GO FET Payload Users Guide

Point of Contact:
Kevin Feld
Director of Engineering
Generation Orbit Launch Services, Inc.
3353 W Hospital Ave
Atlanta, GA 30341
kevin.feld@generationorbit.com
1+404.991.2214

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Revision History

Date	Version	Description
9-25-2014	1.0	Initial Release

Introduction

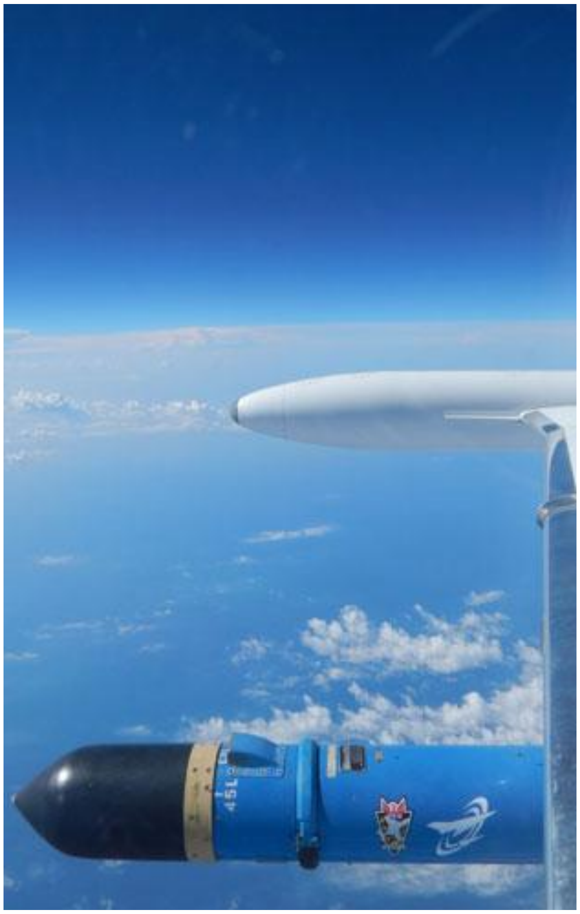

Figure 1. View of pod during flight.

The GO Flight Experiment Test Bed (GO FET) is a captive carry flight test platform for experimentation, demonstration, and qualification of technologies and operational procedures relevant to aerospace applications. Applications include horizontal space launch operations, launch range integration, and avionics hardware and software qualification for autonomous systems. The system consists of a carrier aircraft, a wing-mounted ALQ-167 pod, power management and distribution system, data acquisition system, and set of flight test engineer stations in the cabin. The system is capable of flying a wide range of missions from low to high altitude at speeds of up to Mach 0.81. Figure 1 shows the system at 35,000 ft in preparation for a mock space launch maneuver.

ALQ-167 pods are traditionally used for electronic warfare training and threat radar simulation. In the context of GO FET, they are customized to contain a data acquisition system and payloads to be tested. The pod has two radomes with ram scoops and options for additional external antennas allow communications equipment to be tested in flight. A description of the pod is given in Figure 2. GO's data acquisition (DAQ) system is modular and currently supports logging differential and single ended analog signals, as well as several common digital interfaces. In addition to logging data, the DAQ can also be used to control experiments in the pod. Details of the GO FET architecture are given in Figure 3. The cabin of the Learjet 35/36 provides seats for up to two flight test engineers and contains three flight test engineer stations.

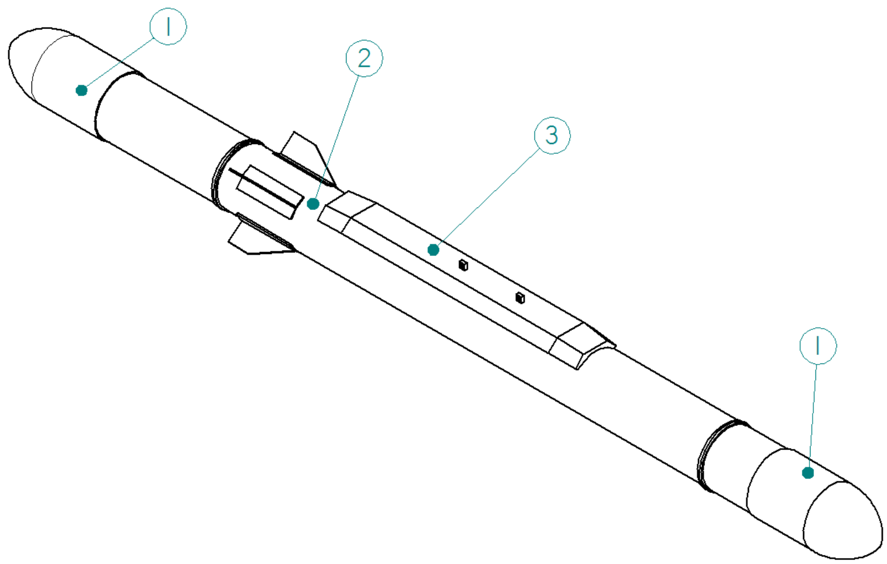

Figure 2. ALQ-167 Pod: Radomes (1), Centerbody (2), and Strongback (3)

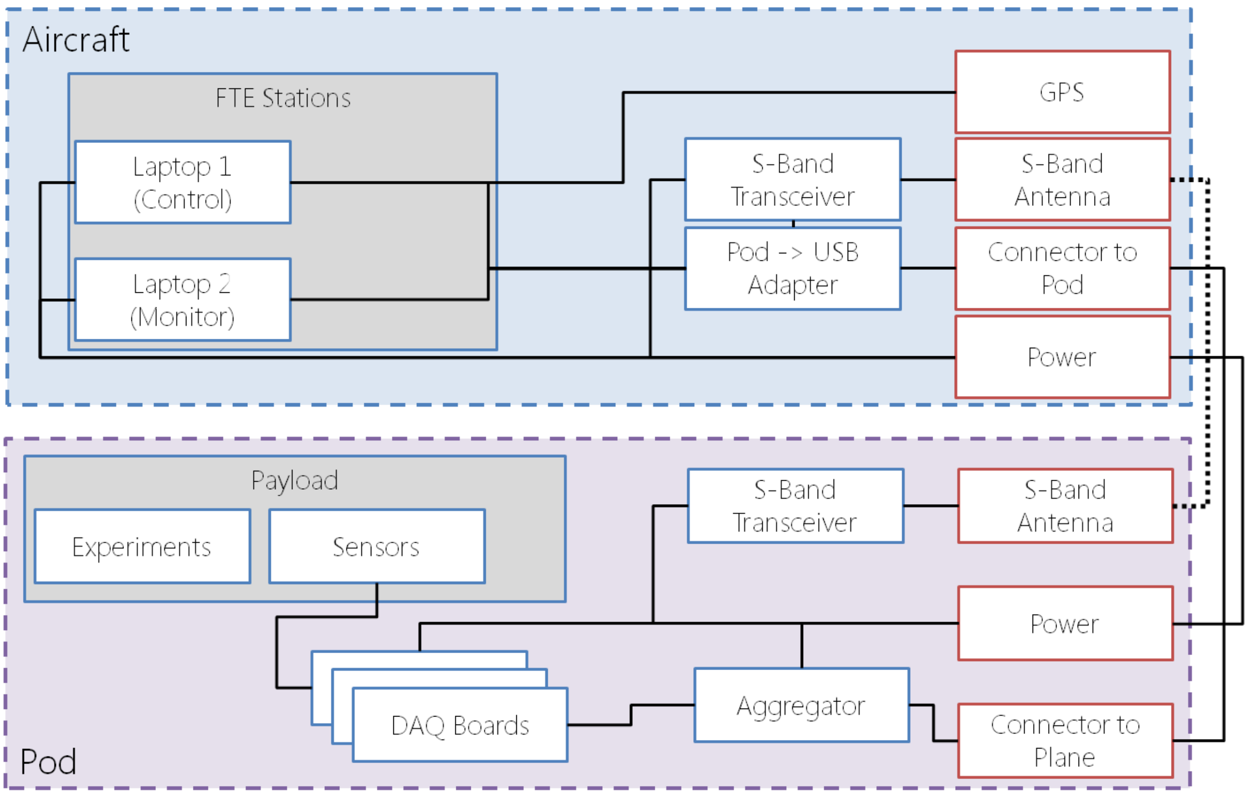

Figure 3. GO FET Block Diagram

Applications

The GO Flight Experiment Testbed offers a low cost platform for flight test and experimentation primarily geared toward aerospace applications. Utilization of flight testing early in a system or subsystem design can often make a substantial contribution to early-stage risk reduction or technology maturation for unmanned aerial systems, airborne intelligence, surveillance, and reconnaissance (ISR) sensor packages, and nanosatellites. Captive carry flight aboard the GO FET offers a relevant environment for:

- Navigation sensor testing and calibration
- Guidance, navigation, and control (GN&C) software verification and validation
- Communication system test and evaluation
- IMINT, SIGINT, and MASINT sensor testing

Additionally, the platform is well suited to educational outreach activities as a means of promoting Science, Technology, Engineering, and Math (STEM). Much like high altitude balloon and CubeSat programs, the GO FET provides a platform to both K-12 schools and universities that challenges students and educators to design, develop, test, and fly experiments. Projects of this nature teach students the value of sound technical thinking and planning, while also allowing them to develop the hardware and software necessary to gather flight test data and solve real-world problems.

GO's scalable hardware setup allows for straight-forward integration with customer payloads. Further, customers concerned primarily with generating data can lean on GO's experience with the GO FET platform to develop both the test plan and payload capable of gathering customer-specified data.

Services

GO provides a range of services to meet customer needs for both standardized and customized flight testing and qualification needs. Depending on customer requirements, schedule, and payload hardware, GO will provide services as necessary including systems engineering, flight planning, payload integration, and flight test engineering. Standard services on-board the pod are available for power, data recording and data processing. Standard services on-board the aircraft are available for payload control, payload monitoring, and data recording. Customized data acquisition and Flight Test Engineering stations can be developed as needed. Detailed capabilities and services are outlined below in Table 1.

Table 1. GO FET Capabilities and Services

Capability	Service
Systems Engineering	Test objectives and requirements definition, requirements traceability, quality and mission assurance
Flight Planning	Flight test campaign development, maneuver definition, customer flight plan implementation
Payload Design, Integration, and Support	Custom payload design, custom payload mounting interface, data acquisition, data storage, custom power management and distribution
Standard Sensor Package	Pod internal environment including pressure, temperature, and humidity; Flight inertial environment including 3 axis accelerometer, gyro, magnetometer, and GPS
Flight Test Engineering	Data display and payload control on Flight Test Engineering Stations with 1 to 2 seats for available for customer engineers. In-cabin features include support for equipment mounting, laptop RAM mounts, a cockpit camera, and voice communication with ground

Operations

Payload Design, Testing, Integration, and Checkout

For GO-developed payloads, the customer will first communicate flight test objectives to GO and work with GO to establish payload requirements. GO will then create a project schedule and conceptual design for the payload. GO will proceed to create a design for the payload as well as any supporting electronics and software. Following a design review with the customer, GO will fabricate and test the payload. With approval of the customer, GO will then proceed to flight operations. The standard milestones for missions with GO-developed payloads are given in Table 2. Mission-specific schedules are prepared and reviewed at the Kickoff Meeting and may deviate from the standard schedule based on mission and payload complexity.

Table 2.Standard Milestones for Missions with GO-developed Payloads

Milestone	Schedule
Kickoff Meeting	ATP + 1 week
Mission Requirements Review	KO + 1 week
Payload Design Review	MRR + 3 weeks
Systems Integration Review	PDR + 4 weeks
Test Readiness Review	SIR + 1 week
Flight Test Operations	TRR + 1 week
Quick-Look Reporting	FTO + 1 day
Post Flight Reporting	FTO + 4 weeks

Table 3.Standard Milestones for Missions with Customer-developed Payloads

Milestone	Schedule
Kickoff Meeting	ATP + 1 week
Mission Requirements Review	KO + 1 week
Systems Integration Review	PDR + 3 weeks
Test Readiness Review	SIR + 1 week
Flight Test Operations	TRR + 1 week
Quick-Look Reporting	FTO + 1 day
Post Flight Reporting	FTO + 4 weeks

For customer-developed payloads, GO will work with the customer to understand mechanical, power, and data interface requirements as well as any mission-specific instrumentation needed. The standard milestones for missions with customer-developed payloads are given in Table 3. Mission-specific schedules are prepared and reviewed at the Kickoff Meeting and may deviate from the standard schedule based on mission and payload complexity. Customer participation is required for pre-flight planning activities. Customer participation is encouraged but not required for ground testing, and flight testing.

Data Acquisition (DAQ) System

The GO FET data acquisition system can stream a subset of experiment data to the plane in real time, while the full data set is stored within the pod. The down-sampled data can be viewed in real time on the flight test engineer stations. The following sensor interfaces are currently supported by the DAQ:

- 16 bit ADC with PGA, single ended and differential modes at 100ksps
- 24 bit ADC with PGA, single ended and differential modes at 4.8ksps
- SPI
- I2C
- USB

Additional interfaces can be implemented to meet customer requirements.

Flight Operations

Carrier aircraft is nominally based out of Cartersville-Bartow County Airport in Cartersville, GA. Flight operations will typically occur in special-use airspace over the Gulf of Mexico or Atlantic Ocean. However, the GO FET is capable of basing out of most regional airports globally, depending on customer requirements. Customer requirements for specific airspace utilization are evaluated upon request. Payload may generally be accessed up to two hours before and less than an hour after flight. Carrier aircraft has seats for up to two flight test engineers.

Aircraft Performance

The GO FET aircraft platform is a Learjet 35/36 business jet, owned and operated by Phoenix Air Group (PAG) from Cartersville-Bartow County Airport in Cartersville, GA. The flight configuration of the ALQ-167 pod and the Learjet 35/36 is shown in Figure 4.

PAG is a unique, international aircraft services company the offers solutions to a wide variety of air transportation and related aircraft service needs of industry and government. As a FAA-certificated Part 135 airline with worldwide operating authority, Phoenix Air provides executive and group passenger service, worldwide air ambulance service and high priority air cargo service, including the transport of explosives and dangerous goods. Its military contracting wing, Phoenix Force, is the world's leading provider of contracted airborne electronic warfare and weapons training/testing services for the United States Department of Defense, NATO and foreign military forces. Phoenix Air's fleet of highly modified aircraft haven successfully performed military airborne services such Electronic Attack (EA), Electronic Warfare (EW), Electronic Counter Measures (ECM), Electronic Counter-Counter Measures (ECCM), Communications Jamming, Target Towing, Target Drone Launch, and Data Relay.

Figure 4. GO FET Flight Configuration

The Learjet 35/36 is certified in the Restricted category under a Supplemental Type Certificate to carry externally mounted target towing packages and carriage of electronic countermeasure pods, including the ALQ-167. The aircraft is certified to fly under visual flight rules (VFR), instrument flight rules (IFR), day, and night. The operational flight envelope for the Learjet 35/36 is given in Figure 5. Flight load acceleration limits are +3g to -1g (flaps up) and +2g to 0g (flaps down). Aerobatic maneuvers may not be conducted without specific flight test approval.

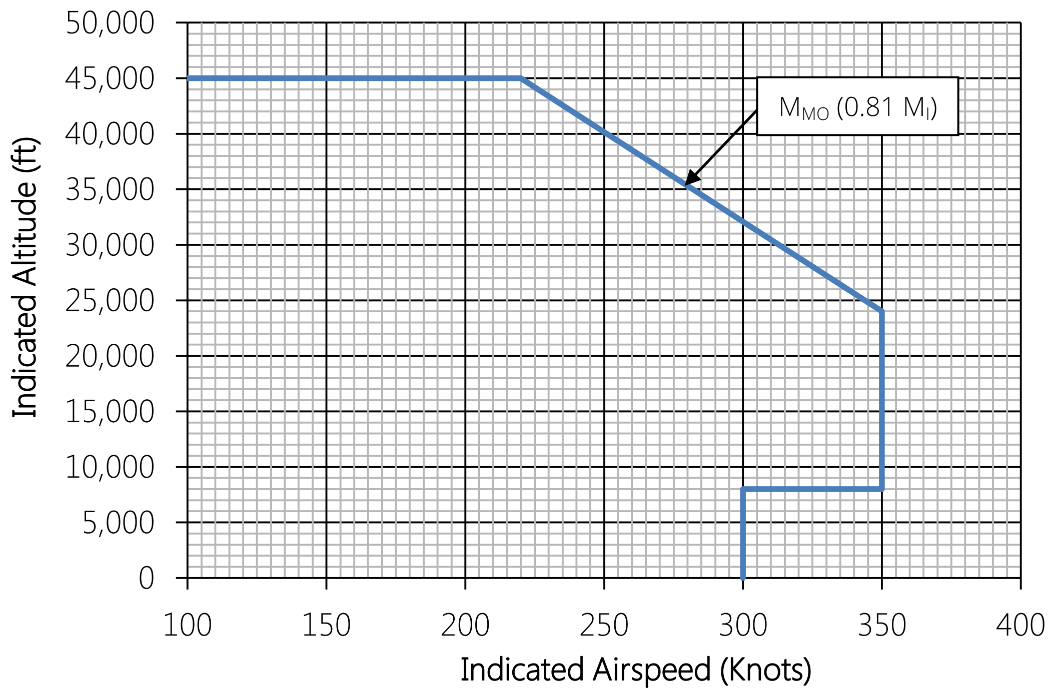

Figure 5. Learjet 35/36 Performance Envelope

Payloads

Payloads must comply with relevant regulatory requirements. Additionally, payloads are also subject to safety approval by the aircraft operator. Payload mass properties cannot move the ALQ-167 pod CG outside of the acceptable range. Contact GO for guidance.

Mechanical Interface

Figure 6 shows a top view of the tray along with standard hole patterns. Figure 7 shows cross sections of the pod with the standard tray configuration. Custom interfaces can be developed at customer request to provide different mounting interfaces, or to increase the maximum payload height.

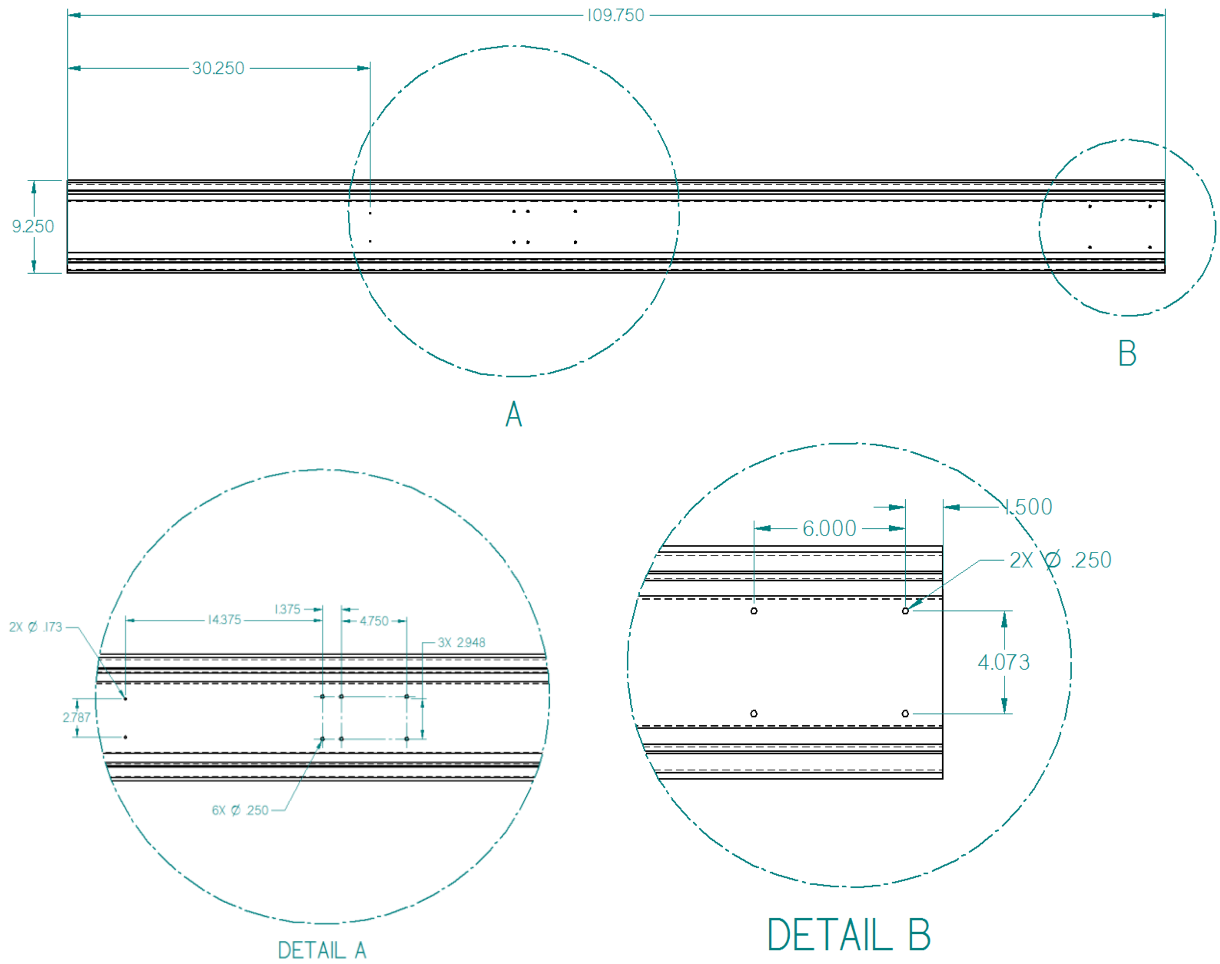

Figure 6. Standard Payload Mounting Tray

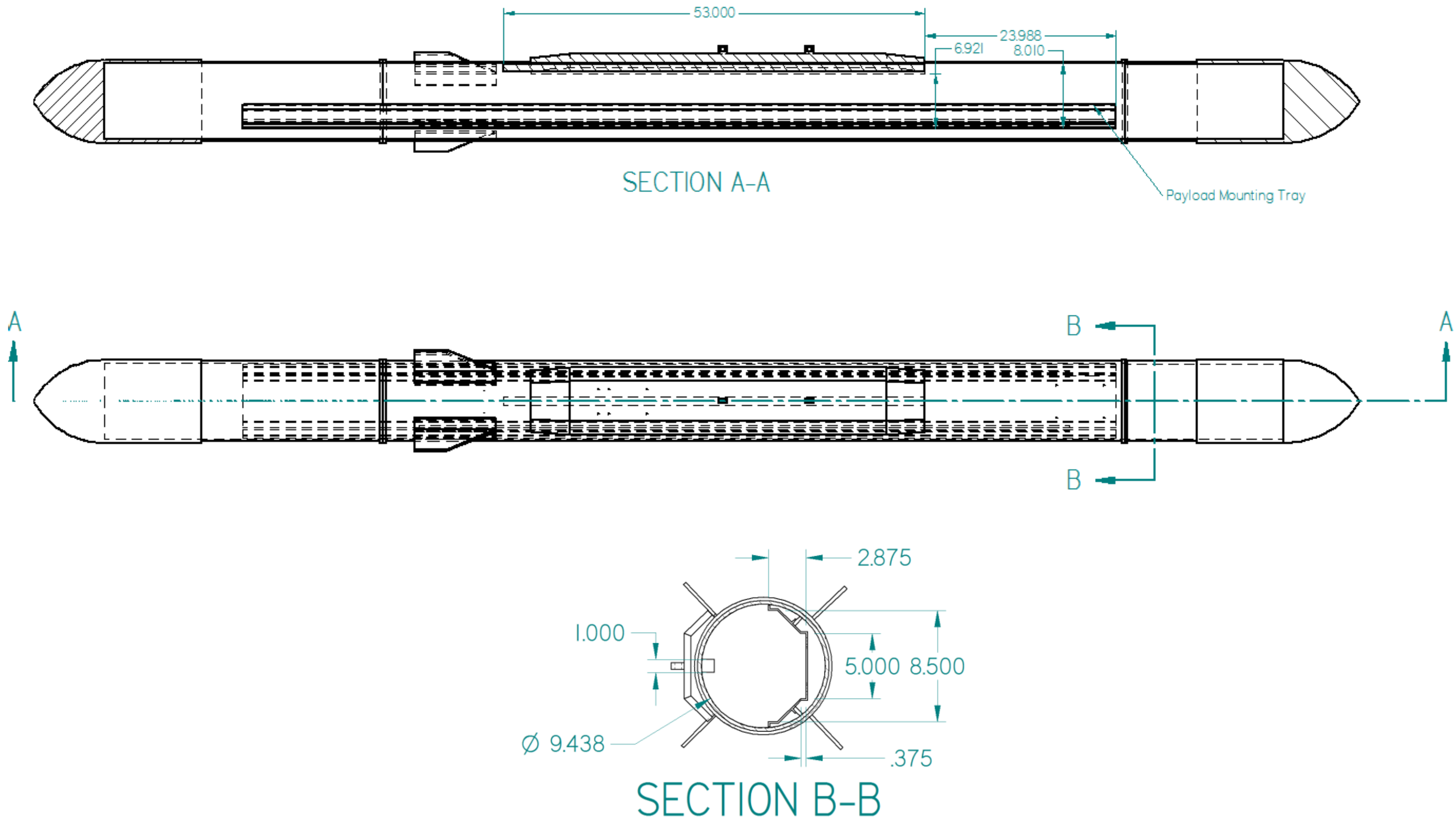

Figure 7. Cross Sections showing payload volume

Electrical Interface

A 55 pin Mil-spec connector is used to provide power to the pod, receive data from the pod, and send commands. Standard power supplies are 2 phase (120V) and 3 phase (115V and 200V) AC power, 26VDC (aircraft power), and 12VDC. GO is capable of meeting custom power and voltage requirements for systems requiring up to 60 amps at any of the listed voltages. Batteries may be used in the pod if they comply with aircraft operator safety requirements.

Environment

The thermal environment depends largely on the flight profile, location, and time chosen by the customer. The internal air temperature and pressure conditions within the pod have been shown to be extremely close to the stagnation conditions of the free stream when the ram scoop is open. Figure 8 provides a guideline for temperature environment that payloads may be subjected to, but actual values will vary depending on flight profile and flight test location.

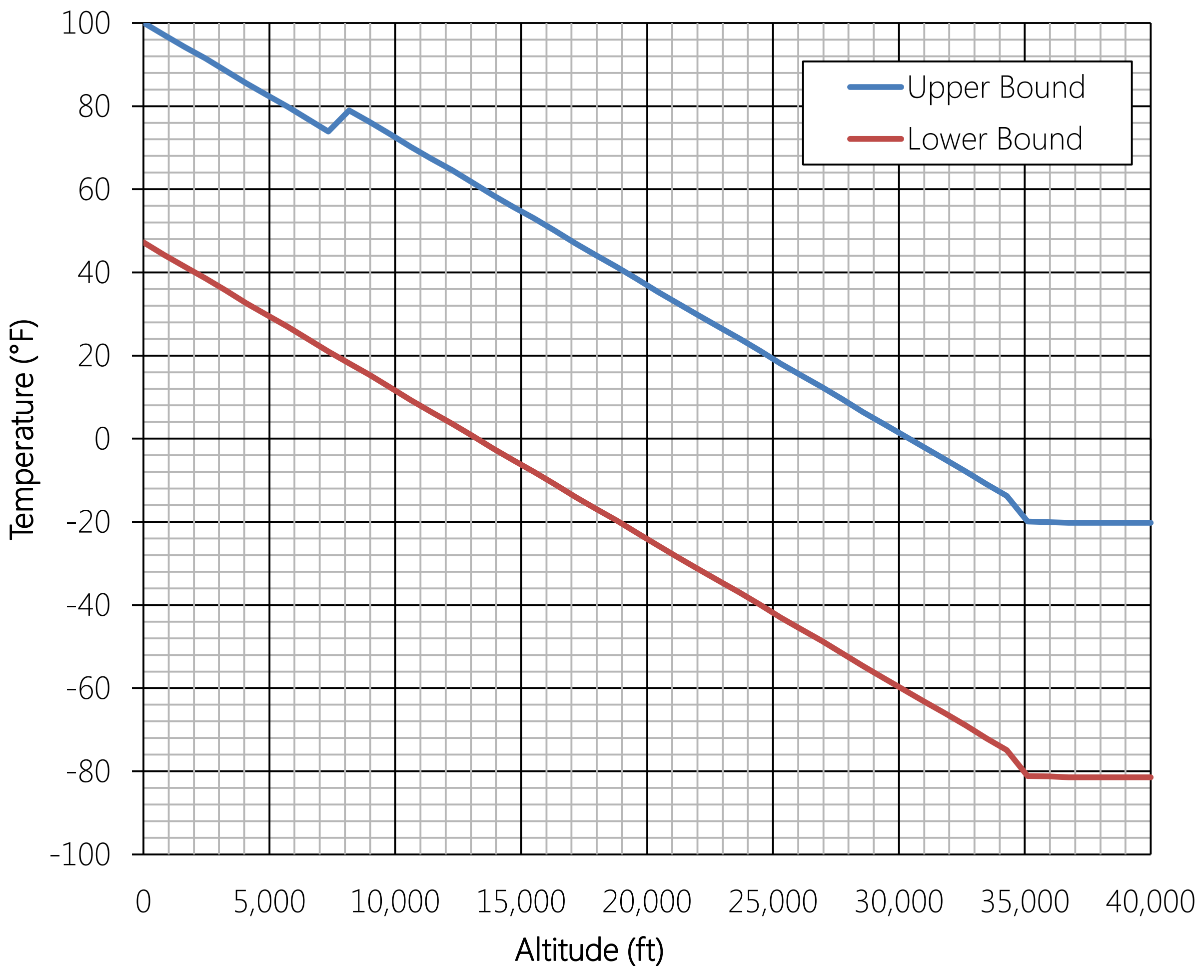

Figure 8. ALQ-167 Internal Temperature Guidelines

Payloads should be developed to survive mild condensation. During climb from takeoff to altitude, water will condense from air within closed volumes. If the volume is not sealed and purged with inert gas or temperature controlled, condensation can also form on cold equipment when the aircraft returns to lower, more humid altitudes. If pod ram scoops are open, airflow through pod will be present. GO can perform analysis of internal flow if necessary.

Vibration and shock environment depend heavily on payload mass and mounting configuration. GO can perform analysis to determine expected shock and vibration power spectra for customer payloads, or can provide data from GO FET flight 1 at customer request. Quasi-static loads depend upon the flight plan and maneuvers required by the customer.

Payload Questionnaire

Interested in flying a payload on the GO FET? Please fill out the questionnaire below. All customer-supplied data is treated as proprietary and will not be disclosed to any party other than GO and PAG without written permission of the customer. Please submit forms to:

Mr. Kevin Feld
Director of Engineering
Generation Orbit Launch Services, Inc.
3353 W Hospital Ave
Atlanta, GA 30341
kevin.feld@generationorbit.com

Customer Information
Customer Organization
Name:
Type (commercial, civil, military, academia):
Customer Point of Contact
Name:
Email:
Phone:

Payload Information
Payload Name:
Payload Description (approx. mass, dimensions, major components, etc.)
Payload-specific Interface Requirements (bolt patterns, data interface, power interface, etc.)
Power Requirements (voltage, amperage, etc.)
Data Acquisition Requirements (number of channels, data rate, storage requirements, etc.)

Mission Information
Outline of test objectives and requirements
Mission Description (altitude, velocity, flight path, maneuvering requirements, etc.)
Operational Requirements (basing location, operating airspace, etc.)
Desired Flight Date

Additional Information
Please describe testing planned prior to delivering the payload to GO for integration.
Please describe any hazardous materials contained within the payload.
Please describe any batteries contained within the payload.

Additional Information (cont.)
Please describe any pressure vessels contained within the payload.

Please describe any additional potential safety issues with the payload.
Please describe any RF systems contained within the payload including transmitters, receivers, function, frequency, sensitivity, power output, and bandwidth.
Please describe any other requirements GO should be made aware of.