SIERRA-B Experimenters Handbook

11/15/2018

Ames Research Center
Aviation Management Office

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, California

Ames Research Center Document	Doc. ID: A9UAV-1400-G013	Revision: D
	Doc. Name: SIERRA Document Change Proposal	Effective Date: June 30, 2017

Previous Versions are Obsolete

Document Change Proposal

SIERRA – Document Change Proposal Form

DCP #: DCP-2018-040	
Open Date: 11-14-2018	Close Date: 11-14-2018
TITLE: Experimenters Handbook Official Release	
ORIGINATOR: Z. Young	PROJECT MANAGER: S.Cahill

CHANGE DETAILS

DOCUMENTS BEING CHANGED:

A9UAV-1401-XM001 - Rev.A
SIERRA-B Experimenters Handbook - Initial Release

RELATED AIRCRAFT: ☐ GENERAL ■ SIERRA-B ☐ VIKING — TAIL NUMBER: N701NA

JUSTIFICATION FOR CHANGE:

■ ENHANCED CAPABILITY (GENERAL) ☐ ENHANCED SAFETY (GENERAL)
☐ PROJECT REQUIREMENT – PROJECT TITLE:
☐ CONFIGURATION CHANGE REQUEST – CCR #: ☐ DISCREPANCY REPORT – DR #:

DESCRIPTION OF CHANGE: (INCLUDE REFERENCES AND/OR ATTACHMENTS IF APPROPRIATE)

This document provides aircraft capability and mission information necessary for mission teams to use the SIERRA-B Aircraft.

CHANGE CLASSIFICATION (to be filled in by CMO and PSE)

CLASSIFICATION: ☐ LEVEL II (MINOR) ■ LEVEL I (MAJOR) — AIRWORTHINESS RELEASE REQ'D: ☐ YES ■ NO

OTHER PROCESS REQUIREMENTS OR ADDITIONAL REMARKS:

DCP APPROVAL (signature and date)

Bryan Marsh (affiliate) Digitally signed by Bryan Marsh (affiliate) Date: 2018.11.15 10:32:20 -08'00'	Samuel Zuniga (affiliate) Digitally signed by Samuel Zuniga (affiliate) Date: 2018.11.15 11:21:31 -08'00'	ZION YOUNG Digitally signed by ZION YOUNG Date: 2018.11.14 09:05:57 -08'00'
Aircraft Crew Chief	Configuration Management Officer	Project Systems Engineer
ZION YOUNG Digitally signed by ZION YOUNG Date: 2018.11.14 09:06:07 -08'00'	DAVID SATTERFIELD Digitally signed by DAVID SATTERFIELD Date: 2018.11.15 10:40:06 -08'00'	ROY WILLIAMS Digitally signed by ROY WILLIAMS Date: 2018.11.15 11:13:47 -08'00'
Project Manager	AMO Rep. Acknowledgement	AFSRB / FRRB Rep. Acknowledgement

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CONFIGURATION MANAGEMENT PLAN

This document is a Sensor Integrated Environmental Remote Research Aircraft (SIERRA) Project Configuration Management (CM) controlled document. Changes to this document require prior approval of the appropriate SIERRA and Aviation Management Office personnel. Proposed changes shall be submitted to the SIERRA Project Configuration Management Officer along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

Questions or comments concerning this document should be addressed to:

SIERRA Configuration Management Officer
Mail Stop 245-5
Ames Research Center
Moffett Field, California 94035

CHANGE TRACKING			
Doc. ID:	A9UAV-1401-XM001		
Doc. Name:	SIERRA-B Experimenters Handbook		
Rev.	**Summary of Changes**	**Author(s)**	**Effective Date**
0.1	Preliminary Release	D. Satterfield	07/21/2017
A	Initial Release	Z. Young	11/15/2018

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1 INTRODUCTION

1.1 Overview

The Sensor Integrated Environmental Remote Research Aircraft (SIERRA) Experimenter's Handbook is provided for the purpose of giving partners/research projects important information for payload integration and aircraft operations.

The SIERRA Unmanned Aircraft System (UAS) based at NASA Ames Research Center, Moffett Federal Airfield, California has been under development to support NASA Earth Science activities in dangerous and remote locations, or where low altitude and low flight speed requirements cannot safely or effectively be met by manned aircraft. While the aircraft was acquired and modified to support NASA Earth Science requirements, the aircraft is able to support a full spectrum of operations within the constraints of payload size and weight.

The SIERRA UAS consists of an Air Vehicle, Ground Control Station (GCS), Remote Control Handset, various Ground Support Equipment (GSE) components, and is capable of Beyond Visual Line Of Sight (BVLOS) operations.

Typical SIERRA missions require deployment of the UAS along with essential flight and ground support personnel and equipment. Early in the mission planning process, near the area of research interest, adequate runway and ground support facilities must be located and procured. Specific operating tasks such as takeoff and landing are controlled by the Remote Pilot through use of a Radio Control (RC) Handset during the line of sight (VFR) phases of flight. Once the aircraft reaches a predetermined handoff point, aircraft control transfers to the autopilot system to execute the flight plan. Aircraft and payload telemetry are transmitted to the GCS for display on the Ground Station, and display on the Payload Operator console may also be arranged. Flight plan updates may be transmitted to the aircraft in real time in addition to flight commands to ensure safe aircraft operation. The Payload Operator has similar monitoring and control capability within payload design constraints. Multiple GCS may be strategically placed along the aircraft route to support long distance operations.

In this document, various terms are used to describe personnel groups that either (a) Own/operate the aircraft or (b) Own/operate the payload. Aircraft Owner/Operators are referred to as the Project Team, Flight Team, Aircraft Operators, Ground Control Station (GCS) Operators, Pilots, Crew Chief, ground support personnel, and Range Safety Officers. Payload Owner/Operators are referred to as Experimenters, Customers, Payload Operators, Sensor Operators, Research Team, Researchers, Users, and Principal Investigators.

Experimenters may request SIERRA for missions by submitting a Flight Request to the NASA Airborne Science Program (ASP) Science Operations Flight Request System (http://airbornescience.nasa.gov/sofrs/). The Flight Request initiates mission planning and cost estimation in coordination with the SIERRA Project Team at Ames Research Center.

1.1 Purpose and Scope

This handbook provides information for Experimenters with interest in utilization of SIERRA to carry research payloads. The following subject matter is contained within this document:

- SIERRA UAS features.
- Operational capabilities and limitations.
- Standard payload interface within the aircraft:
    - Envelope
    - Mass
    - Power
    - Data
- Design Standards for Payloads
- Payload Integration process

The information provided within this handbook will assist potential SIERRA UAS users/Experimenters to safely integrate payloads to ensure mission success.

Applicability of this document is confined to the B-variant of SIERRA which is expected to be certified for operations in November 2018.

2 REFERENCE DOCUMENTS

Aircraft Capability and Operational Documents:
A9UAV-1401-XTR001 - SIERRA-B Flight Test Report
A9UAV-1401-XM002 - SIERRA-B Operations Manual
A9UAV-1401-XM003 - SIERRA-B Maintenance Manual
A9UAV-1401-FT1-XM007 - Aircrew Checklist

Aircraft Interface Control and Technical Documents:
A9UAV-1401-XR001 - MICD – Small Nose Volume and Interface
A9UAV-1401-XR002 - MICD – Large Nose Volume and Interface
A9UAV-1401-XR003 - MICD – Fuselage Volume and
A9UAV-1401-E016 – Ground Bonding Wires & Grounding Diagram
A9UAV-1401-E010 - DC Power

Aircraft Reference CAD Models:
A9UAV-1401-XR005 RevA - MICD REF - Aircraft with Small Nose
A9UAV-1401-XR006 RevA - MICD REF - Aircraft with Large Nose
A9UAV-1401-XR007 RevA - MICD REF - OML with Small Nose
A9UAV-1401-XR008 RevA - MICD REF - OML with Large Nose

3 AIRCRAFT DESCRIPTION

3.1 General

The SIERRA-B aircraft is a high wing, 480 lb. gross weight (UAS Class III), monoplane with twin tail booms and inverted V-tail. Airframe construction consists of carbon composite and aluminum structural members. Airframe skin consists of carbon/fiberglass composite material covered with epoxy-based paint. Aircraft landing gear is fixed tricycle-type with steerable nose wheel and hydraulic brakes.
The SIERRA power plant is a rear mount, reciprocating 2-cylinder internal combustion engine with attached fixed-pitch propeller.

Payloads are normally carried in the nose cone and/or the forward fuselage bay, see figures in Section 4. If required, within aircraft weight and balance margins, payloads may be integrated into the aft fuselage bay. However, relocation of aircraft components to the forward fuselage bay may be necessary.

Figure 1 – SIERRA-B Preflight

3.2 Aircraft Specifications

Table 1 - Aircraft Specifications

Wing Span	20 feet	6.1 Meters
Length	12’10.5”	3.9 Meters
Height	5 feet	1.5 Meters
Max. Gross Takeoff Weight (MGTOW)	*480 pounds*	*217.7 kg*
Empty Weight at nominal CG	*340 pounds*	*154.2 kg*
Useful Load (Fuel and Payload)	*140 pounds*	*63.5 kg*
Maximum Fuel Load	*17 gallons*	*64.4 L*
Maximum Payload Weight Max. fuel (17 gallons = 102 pounds) Min fuel (5 gallons = 30 pounds)	 *38 pounds* *110 pounds*	 *17.2 kg* *49.9 kg*
Max. Payload Volume	Appendix A	Appendix A

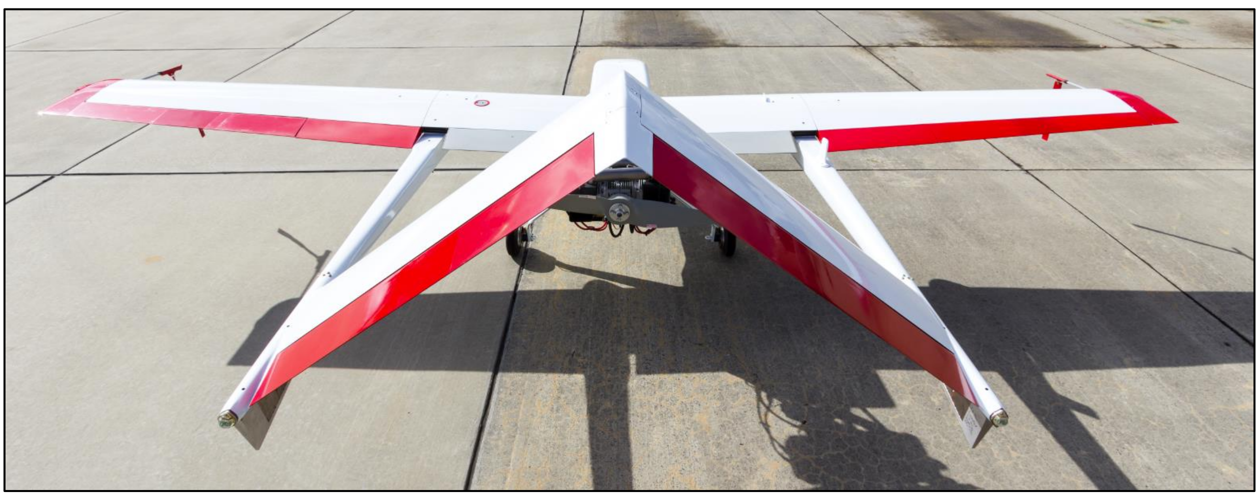


Figure 2 – SIERRA-B Aft Vew

3.3 Aircraft Performance Factors

Service Ceiling [at Max. Gross Weight of 480 lbs (217.7kg) 13,000 ft.

(Service Ceiling increases as TOW decreases IAW ROC Chart, where 100 ft/min defines the Ceiling Limit)

Best Rate of Climb Airspeed (V_Y RC Mode) 55 to 63 kn

Best Rate of Climb Airspeed (V_Y AP Mode) 51 to 61 kn

Best Cruise Speed (V_C) 54 to 59 kn

Approach Speed 50 kn

Best Glide Speed 57 kn

Maneuvering Speed (V_A) 72 kn

Maximum Operating Speed (V_{MO}) 85 kn

Never Exceed Speed (V_{NE}) 85 kn

- Exceeding 85 knots for durations less than 5 seconds is permitted
- In an emergency and if necessary to do, flying at 85-90 knots sustained is permitted

Glide Ratio 10.4:1

Maximum Turn Rate 15°/sec

Flight Bank Angles limited to +/- 70 degrees

Maximum Flap Extension Speed (V_{FE}, 40° Inboard, 30° Outboard) 65 kn

Maximum Endurance (SL) *(Full Fuel Load)* 8.8 hours

Maximum Range *(Full Fuel Load)* 527 NM

Takeoff Distance (at Max. Gross Weight) 1,100 ft. (335 m)

Landing Distance 1,200 ft. (365 m)

Flight Path Repeatability

- Vertical Consistency +/- 12 ft
- Lateral Consistency +/- 15 ft
- Turn Placement consistency < 175 ft
- Distance to align with track <2000 ft.
-

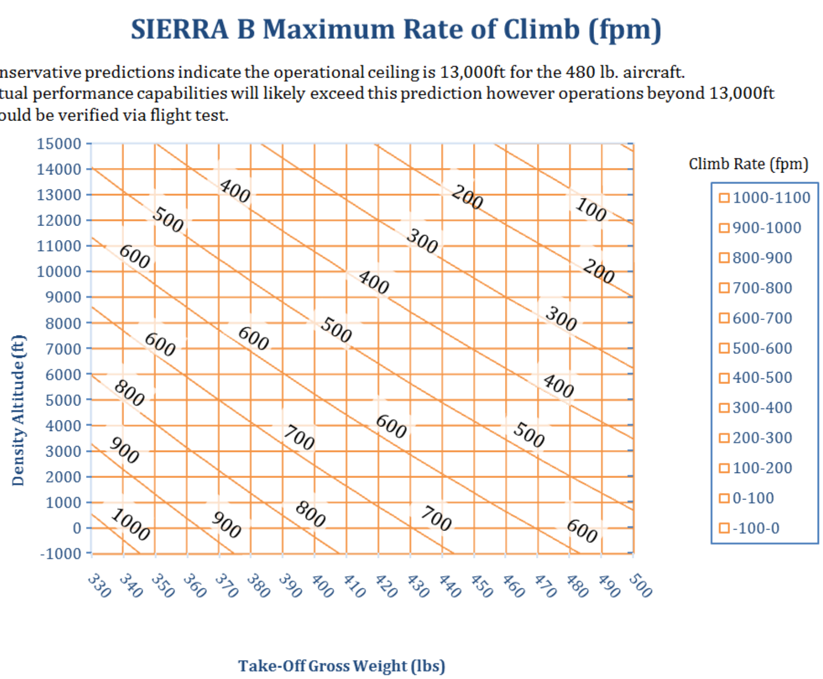


Figure 3 – SIERRA-B Maximum Rate of Climb (RoC)

3.4 Operating Restrictions

SIERRA operates under Visual Flight Rules (VFR). The Federal Aviation Administration (FAA) requires that UAS operating in the National Airspace System above 400' altitude obtain a Certificate Of Authorization (COA), *unless operating in Restricted Airspace*. The COA application process requires significant planning that includes details such as operating procedures, area of operations, maintenance, and weather. COA applications are developed by the Ames Research Center Aviation Management Office in cooperation with the SIERRA Project and the FAA. Expect a minimum 6 month lead time for approval of COA applications once submitted to the FAA. An approved COA will provide rules for UAS operations, aircraft maintenance, and communication procedures, as well as collect data for FAA use and ensure flight safety. In addition to restrictions set by the COA, other operating restrictions set by the NASA Ames Airworthiness and Flight Safety Review Board (AFSRB) and the NASA Ames Flight Readiness Review Board (FRRB) may be imposed.

Important note: Operations conducted outside of the United States will require compliance with host country Civil Aviation Authority policies and procedures.

Range Safety is an important aspect of UAS operations within NASA. Although flight safety is the responsibility of UAS operators, NASA elects to assign a Range Safety Officer (RSO) to the flight team to provide enforcement of COA, AFSRB, and FRRB requirements. The RSO has full and final authority to terminate flight and/or order any flight maneuver to avoid other aircraft, personnel, and property. Range Safety is an integral part of the mission planning process.

3.4.1 Environmental Operating Limitations

- Operations limited to Daytime VFR only:
  Class E Airspace:
  < 10,000 ft. mean sea level (MSL) 3 statute miles visibility, Cloud clearance – 500 ft. below, 1,000 ft. above, 2,000 ft. horizontal
  ≥ 10,000 ft. mean sea level (MSL) 5 statute miles visibility, Cloud clearance – 1,000 ft. below, 1,000 ft. above, 1 statute mile horizontal
  Class G Airspace:
  ≤ 1,200 ft. above ground level (AGL) 1 statute mile visibility, Remain clear of clouds.
- Nominal Runway Requirements:
  Min. Runway Dimensions: 1500ft x 50ft (460m x 15m).
  Surface conditions – paved surface or graded/rolled or packed unpaved surface
- Maximum 20 knot wind gust & 10 knot crosswind component
- Normal operating temperature range: -20°C (-4°F) to 49°C (120°F)
- Relative Humidity: 5 to 95%
- Operation Prohibited within 5 NM of thunderstorm activity.
- Avoid operations in areas of visible moisture (precipitation, mist, fog).
- Avoid operations in areas of moderate turbulence or worse.
- Aircraft is prohibited from operating in known or forecast icing conditions, unless approved by the NASA FRRB.
- Avoid flying in volcanic ash clouds.

3.4.2 Operating Facilities and Weather

SIERRA operates from improved (paved surface) or unimproved (well-graded dirt) runways/airstrips. Paved surfaces are preferred for safety and reliability. Operational facilities must provide workspace for personnel and equipment. Facilities should be adequate for safe and successful mission operations.

Proper mission planning will include the operating requirements of the host managers/field owners. These requirements will impact aircraft operating procedures. Payload teams will coordinate with the NASA Ames Aviation Management Office and the SIERRA Project Team to select an appropriate airfield.

Weather has a direct impact on aircraft operations. High wind, gusts, visible moisture, and icing conditions can have detrimental effects on aircraft performance and control. A reliable source of weather forecasting is needed to ensure acceptable weather conditions throughout the planned mission.

3.4.3 Flight Management and Navigation Systems

The SIERRA Flight Management System (FMS) is provided by the CloudCap Inc. Piccolo II autopilot. The software provides the Ground Control Station (GCS) the ability to communicate with the aircraft during flight for control and flight plan uploads. The GCS monitors aircraft position and altitude while the aircraft is under autopilot control. The autopilot combines Global Positioning System (GPS) signals and Inertial Navigation System (INS) inputs to keep the aircraft on route. Flight plans are executed from waypoint to waypoint. In certain circumstances, the autopilot may be reprogrammed to carry out certain commands depending on mission objectives.

3.4.4 Ground Control Station

While the GCS is communicating with the aircraft autopilot, the GCS is recording telemetry from the aircraft such as: location/position, altitude, attitude, roll/pitch rates, acceleration/deceleration, engine speed, control surface position, and other performance parameters. No data is stored on the aircraft, but instrument status, and some data packets can be transmitted through the GCS.

3.5 Aircraft Preparation

3.5.1 Inspection and Maintenance

Aircraft inspections and maintenance will be performed consistent with procedures contained in the SIERRA UAS Maintenance Manual. Scheduled maintenance will be performed prior to deployments. Unscheduled maintenance (field repair) and inspections are dependent on the failure mode, operational considerations such as payload/weather and general aircraft condition. Unscheduled maintenance tasks may require approval at the AFSRB level and specialized inspection requirements.

3.5.2 Weight and Balance

Aircraft weight and balance are critical variables to flight. Weight and Balance procedures are to be carefully followed prior to aircraft operation. Three items affect Weight/Balance: (1) Aircraft (and configuration), (2) Mission Payload, (3) Fuel Load. In order to keep Weight/Balance within limits, design of payload integration will be such that location of instrument hardware on the aircraft will not compromise weight and/or balance. Payload hardware must accommodate mission science and allow for sufficient fuel load to safely perform the flight profile. Certain adjustments can be made to the aircraft configuration and fuel load to accommodate the payload, but only to a point. Aircraft Weight/Balance considerations are integral to payload integration planning and mission planning.

The aircraft (with payload) will be weighed to determine aircraft weight without fuel (known as Zero Fuel Weight). Then fuel added (or subtracted) according to mission requirements. Final weight shall not exceed Maximum Aircraft Gross Weight.

Use Weight/Balance procedures contained in the SIERRA – B Weight/Balance Plan A9UAV-1401-XM004 and the SIERRA – B UAS Maintenance Manual A9UAV-1401-XM003.

4 AIRCRAFT AND PAYLOAD ENVIRONMENTS

4.1 Payload Accommodations

The aircraft is configured for payload integration in the forward fuselage bay and removable nose cone within mass, envelope, weight, balance, and aerodynamic stability constraints. The removable nose cone feature provides the ability to separate the cone from the fuselage in order that payloads may be pre-installed in a laboratory or other facility. Two standard nose cone configurations of different sizes are available. As long as payloads fit within the nose cone envelope, integration is straightforward within mechanical and electrical interfaces described in Appendix A and Appendix B respectively.

Accommodation of payloads of unusual size and shape may be possible with appropriate engineering. Some small payloads will fit in the aft fuselage bay. External hard point wing mounts are possible (but not currently installed) for under-wing payloads. Placement of antennae and other sensor apparatus on wing tip or tail structures are possible (but not currently installed) as long as these apparatuses do not generate radio frequency interference.

Adjustments for weight and balance may be necessary depending on flight duration, payload weight, and payload location. Heavier payloads may require a lower aircraft fuel load. Lighter payloads will allow for higher fuel loads. Proper mission planning will achieve an optimum balance of flight duration and payload weight.

Fuel tanks are integral to the wing and a portion of the center fuselage. Since the wing is attached near the aircraft Center of Gravity (CG), fuel weight ensures aerodynamic stability. As fuel burns off, stability is maintained by flight control trim and payload ballast.

Installed payloads are subject to atmospheric and aircraft dynamic conditions encountered in flight. The International Civil Aviation Authority Manual on Standard Atmosphere provides data on temperatures/pressures at various altitudes and latitudes.

4.1 Pressure, Temperature, and Humidity

The SIERRA payload bays are not pressurized. Pressurized payload enclosures are allowed (subject to limitations levied by the AFSRB/FRRB).

Listed temperatures for ‘Standard Day’ information are unlikely to reflect actual temperatures at altitude. Significant deviations are likely depending on the specific location/latitude/altitude. Aviation weather information is crucial to the mission planning process. Maximum payload bay temperature would be reached with the aircraft on the ground in direct sunlight.

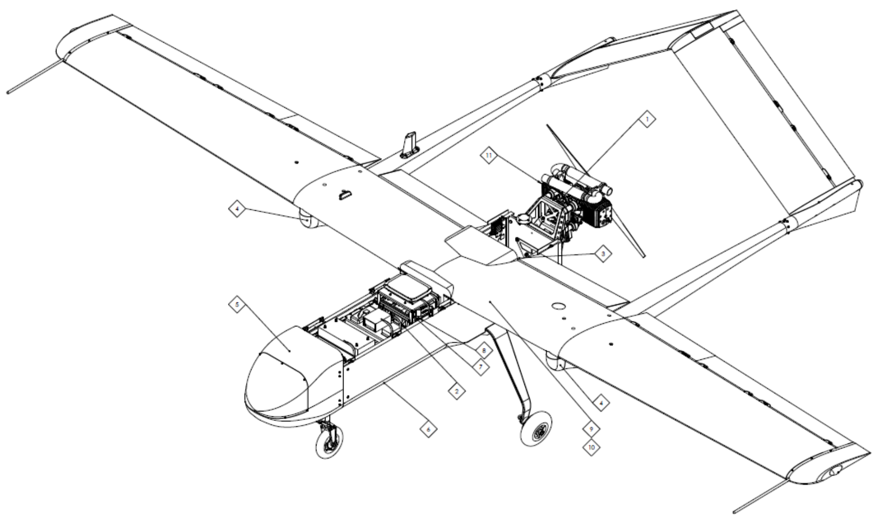
Payload design should account for the closed, unheated, unpressurized payload bay. Payload integration may require a custom nose cone to provide ventilation (with minimized aerodynamic impact) to avoid payload overheating. Payload heating systems and insulation are recommended for low temperature sensitivity. Payload heat dissipation rates should be included in design calculations. The best thermal profile is achieved by forced ventilation for cooling on the ground along with insulation for heat retention in flight.

Since the payload is cooled by external air, complete air saturation (100% humidity) may be encountered in the payload bay with moisture condensing within the bay and on the instrument. Condensation often occurs when descending from altitude to into humid air. Cooling is not compromised, but the payload may need to be protected from the negative effects of moisture.

Temerature ranges inside the aircraft are defined from flight testing and captured in *Figure 4* and *Figure 5*.

4.1.1 Thermal Environment

TEMPERATURE SENSOR LOCATIONS



SUGGESTED TEMPERATURE SENSOR LOCATIONS

SENSOR NUMBER	LOCATION
1	ALTERNATOR HOUSING, UNUSED FASTENER LOCATION
2	AUTOPILOT EXTERNAL SURFACE/PAYLOAD BAY
3	FUEL SUPPORT TRAY ASSEMBLY/ECU EXTERNAL FACE
4	IRIDIUM MODEM SURFACE, TRANSPONDER SURFACE, OR BOOM INTERNAL VOLUME
5	SMALL AIRCRAFT NOSE INTERNAL VOLUME
6	EXTERNAL FACE - SHADED
7	POWER SUPPLY BOX BASEPLATE EXTERNAL FACE
8	POWER SUPPLY BOX FAN OUTLET
9	VOLTAGE REGULATOR HEAT SINK
10	ENGINE RIGHT CYLINDER HEAD TEMPERATURE

Figure 4 – SIERRA-B Thermal Environment Sensor Zone Map

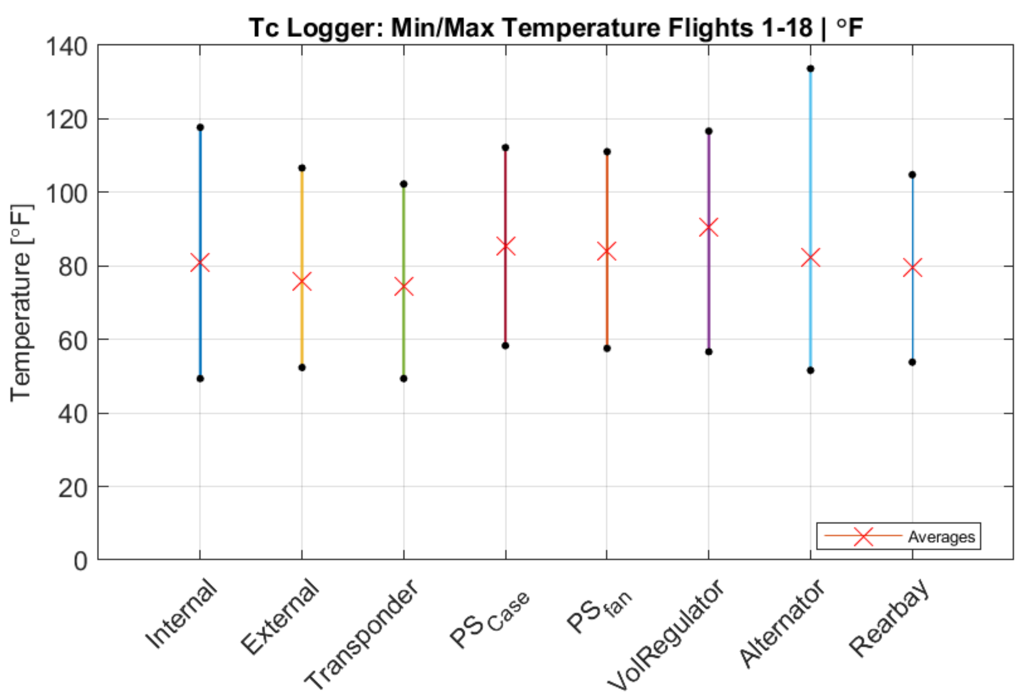


Figure 5 – SIERRA-B Thermal Environment Temp Range Per Zone

4.2 <u>Acceleration Loads</u>

All Sources of acceleration loading come from three contributors: aircraft maneuvers (G-loads), turbulence and gusts in the vertical axis. Turbulence induced XYZ acceleration loads in flight will be within *Figure 7 – SIERRA-B VN Load Diagram*. Payloads shall be designed to meet handle the inertial load set defined below in *Table 2 – Operational Inertial Load Set*

4.2.1 Inertial Environments

Table 2 – Operational Inertial Load Set

Orientation	Inertial Load (G's)
+Z (Down)	3.8
-Z (Up)	1.52
+/- X (Fore/Aft)	2.0
+/- Y (Lateral)	1.25

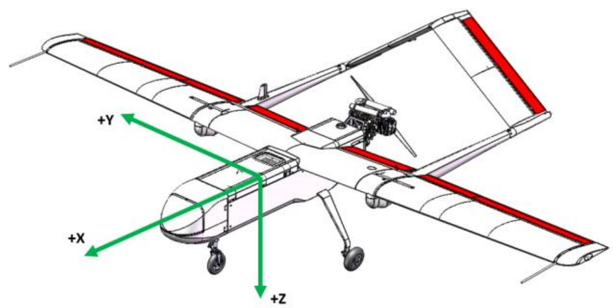


Figure 6 – SIERRA-B Inertial Axis Diagram

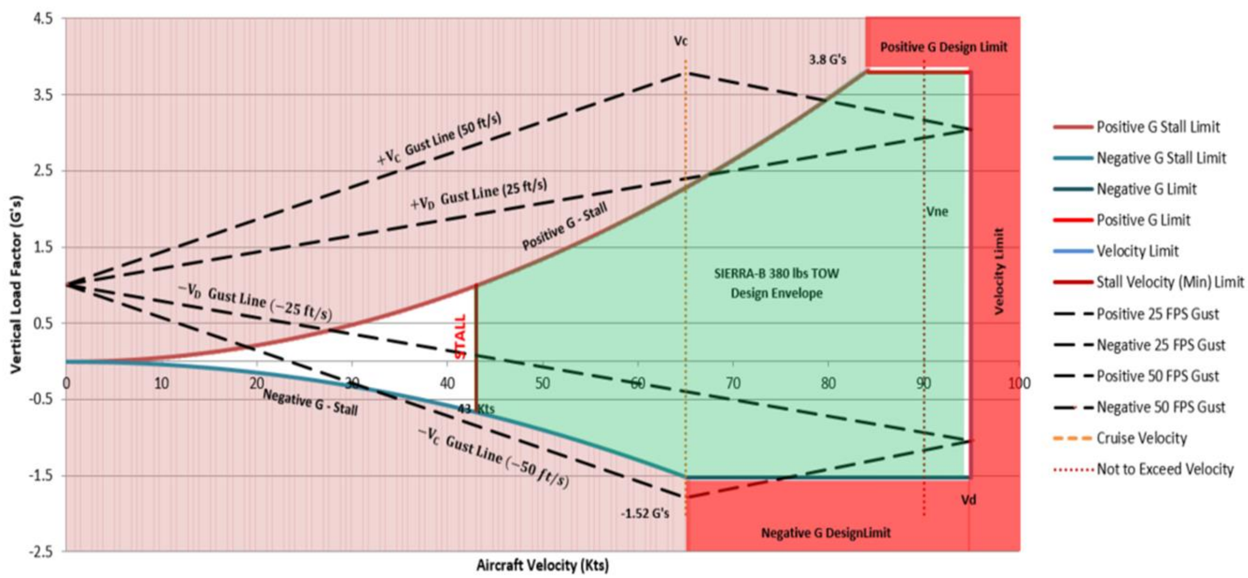


Figure 7 – SIERRA-B VN Load Diagram

4.3 Vibration & Shock Environment

The engine is the primary source of vibration; Payloads should be designed to handle the random vibration environments defined below. In terms of shock environment payloads should be designed to handle a 5G shock due to landing.

- All Aircraft Random Environments, Per Region are defined below. All "Integrated Flight Environment Levels" are in GRMS units.
    - Nose Payload Environment: Bounding environment applied at the small nose attachment interface plane.
    - Fuselage Payload Environment: Bounding Environment of the 30lb payload simulation mass used during "heavy" flight tests.
    - Aircraft Environment Bounding Line: Bounding Environment of the Vibration Isolated Autopilot.

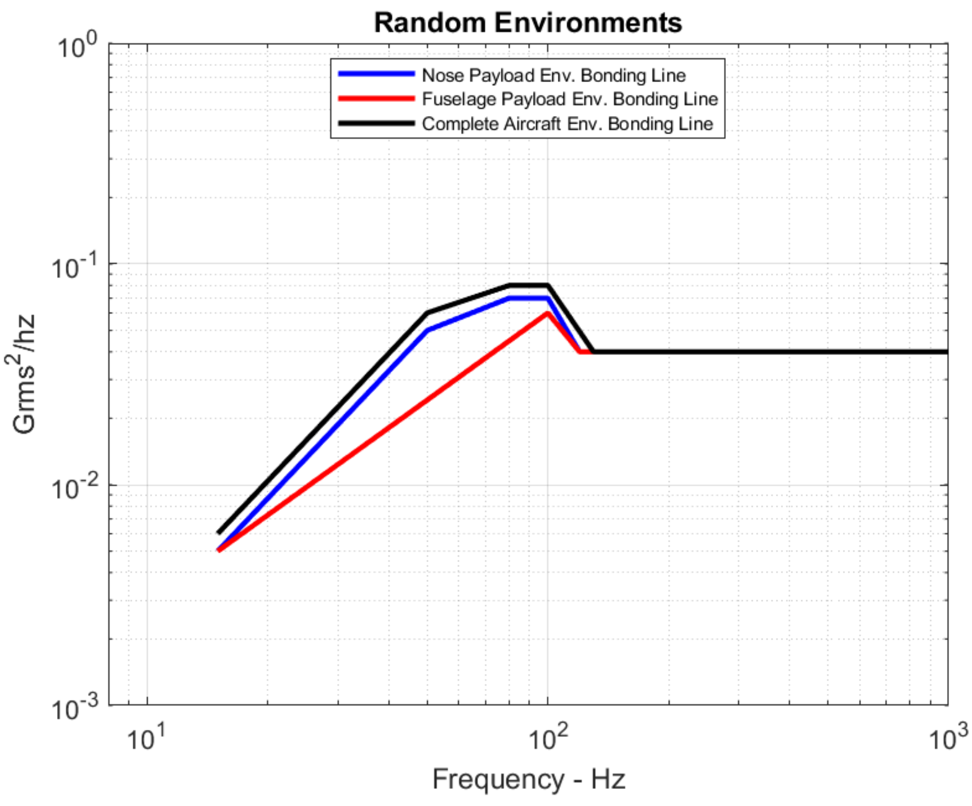


Figure 8 – SIERRA-B Aircraft All Randon Environments

- Payload Bay Environments – Mechanical/Random

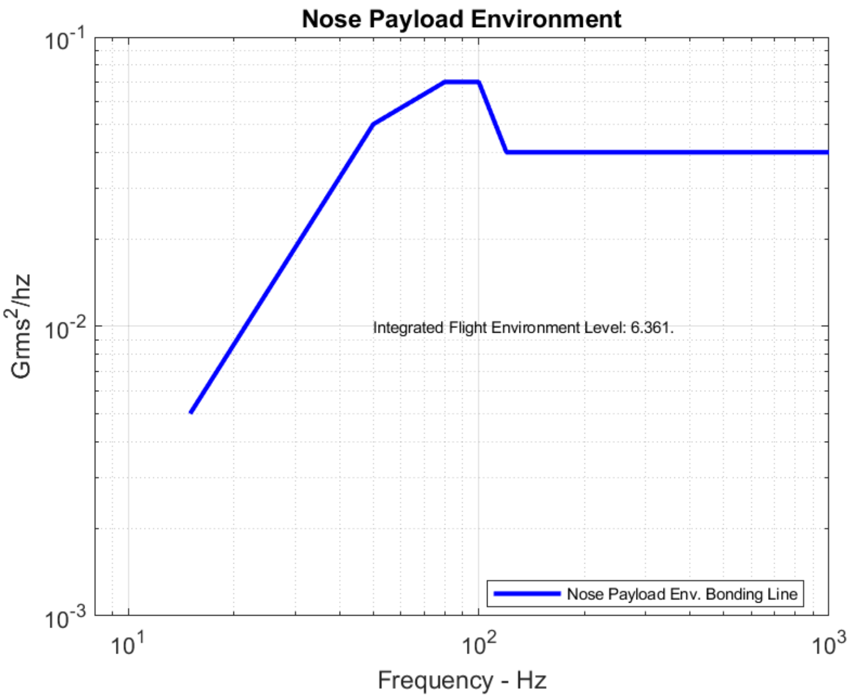


Figure 9 – Payload Bay – Nose Random Environment

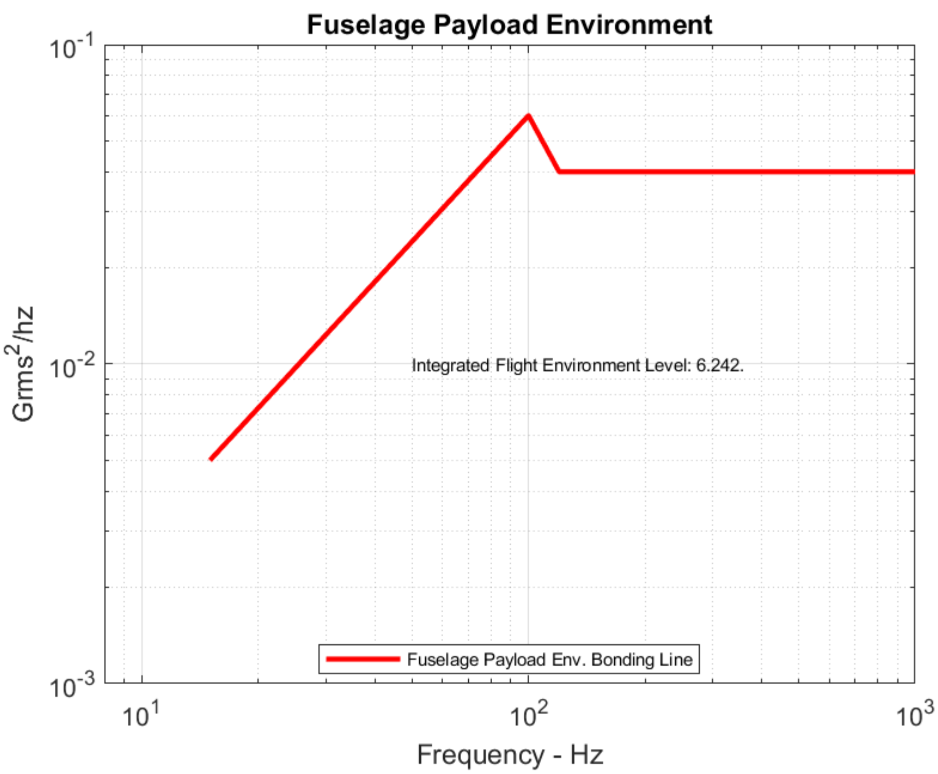


Figure 10 – Payload Bay – Fuselage Random Environment

- Aircraft Environments – Mechanical / Random

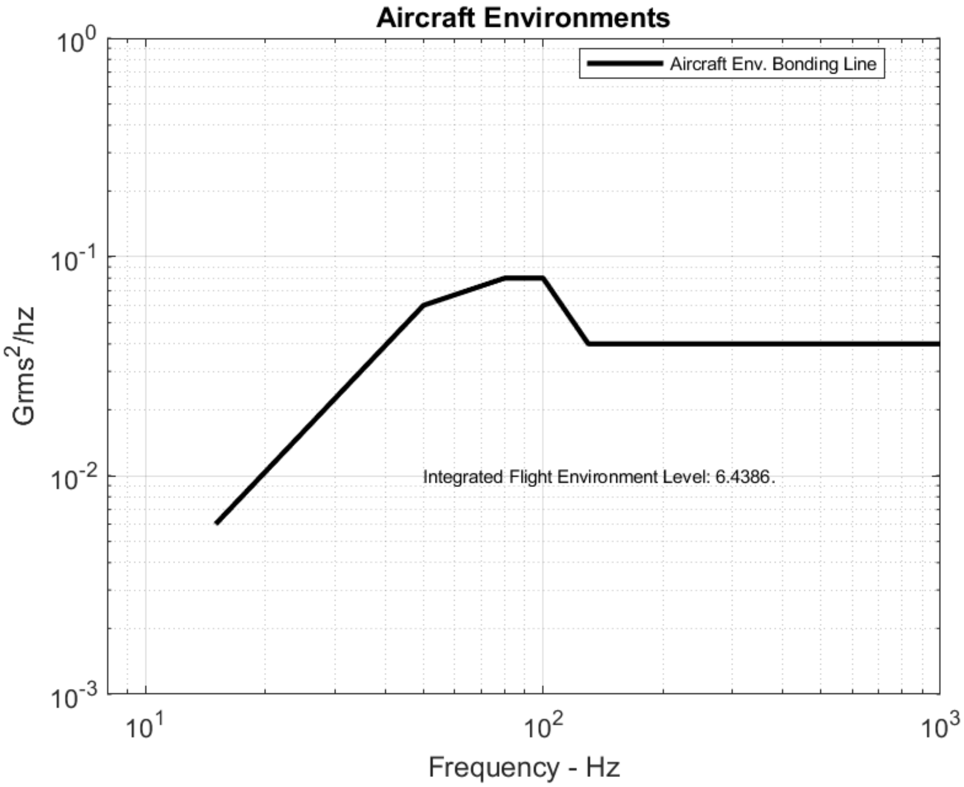


Figure 11 – Aircraft Bounding Random Environment

4.4 RF and Electromagnetic Interference

Engine ignition produces the most electromagnetic interference in and around the aircraft. The frequency of this radiated electromagnetic interference (EMI) is approximately 125 Hz. To diminish this source of interference, shielding has been installed on the spark plug wires and grounded to the engine block. The alternator and switching frequency of DC-DC power converters is an additional source of conducted EMI. Payloads that require very clean power may install standard ‘ripple attenuation’ filters.

The UAS produces the following RF emissions:

- Line of Sight Control Link: (421 MHz, 900 MHz, and 2.4 GHz).
- Iridium Satellite Communications Datalink: (1616 MHz to 1626.5 MHz), when the datalink is operating.
- Air Traffic Control Transponder: (1100 MHz).

Inform the SIERRA Project Team early on in the process for payloads that will be transmitting RF signals or radiating laser emissions, there are constraints where transmitting antennae optics may be mounted, frequency, wavelength, power, duty cycle, and it is very likely the AFSRB will impose additional technical and risk analysis. The customer is responsible for obtaining all regulatory certifications from the FCC, CDRH, FAA, and NASA as applicable.

5 PAYLOAD ENVELOPE AND INTERFACE SYSTEMS

Payloads are normally carried in the nose cone and forward payload bay. Two nose cone variants are available. A payload nose cone may be taken to a laboratory or other site for integration activities. Fuel and payload weight are adjustable according to mission requirements. Careful mission planning will produce the optimum balance between flight endurance and payload weight. Aircraft balance requirements dictate that weight should be distributed with a forward bias. The SIERRA Project Team can assist with information detailing mechanical interfaces, structural attach points, racks, pods, and equipment bays. CAD models of payload interfaces are available.

The standard (short) nose provides lower drag but substantially less volume over the large nose cone configuration. The standard nose cone normally contains ballast weight to keep the aircraft within CG limits when operating without a payload. Depending on payload mass and volume, this ballast may be adjusted. The standard nose cone features a cutout to accommodate a turret-type payload or instrument that may protrude up to 8 inches into the airstream.

The large nose cone configuration provides more room and flexibility for the payload requirements. Four removable panels allow access from both sides, top, and bottom. Custom panels may be fabricated according payload or mission requirements. This variant allows substantially more airflow volume and has more flexibility to be modified to accommodate gas sampling, stagnation probes, and other apparatus that require a clean boundary layer. Custom nose cones may be fabricated as required subject to aerodynamic analysis and validation.

The fuselage payload sections (forward and aft) can accept apparatus as required. The forward bay features a removable nadir port panel. The aft bay is close to the engine and is subject to higher vibration and electromagnetic interference. Equipment may be repositioned as necessary to accommodate payloads. The aircraft battery position can be changed as necessary for payload accommodation and CG adjustments.

Delicate payload components should be isolated from shock and vibration using vibration isolation techniques. Payload designers are responsible for ensuring proper vibration and shock protection is built into the payload design.

5.1 Payload Bay Dimensions

All Dimensions provided are approximated for exact volume dimensions refer to Appendix A

Table 3 - SIERRA Fuselage Payload Bay Dimensions

SIERRA Payload Envelope Dimensions and Information		**Volume**			
Large Nose		in^3	ft^3	cm^3	m^3
Outer dimensions (LxWxH)	34x18x18 inches				
Useful inner dimensions (LxWxH)	21x17x17 inches	6069	3.5	99,453	.1
Vibration isolation mount bolt pattern	14.6 x 13.38 in				
Side Panel Openings (L x H)	17.6 x 12.4 in				
Top Panel Opening (L x H)	17.6 x 12.4 in				
Bottom Panel Opening (L x W)	14.7 x 8.5 in				
Standard (Small) Nose					
Outer dimensions (L x W x H)	19.6 x 16 x 16 in				
Useful inner dimensions (L x W x H)	11.2 x 13.2 x 11.4 in	1693.7	.9	27,755	.03
Vibration isolation mount bolt pattern (L x W)	8.0 x 10.0 in				
Bottom panel opening (Diameter)	8.0 in.				
Forward Fuselage (Aft Battery Location)					
Outer Dimensions (L x W x H)	19.75 x 16 x 16				
Useful inner dimensions (L x W x H)	19 x 13.4 x 15	3819	2.2	62,582	.06
Rail Mount Holes (Separation, Spacing)	13.9, 1.5 inches				
Bottom Panel Opening (L x W)	16.4 x 10.6 inches				
Aft Fuselage (Forward Battery Location)					
Outer Dimensions (L x W x H)	19.75 x 16 x16				
Useful inner dimensions (L x W x H)	10.4 x 13.4 x 11.7	1631	.9	26,727	.03
Rail mount holes (Separation, Spacing)	13.9, 1.5 inches				
	Total Volume Available	**9,888**	**5.7**	**162,035**	**.2**

Figure 5.1-1 Forward Fuselage Payload Bay

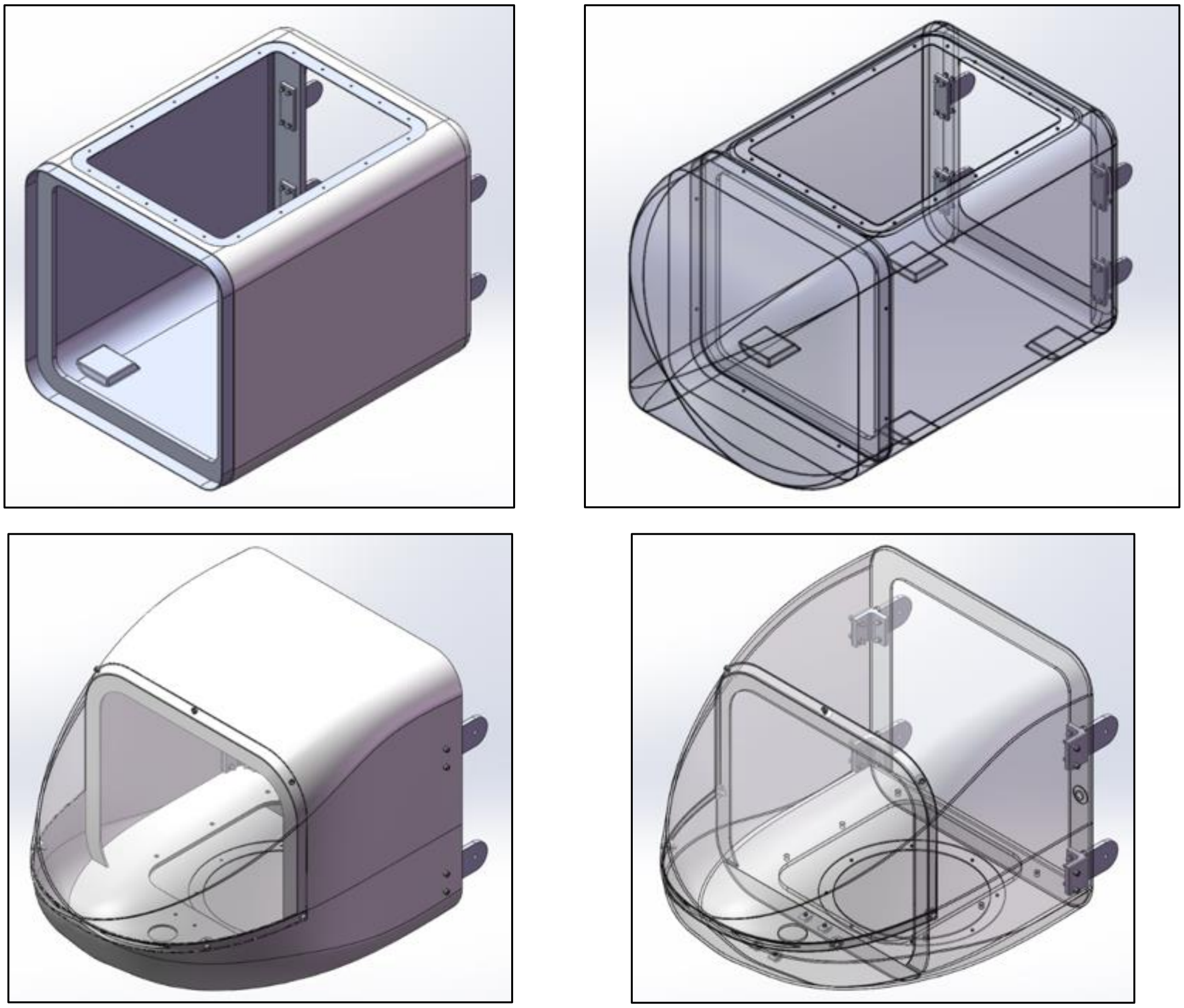


Figure 5.1-2 Large and Small Nose Cone Configurations

5.2 Electrical Interface

Refer to Appendix B: Electrical Interfaces

5.3 Mechanical Interface

Refer to Appendix A: Mechanical Interfaces
Reference CAD Models are also available to support Payload Development, See Reference Documents / CAD Models for list of available models. Requests for CAD models can be made through the Aircraft Management Office or Mission Manager.

5.4 Payload Control and Communications

The aircraft system maintains both line-of-site radios and beyond-visual-line-of-site satellite communications radios for communicating with instrument payloads. Payload teams may provide a separate data link for payload control, operation, and data download. The SIERRA Team will assist.

The Payload Power Relay provides the GCS Operator with the option of switching the payload power off in the event of emergency or other aircraft operating procedure. Payloads should automatically start and initialize data acquisition on power up. If a sudden power loss were to occur, the design of the data acquisition system should preclude data loss.

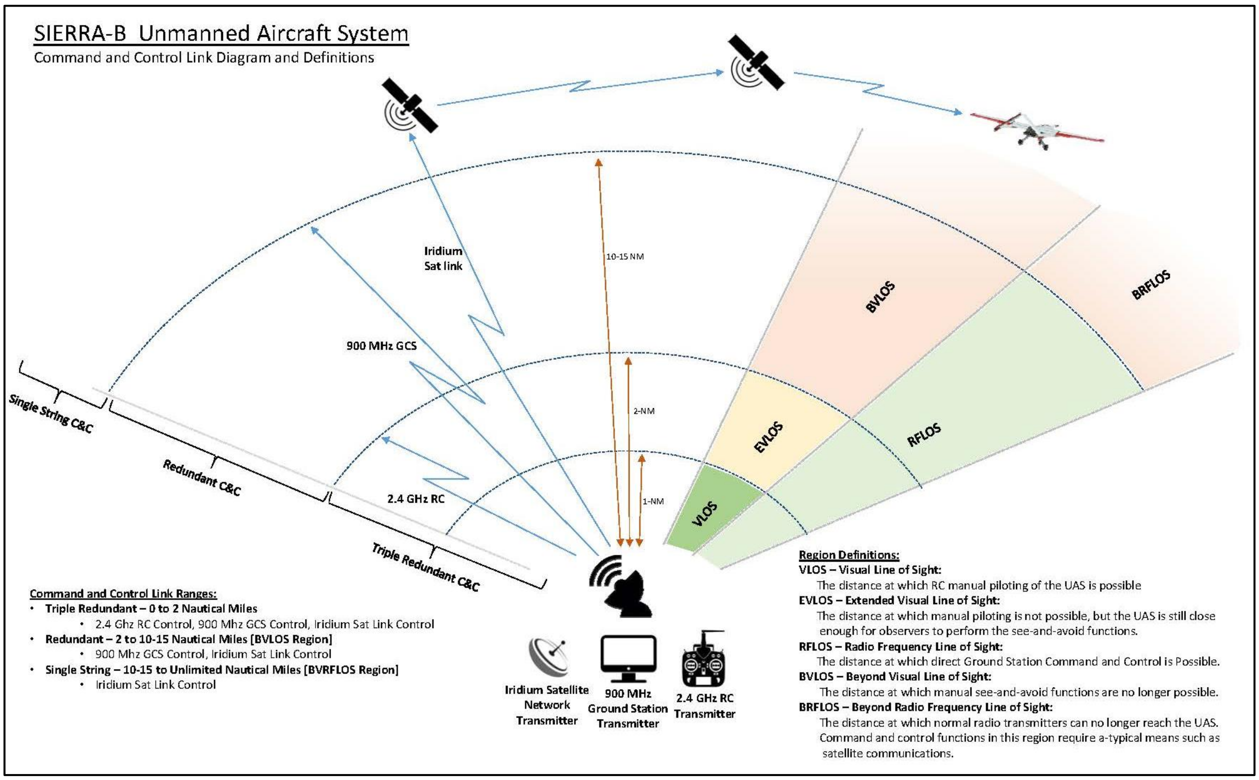


Figure 3 – Comm Link Diagram

6 PAYLOAD DESIGN, ENGINEERING, AND INTEGRATION PROCESSES

6.1 Payload Development and Integration Planning

The Payload Team is responsible determining the experimental approach and measurement strategy. The SIERRA Project Team is available to assist with payload integration to the aircraft. The SIERRA Project Team will provide technical and procedural expertise for the NASA Mission Review process.

To ensure seamless integration with SIERRA, payload technical information such as drawings, textual descriptions, photographs, etc. will need to be made available to the SIERRA Project Team.

All equipment that have hazardous or potentially hazardous system components such as lasers, pressure vessels, cryogenic fluids, radiation, etc. will have appropriate mitigations in place to minimize risk to the aircraft, payload, and personnel. A thorough understanding of such equipment will be necessary during the review process.

6.2 Certifications, Reviews, and Approvals

NASA Procedural Requirement (NPR) 7900.3(D) provides procedures for airworthiness certification and mission assurance. Customers are advised to not take these reviews lightly, as these can be extensive investigations of the entire proposed project/mission. Awareness of these processes should be part of every step involving the aircraft, payload, and mission with appropriate documentation/rationale. The Airworthiness and Flight Safety Review Board (AFSRB) purpose is confined to the aircraft and payload. The AFSRB is a technical review that determines the readiness of the aircraft/payload for flight. The Flight Readiness Review Board (FRRB) reviews the mission including location, personnel, facilities, etc.

The AFSRB will issue an Airworthiness Certification for the aircraft and payload. The FRR will issue a Flight Release granting final authorization to conduct the mission.

Changes to the aircraft, payload, or mission after AFSRB certification or FRR flight release will require additional reviews and approval.

6.3 Configuration Management

Aircraft configuration is managed through the projects configuration management process and aircraft maintenance procedures. Modifications to the aircraft to accommodate payloads must be documented, reviewed and approved by the AFRB prior to incorporating them in NASA's Aircraft Management Information System (NAMIS) with appropriate entries and signoff by qualified technicians. Changes to baseline equipment lists for the aircraft will require similar entries into NAMIS. This includes the addition or removal of optional equipment. Any change to aircraft configuration, after AFSRB certification, will require Board approval. Approvals may be obtained by email and are incorporated into aircraft maintenance documentation.

6.4 Payload Integration

The following guidelines will assist with general payload requirements:

- Although payloads may be installed in the removable nose cones at customer facilities, final payload integration will take place at Ames Research Center.
- A complete systems check will be successfully accomplished prior to AFSRB/FRRB reviews and Check Flights.
- Payload power use affects the thermal profile in the payload bay. For example, payloads with high power consumption will experience higher temperatures when operating on the ground without cooling. Payloads that are not switched on until in-flight cruise will experience lower temperatures. Payloads that cycle power will have a moderate temperature profile. Payload power control switching is accomplished from the Ground Control Station.
- During preflight and postflight periods, a Ground Power Unit (GPU) may be connected to the aircraft to provide continuous 28.5 VDC power to the aircraft. The GPU is capable of 25 amps continuous/50 amps peak when supplying 115 VAC to the aircraft. The GPU will charge and maintain the aircraft battery while providing power for the aircraft and payload electrical demands. This is useful for long periods the system operation that have the potential to deplete the aircraft battery. Operation of the GPU and aircraft connections will be performed by qualified SIERRA crew members.
- Heat transfer is affected by lower air density as a function of altitude. High altitude negatively affects (limits) convective heat transfer; the higher the flight altitude, the lower the convective heat transfer.
- Payload shall not generate radiated or conducted electromagnetic emissions that interfere with aircraft electrical power systems, avionics, or electronic components. Similarly, the payload must be able to withstand Electromagnetic Interference (EMI) generated by aircraft systems, and Electrostatic Discharge (ESD) events. This will be addressed and evaluated during reviews.

7 OPERATIONS

7.1 Mission Planning

Mission planning for the Certificate of Authorization (COA) will dictate the operational limits of the mission. Changes to the operational plan may not exceed COA rules without a waiver from the FAA. Therefore, mission planning must minimize the possibility of necessarily having to request waivers as these can be difficult to obtain on short notice.

Flight Operations will be conducted in accordance with current FAA regulations and limitations specified in the Certificate of Authorization (COA). Operations within restricted airspace will be conducted in accordance with the Controlling Authority' policies and procedures.

Changes within COA limitations will be considered, however notification to the SIERRA Project Team of mission profile modification should be made as soon as the need for a change is known. Flights may be canceled at any time prior to launch for safety reasons. SIERRA Project Team Management or Payload Team Management may cancel a flight for operational reasons, however non-recoverable costs may have been incurred.

7.1.1 ATC/Operating Authorities

All controlling authorities (FAA, ATC, Airfield Management, Ames FRRB) and participating organizations/groups will be informed of current UAS operations as required. A Mission Plan will be provided to the NASA Ames Flight Readiness Review Board (FRRB) for approval prior to conducting flight operations. Flight Operations will be conducted in accordance with the NASA Ames Aviation Management Office Flight Operations Manual (JO-3). Flight Plans and Mission Briefings will be logged and conducted as required/appropriate for the mission.

7.2 Flight and Maintenance Crew

Operational risk mitigation dictates that crew work and rest rules apply to SIERRA operations. Proper mission planning will take this factor into account. The SIERRA Project Team can tailor a work/rest plan that is a 'best fit' for the mission within certain limits.

7.3 Operational and Inspection Checklists

As a tool for procedural discipline, checklists are indispensable. Steps for complex aircraft and payload operations should never be committed to memory. Therefore, the Research Team will submit an expanded (step by step instructions with explanation) checklist to the AFSRB for review. Within this checklist, emergency procedures will be clearly defined with a minimum number of steps to render the payload safe.

Payloads will require a preflight and postflight inspection with appropriate checklists guiding responsible personnel. Payloads requiring continuous power will require changes to the aircraft fueling procedure and will be part of the AFSRB review, hence this must be addressed well in advance of flight operations.

8 OPERATIONS AND SAFETY

Payload Teams will participate in payload integration activities at ARC. This is important since problems encountered during integration have the potential to interrupt other processes important to the aircraft and mission. The SIERRA Crew Chief will brief the Research Team on facility use and power availability.

Integration participants will need to coordinate activities with the SIERRA Crew Chief at all times. Do not switch power, remove/install panels, perform maintenance, energize/deenergize circuits, etc. without first obtaining permission from the Crew Chief. Individuals may unknowingly trigger faults, cause process interruption, commit unsafe acts, cause aircraft damage, and/or injure personnel by not coordinating activities in advance. Good teamwork requires communication well in advance of actualization. The SIERRA Team expects that all participants will act in a safe and cohesive manner. To not do so invites a mishap.

- Gaseous/liquid nitrogen may be obtained for use. Identify these items early in mission planning.
- During normal aircraft refueling, the payload must be powered down and only essential personnel can remain in the area of the aircraft.
- Smoke only in Designated Smoking Areas at ARC and at flight locations. There are no Designated Smoking Areas in the aircraft operations/maintenance facilities and parking ramps at ARC.
- When walking through hangar facilities remain in walkways delineated by yellow painted lines.
- Access to aircraft and ramp areas require SIERRA Project Team designated escort.
- Stay away from aircraft with running engines.

- Wear proper clothing for an industrial environment. Other safety items and Personal Protective Equipment (PPE) may be issued or required. Use these items when working in and around SIERRA.
- A Material Safety Data Sheet (SDS) is required for any chemicals used.

Mission Support at ARC

Special equipment required for handling, storage, or transportation of the payload is the sole responsibility of the Research Team. Shipment of equipment to the deployment location must be coordinated through the Project Manager and the ARC Logistics Management Office. This is a NASA requirement that will be discussed at review.

ARC has extensive fabrication capabilities available for use should the payload and/or the aircraft require modification due to mission requirements. However, this type of activity must be coordinated early in the planning phase with the Project Manager so that necessary agreements and funds can be appropriated.

The SIERRA Team will support and enable the Research Team to obtain additional resources if needed. Maintenance Technicians can assist with integration activities and answer many aircraft related questions. The Aviation Management Office (AMO) has direct oversight of the SIERRA Program. The AMO also provides interface with NASA and other government agencies.

8.1.1 Personnel Access to ARC

Access to Ames Research Center is coordinated with the Visitor Control Office. Federal Civil Servants and U.S. Citizens will coordinate with the SIERRA Project Manager for streamlined access. Foreign Nationals will require a minimum 90-day advance notice to Visitor Control and provide necessary documentation such as a passport/visa for access to the Center.

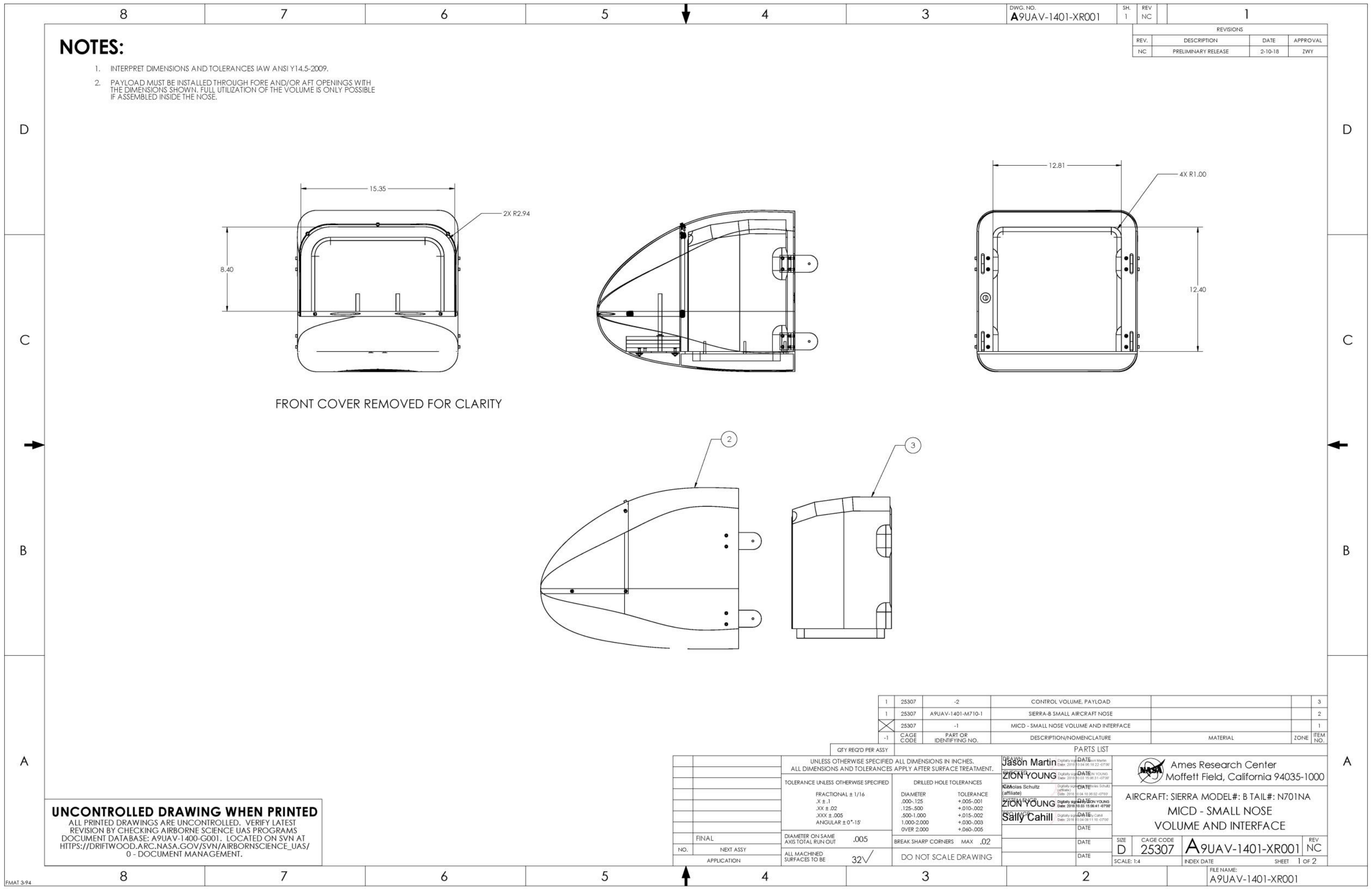
9 ACRONYMS

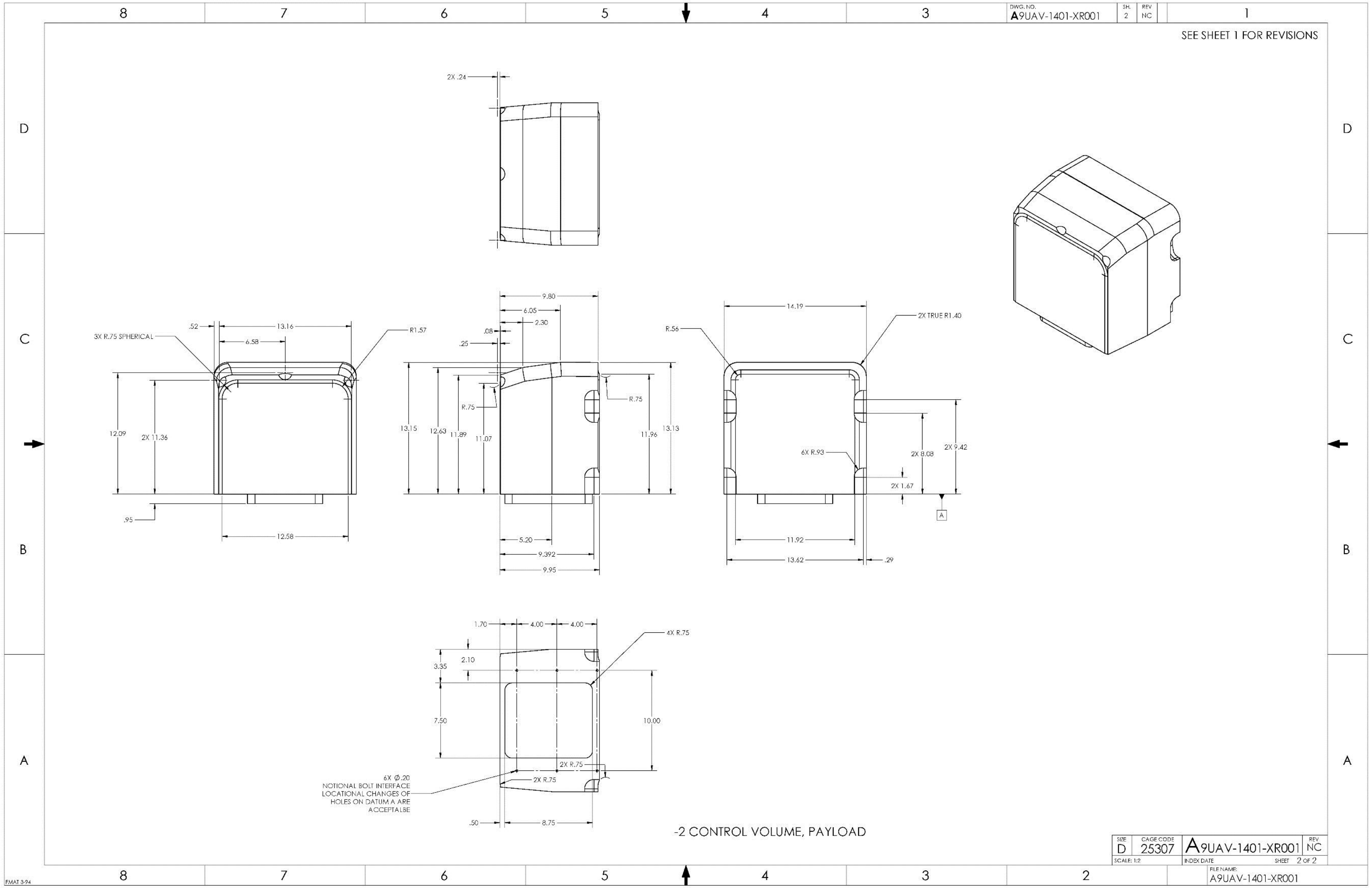
AFSRB	Airworthiness and Flight Safety Review Board
AMO	Aviation Management Office
ARC	Ames Research Center
ASP	Airborne Sciences Program
ATC	Air Traffic Control
BVLOS	Beyond Visual Line of Sight
C	Centigrade
CAD	Computer Assisted Drawing
CCR	Configuration Change Request
CG	Center of Gravity
cm^3	Cubic Centimeters
COA	Certificate Of Authorization
DCP	Document Change Proposal
deg	Degree(s)
EMI	Electro-Magnetic Interference
F	Fahrenheit
FAA	Federal Aviation Administration
FMS	Flight Management System
FRRB	Flight Readiness Review Board
fpm	Feet Per Minute
ft	Feet
ft^3	Cubic Feet
G (or g)	Gravitational Acceleration
GCS	Ground Control System
GPS	Global Positioning System
GPU	Ground Power Unit
GSE	Ground Support Equipment
H	Height
Hz	Hertz
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
in	Inches
in^3	Cubic Inches
INS	Inertial Navigation System
km	kilometers
KIAS	Knots Indicated Air Speed
kg	Kilograms
KHz	Kilohertz
KPH	Kilometers Per Hour
L	Length
m	Meters
m^3	Cubic Meters
MGTOW	Maximum Gross Take Off Weight

MHz	Megahertz
MSL	Mean Sea Level
N/A (n/a)	Not Applicable
NASA	National Aeronautical and Space Administration
NPR	NASA Procedural Requirements
NM	Nautical Miles
RC	Radio Control
RF	Radio Frequency
RSO	Range Safety Officer
SIERRA	Sensor Integrated Environmental Remote Research Aircraft
SL	Sea Level
SLS	Sea Level, Standard Day
TBC	To Be Confirmed
TBD	To Be Determined
UAS	Unmanned Aircraft System
UASAS	Unmanned Aircraft System Airborne Science
U.S.	United States
VAC	Volts, alternating current
VC	Velocity, Cruise (Cruise Speed)
VDC	Volts, direct current
VFR	Visual Flight Rules
VNE	Velocity (Never Exceed)
W	Width

APPENDIX A – MECHANICAL INTERFACE CONTROL

A9UAV-1401-XR001 - MICD - SMALL NOSE VOLUME AND INTERFACE





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SHEET 2 OF 2

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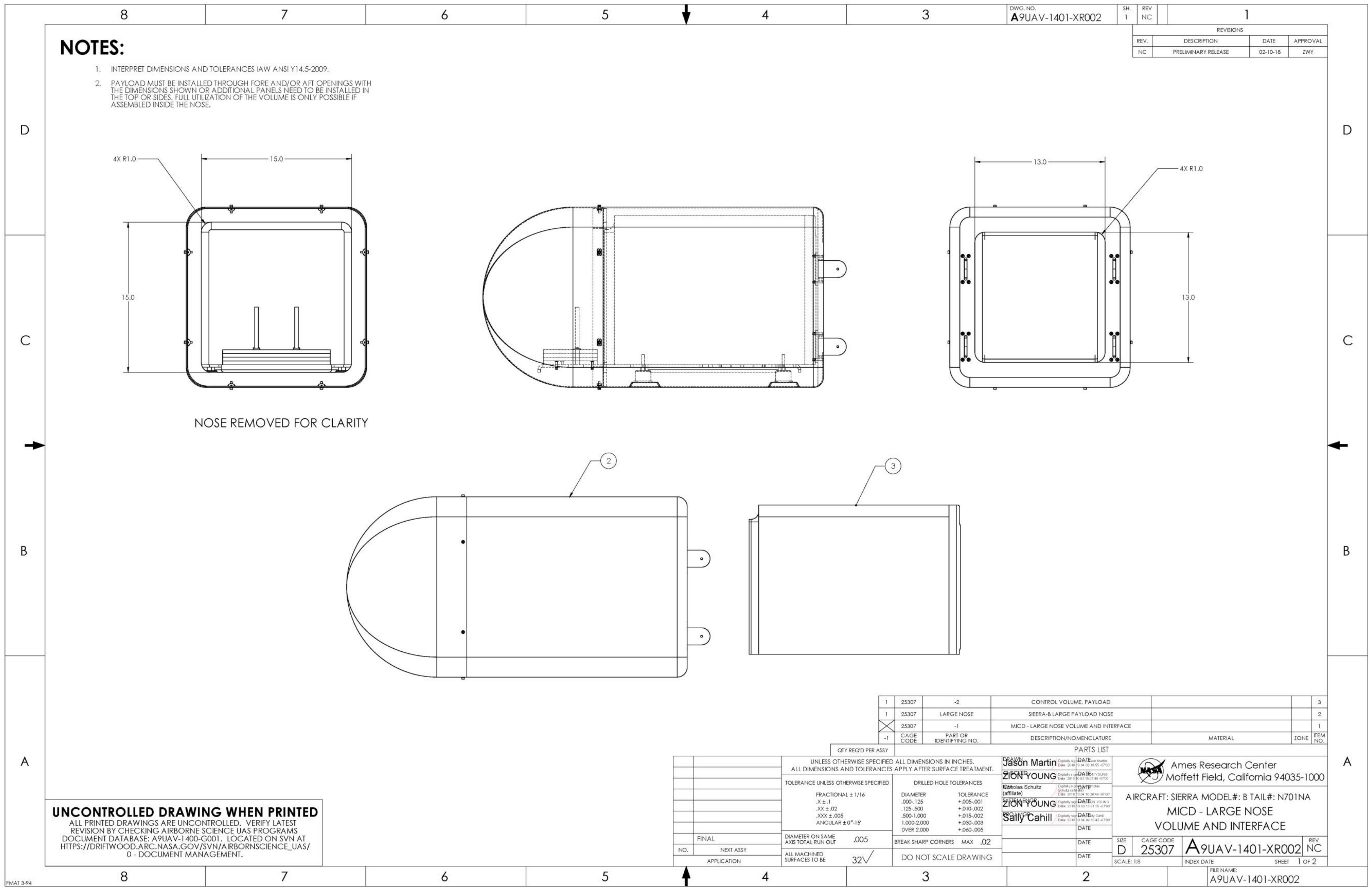

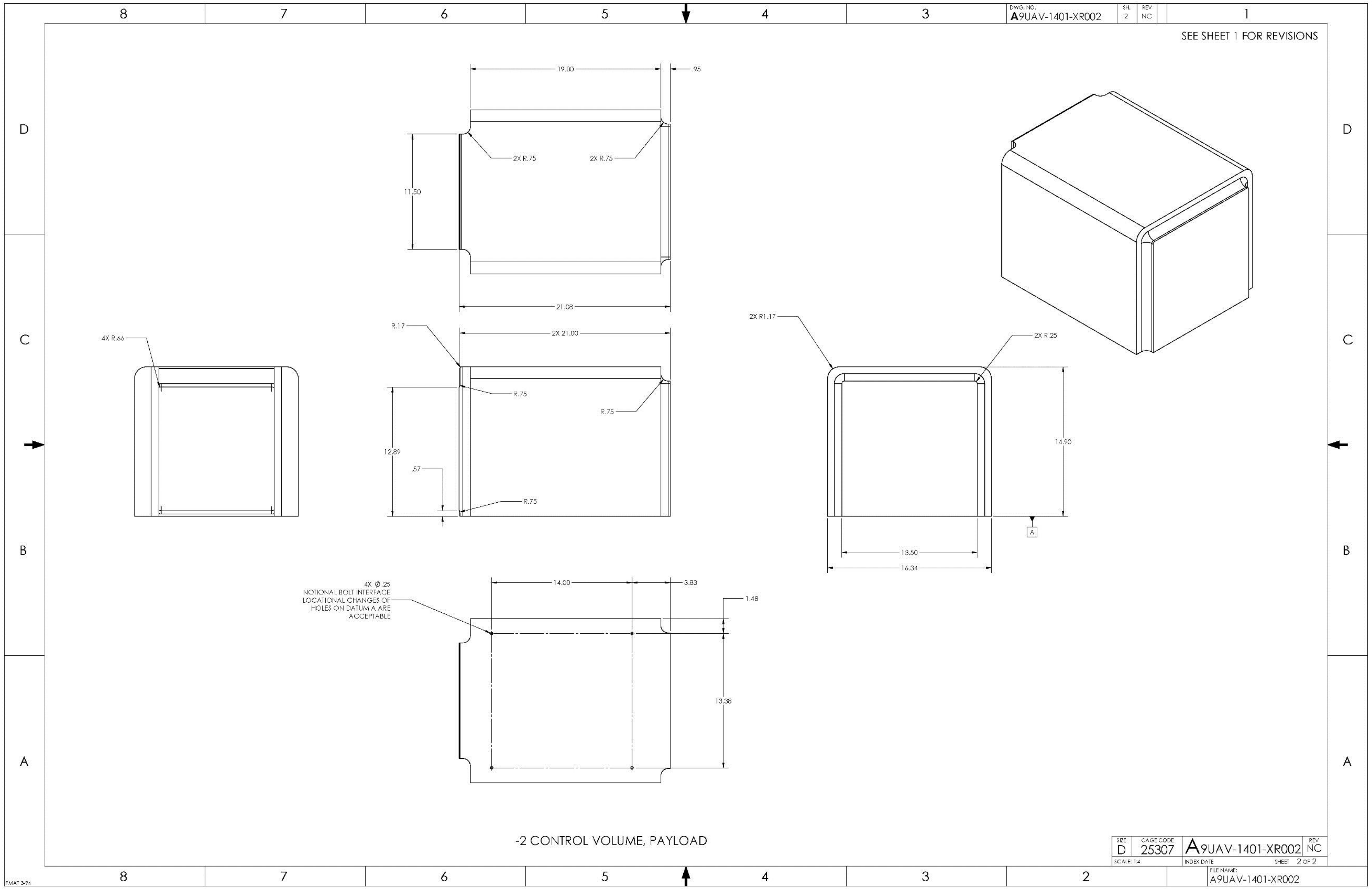
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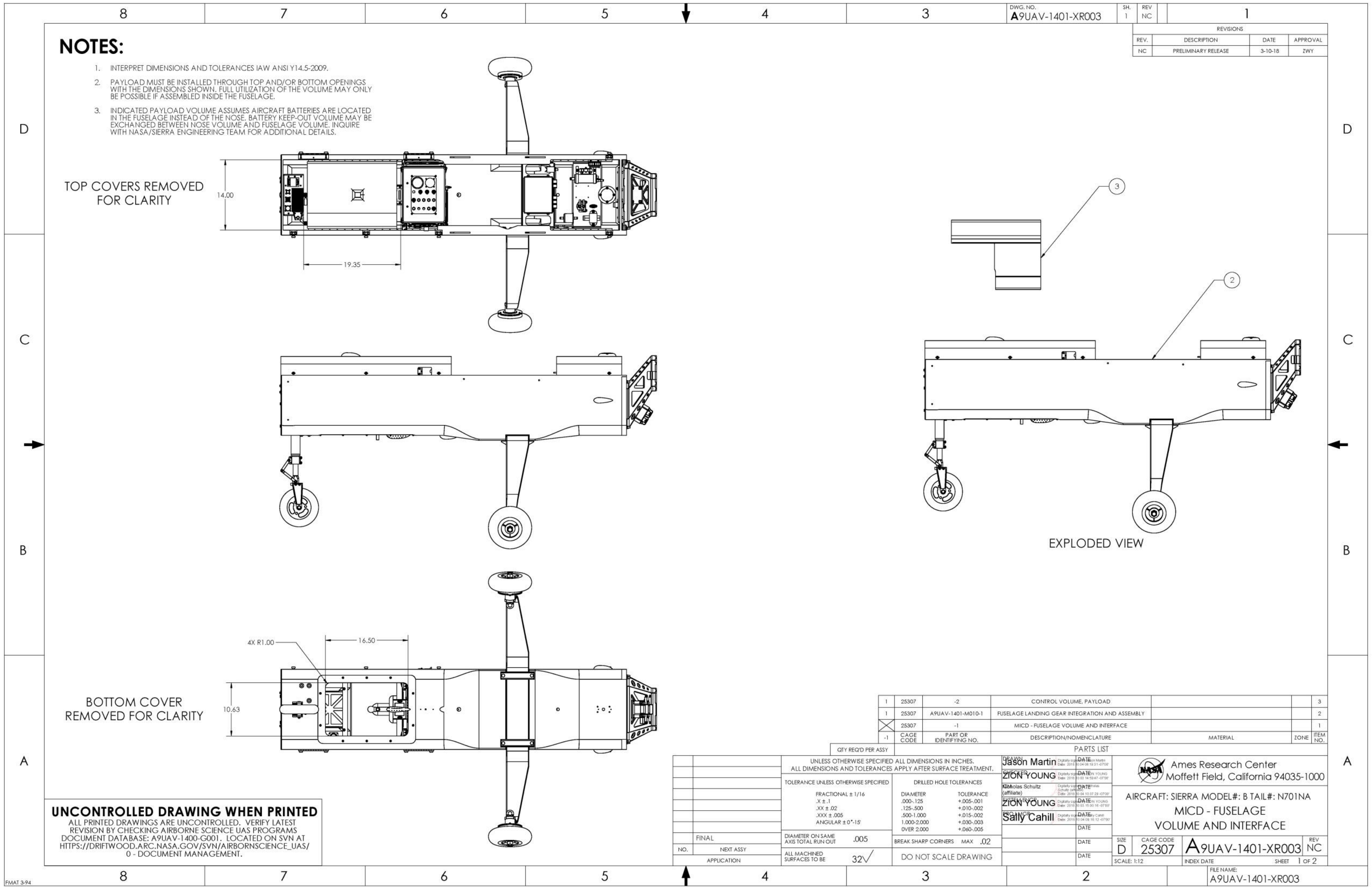
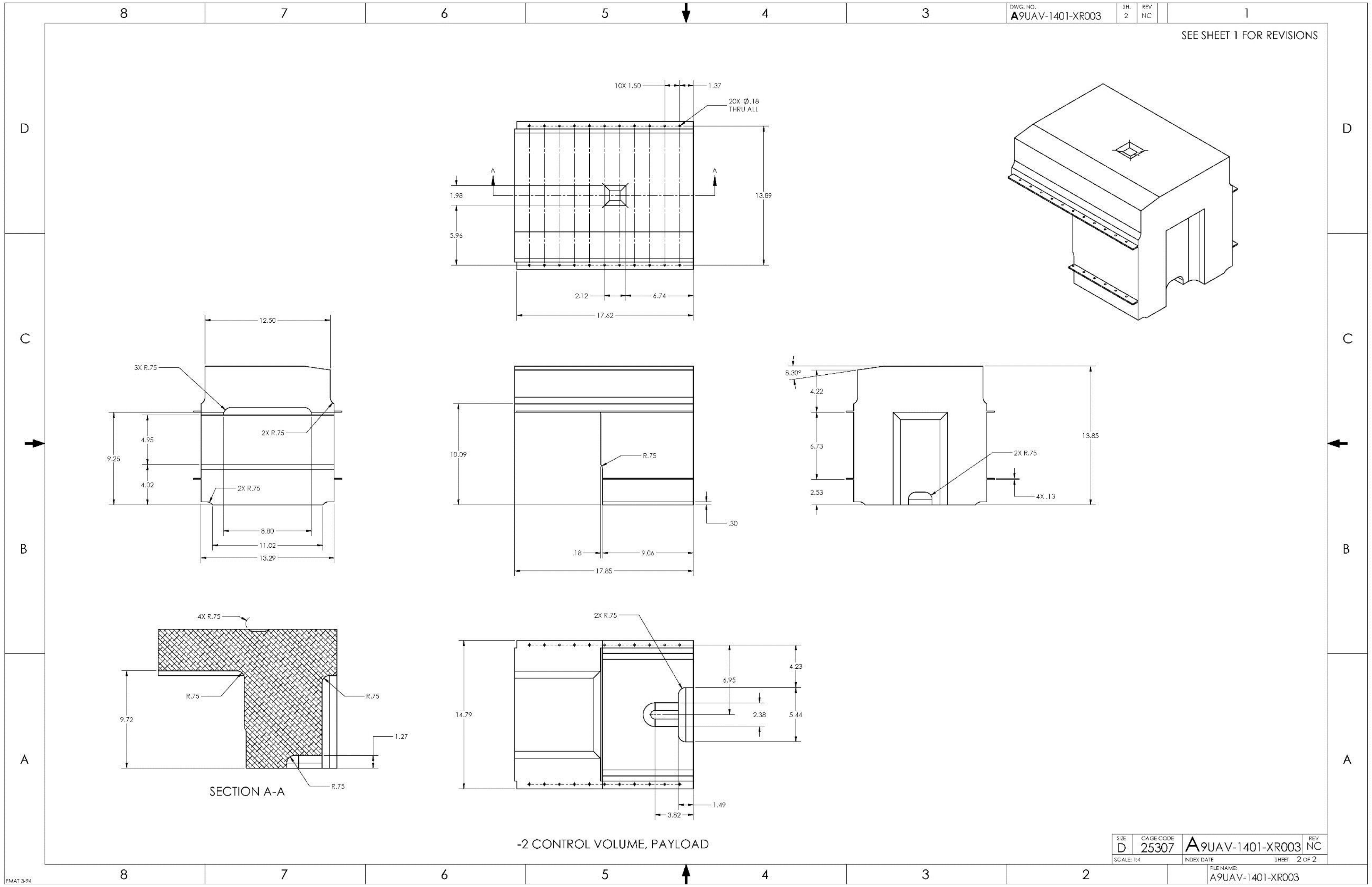
A9UAV-1401-XR003 - MICD - FUSELAGE VOLUME AND INTERFACE





SEE SHEET 1 FOR REVISIONS
A9UAV-1401-XR003
SECTION A-A
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APPENDIX B – ELECTRICAL INTERFACE CONTROL

Electrical Interface

The payload generally has one module, or multiple modules or subsystems distributed in different parts of the aircraft in order to maintain balance requirements with minimal additional ballast weight. Electrical cables, pneumatic tubing, and fluidic plumbing perform interconnection duties between the payload module(s), the aircraft avionics, and external payload antennas and sensors.

Conventions

The convention throughout this document is that for a given interface, the jack is the connector on the fixed side, i.e. mounted on the aircraft or payload module. The plug is the mating connector to aforementioned jack, almost always on the end of a cable.

Requirements – Payload Module

All payload electrical loads drawing power from the aircraft must be fused. Payload must be fail safe in the event of blown fuse, load shedding, or temporary or total loss of power.

While the proper use of small commercial grade batteries (such as AA, AAA, C, and D size Alkaline or Ni-Cd units) is normally acceptable, the use of large numbers of batteries or large capacity batteries, particularity lithium based, may present a significant hazard and therefore require review and approval. For safety considerations, acid type batteries with liquid electrolyte are not permitted.

For payloads mounted in the fuselage belly, an analysis is required to demonstrate that thermal dissipation does not lead to excessive heat buildup in the fuselage.

Requirements – Wiring Harness

All cables harnesses must be assembled per NASA-STD-8739.4 “Crimping, interconnecting cables, harnesses, and wiring.”

Cabling that is external to payload enclosures shall have self-extinguishing insulation, for example any of the MIL-W-22759/11 or /16 series of wire or equivalent.

For some cabling (e.g. CAT6 Ethernet) there is a minimum bend radius which must be observed. Electrical cables, pneumatic tubing, and fluidic plumbing must be dressed and mounted to minimize pinching, abrasion, and chafing. Sufficient length for service loop(s) must be incorporated into cable length values.

Electrical Power Interface

The main aircraft direct current (DC) power bus is supplied by one or more power sources. The amount of regulation and noise environment is dependent on whether power is being provided by the external charger, aircraft batteries, or by the alternator. During engine operation, depending on throttle position large amounts of ripple, transients, DC voltage offsets, dropouts, and random noise can be present on the main aircraft power bus.

The electrical interface between the payload and the SIERRA-B aircraft is the Experimental Interface Panel (EIP) which is mounted just aft of the front bulkhead. Figure 1 is a top view of the EIP, showing three circular connectors, circuit breaker, and solid-state relay. Isolated, regulated power is provided by a Vicor V24A24C400BL full-brick DC-DC converter module and provides approximately 400 Watts of electrical power at a nominal voltage of 24.0 VDC.

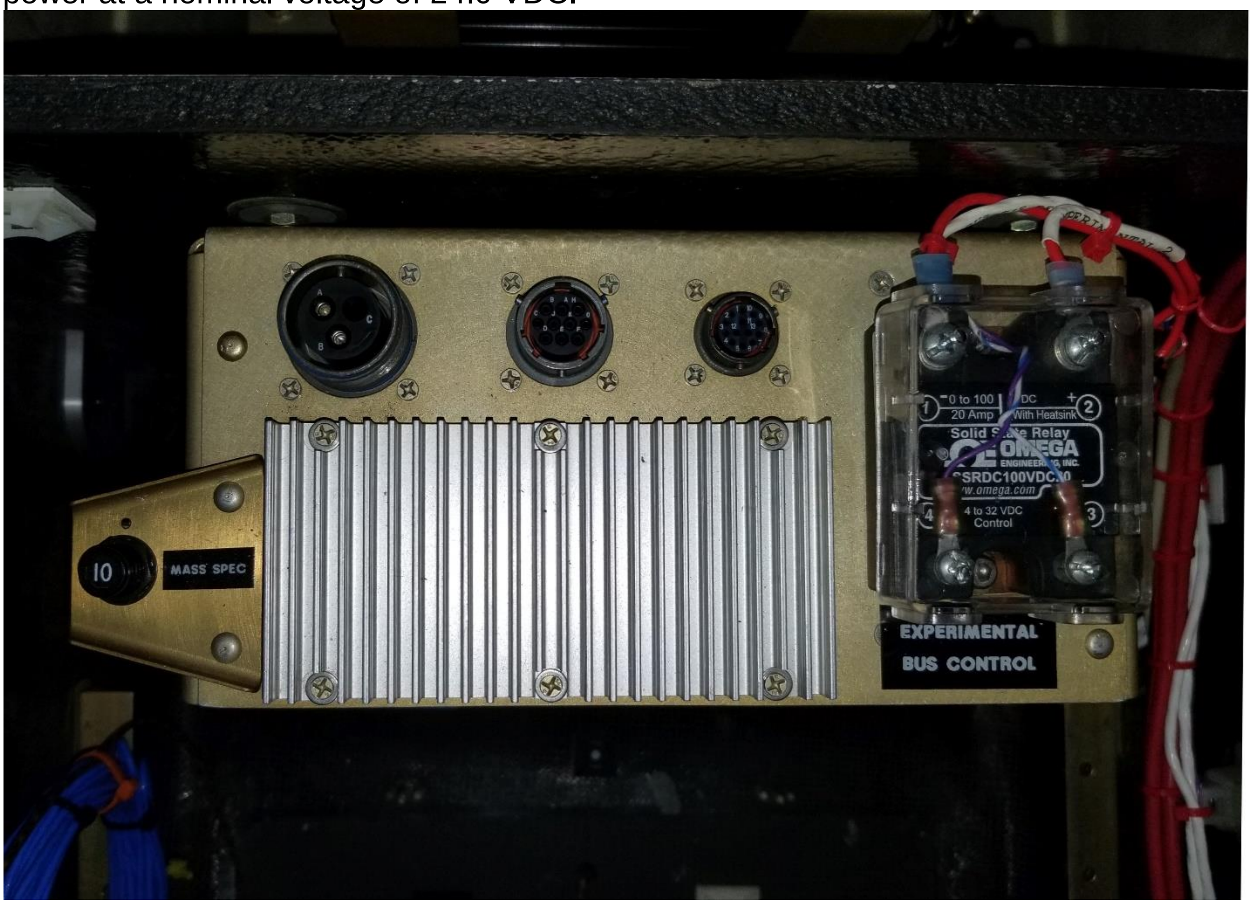

Figure 4 - Top view of Experiment Interface Panel (EIP), showing Vicor DC-DC converter under heat sink.

Operating Voltage

The salient characteristics of the DC power provided by the aircraft to the payload at the EIP is summarized in Table. This electrical power is provided to the jack designated as EIP-J1.

Table 1: SIERRA-B Payload Supply Voltage

MODE	VOLTAGE	NOISE
Battery Only	24.0 VDC ±1% fully charged	See note
Charger & Battery (Ground Ops)	24.0 VDC ±1%	See note
Alternator & Battery (Flight Ops)	24.0 VDC ±1%	See note

Because a switching power supply is used to provide payload power there will be ripple, switching transients, dropouts, random noise, and radio-frequency EMI present on the power provided by the aircraft to the payload.
A prudent payload design would include careful attention to power supply filtering, transient protection, power-on-reset, and other measures to maximize immunity to noise and faults on the power supply.

Operating Power

The maximum amount of power provided by the aircraft to the payload at the EIP is 400 Watts, corresponding to roughly 16.6 Amps continuous at a nominal 24 VDC output.

Continuous and Inrush Current

The maximum amount of continuous current provided by the aircraft to the payload is limited by a circuit breaker, shown on the left of the EIP in Figure 1. The specific circuit breaker rating is selected to suit the absolute maximum ampacity demanded by the payload, and Table 2 shows an example list of aircraft-grade circuit breakers and their ratings.

Table 2: SIERRA-B Payload Continuous and Inrush Current

Tyco Part No.	Rating (Amps)	Inrush (Amps)
W23-X1A1G-1	1.0	2.0 < 11 sec
W23-X1A1G-2	2.0	4.0 < 11 sec
W23-X1A1G-3	3.0	6.0 < 11 sec
W23-X1A1G-5	5.0	10.0 < 6 sec

W23-X1A1G-7.50	7.5	15.0 < 6 sec
W23-X1A1G-10	10.0	17.0 < 6 sec
W23-X1A1G-15	15.0	17.0 < 6 sec

Under no conditions may a payload draw more than a 15 Amps continuously. Generally the maximum surge or inrush current of the payload shall be limited less than double the circuit breaker rating or 17.0 Amps, whichever is less.
Note that all current ratings are specified for 25°C [77°F] and should be reduced for elevated temperatures. For example, for the W23-series at 35°C [95°F] the values in table 2 would be derated by a factor of 0.92, and at 45°C [113°F] the derating is 0.84. Refer to the circuit breaker manufacturers specifications for details and the full derating curve.

Load Shedding

A relay in series with the payload power supply permits the payload to be disconnected from the 24 VDC power supply via command from the ground station. This is to allow aircraft engine load-shedding in the case of a malfunctioning payload or other off-nominal conditions. In practice load shedding would be a rare occurrence however is performed at the sole discretion of the Pilot in Command or other authorized personnel, without notice.

Electrical Data Interface

The Auxiliary Interface Panel (AIP) is a secondary panel located amidships, that permits straightforward connectivity to the avionics, as shown in Figure 2. Like the EIP, the AIP will have a number of connectors to facilitate payload-to-avionics interconnection that will be described in subsequent sections of this document.

Figure 5: Top view of Auxiliary Interface Panel (AIP) and D-subminiature connectors. The AIP features a number of RS-232 ports, dummy jacks to permit parking of avionics cable plugs when not in use, and facilities for straightforward routing of payload cables to the AIP and fixing them in place.

Autopilot

The AIP provides communication with the Piccolo II autopilot and compass via serial RS-232, Pulse Width Modulation (PWM), and Time Processor Unit (TPU) channels. Table 3 shows one possible configuration for the 9-pin D-subminiature connectors shown with both of the aircraft plugs disconnected and "parked" on the dummy jacks, which are not connected (NC).

Table 3: Typical AIP Serial RS-232 Ports and Dummy Connector Configurations

AIP LABEL	TYPE	NO PAYLOAD INSTALLED	PAYLOAD OPTION
COM1 DUMMY	Jack (NC)	-	Plug from transponder cable
COM1 RS-232	Jack	Plug from transponder cable	Plug from payload cable
COM3 RS-232	Jack	Plug from aircraft radio cable	Plug from payload cable
COM3 DUMMY	Jack (NC)	-	Plug from aircraft radio cable

It is <u>not</u> recommended to use the AIP unless absolutely necessary for payload operation, as additional risk analysis will be required.
ALL PAYLOAD ELECTRICAL CONNECTIONS THAT INTERFACE WITH THE AUTOPILOT SHALL BE ISOLATED USING AN OPTICAL ISOLATOR OR BY SOME OTHER MEANS.

Compass

A Honeywell HMR3000 compass is located in the starboard outer wing, and is powered by the aircraft. This is a dedicated sensor for payload use, and the RS-232 signal is available at the AIP via the 15-pin Auxiliary connector AIP-J3. Refer to the HMR3000 data sheet for details.

CANBUS

A second CANBUS interface is included on the AIP as AIP-J4. This is for future expansion and is not to be used for payload purposes. There is a 120-ohm termination at the autopilot, and there must be a second 120-ohm termination resistor on the far end of the CANBUS.

List of Connectors

This section states the general function, the name of the connector, the type, polarization, principle of the shielding connection points, and any ground support interfaces for the payload. Table summarizes the salient characteristics of the aircraft connector jacks that are available to interface to the payload on the EIP and AIP.

Table 4: SIERRA Aircraft Electrical Connector Jacks.

Sub-system	Desig-nator	Type, Part Number	Function	Description	Location
Power	EIP-J1	MS3452W16-13S	Power	24 VDC	On EIP
N/A	EIP-J2	MS3470W12-10S	Not Connected	For future use	On EIP
N/A	EIP-J3	MS27472E10B-35S	Not Connected	For future use	On EIP
Autopilot	AIP-J1	M24308/4-1	RS-232	COM1	On AIP
Autopilot	AIP-J2	M24308/4-1	RS-232	COM3	On AIP
Autopilot	AIP-J3	M24308/4-2	Auxiliary	PWM, TPU	On AIP
Autopilot	AIP-J4	MWDM2L9PSP	CAN Bus	For future use	On AIP

Power Connector

Electrical power is provided by the aircraft to the payload via the connector EIP-J1 on the EIP. The pinout for this circular connector is described by Figure 3 and Table 5.

Figure 6. EIP-J1 connector and pin numbering.

Table 5: Pinout for the connector to the SIERRA-B payload power supply.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
A	Power	24POS	24 Volt Power Supply	Power
B	Power	24RTN	24 Volt Power Return	Power Return
C	NC			

Serial RS-232 Interface (COM1)

Access to the COM1 serial interface of the Piccolo II autopilot is provided by the connector AIP-J1 on the AIP. The pinout for this 9-pin D-subminiature connector is described by Figure 4 and Table 6. The connector is a male jack with a reduced pinout corresponding to Data Terminal Equipment (DTE) in the RS-232 standard. Note that only three (3) of the full complement of RS-232 wires are used.

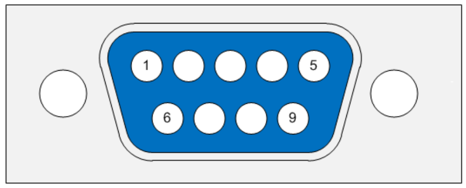

Figure 7: AIP-J1 connector and pin numbering.

Table 6: Pinout for RS-232 serial COM1 connector to the SIERRA-B autopilot.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1	NC	DCD	Data Carrier Detect	Input
2	Autopilot	RXD	Receive Data	Data Input
3	Autopilot	TXD	Transmit Data	Data Output
4	NC	DTR	Data Terminal Ready	Output
5	Ground	GND	Signal Ground	Ground
6	NC	DSR	Data Set Ready	Input
7	NC	RTS	Request to Send	Output
8	NC	CTS	Clear to Send	Input
9	NC	RI	Ring Indicator	Input

Serial RS-232 Interface (dummy)

This connector is for safe stowage of the SIERRA's transponder cable when it is not connected to the autopilot COM1 port via AIP-J1. The pinout for this 9-pin D-subminiature connector is described by Figure 4 and Table 7.

Table 7: Pinout for RS-232 parking connector.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1-9	NC	N/A	N/A	NC

Serial RS-232 Interface (COM3)

Access to the COM3 serial interface of the Piccolo II autopilot is provided by the connector AIP-J2 on the AIP. The pinout for this 9-pin D-subminiature connector is described by Figure 5 and Table 8. The connector is a male jack with a reduced pinout corresponding to Data Terminal Equipment (DTE) in the RS-232 standard. Note that only three (3) of the full complement of RS-232 wires are used.

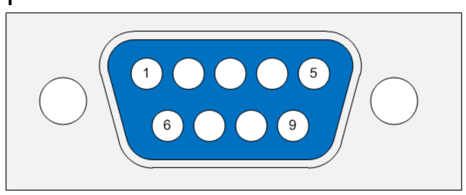

Figure 8: AIP-J2 connector and pin numbering.

Table 8: Pinout for RS-232 serial COM3 connector to the SIERRA-B autopilot.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1	NC	DCD	Data Carrier Detect	Input
2	Autopilot	RXD	Receive Data	Data Input
3	Autopilot	TXD	Transmit Data	Data Output
4	NC	DTR	Data Terminal Ready	Output
5	Ground	GND	Signal Ground	Ground
6	NC	DSR	Data Set Ready	Input
7	NC	RTS	Request to Send	Output
8	NC	CTS	Clear to Send	Input
9	NC	RI	Ring Indicator	Input

Serial RS-232 Interface (dummy)

This connector is for safe stowage of the SIERRA's transponder cable when it is not connected to the autopilot COM3 port via AIP-J2. The pinout for this 9-pin D-subminiature connector is described by Figure 4 and Table 9.

Table 9: Pinout for RS-232 parking connector.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1-9	NC	N/A	N/A	NC

Serial Auxiliary Connector

Access to additional signals of the avionics is provided by the connector AIP-J3 on the AIP. The pinout for this 15-pin D-subminiature connector is described by Figure 6 and Table 10.

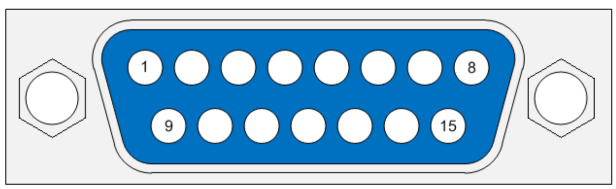

Figure 6: AIP-J3 connector and pin numbering.

Table 10: Pinout for auxiliary serial communications to the SIERRA autopilot.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1	NC			
2	Autopilot	GND	SERVO_2_RTN	Ground
3	Autopilot	PWM11	TPU_B[4]	TPU I/O
4	Ground	GND	Spare Ground	Ground
5	Autopilot	PWM10	TPU_B[3]	TPU I/O
6	Ground	GND	Spare Ground	Ground
7	Compass	GND	Compass Ground	Ground
8	Compass	RXD	Compass RXD	Input
9	Autopilot	PWM02	SERVO_2_PWM	PWM Output
10	NC			
11	Autopilot	GND	TPU_B[4]_RTN	Ground
12	Autopilot	GND	TPU_B[3]_RTN	Ground
13	NC			
14	NC			
15	Compass	TXD	Compass TXD	Output

SECONDARY CANBUS

The CANBUS interface is for future expansion hardware-in-the-loop testing, and is not to be used by any payload. There is a 120-ohm resistor termination at the source end of the CANBUS_B interface at the Piccolo II autopilot. The pinout for this 9-pin micro-D connector is described by Figure 7 and Table 11.

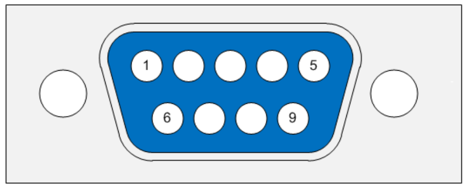

Figure 7: AIP-J4 connector and pin numbering

Table 11: Pinout for secondary CANBUS connector to the SIERRA-B autopilot.

PIN	CONNECTION	ID	SIGNAL NAME	TYPE
1	NC			
2	Autopilot	CANL	CANBUS Data	I/O
3	NC	V+	Power	Power
4	NC			
5	Ground	SHIELD	Chassis Ground	Ground
6	Autopilot	GND	Signal Ground	
7	Autopilot	CANH	CANBUS Data	I/O
8	NC			
9	NC	V+	Power	Power

GROUND STATION EQUIPMENT CONNECTED TO THE SECONDARY CANBUS INTERFACE MUST HAVE A 120 OHM TERMINATION RESISTOR PRESENT AT THE FAR END OF THE CANBUS CABLE.

LIST OF MATING CONNECTORS

Mating connectors for payloads attaching to the aircraft are listed below. Specification does not constitute endorsement by NASA or the US Government.

Table 4: SIERRA Aircraft Electrical Connector Jacks.

Subsystem	Plugs Into	Part Number	Function	Description	Type
Power	EIP-J1	TBD	Power	3-pin circular	Plug
Autopilot	AIP-J1, J2	M24308/2-1	RS-232	9-pin D	Plug
Autopilot	AIP-J3	M24308/2-2	Auxiliary	15-pin D	Plug

Aircraft Ground System (AGS)

The aircraft structure serves as the “earth” ground, specifically the starboard aluminum rail on the inside of the fuselage avionics bay. Payload chassis grounds should have good continuity to this ground bus, it is recommended to use AA59569 type plated copper braided conductor for ground bonding, and multiple payload modules should be “star” grounded.

There is a test point is identified by the gold-plated screw head on the upper starboard rail. Metallic payload enclosures should demonstrate < 50 milliohms resistance to this test point.

Payload antennas are usually mounted externally, and their placement is constrained by proximity limits to existing telemetry antennas. The composite aircraft structure does not offer any conductive path to ground or any kind of ground plane. Payload antennas should be grounded via their connections to their respective transmitter/receiver/transceiver.