aft pallet bay experiments. The control switch activates a single pole, double throw (S.P.D.T) relay (Figure 13). The relay contacts are rated at 1.0 Amp max. The contacts are user definable and are available at receptacles J1 through J5 on the experiment interface panel.

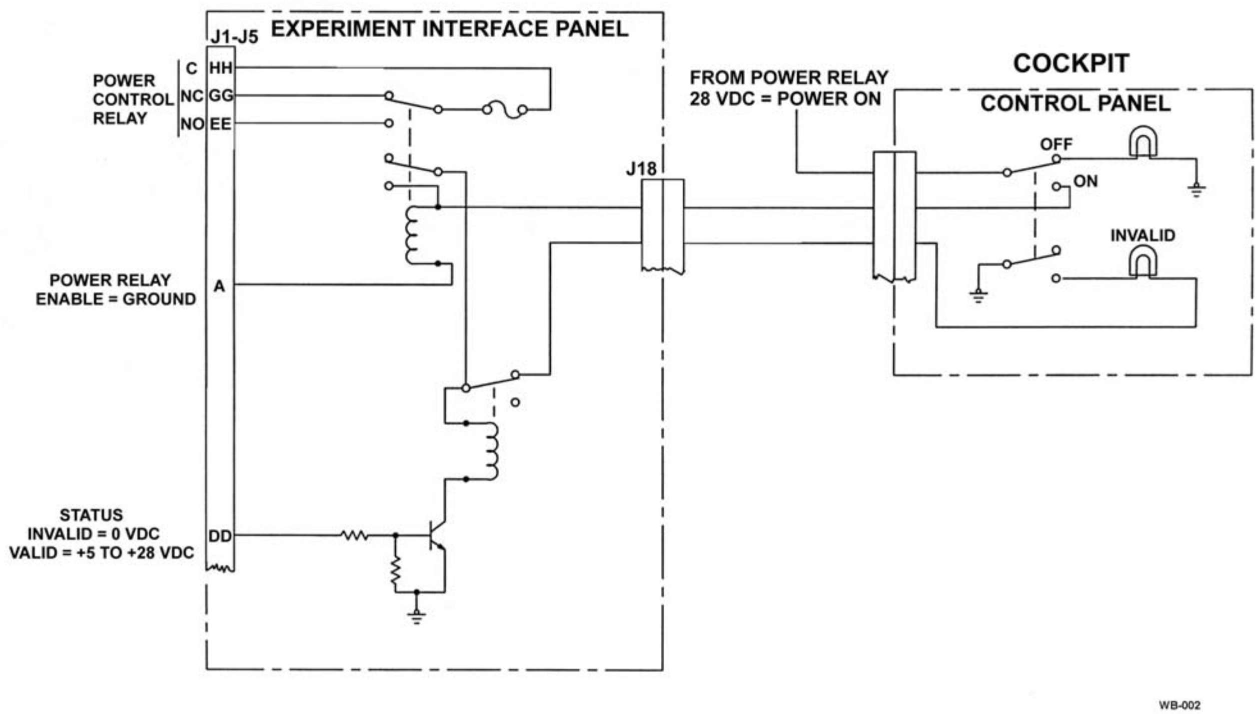


Figure 13. Power and Status Simplified Schematic

Corresponding to switches 1 through 5 on the control panel are receptacles J1 through J5. These identical receptacles provide the various timing, control and aircraft navigation signals. The pinout for these receptacles is shown in Figure 14.

AC and DC power are provided through identical receptacles J6 through J10. These five receptacles provide a total of 15 amperes of AC current per circuit or 35 amps of DC current per circuit. Each plug contains two 115 VAC-400 HZ-3 phase circuits and two 28 VDC circuits. Each pin is limited to a maximum of 15 amperes. Figure 15 shows the pinout configuration for these receptacles.

Receptacles J11 and J12 are identical and accommodate higher current DC power connections. These receptacles provide a total (per circuit) of 35 amperes. Figure 16 displays these pinout configurations.

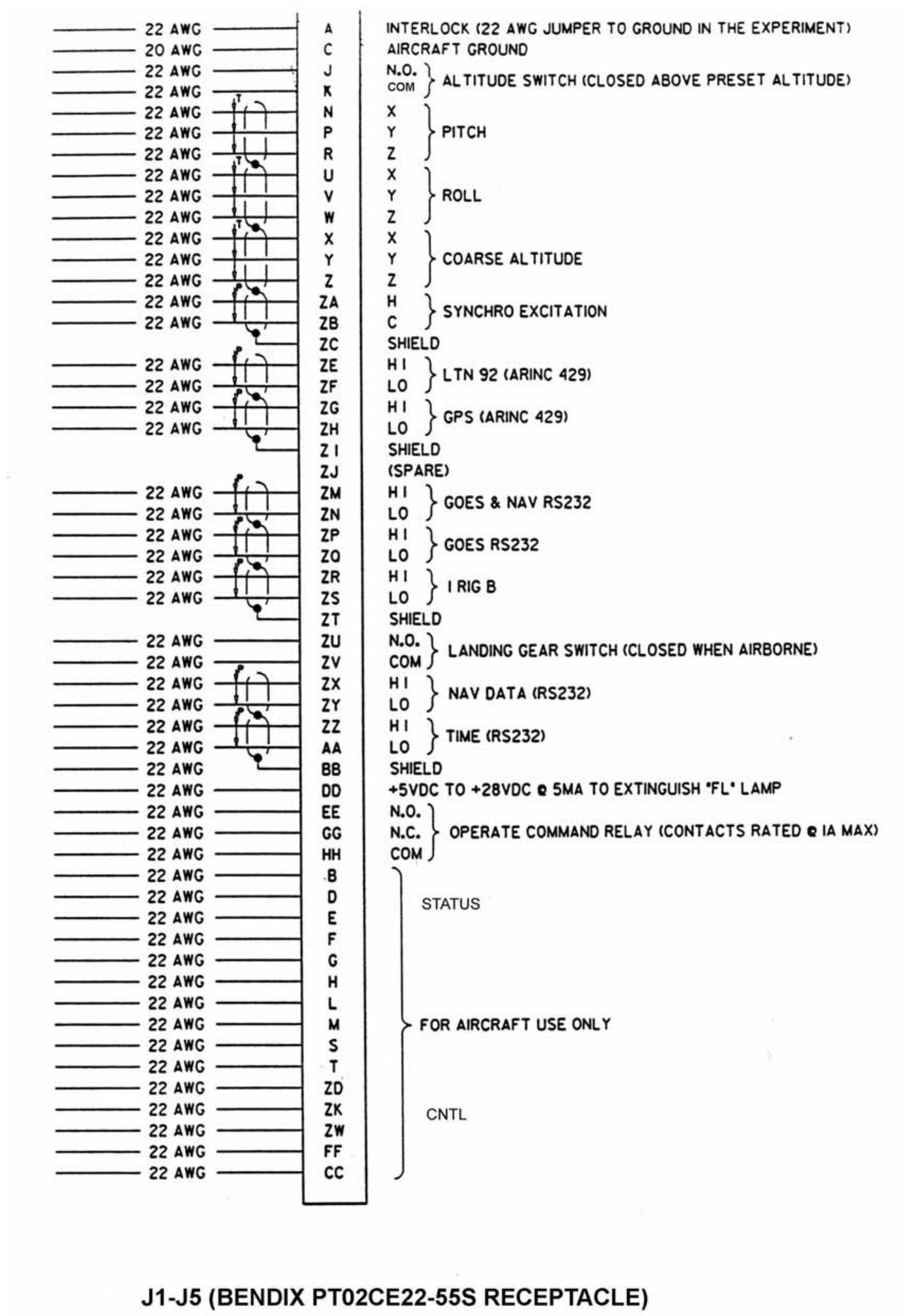


Figure 14. Pinout Receptacles J1 through J5

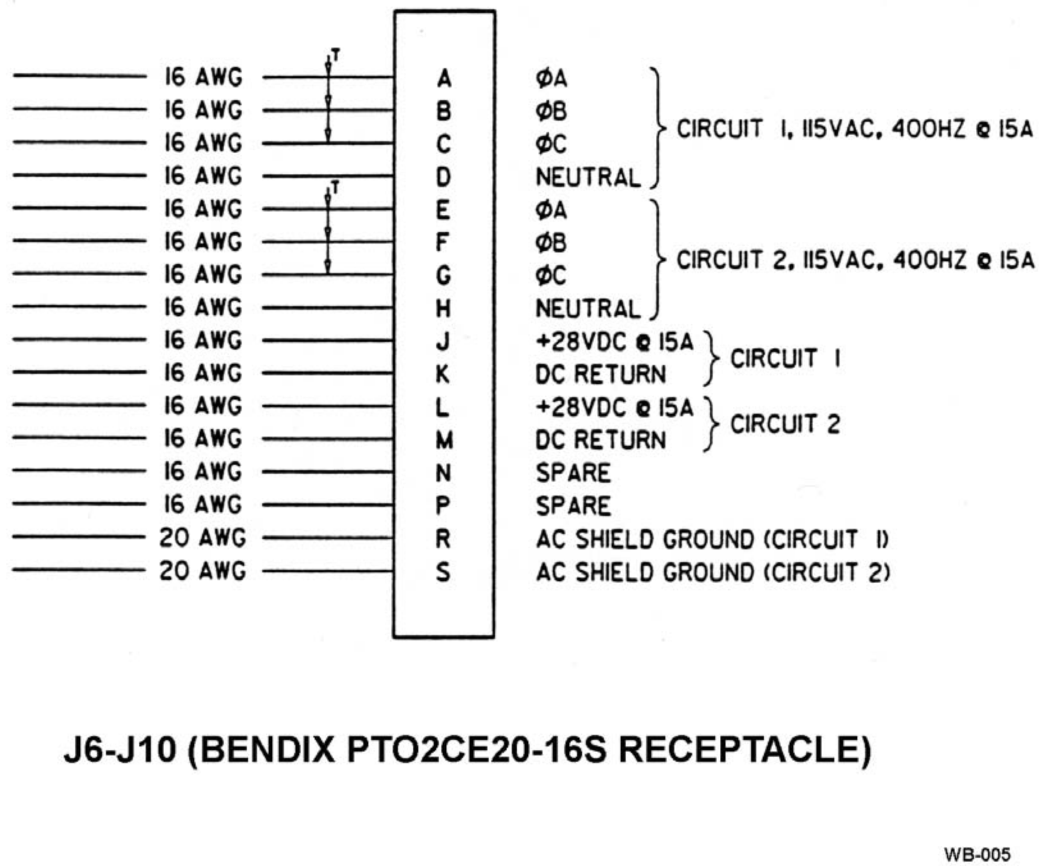


Figure 15. Pinout Receptacles J6 through J10

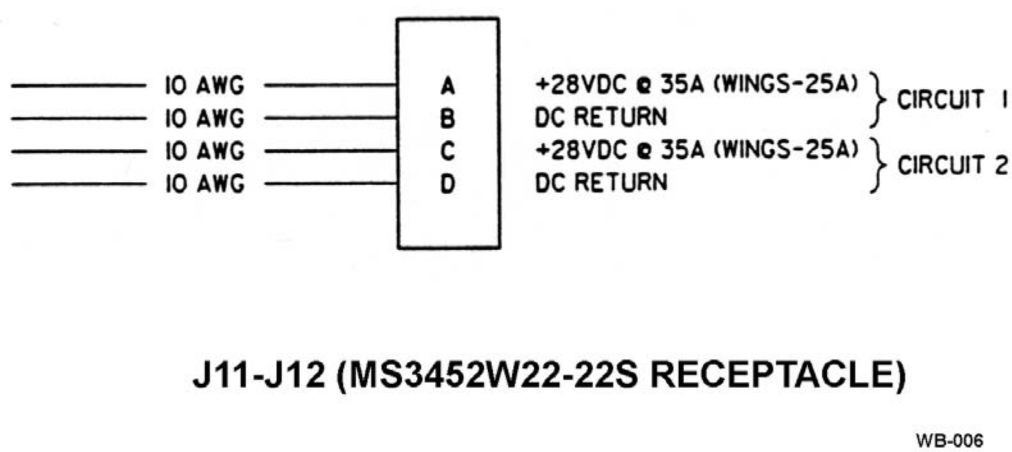


Figure 16. Pinout Receptacles J11 and J12

2.4.2 Auxiliary Power Panels

All typical payload integration areas have additional power interface panels. These panels provide connections to 115VAC 60Hz power in addition to the 115 VAC 400Hz and 28VDC power. Configurations for these power panels vary between the payload locations. Figure 17 details the typical arrangement and connectors used for each type of power. Power to these panels is not individually controllable like the experimenter interface panels; they are energized throughout the entire flight.

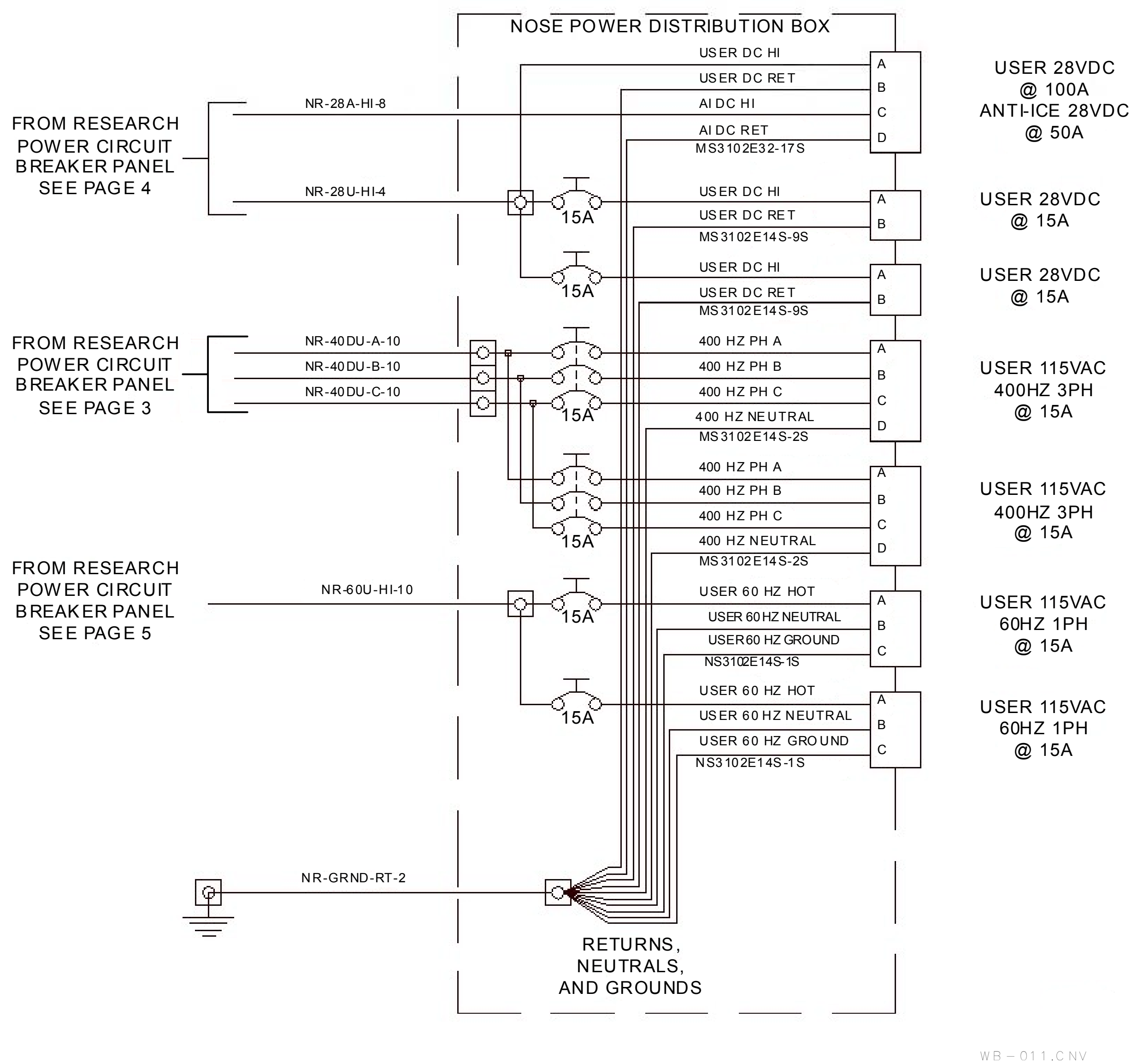


Figure 17. Typical Auxiliary Power Panel

2.4.3 RS232 Navigation Data Recorder Output

Navigation Data Output To Payload Areas

Data from all navigation data inputs is accumulated in a time buffer for one second. The data is processed and output to the RS232 data bus at 9600 baud. This results in a delay of one second between the actual time the data is received and the time it is output on the RS232 data bus. The time is correct to one millisecond. The data bus output format is as follows:

Parameter	Units	Output Format	Byte Size	Source
Header, GPS Status	'SOH' [G/N]	ASCII XX	2	Inserted
UTC Time (GMT)	Days:hrs:min:sec	ASCII XXX:XX:XX:XX	12	GPS
Present Pos. Latitude	Degrees	ASCII N/S XX.XXXXX	9	INU
Present Pos. Longitude	Degrees	ASCII E/W XXX.XXXXX	10	INU
True Heading	Degrees	ASCII XXX.XX	6	INU
Pitch Angle (up +)	Degrees	ASCII ±XX.XXXX	8	INU
Roll Angle (rt. +)	Degrees	ASCII ±XX.XXXX	8	INU
Ground Speed	Meters/Sec	ASCII XXX.XX	6	INU
Track Angle True	Degrees	ASCII XXX.XX	6	INU
Inertial Wind Speed	Meters/Sec	ASCII XX.X	4	INU
Inertial Wind Direction	Degrees	ASCII XXX.X	5	INU
Body Longitude Accl.	G	ASCII ±X.XXX	6	INU
Body Lateral Accl.	G	ASCII ±X.XXX	6	INU
Body Normal Accl.	G	ASCII ±X.XXX	6	INU
Track Angle Rate	Degrees/Sec	ASCII ±XX.X	5	INU
Pitch Rate	Degrees/Sec	ASCII ±XX.X	5	INU
Roll Rate	Degrees/Sec	ASCII ±XX.X	5	INU
Inertial Vertical Speed	Meters/Sec	ASCII ±XX.XX	6	INU
GPS Altitude	Meters	ASCII ±XXXXX.X	7	GPS
GPS Latitude	Degrees	ASCII N/SXX.XXXXX	9	GPS
GPS Longitude	Degrees	ASCII E/WXXX.XXXXX	10	GPS
Static Pressure*	Millibar	ASCII XXXX.XXX	8	Analog
Total Pressure	Millibar	ASCII XXXX.XXX	8	Analog
Differential Pressure	Millibar	ASCII XX.XXX	6	Analog
Total Temperature*	Degree C	ASCII ±XX.XX	6	Analog
Static Temperature*	Degree C	ASCII ±XX.XX	6	Derived
Barometric Altitude*	Meters	ASCII XXXXX.X	7	Derived
Mach No*	N/A	ASCII X.XXX	5	Derived
True Air Speed*	Meters/Sec	ASCII XXX.XX	6	Derived
Wind Speed*	Meters/Sec	ASCII XX.X	4	Derived
Wind Direction*	Degrees	ASCII XXX.X	5	Derived
Sun Elevation	Degrees	ASCII ±XX.XX	6	Derived
Sun Azimuth	Degrees	ASCII XXX.XX	6	Derived
Analog Channels (12)	Volts	ASCII ±X.XXX	6 (72 Total)	Analog
End of Frame	CR, LF	ASCII	2	Inserted

G: GPS Valid
N: GPS Not Valid
<u>NOTE</u>: Each parameter is followed by a space. The values for each of the 12 analog channels are separated by spaces.
* These values are not valid below an aircraft altitude of 10 km.

2.4.4 RS232 Time Channel Data Format

Data from the Global Positioning System (GPS) time and date labels are read, translated and formatted. This data is sent on the RS232 Time Channel at 9600 baud. The date is Julian and the time is Universal Coordinated Time (UCT). The string is terminated by a carriage return and line feed. The effective time begins at the first character of this frame with less than 0.1 milliseconds of delay. The output format (in ASCII) is as follows:

DATE_ _XXX_ _TIME_ _XX:XX:XXCRLF [27 characters total]

CR = Carriage Return
LF = Line Feed

2.4.5 ARINC 429 GPS Output To Payload Areas

The Navigation Data Recorder provides GPS data to all payload areas in ARINC 429 format. The GPS ARINC 429 output format is as follows:

BINARY LABEL	PARAMETER	OUTPUT RATE (Hz)	NUMERIC RANGE	UNITS	SIG BITS *	RESOLUTION	POSITIVE SENSE
072	Inertial Latitude	8	± 90	Degrees	20	0.000172	North from Zero
073	Inertial Longitude	8	± 180	Degrees	20	0.000172	East from Zero
076	GPS Altitude	1	± 131,072	Feet	20	0.125	Up
101	GPS HDOP	1	0-1024	Meters	15	0.031	Always Positive
102	GPS VDOP	1	0-1024	Meters	15	0.031	Always Positive
103	GPS Track Angle	1	± 180	Degrees	15	0.0055	CW from North
110	GPS Latitude	1	± 90	Degrees	20	0.000172	North from Zero
111	GPS Longitude	1	± 180	Degrees	20	0.000172	East from Zero
112	GPS Ground Speed	1	0-4096	Knots	15	0.125	Always Positive
114	Desired Track **	2	± 180	Degrees	15	0.005493	CW from North
116	Cross Track	4	± 128	Naut. Mi.	15	0.004	Right
120	GPS Latitude-Fine	1	0-0.000172	Degrees	11	8.38E-8	North from Zero
121	GPS Longitude-Fine	1	0-0.000172	Degrees	11	8.38E-8	East from Zero
130	GPS Integrity Limit	1	0-16	Naut. Mi.	18	6.1E-5	N/A
136	GPS Vert FOM Or EVE	1	0-32,768	Feet	18	0.125	Always Positive
150	UTC (BCD Format)	1	23:59:59	Hr:Min:Sec	17	1.0	Always Positive
165	GPS Vert Vel.	1	± 32,768	Ft/Min	15	1.00	Up
166	GPS N-S Velocity	1	± 4,096	Knots	15	0.125	North
174	GPS E-W Velocity	1	± 4,096	Knots	15	0.125	East
247	GPS Horiz FOM	1	0-16	Naut. Mi.	18	6.1E-5	Always Positive
260	Date	1	N/A	BCD	6	1 Day	N/A
273	GPS Sensor Status	1	N/A	DIS	19	N/A	N/A

* Does not include sign bit
** Outputs magnetic information when magnetic mode is selected. True mode is selected for Arctic/Antarctic Navigation (Latitudes above 73° N or below 60° S)

2.4.6 ARINC 429 INS Output to Payload Areas

In addition to GPS data, the navigation data recorder provides Inertial Navigation System (INS) data to all payload areas. The following INS parameters are output to all payload areas in the ARINC 429 output format:

BINARY LABEL	PARAMETER	OUTPUT RATE (Hz)	NUMERIC RANGE	UNITS	SIG BITS *	RESOLUTION	POSITIVE SENSE
310	Present Position Lat (UPD)	8	± 90	Degrees	20	0.000172	North from Zero
311	Present Position Lon (UPD)	8	± 180	Degrees	20	0.000172	East from Zero
312	Ground Speed	32	0 – 4096	Knots	15	0.125	Always Positive
313	Track Angle True	32	± 180	Degrees	15	0.005493	CW from North
314	True Heading	32	± 180	Degrees	15	0.005493	CW from North
315	Wind Speed	16	0 – 256	Knots	15	0.007813	Always Positive
316	Wind Direction True	16	± 180	Degrees	15	0.005493	CW from North
317	Track Angle (Magnetic)**	32	± 180	Degrees	15	0.005493	CW from North
320	Heading (Magnetic)**	32	± 180	Degrees	15	0.005493	CW from North
321	Drift Angle	32	± 180	Degrees	15	0.005493	Right
322	FLT Path Angle	32	± 180	Degrees	15	0.005493	Up
323	FLT Path Accel	64	± 4	G	15	0.000122	Forward
324	Pitch Angle	64	± 180	Degrees	15	0.005493	Up
325	Roll Angle	64	± 180	Degrees	15	0.005493	Right Wing Down
326	Body Pitch Rate	64	± 128	Deg/Sec	15	0.003906	Up
327	Body Roll Rate	64	± 128	Deg/Sec	15	0.003906	Right Wing Down
330	Body Yaw Rate	64	± 128	Deg/Sec	15	0.003906	Nose Right
331	Body Longitude Accel	64	± 4	G	15	0.000122	Forward
332	Body Lateral Rate	64	± 4	G	15	0.000122	Right
333	Body Normal Rate	64	± 4	G	15	0.000122	Up
334	Platform Heading	32	± 180	Degrees	15	0.005493	CW from Zero
335	Track Angle Rate	64	± 32	Deg/Sec	15	0.000977	CW
336	Pitch ATT Rate	64	± 128	Deg/Sec	15	0.003906	Up
337	Roll ATT Rate	64	± 128	Deg/Sec	15	0.003906	Right Wing Down
360	Potential Vert Speed	64	± 32,768	Ft/Min.	15	1.00	Up
361	Inertial Altitude	32	± 131,072	Feet	20	0.125	Up
362	Along TRK Horiz Accel	64	± 4	G	15	0.000122	Forward
363	Cross TRK Horiz Accel	64	± 4	G	15	0.000122	Right
364	Vertical Accel	64	± 4	G	15	0.000122	Up
365	Inertial Vert Speed	32	±32,768	Ft/Min	15	1.00	Up
366	N-S Velocity	16	± 4096	Knots	15	0.125	North
367	E-W Velocity	16	± 4096	Knots	15	0.125	East

* Does not include sign bit
** Information not valid when Latitude is greater than 73° North or 60° South (Arctic/Antarctic Navigation)
UPD = UPDated information form GPS

2.5 Overboard Vent

An overboard vent line is available in the WB-57 pallet bay. The manifold fittings on the multi-user vent line are female (internally threaded) 3/8" NPT fittings. Researchers must provide a suitable type and length of hose to reach the manifold from their pallet integration location. Service coils (slack) must be figured into the length of the hose for ease of payload integration and maintenance. Requests for use of the overboard vent system shall be made through contacting the WB-57 Program Office. It is required that the chemical composition, physical characteristics, and quantity of the vented gas be completely understood by the researcher, and that no liquid be present in the vented gas line for "freeze-up" purposes. It is the responsibility of the researcher to inform the WB-57 Program Office, via the Payload Data Package (reference chapter 3), of all possible hazards associated with the vent gas. This includes, but is not limited to, the possibility of freeze-up, blockage, ignition, corrosion, and chemical reaction with other agents that could be introduced by another payload on the same vent line. Contact the WB-57 Program Office for detailed drawings of the Overboard Vent System.

2.6 Lasers

The Johnson Space Center (JSC) Radiation Safety Committee has adopted the latest revision of ANSI Z136.1 (American National Standard for Safe Use of Lasers) as the guide for approving lasers and/or laser systems proposed for use in Ellington Field facilities and on the WB-57. Contact the WB-57 Program Office for more information on the use of lasers.

2.7 Payload Fail-Safing

All equipment must be designed so that in the event of payload power loss, power surge, rapid depressurization, fluid leaks, fire, etc., there will be no chance of inducing another hazardous situation.

2.8 Hazardous Materials

If possible, avoid the use of hazardous materials, including high pressure, toxic, corrosive, explosive, and flammable materials. If such materials are required, proper containment and hazard controls must be provided. Early contact with the WB-57 Program Office for discussions on proper hazard controls and containment of proposed hazardous materials may prevent delays in getting approval for the use of such materials. If such materials are necessary, provisions for dumping and purging in flight may be required. A current MSDS must be supplied for each hazardous material via the Payload Data Package (reference chapter 3).

2.9 Researcher Tools and Support Equipment

Researcher tools and support equipment brought to Ellington Field should be kept to a minimum and controlled in an organized fashion to mitigate any Foreign Object Damage (FOD) hazards on the WB-57. All tools should be stored in a proper container such as a tool bag or box. Each container should have an inventory sheet listing all the tools contained. Tools needed for aircraft/payload integration will be briefed to the WB-57 Program Office upon arrival at Ellington Field. The WB-57 Program Office provides an inventoried toolbox designated for researcher use. The toolbox contains standard tools in both English and metric units. Before bringing your own tools to Ellington, contact the WB-57 Program Office to confirm whether or not it will be necessary.

2.10 Spill Control

Fluids approved for flight on the WB-57 must be contained in a system that is structurally capable to withstand design and crash loads specified in Section 2.2. Hardware used to contain fluid must be designed with suitable provisions for leak control to ensure a leak free system during ground and flight operations. In the event of payload power loss, power surge, rapid depressurization, etc., all hardware must fail to a mode allowing for sound fluid containment. If fluid is drained to an ambient pressure reservoir during flight operations, fluid absorption methods must be installed to eliminate the chance of leaks through loose seals. If possible, avoid the use of toxic, corrosive, and explosive fluids. A MSDS form must be submitted via the Payload Data Package (reference chapter 3) for all fluids other than water.

2.11 Electromagnetic Interference (EMI)

All electrical components on payloads should meet reasonable requirements for EMI transmission and EMI susceptibility. Any experiment determined to be interfering with other experiments or aircraft instrumentation systems during any phase of a flight will be powered down. Experiments may also be powered down to help troubleshoot an EMI problem.

2.12 Cleaning, Stowing, and Repairing Equipment for Flight

Material shavings, splinters, dirt, and miscellaneous loose objects on payloads pose as very dangerous Foreign Object Debris (FOD) hazards in flight. Loose objects will shift throughout the various phases of a flight, and could interfere with aircraft systems (flight controls, engine controls, etc.). For this reason, ensure all payload piece parts are clean and securely fastened during payload assembly. After assembly, vacuum and/or blow out all material shavings created during the assembly phase.

Equipment repairs (i.e. drilling, sanding, filing, or any other operation that may produce shavings or splinters) performed while integrating a payload to the aircraft must be approved by the WB-57 Program Office.

2.13 Touch Temperature for Research Hardware

Payloads utilizing heaters or other heat producing devices shall maintain a touch temperature of no greater than 122° F (50° C). Guards or other protection measures must be employed for research hardware where the touch temperatures are greater than 122° F. Cold surface temperatures must also be guarded if below 32° F (0° C).

3 PAYLOAD DATA PACKAGE REQUIREMENTS

A Payload Data Package must be prepared for each payload proposed for flight on the WB-57. The Payload Data Package must be submitted to the WB-57 Program Office no later than six weeks prior to flight. All payload documentation requirements are presented in this chapter, as well as the recommended format. It is imperative that all sections of the Payload Data Package be addressed. If a section is not applicable to your experiment, do not leave it out. Instead, address the non-applicable section with a brief statement explaining why it is not applicable to your experiment.

The Payload Data Package requirements presented in this chapter are the absolute minimum required. These minimums should be exceeded if necessary to thoroughly explain a payload. Any changes to a payload design occurring after the Payload Data Package has been submitted must be approved by the WB-57 Program Office through submitted documentation of the change.

The recommended Payload Data Package format is listed below.

1. Cover Page
2. Quick Reference Data Sheet
3. Table of Contents
4. Proposed Mission Profile and Flight Schedule
5. Payload Description
6. Structural Analysis
7. Electrical Analysis
8. Pressure/Vacuum Systems
9. Laser Systems
10. Hazard Analysis
11. Ground Support Requirements
12. Hazardous Material
13. Material Safety Data Sheets (MSDS)
14. Mission Procedures

The remainder of this chapter provides detailed writing instructions for each section of the Payload Data Package.

3.1 Cover Page

The cover page to the Payload Data Package should contain the principal investigator's name, research organization and contact information (email address, phone number, and mailing address), the payload or mission name, and the date the package was submitted.

3.2 Quick Reference Data Sheet

The Quick Reference Data Sheet should be completed in the format shown below and be submitted on a dedicated page.

WB-57F Payload Quick Reference Data Sheet

Note: Please Address Each Payload Separately

Principal Investigator:

Contact Information:

Payload / Mission Name:

Mission Profile / Number of Flights Requested:

Requested Flight Date(s):

Payload Installation Location on Airplane (e.g. pallet, wing pod, etc.):

Payload Overall Assembly Weight (pounds):

Gas/Cryogenic Cylinder Requests (type and quantity):

List any Hazardous Materials to be used (include quantity):

Overboard Vent Requests (Yes or No) and Type of Gas to be Vented:

Payload Power Requirement (Voltage and Current Required):

Ground Laboratory Work Space Requests (include storage requests):

Computer Network Access Requests:

Sheet Metal Work Requests (only on NASA owned hardware):

Electrical Wiring Requests:

Miscellaneous Requests:

3.3 Table of Contents

In the Table of Contents, list the sections of the Payload Data Package and their corresponding page numbers.

3.4 Proposed Mission Profile and Flight Schedule

The Proposed Mission Profile and Flight Schedule section should address the type of flights being requested (where, how high, maneuvers, etc), the number of flights being requested, and the proposed mission timeline with dates. This section should also address whether the experiment is a follow-up of a previous flight, a preliminary step to a future flight, etc. The name of any supporting organization/sponsor should also be listed here.

3.5 Payload Description

The Payload Description section should briefly explain the payload design and objective, and should be written so that a practicing engineer can understand the experiment. Science (or engineering) goals should be presented along with a description of the expected results.

Include drawings and/or photographs of the payload, its overall weight and CG location, and a proposed dimensional layout of the equipment in the aircraft. Any laser, fluid, chemical, RF transmission, and/or pressure vessel system should be described. Any component with special handling requirements or specific hazards must also be described in detail.

3.6 Structural Analysis

Follow the guidelines below to meet the documentation requirements for the structural analysis section of the Payload Data Package.

- Submit free body diagrams (FBDs) for all crash load conditions listed in the Structural Design Requirements section (Section 2.2) of this User's Guide (FBD's are sketches used to dimensionally locate where g-loads are applied on test equipment.). G-loads are to be applied at equipment centers of gravity (CG's).

- Create a table documenting individual component weights and overall payload assembly weight. Specify all materials used for payload fabrication and their allowable loads. Specify all fasteners used, weld types, and their location on the test equipment assembly (this is best accomplished by using a table, detailed drawing/schematic, and/or digital pictures).

- For all structural welds, submit certification documents as specified in SAE specification AMS-STD-2219. Contact the WB-57 Program Office for further instruction.

- Submit all design calculations (for both design and crash loads) that detail compliance with all payload structural design requirements outlined in Section 2.2. This includes calculations on the following:

- The attachment of components to the payload frame (prove all components will remain intact and attached to the payload frame under crash loads).
- The full assembly (prove the payload frame will withstand the g-loads specified in Section 2.2 induced from its own mass and those masses of the components attached to it).
- The attachment of the payload to the aircraft (prove all fasteners attaching the payload to the airplane will withstand g-loads specified in the Section 2.2).

- Provide a table that displays the factor of safety/safety margin result from each structural analysis performed. Label the load case analyzed (i.e. 9g forward load), location of the analysis on the payload assembly (i.e. pump bracket attachment), the critical failure mode (e.g. bending, shear, buckling, etc.) and the calculated factor of safety or safety margin.
- Components may be pull-tested at a component's CG using a properly calibrated tension gauge to simulate g-loads on equipment. This can be used for the structural analysis of lightweight components to determine whether or not attachment brackets can withstand structural design requirements. It is not recommended that this be performed on heavier assemblies. To properly document pull tests, contact the WB-57 Program Office for more information.

3.7 Pressure/Vacuum Systems

All pressure/vacuum systems must comply with the documentation requirements outlined in Johnson Space Center Document JHB 1710.13B. Contact the WB-57 Program Office for more information.

3.8 Laser Systems

For all lasers used in flight payloads and/or on the ground, provide the following information in the Laser Systems section of the Payload Data Package:

- Laser class, type, and manufacturer.
- Description of the laser's purpose, ground or flight.
- Describe the containment controls (i.e. describe the protective housing, interlock switches, emergency kill switch, temperature/fire control, protective eyewear, etc.) that will be implemented in your laser system design.

Use of Class 3 or higher lasers must be accompanied by submitting an additional Johnson Space Center form. Contact the WB-57 Program Office for more information.

3.9 Hazard Analysis Report Guidelines

A hazard analysis should be provided in the Payload Data Package to document the review and implemented control of hazards associated with a specific payload. Reference the hazard checklist below. If any of the hazards listed pertain to your experiment, describe the hazard and explain the control that exists to eliminate or mitigate the risk involved. If the payload presents a potential hazard for which no suitable hazard control is available, the deficiency must be documented and provided to the WB-57 Program Office. NASA will analyze this hazard and make a decision on risk acceptance.

HAZARD SOURCE CHECKLIST

Enumerate or mark N/A

_____ Flammable/combustible material, fluid (liquid, vapor, or gas)
_____ Toxic/corrosive/hot/cold material, fluid (liquid, vapor, or gas)
_____ High pressure system (static or dynamic)
_____ Evacuated container (implosion)
_____ Frangible material
_____ Stress corrosion susceptible material
_____ Inadequate structural design (i.e., low safety factor)
_____ High intensity light source (including laser)
_____ Ionizing/electromagnetic radiation
_____ Rotating device
_____ Extendible/deployable/articulating experiment element (collision)
_____ Stowage restraint failure
_____ Stored energy device (i.e., mechanical spring under compression)
_____ Vacuum vent failure (i.e., loss of pressure/atmosphere)
_____ Heat transfer (habitable area over-temperature)
_____ Over-temperature explosive rupture (including electrical battery)
_____ High/Low touch temperature
_____ Hardware cooling/heating loss (i.e., loss of thermal control)
_____ Pyrotechnic/explosive device
_____ Propulsion system (pressurized gas or liquid/solid propellant)
_____ High acoustic noise level
_____ Toxic off-gassing material
_____ Mercury/mercury compound
_____ Organic/microbiological (pathogenic) contamination source
_____ Sharp corner/edge/protrusion/protuberance
_____ Flammable/combustible material, fluid ignition source (i.e., short circuit; under-sized wiring/fuse/circuit breaker)
_____ High voltage (electrical shock)
_____ High static electrical discharge producer
_____ Software error or computer fault
_____ Carcinogenic material
_____ Other:____

3.10 Ground Support Requirements

In this section of the Payload Data Package, describe what you will need in terms of ground support from the WB-57 Program Office. Please address the following:

- Type of ground power needed for testing/operating research equipment.

- The need for any pressurized gas or cryogenics. State how much is needed of each to assess storage space. Procurement of pressurized gases or cryogenics will be the responsibility of the researcher. MSDS sheets must be provided. K-bottles can be delivered to the:

  WB-57 Program Office
  Ellington Field – Building 994
  Houston, Texas 77034

- State whether or not you will be mixing or storing any chemicals that are toxic, corrosive, and/or explosive. If so, what type of material handling procedures will be required?

- Working hours/access to Building 994 (the WB-57 Payload Laboratory). Will you need access to Bldg. 994 during hours other than normal business hours (7 a.m. – 5 p.m., M-F)?

- Laboratory space requested. Working and storage.

- Computer network access requested.

- Requests for special ground handling/support equipment (e.g. forklift, crane, etc.).

- Miscellaneous requests.

3.11 Hazardous Materials

Please state whether or not you will be using any toxic, corrosive, explosive, and/or flammable materials. Describe what the material is, how it will be used, and quantities being used. If at all possible, avoid the use of hazardous materials. If such materials are required for a payload, proper containment must be provided. Please describe how you plan to safely contain and handle any hazardous materials. Early contact with the WB-57 Program Office and the JSC Safety Office for discussions on proper use and containment of proposed hazardous materials may prevent delays in getting approval for the use of such materials. If such materials are necessary, provisions for dumping and purging in flight and on the ground may be required. A current MSDS must be supplied for each hazardous material.

3.12 Material Safety Data Sheets

In this section of the Payload Data Package, include the Material Safety Data Sheets (MSDS) that apply to any composite, plastic, chemical, fluid, etc. that you are utilizing with your experiment. MSDS sheets must be provided for all chemicals taken onto NASA property. Copies of MSDS sheets must also be kept with the chemicals at their ground-based storage areas.

3.13 Mission Procedures

Researchers are responsible for all equipment sent to and from Ellington Field. The WB-57 Program Office is not be responsible for any shipping arrangements (see section 5.1 for additional information on the shipping and receiving of equipment to/from Ellington Field). The information presented in this section of the Payload Data Package will describe all of the procedures involved with operating your experiment at Ellington Field or at a remote deployment site. These procedures should be broken down in the following order:

Equipment Shipment

State how equipment will be shipped (e.g. freight - include the shipping company name), when it will be shipped (i.e. month, day, and time), and what storage requirements are needed to safely store your hardware (e.g. space requirements, temperature, etc).

Ground Operations

State the procedures proposed to set-up and operate your equipment on the ground at Ellington Field. All equipment will be inspected at the Test Readiness Review (reference Chapter 7) prior to flight.

Loading

State the procedures proposed to load and integrate your equipment onto the WB-57.

Pre-Flight

State the procedures proposed for pre-flight operations.

Flight Operations

Flight checklists for payload operation will be generated through researcher consultation with the WB-57 sensor operator. Please state the backseat procedures that will most likely be requested to operate your payload during take-off, cruise, and/or landing operations.

Post-Flight

State the procedures proposed for readying equipment for a following flight.

Off-Loading

State the procedures proposed for off-loading your payload from the WB-57. State the shipping arrangements that have been made for the removal of equipment from NASA property.

4 USER REQUEST & MISSION ARRANGEMENTS

This section will cover topics such as how to get a flight request processed, badging, and funding requirements.

4.1 Flight Request Procedure

Contact the WB-57 Program Office to discuss the feasibility of flying an instrument on the WB-57, to establish tentative dates, and to answer any specific questions. This should occur at least **six months** prior to flight.

WB-57 Program Office
Mail Code CC5
NASA Johnson Space Center
2101 NASA Road One
Houston, Texas 77058

Phone: 281-244-9642
Fax: 281-244-9828
E-Mail : wb57@jsc.nasa.gov

If sponsored by NASA, the scientist or project manager must also complete a formal flight request in the format of the Airborne Science Flight Request Form. This form must be sent at least **six months** prior to flight (visit www.dfrc.nasa.gov/airsci/nforms.html). After processing at Dryden, the form will be relayed to the WB-57 Program Office. This request is valid for 5 years from the date signed.

The Airborne Science Flight Request Form contains general information describing the following:

- Science objectives
- Desired schedule (exact flight dates will be determined later) and location
- Brief description of the scientific instruments and associated equipment
- Special support required or constraints, including security classification of project, if applicable
- Preliminary hazard analysis identifying hazards and controls (any format is acceptable)
- Data requirements from the WB-57
- Names, addresses, and phone numbers of contacts

The WB-57 Program Office will work with the principal investigator to establish experiment manifests for individual flight weeks.

4.2 Funding

The WB-57 Program is a cost-reimbursable program. All instruments that fly on the WB-57 must be funded through direct transfer of funds between the organization conducting the research and NASA Johnson Space Center. Foreign government organizations requesting flight time on the WB-57 must have a Memorandum of Understanding (MOU) with NASA Headquarters prior to flight. Supplementary support required from NASA (i.e., overtime hours, deployment expenses, etc.) will be figured into the total cost of a WB-57 mission as an additional expense.

4.3 Badging Requirements

All individuals working and visiting the Johnson Space Center, Aircraft Operations Division at Ellington Field must display the appropriate access badge. This section discusses the badging requirements. There are different badging requirements for U.S. citizens, permanent resident aliens, and other foreign nationals.

4.3.1 U.S. Citizens

All non-NASA visiting personnel will be required to have the appropriate badge during their stay at JSC (Ellington Field). It is the responsibility of the user to provide badge request information (name, organization, and dates of visit) to the WB-57 Program Office three weeks prior to visit. U.S. citizens working for a company or corporation headquartered outside the United States shall follow the same procedures as foreign nationals (reference Section 4.3.3). Individuals in this category are listed as "foreign representatives."

4.3.2 Permanent Resident Aliens ("Green Card" Holders)

Badging for Permanent Resident Non-U.S. citizens who have a Permanent Resident Alien Card ("Green Card") shall follow the same procedures as a U.S. citizen (see above). The only difference is that when a Permanent Resident Alien arrives at JSC and receives their badge, they must have their (original) Resident Alien Card ("Green Card") with them.

4.3.3 Foreign Nationals and Foreign Representatives

Access to JSC facilities by foreign nationals or representatives are strictly controlled. Since access requires many levels of approval, this process should begin three months prior to arrival. Contact the WB-57 Program Office with foreign national badge requests.

U.S. citizens working for a company or corporation headquartered outside the United States shall follow the same procedures as foreign nationals. Individuals in this category are listed as "foreign representatives."

4.4 Timeline

This timeline has been designed to assist researchers in the timely submittal of required documentation. All times are prior to first flight unless otherwise noted.

6 months to 1 year

Make initial inquiry about the feasibility of flying an experiment on the WB-57.

For very complex payloads, inquiries should be made further in advance.

3 months (prior to arrival)

Submit badging request for foreign nationals (reference Section 4.3.3)

6 weeks

Submit Payload Data Package (reference Chapter 3)

3 weeks (prior to arrival)

Submit badging request for all U.S citizens and permanent resident aliens (reference Sections 4.3.1 & 4.3.2)

3 days – 2 weeks

Research hardware arrives at Ellington Field and is installed on the WB-57. Electrical and control checkouts are complete.

1-3 days

All research hardware goes through the Test Readiness Review (reference chapter 7).

Operational checklist including instrument failure procedures is signed off.

5 TEST OPERATIONS

5.1 Pre-Flight

Payloads and equipment should be received at JSC Ellington Field in a timely manner to allow for buildup, aircraft installation, electrical checkout, and the Test Readiness Review (TRR). The address to use for shipping prior to the mission is:

DynCorp
Attn: WB-57 Program Office
Building 270, Ellington Field
Houston, Texas 77034

During the mission, it is recommended that smaller shipments be shipped to your hotel if possible. NASA's shipping and receiving department has limited hours.

The buildup of instrumentation is solely the responsibility of the researcher. The WB-57 Program Office provides toolboxes with standard tools in English and metric units. The researcher must provide special tools and checkout equipment.

The TRR will normally be conducted in Building 994 or Hangar 990 one to three working days prior to the first flight. Instrumentation, procedures, and documentation will be examined as indicated in Section 7.3. If hardware has changed, a list of modifications to previously flown equipment and changes to test procedures must be provided to the WB-57 Program Office no later than **six weeks** prior to flight.

One to two days prior to the flight, a list of the payloads to be flown and an operational checklist will be posted. All checklist changes must be marked by noon on the day prior to the flight. Prior to all flights, the mission scientists and flight crew will attend a pre-flight brief. The briefing will cover the flight plans, meteorology, go/no-go criteria, contingency plans, etc. Below lists a typical pre-flight timeline for both low and high flights.

High Flight (above 50,000 ft.)

T-3 hours Hands Off and Tow Out

T-2.5 hours Preflight Briefing

T-2 hours Aircraft Preflight

T-1 hour Pressure Suit-up

T-0 hour Aircraft Takeoff

Low Flight (at or below 50,000 ft.)

T-2 hours Hands Off and Tow Out

T-1.5 hours Preflight Briefing

T-1 hour Aircrew Preflight

T-0 hours Aircraft Takeoff

5.2 In-Flight

If requested, telemetry of payload data can be arranged. Aircrew may also contact ground personnel via aircraft radios or SAT phone if there are any problems or questions regarding instrumentation. At times, this communication may not be available; therefore, principal investigators should take care to properly convey all failure procedures to the sensor operator.

5.3 Post-Flight

A post flight debriefing will be held immediately after landing to review all aspects of the flight. This review includes the profile executed, general payload operation information, and/or any anomalies that occurred during the flight.

Payloads should be offloaded from the WB-57 for data processing immediately after the aircraft is towed into the hangar. Take care to ensure your payload is removed from the aircraft according to your wishes prior to the departure of the ground crew.

5.4 Post-Mission

Upon completion of the mission, payloads will be offloaded and prepared for shipment by the user. It is the researcher's responsibility to ensure that all payloads and ground equipment used for the mission (including compressed gas cylinders, chemicals, packing, and crating) are removed promptly from Building 994 and Hangar 990. It is also the responsibility of the user to make arrangements for the shipment of all equipment. Be sure to advise your shipper that pickups must be made no later than 3:15 p.m., Monday through Friday only.

On the last flight day of the mission, the WB-57 Program Office will hand out a customer feedback form (JSC Form 902). Customer feedback received concerning the facilities, staff, and the WB-57 Program is greatly appreciated. Customer feedback enable us to better serve our customers.

6 Ground Facilities

This chapter of the WB-57 User's Guide describes the ground facilities available to the researcher at Ellington Field – Houston, Texas.

Figure 18. Building 994 - WB-57 Payload Laboratory

6.1 WB-57 Program Office

Building 994 at Ellington Field provides visiting researchers with a payload lab area. This air-conditioned workspace is available for payload buildup and checkout. The high bay is equipped with workbenches, phones/FAX, and computer network drop lines for researcher use. Access to Building 994 includes a 12 ft. x 12 ft. roll-up door. The building also has and adjacent conference room. Each workstation has the following power options:

- 115 VAC - 60 HZ, single phase, 30 amps
- 115 VAC – 400 HZ, 3 phase, 20 Amp
- 28 VDC, 20 amps

NOTE: Building 994 does not have a vent hood for the mixing of chemicals inside the building.

Figure 19. Building 994 High Bay Work Area

6.2 Building 994 Computer Network Access, Printers, and Phones

Multiple network drops are available at each workstation and in the conference room. With access to NASA's computer network, printers are also available. Phones are located throughout Building 994. Incoming calls or faxes for the researcher should use the following numbers:

Main Office: 281-244-9789
Conference Room: 281-244-9026
Fax: 281-244-9788

6.3 Payload Equipment and Material Storage

Limited storage space is available. Requests for space must be prearranged with the WB-57 Program Office. Limited chemical storage is available in the payload lab area.

6.4 Shipping and Receiving

The address for shipping research hardware is:

DynCorp
Attn: WB-57 Program Office
Building 270
Ellington Field
Houston, Texas 77034
Phone Number (281) 244-9642

Shipping arrangements should be made with the WB-57 Office prior to shipment.

6.5 Forklifts and Hoists

Building 994 is equipped with a 2000-pound capacity A-Frame hoist. Forklifts are available for the unloading and loading of research equipment. Please contact the WB-57 Program Office for any special handling requirements.

6.6 Hand Tools

A complete toolbox is provided for researcher use while at the aircraft. It contains standard tools in both English and metric units. This toolbox is shadowed to enable ease of inventory. Prior to flight, this toolbox and all tools assigned to the WB-57 aircraft will be inventoried. Any researcher tools brought to Ellington must be inventoried and accounted for prior to all WB-57 flights.

Figure 20. Building 994 Toolbox

7 SAFETY

The Johnson Space Center (JSC) WB-57 Research Program is operated in accordance with established NASA safety procedures. Due to the critical nature of this program, a multi-stage review and approval procedure has been developed to ensure personnel and flight safety. This section describes the general safety practices and guidelines that all personnel and equipment must comply with in order to occupy, work, and operate on NASA property. Please contact the WB-57 Program Officewith any questions regarding safety practices at Ellington Field.

7.1 Johnson Space Center Requirements

All personnel and equipment at Johnson Space Center, Ellington Field, must adhere to the safety guidelines as defined in the JSC Handbook for Safety, Health, and Protection (JPG 1700.1 Rev. H). A copy is available from the WB-57 Program Office.

7.2 Aircraft Operations Division Requirements

A safety briefing will be given to all program participants upon arrival at Ellington Field. Attendance at this briefing is required for all program participants. Specific areas addressed at this briefing include:

Emergency Procedures:

Dial x44444 from any NASA telephone to report an emergency at Ellington Field.

Proper evacuation route and procedure in the event of an incident or emergency.

Laboratory/Facility Safety:

Only **authorized personnel** are permitted in the various facilities. Identification badges issued by JSC Security must be displayed at all times while on NASA/JSC property.

Smoking is discouraged, but allowed in designated areas.

All **trash** must be placed in provided trash receptacles. Use specifically labeled trash receptacles for batteries, oil rags, chemicals, etc.

Hazardous materials/chemicals must be properly identified. All requisite precautions consistent with the safe handling of hazardous materials and chemicals must be followed at all times.

Tool Control: All equipment (tools, test hardware, fluids, etc.) brought to Ellington Field must be inventoried and accounted for at all times.

Equipment: Operation of research or other equipment must be attended at all times.

Hangar Safety:

Aircraft hangars are large industrial work areas. Hazards are always present and may include:

- Aircraft and equipment being towed
- Aircraft on jacks
- Hoses, cables, grounding wires, and other trip hazards
- Fuel and lubricant spills on the hangar floor.

Aircraft Safety:

Access to the aircraft is controlled. An AOD employee or contractor must accompany anyone requiring access to the aircraft.

FOD: Foreign Object Debris (FOD) damage is a major concern for any aviation activity. Loose items being left in and around the aircraft cause FOD.

Flight Line Safety:

The flight line is a controlled access area. An AOD employee or contractor must accompany anyone requiring access to the flight line.

Hearing protection is required during all outdoor and flight operations. Earplugs are readily available at various locations at Ellington Field.

7.3 WB-57 Program Office Requirements

Payload Data Package (PDP):

A Payload Data Package is required for all payloads on the WB-57. This package must provide detailed documentation of the payload and address all aspects of its design and operation (reference Chapter 3).

Test Readiness Review (TRR):

The Test Readiness Review is the final safety review of a payload prior to its flight. It includes a complete payload review of supporting analyses and documentation, an inspection of the payload hardware, and a final integrated verification of flight readiness. A TRR is required for **all** payloads, both new and previously flown. During the TRR, each experiment will be "approved", "approved pending corrections implemented", or "not approved" for flight. Researchers may be required to operate their equipment during the TRR. A unanimous decision from the reviewers is required for flight approval.

Safety of Flight:

The flight crew for the WB-57 is made up of a pilot (front seat) and a sensor operator (back seat). The pilot is responsible for flying the aircraft (including navigation, radio, and system diagnostic responsibilities) during all phases of a flight. The pilot is ultimately responsible for the safety of the crew and aircraft and has the final say as to whether or not the flight will proceed.

The sensor operator is responsible for the safe operation of all payloads on the WB-57 as well as some navigational and pilot assistance responsibilities. The sensor operator, in coordination with the pilot, has the authority to shut down all payloads for safety of flight issues. Payload operation checklists will be generated and certified for flight through regularly scheduled briefings attended by the researcher, pilot, and sensor operator. Deviations from the payload operation checklist are allowed to address issues pertaining to the overall safety of the flight.

INDEX

Aft Fuselage Payloads, 18
Aft Fuselage/Tail Cone Integration, 17
aircraft, 46
Aircraft Description, 7
Aircraft Operations Division Requirements, 46
Aircraft Safety, 47
Aircraft/Payload Integration, 14
ARINC 429 INS Output to Payload Areas, 27
ARINC 429 GPS Output To Payload Areas, 26
Auxiliary Power Panels, 24
Backseat - Forward Console Configuration, 10
Badging Requirements, 39
Building 270, 45
Building 994, 35, 42, 43, 44, 45
Cleaning, Stowing, and Repairing Equipment for Flight, 29
Computers, Network Access, Printers, and Phones, 44
Cover Page, 31
Crash Loads, 17
Data Communications, 11
deployment, 36, 39
Deployment, 11, 12, 13
Design Loads, 17
Electrical, 30
Electrical Interface, 11, 20
Ellington Field, 7, 11, 15, 16, 28, 35, 36, 39, 40, 41, 43, 45, 46, 47
Emergency Procedures, 46
Equipment, 46, 47
Equipment and Material Storage, 44
Equipment Shipment, 36
Experiment Interface Panel, 20
Flight Line Safety, 47
Flight Operations, 29, 36, 47
Flight Request Procedure, 38
Foreign Nationals, 39
Forklifts and Hoists, 45
Funding, 38, 39
Ground Facilities, 43
Ground Operations, 9, 15, 16, 36
Ground Support Requirements, 35
Hand Tools, 45
Hangar 990, 41, 42
Hangar Safety, 47
Hazard Analysis, 33
Hazard Analysis Report Guidelines, 33
Hazard Control, 28, 34
HAZARD SOURCE CHECKLIST, 34
High Flight, 41
In-Flight, 42
Johnson Space Center Requirements, 46
Laboratory/Facility Safety, 46
Laser, 28, 33
Loading, 36
Low Flight, 42
Material Safety Data Sheets, 36
Material Safety Data Sheets (MSDS), 30, 36
Mission Procedures, 36
Navigation Data Recorder Output, 25
Nose Cone, 8, 14, 16, 18
Off-Loading, 37
Pallet, 8, 9, 15, 17, 18, 19
Pallet Integration, 15, 27
Payload Data Package, 17, 19, 28, 29, 30, 31, 32, 33, 35, 36, 40, 41, 47
PAYLOAD DATA PACKAGE REQUIREMENTS, 30
Payload Description, 30, 32
PAYLOAD DESIGN REQUIREMENTS, 14
payload design specifications, 14
Payload Fail-Safing, 28
Payload Integration Locations, 8, 14
Payload Structural Design, 17
Payload Weight Restrictions, 19
Permanent Resident Aliens, 39, 40
Pinout Receptacles J1 through J5, 22

Pinout Receptacles J11 and J12, 23
Pinout Receptacles J6 through J10, 23
Post-Flight, 42
Post-Mission, 42
Pre-Flight, 41
Pressure/Vacuum Systems, 20, 30, 33
Processing and Recording, 9
Proposed Mission Profile and Flight Schedule, 32
Quick Reference Data Sheet, 30, 31
Right side console, 10
RS232 Time Channel Data Format, 26
SAFETY, 44
Safety of Flight, 48
Security, 38, 46
Shipping and Receiving, 45
Spill Control, 28
Structural Analysis, 30, 32
Structural Fasteners, 19
Structural Materials, 19
Table of Contents, 4, 30, 32
TEST OPERATIONS, 41
Test Readiness Review, 36, 40, 47
Timeline, 40
Tool Control, 46
Toolbox, 28, 41, 45
Tools and Support Equipment, 28
Touch Temperature for Research Hardware, 29
U.S. Citizens, 39
USER REQUEST, 38
Voice Communications, 11
WB-57, 7, 8, 9, 11, 14, 15, 16, 18, 19, 20, 27, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 46, 47
WB-57 Program Office, 7, 9, 11, 14, 15, 16, 17, 27, 28, 43, 46, 47
WB-57F Payload Quick Reference Data Sheet, 31
Welding, 20
Wing Pod, 8, 14, 15, 16, 18, 19, 31