STATEMENT OF WORK

Helicopter-
Intelligent Payload Module (IPM) Flights

February 14, 2013

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STATEMENT OF WORK

EO-1 SensorWeb
IPM Initial Flights

SCOPE OF WORK

The Intelligent Payload Module (IPM) Airborne Testing seeks to demonstrate an end-to-end simulation of on-board satellite image processing with a live aeronautical platform. The initial testing described here will detail the use of a manned aircraft; however the intention is to migrate to an automatically piloted Unmanned Aerial Vehicle (UAV) to demonstrate the capability of this system coupled with a fully autonomous platform. The purpose of this testing is to demonstrate the viability of these on-board processing techniques, leading ultimately to their use in NASA satellite missions with the goal of increasing mission utility and decreasing cost.

The IPM consists of a high resolution camera coupled with an on-board computer, which has image processing software called Web Coverage Processing Software (WCPS) running on it. This computer is powered by a Tilera, a high performance multi-core processor. As the camera captures images, the images are fed to the computer, where they are processed by WCPS with the Tilera processor. WCPS can be configured to run one of a number of predefined algorithms on the image product, depending on the instructions it has been provided. Once completed, these image products are transmitted to the ground via a radio transmitter, which is connected to the on-board computer. Thus, scientists and engineers on the ground can receive completed image products exactly as though the IPM were flying on a satellite instead of an atmospheric craft.

The plan is to fly five flights over a 2 year period with the IPM payload attached to bottom of helicopter

Obtaining approval from the FAA and the NASA Flight Review board shall be the responsibility of the helicopter vendor. This includes fulfilling the requirements of the NASA Flight Review board based at Wallops Island facility. This Review Board requires a Flight Readiness Review before the first flight. The first round of testing, which will involve a helicopter operating in or around Goddard Space Flight Center (GSFC) and/or around Manassas Regional Airport. Imagery would be taken of GSFC and the surrounded area or the area around Manassas Regional Airport and would processed by WCPS with vegetation analysis algorithms, just as a satellite would.

The target date for the first test flight would be April 2013, however, if the process of obtaining the final procurement in place along with NASA approvals to fly gets delayed, then the earliest flight date available will be used. One key goal is to allow summer interns the opportunity to participate in the exercise by helping to develop the technology involved in the flight demonstration as well as directly assisting in execution of the test, thus the desire to obtain a preliminary summer flight. Intern participation allows this project to contribute to one of NASA's most important missions: the education and inspiration of the next generation or engineers. Furthermore, it will enhance community interest in GSFC and generate positive publicity for center activities.

A. AIRCRAFT PERFORMANCE AND FLIGHT PARAMETERS:

The critical aircraft performance requirement is for low speed and low altitude flight with a mount point for the IPM instrument.

A1. Aircraft Specifications:

Type:	MD500 (369HS)
Crew:	1
Ceiling	14,800
Operational air speed:	60 Knots
PALS Power	12 Volt, 10 amps
Cabin Interior Size	N/A
Nadir Port	N/A
GPS/XM Fuselage ports:	N/A
AFT Baggage compartment	N/A
Payload	20 lb IPM module
Intercom	All aircraft crewmembers and instrument operators must be on an intercom at all times.

A2. Mission Profile:

- Altitude: 5000 feet Above Ground Level (AGL)
- Nominal Speed: 60 Knots ground speed
- Straight and level
- Deployment Site:

B. INSTALLATION:

Appendix A.3 contains technical drawings of the IPM instrument. The aircraft contractor is responsible for installation of the IPM payload onto the aircraft, along with certification for flight worthiness. IPM team members will work with the aircraft contractor to ensure a proper installation of the instrument into the aircraft. After the IPM is installed, the IPM team will conduct ground tests to confirm the IPM instrument is installed correctly and the IPM mission is ready for a test flight.

C. NASA DELIVERABLES:

NASA will provide the following:

1. Provide flight scheduling requirements with the concurrence of the Contracting Officer's Technical Representative (COTR) within 24 hours prior to each flight.
2. Provide comprehensive flight requirements over study sites within 7 days prior to each flight, to allow time for TSA clearance. *Appendix A.1*
3. Provide engineering support and instrument operators

4. IPM team will evaluate the in-flight performance of data systems
5. Government furnished property will include the IPM instrument payload

D. KEY MISSION REQUIREMENTS:

1. The air and ground crews shall be provided by the aircraft contractor.
2. The contractor shall carry a current and acceptable NASA Safety Review.
3. The contractor is responsible for any and all FAA certifications/approvals for the instrument installation.
4. Adherence to the requirements set forth in Appendix B.
5. The contractor shall participate in an Engineering Risk Analysis (ERA) review that will be conducted 1 week prior to the Flight Readiness Review. All requested documentation required by this SOW will be reviewed by the NASA review board at this time. All action items assigned to the contractor shall be addressed prior to the Flight Readiness Review. Upon successful completion of the ERA review a Safety of Flight Release will be issued.
6. The contractor shall participate in and successfully complete a Flight Readiness Review (FRR) 24 hours prior to the first flight with the IPM payload. A FRR telephone conference will be convened by the WFF Aircraft flight office. Included in the telephone conference will be members of the IPM team, contractor team, NASA/GSFC safety office. The FRR review board will review the entire IPM installation, aircraft operation areas, flight plans, aircraft safety and aircraft / instrument security. If the FRR is successful, WFF Aircraft flight office will approve the contractor to start the IPM mission flights. *Appendix A.4 (Sample FRR)*
7. A medium lift, un-pressurized aircraft capable of integrating the IPM instrument payload.
8. The aircraft must be available from July 2012 through April 2014, although there is flexibility in the deployment of the flights.
9. Aircraft need not carry any IPM operators.
10. Aircraft contractor to install the IPM system to FAA requirements for a restricted use aircraft.

E. ADDITIONAL REQUIREMENTS:

1. The contractor shall perform initial integration of the IPM instrument at the contractor's base of operations, to include all necessary certifications, which the contractor's FAA Designated Engineer Representative (DER) deems necessary.

F. ENGINEERING REQUIREMENTS

As additional supplemental information on the instrument and hazards, please review Appendix C for more information on the payload.

Vendor shall provide the following information in paper or electronic format to NASA WFF for review in accordance with NASA document 800-PG-1060.2.2 Airworthiness Review Board Process (See Appendix D for excerpt)

1. MECHANICAL – Aircraft

Floor Plan Drawing – A floor plan layout drawing shall be provided detailing the fuselage station location of all installed experimenter equipment mounted externally and internally to the aircraft.

2. ELECTRICAL- Aircraft

A description shall be provided explaining how experiment power is removed from all experiment equipment in the event of an emergency that requires all experiment power to be shut off. If a process or electrical system does not exist one shall be created or installed.

An electrical load analysis for the IPM payload and rack instrumentation shall be provided.

An EMI test shall be performed with all aircraft navigation system turn on during tests.

3. MECHANICAL – IPM

Note: If a DER performed engineering work for the IPM installation and an 8110 and 337 exist from previous missions or will be acquired for this mission then the vendor is exempt from the following requirements in this section.

Drawings – formalized installation/assembly and manufacturing drawings that provide enough information for mechanics to install (bolt sizes, torque specs, material specifications, bolt locations, fuselage station number for overall installation, weld specifications). Drawings should be in proper drawing boarder with drawings title, drawing number, draftsman name, peer reviewers name, date completed, and provisions for drawing revision history.

Analysis- Shall use Factor of Safety of 2 on limit loads for metallic structures and Factor of Safety of 3 on limit loads for composite structures unless load test performed but shall not be less than 1.5 even with load test performed, factor of safety used for fitting form factors shall be stated in analysis if used. All analysis shall have positive margin of safety on material specifications.

- Aerodynamic
- Structural
  - Gust loads (comply with manufacturers recommended gust loads, provide manufacturers gust load specification)
  - Aerodynamic loads

Modal – compare payload natural frequency to aircraft natural frequencies.

Assessment of performance degradation due to installation and reduction of aircraft envelope if any

Load Test – All load tests (static, dynamic, in-flight) performed shall be properly documented with photographs or drawings that show how the load was applied and with instructions on how to perform the load test. Load Test shall comply with NASA-STD-5001.Results of load test shall be documented in formal report detailing results.

Welds – When welding is required, care shall be taken to use only materials suitable for welding. The welds should be performed in accordance with SAE-AMS-STD-2219, "Fusion Welding for Aerospace Applications" and by a welder who is currently certified to AMS-STD-1595 specifications. The assembly should then be heat-treated if full joint strength is required. Proof of conformance to both specifications should be submitted with the welded assembly. In addition, non-destructive inspection (such as dye penetrates) should be performed on the welded assembly to find any weld defects. If the weld inspection is not performed at NASA WFF then the vendor is required to provide proof of certified weld inspection. If the welded assembly does not pass inspection, it may not be permitted on the aircraft.

Important Note:

Any action items assigned to the vendor or IPM experiment team through the NASA WFF Airworthiness Review process shall be complied with and corrective action provided to the review board(s) prior to flight.

G. PERFORMANCE/MILESTONE SCHEDULE:

Date of Contract Award – TBS

See Appendix A2 for preliminary flight schedule and Flight Readiness Review milestone

H. PERFORMANCE STANDARDS:

1. Contractor shall provide a fully functional integration of the IPM payload, per Appendix A.3.
2. Integration must be performed on time within the established milestone schedule incorporated as an attachment to this contract.
3. Instrument test flights must be performed per science requirements and on a real-time basis within the not to exceed mission flight hours.
4. Coordination with the science team to generate flight plans to maximize the data return from each science flight.
5. Submission of the mission summary in a timely manner i.e., in accordance with Section E.3.
6. Active role in ensuring the safety of the aircraft, qualified and non-qualified personnel, and instrument.
7. Successful completion of all NASA reviews, including the Engineering Risk Analysis Panel (ERAP) and FRR, and successful compliance with all applicable FAA certifications for the aircraft and/or instrument.
8. Timely and accurate reporting of any/all mishaps as outlined in Appendices E and F.

9. The contractor shall fully comply with all applicable NASA Procedural Requirements (NPRs), NASA Policy Directive (NPDs), Goddard Procedural Requirements (GPRs) and/or Goddard Policy Directives (GPDs). These documents are accessible at http://nodis3.gsfc.nasa.gov/main_lib.html.

I. CONTRACTOR DELIVERABLES:

1. Flight planning to accommodate mission flight requirements
2. Mission Summary Report as described in Section F.3
3. All drawings and analysis documents produced as a result of the requirements outlined in Section F.
4. Completion and submission of Appendix G

Appendix A.1 IPM Area of Operation:

GSFC, Manassass Regional Airport and Morgan State Univeristy Estuarian Research Center in Calvert County, Md

Appendix A.2 Preliminary Flight Schedule

1. Flight Readiness Review (approximately April 2013)
2. Flight 1 (approximately May 2013)
   a. Test flight as required with the IPM containing only the electronics box and the plate. The purpose of the flight is to test the assembly for flight as required by NASA and FAA
   b. Customer plans to test the uplink and downlink during this test flight.
3. Flight 2 (approximately August 2013)
   a. Test flight as required with IPM containing both boxes and the plate. The purpose of the flight is to test the assembly for flight as required by NASA and FAA
   b. Customer plans to test the uplink, downlink and the transmission of sensor data to the ground
4. Flight 3 (approximately October 2013)
   a. Flight for 1 hour which will be used to gather data with sensor
   b. Includes setup and tear down
   c. Location can be at airport facility of vendor
5. Flight 4 (approximately June 2014)
   a. Flight for 1 hour which will be used to gather data with sensor
   b. Includes setup and teardown
   c. Includes the flight to NASA/GSFC, Landing, 1 hour flight and return to vendor airport
6. Flight 5 (approximately August 2014)
   a. Flight for 3 hours which will be used to gather data with sensor on Morgan State University Estuarine Research Center in Calvert County Md.
   b. Includes set up tear down

Schedule allows for enough slack so that the last flight can slip to as late as April 2015. Thus, if any of the flights with the approximate dates are slipped, the user will slip the flights as needed with the vendor's concurrence.

Appendix A.3 Intelligent Payload Module and Hazards

Flight Intelligent Payload Module (IPM) which consists of 2 boxes and a plate as follows:

1. box 1 approximately 14" x 14" x 7" containing electronics and requiring 28 volt power connection supplied helicopter, drawing less than 90 watts and weighing no more than 10 lbs.
2. Box 2 approximately 14" x 10" x 7.3" containing the Chai640 instrument with camera and electronics, requiring a 28 volt power connection supplied by helicopter , drawing less than 60 watts, weighing no more than 20 lbs
3. Box 1 and Box 2 are mounted on aluminum plate with dimensions 27" x 17"
4. Helicopter vendor shall supply the appropriate vibration dampers for the size and weight of the IPM.
5. Non-recurring engineering for mounting the IPM to the helicopter and vibration dampers shall be included in quote

Appendix A.4 Sample FRR package

PolSCAT Cold Land Processes Experiment (CLPX-09)

GOAL: Advance remote observation of fresh water stored in terrestrial snow.

Supports a wide array of science and application objectives related to Earth's water and energy cycles, fresh water resources, and the International Polar Year (IPY). Supports the ESA Core Earth Explorer mission CoReH2O, recently selected for further study.

- Two campaigns during winter 2006-2007 (Colorado)
  - *Dec 06 (Shallow snow), Jan/Feb (Intermediate snow), Feb 07 (Deep snow)*
- Two campaigns during winter of 2009 (Alaska)
  - *Focus on observing snow conditions under various climatic regimes*
- **Two campaigns during Nov 2009 and Feb 2010**
  - ***Grand Mesa, baseline (very little snow) 11/09***
  - ***Grand Mesa, shallow snow 2/10***
- **Principal Investigators**
  - *NOAA, USDA, NASA JPL*
- **Participating Collaborators**
  - *United States*
    - ***Colorado State Univ.; U. of Colorado; U. of Alaska***
    - ***Army Corps of Engineers***
  - *Europe*
    - ***German Aerospace Center (contributing spaceborne X-band radar data)***
    - ***UK Met Office (contributing aircraft measurements in Alaska)***
    - ***U. of Innsbruck (Austria); U. of Aberystwyth (Wales)***

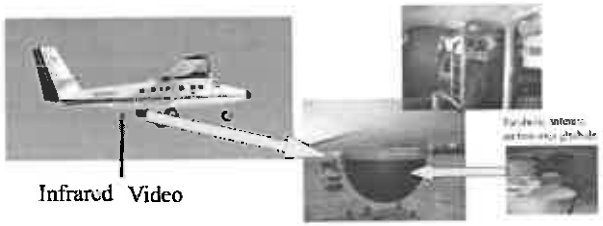
Ku-band Backscatter Observed by POLSCAT
CLPX, North Central Colorado December 2006

JPL PolSCAT- CLPX-09 Aircraft configuration:

- PolSCAT antenna reinstalled on the Twin Otter 614 (was 252)
  - Same antenna and fairing as CLPX 2007/8 experiment.
  - Same antenna mounting structure
  - **No changes to the aircraft basic configuration.**
- PolSCAT/Twin Otter racks reinstalled in the aircraft.
  - **Same rack configuration as CLPX 2007/8**
- Twin Otter cabin configured for 2-3 JPL operators.

PolSCAT CLPX -09 on the Twin Otter

- PolSCAT Ku-band radar with VV, HH, VH and HV polarizations
- Conical scanning imager with commandable incidence angle (0-65 degrees)
- Ancillary nadir-looking infrared sensor and video cameras



PolSCAT CLPX-09 Experiment:

- Experiment dates:
  - October 26 - November 11
- Deployment Location:
  - Twin Otter International- Grand Junction airport
  - Science area, Grand Mesa (~ 20 Miles from Grand Junction airport)
- CLPX-09 Flight hours:
  - ~ 15 Flight hours
  - 3 flight hours- local test flight
  - 12 science data flight hours
- CLPX 09 Typical Flight Plan:
  - Science area, Grand Mesa (~ 20 Miles from Grand Junction airport)
    - VFR only
    - Clear skies below the aircraft
    - 15,000' MSL flight lines, ~5,000 AGL
    - Each Flight line approximately 10 mins. long (4 lines both directions)
    - Total daily flight time approximately less than 2 hours
    - Solo flights (no other aircraft participating during CLPX-09 experiment)
    - Straight and level lines, no calibration manuvers

PolSCAT Instrument:

- 13 Ghz Polarimetric Radar:
  - –Down looking scanning radar
  - –2 Watt average output power
    - No risk to ground personnel
    - We don't transmit on the ground or in the hanger (possible damage to Polscat's sensitive receivers)
  - –Hardw are installed into 3 Tw in Otter racks, and under weight control
  - –Radar and Raydome suspended from aft seat tracks
  - –FCC Polscat License: NASA01306
  - –Polscat requires 120 volts, 60 herts ~10 amps of power

- PolSCAT Flight History:
  - –PolSCAT has flown on the:
    - DC 8 (2)
    - Wallops P-3 (3)
    - NCAR C-130 (5)
    - Twin Otter (5)

PolSCAT CLPX-09 Experiment Support:

- Polscat Operators:
  - – JPL operators (Dinardo, Yueh, Chaznoff)
  - – All JPL personnel have current:
    - – FAA medical (third class) certification
    - – FAA Hypoxia training and ground survival certificates
    - – JPL First Aid and AED training.
    - (All certs. on file with JPL medical and Twin Otter)
  - – JPL personnel will use Twin Otter supplied Oxygen above 10,000 MSL

- JPL supplied safety equipment:
  - – FAA approved oxygen masks
  - – Clip on Oxygen monitor
  - – Personal EPIRB (Emergency Position Indicating Radiobeacon)
  - – Survival case containing (first aid, flashlight, food, water, strobe, signal mirror, etc)
  - – Cold weather gear

- Emergency contact numbers (in the flight pack):
  - – JPL Emergency Number- (818)-354-2530
  - – Ames (650)-604-2864 - Bruce Coffland
  - – Twin Otter (970)-261-1055 - Scott Seibold
  - – PolSCAT point of contact (818) 371-6341 - Steve Dinardo

PolSCAT CLPX-09 Typical Flight day:

- 6:00 Am PolSCAT team checks weather (determines if it's a flight day, delay for weather or cancel)
- 6:15 Am. If flight day, Inform pilots, Pilots verify weather at project site and airport
- 6:30 Am, If Pilots agree, print PolSCAT flight plan of the day
- 6:30 - to 7:00 Am breakfast
- 7:15 Am, meet at the Twin Otter, PolSCAT team confirms PolSCAT is operational
  - Pilots check weather, file VFR flight plans (flight following) and Preflight plane.
- 7:30 Am, PolSCAT flight meeting (Pilots, and PolSCAT crew)
  - PolSCAT manager presents "flight plan of the day" and confirm GPS waypoints.
- 7:45 Am, Twin Otter aircraft safety brief
- 8:00 Am, tow Twin Otter out of hangar
- 8:15 Am, Engine start, Turn on PolSCAT
- 8:30 Am Take off, Sync PolSCAT time
- 9:00 am Start acquiring PolSCAT Science data over project site

PolSCAT CLPX-09 Typical Flight day:

- ~11:00 Am, RTB
- 11:15 Am, land and refuel
- 12:00 Pm, Team hangar debrief
  - PolSCAT operations
  - Flight operations
  - Improvements to operations- any concerns
  - Next day's plan (fly or hard day down)
- 12:30 Pm Lunch
- 1:00 Pm, transfer data to JPL, send email to Wallops (PolSCAT CLPX -09 flight summary)
- 5:00 Pm, PolSCAT Science team telcon.
  - Summary of current days flight accomplishments
  - Review processed PolSCAT data
  - Next day weather outlook
  - Plan for next flight day (fly, or down day)
- 6:00 Pm, Write next days flight plan

Typical PolSCAT / Twin Otter flight plan

Appendix B NASA GSFC Airborne Science Flight Operations Standards

1. Minimum Operating Standards For All Aircraft Operations

Operations
- PIC – Airline Transport Pilot (ATP) Certificate
- SIC – Commercial Pilots Certificate with an instrument rating
- All pilots in previous year - 100 hrs TT & a satisfactory proficiency flight check
- All pilots in previous 90 days – 3 Takeoffs & Landings (Night if night ops)
- Continuous radio capability with a ground station for flight following
- Alcohol use policy – 10 hours prior & not under the influence
- Flight plans will be filed for all flights with appropriate ATC

Maintenance
- Aircraft History - date of manufacture, registration #, & total time
- Copy of Aircraft Registration & Airworthiness Certificate
- Copy of Current Weight & Balance
- Copy of last Airframe and Powerplant Inspection
- FAA Form 337 or other documentation on any modifications
- FAA Form 337 or other documentation on any equipment installations
- Documentation showing compliance with all Airworthiness Directives
- List personnel authorized to perform aircraft maintenance & their qualifications
- List personnel authorized to return aircraft to service & their qualifications

2. Other standards requiring justification/management approval for deviation from

Operations
- Non-turbine or Single pilot aircraft operations
- PIC without 200 hours in make/model
- PIC without – ATP, 500ME, 2500TT, 200Inst, 50 Night, 40(10 make/model) last 90 days
- SIC without – Comm w/inst, 700TT, 100Inst, 50 Night, 30(10 make/model) last 90 days
- Pilots without – 6 T/Os & Ldgs (Night if night ops), 3 instr appr/3 instr hrs in last 90 days
- No GPWS or radar altimeter for flight below 2000 feet (except for t/o & land)
- No ELT for remote (outside of VHF range from ground station) operations
- Crew Duty over 12 hours (14hrs if none midnight-4AM) & crew rest less than 12 hours
- Crew flight time limits greater than 8 hours a day or 40 hours a week
- Flights in close proximity to known or forecast severe weather
- No filed alternate landing site with destination weather below 5000/5
- No operating weather radar for other than day VFR flights

Maintenance
- Any deviations from manufacturers' overhaul & replacement schedule

3. Documentation to be reviewed for all flight operations
- Description of company that owns/operates the aircraft with contact info
- Description of company personnel by position & organization chart

- Training & medical records - Initial & recurrent for crewmembers & maintenance personnel
- List of aircraft radios, navigation equipment, & survival gear
- Company operations rules – include Min runway length, Min fuel, Min Wx for T/O, Ldg, & Alt, and drug & alcohol testing policy along with aviation safety program/policy.
- Copy of Contract or Letter of Agreement
- Project Documentation– Description of project including NASA project manager contact info, project objectives, payload description, list of personnel & equipment onboard during flight and:
  - Flight plan – include airports, route of flight, op area, other aircraft involved
  - Safety plan – list of possible ground & flight hazards and risks including safety controls
  - Flight Readiness Review Briefing – brief to mgmnt on readiness of maint, ops, & project

Appendix C CONTRACT AIRCRAFT SCIENCE INVESTIGATOR QUESTIONNAIRE

- Please respond to each item. If an item does not apply or is yet to be determined, indicate so with "Not Applicable (N/A)" or "To Be Determined (TBD)".
- Please provide a separate questionnaire for each instrument.
- Please provide a new or updated questionnaire for each recurring installation.

I. GENERAL INFORMATION

1. Experiment Description

Mission/Program: Advanced Information System Technology (AIST) 2011, Earth Science Technology Office (ESTO)
Experiment Name and Acronym: IPM
Instrument: Brandywine Hyperspectral imager
Measurements: Visible and near infrared
Measurement Technique(s):
Detection Limit:
Time Resolution:

2. Points of Contact

NASA Program Executive : Daniel J Mandl
Phone: 301.286.4323
E-mail: daniel.j.mandl@nasa.gov

Principal Investigator Name: Daniel J Mandl
Organization: NASA/GSFC Code 581
Citizenship: USA
Address: 8800 Greenbelt Rd
Phone: 301.286.4323
Fax:
E-mail: daniel.j.mandl@nasa.gov

Lead Technical POC Name: Matthew Handy/Vuong Ly
Organization: NASA/GSFC Code 583
Citizenship: USA
Address: 8800 Greenbelt Rd
Phone: 301.286.2106

Fax:
E-mail: matthew.handy@nasa.gov, vuong.t.ly@nasa.gov

II. HAZARDOUS MATERIALS/EQUIPMENT (list information for each item for aircraft and/or ground use)

1. Lasers None

Laser type: N/A
Laser class: N/A
Laser wavelength: N/A
Output power/energy: N/A
Output power/energy pulse width: N/A
Output power/energy rep rate: N/A
Shielding requirements: N/A
Do you have authorization to operate inside the United States? (Please provide proof):N/A
Do you have authorization to operate outside the United States? (Please provide proof): N/A
Note: Attach MSDS's for laser dyes, etc. used in flight or on the ground. N/A

2. Radio Frequency Emitters

Description: Freewave Transceivers
RF Power: 1 Watts
Frequency Range: TBD
Operational constraints: N/A
Installation constraints: N/A
Do you have authorization from the FCC to operate inside the United States? (Please provide proof):Yes, radio unlicensed
Do you have authorization to operate outside the United States? (Please provide proof):N/A
Note: On the ground, Transmitter has a safety power interlock and transmitter safety loads, when in flight transmitter controlled by establish proven flight plan procedures.

3. Compressed Gasses: None,

4. Chemicals (solids & liquids): None

Description (name, concentration): N/A
Total quantity on aircraft and in integration area: N/A
Usage/Access (ground only, flight only, ground & flight): N/A
Container description: N/A

Purpose: N/A
Note: Attach MSDS's for each chemical used in flight or on the ground.

5. Radioactive Materials None

Source: N/A
Half-life: N/A
Quantity: N/A
Note: Attach MSDS's for each material used in flight or on the ground.

6. Cryogens None

Material description: N/A
Container description: N/A
Quantity required on flight days: N/A
Quantity required on non-flight days: N/A
Usage/Access (ground only, flight only, ground & flight): N/A
Operational constraints: N/A
Installation constraints: N/A
Note: Attach MSDS's for each cryogen used in flight or on the ground.

7. Batteries/UPS None

Battery& UPS description (manufacturer name & model number): N/A

8. Pressure Vessels (containment vessels, compressor tanks)

Description (purpose, contents):N/A
Internal volume: N/A
Vessel pressure: N/A
Installation constraints: N/A

9. Motors/Pumps

Description: N/A
Manufacturer name/model number: N/A
Motor type (capacitor start, brush less, explosion proof): N/A

10. Heaters

Description (system components, location):N/A
Manufacturer name/model number: N/A
Maximum temperatures: N/A
Comments: N/A

11. **Power Distribution Equipment (non-aircraft outlets, power converters)**

Description: N/A
Manufacturer name/model number: N/A

III. A/C INSTALLATION

1. **Seats & Operators**

Total number of seats required during experimenter check-out flights: 0
Total number of seats required during transit flights: 0
Total number of seats required during science flights: 0

2. **Racks and Floor Mounted Equipment**

Number & type of racks required: 0
Estimated weights of cabin rack: N/A
Name and size of floor mounted equipment (besides racks):N/A
Special installation constraints:

3. **Storage Boxes**

Provide estimate of storage volume and weight for transport on the aircraft: None
In-flight access requirements for boxes: N/A
Special installation constraints: N/A

4. **Probes, Sensors, Antenna, View Ports, Radiometers, Etc.**
PALS antenna
Design support required: None
Fabrication support required: None
What aircraft has this instrument flow on before (provide mission name, aircraft name, and date)? N/A
Have there been any changes since last flown? No
Were any discrepancies noted at the last installation? No
Were all noted discrepancies resolved?

a. Probes

Description: N/A
Preferred location on the aircraft: N/A
Sampling Direction (fwd. or aft): N/A
Probe alignment (with aircraft or with free stream): N/A
Equipment to be installed with probe: None
Maximum allowable distance from aft rack: N/A
Special installation constraints: N/A

b. Optical Windows

Optical window size: None
Preferred location on the aircraft: N/A
Optical pass-band: N/A
Preferred material and coating: N/A
Window cleaning requirements: N/A
Special installation constraints: N/A

c. Exhaust Port(s) None

Description: N/A
Preferred location on the aircraft: N/A
Contents of exhaust: N/a
Special installation constraints: N/a

d. Antenna(s) None

Description: N/A
Antenna size: N/A
Preferred location on the aircraft: N/A
Maximum distance from rack: N/A
Antenna orientation: N/A
Special installation constraints: N/A

e. FTS None

Description: N/A
Radiometer size: N/A
Preferred location on the aircraft: N/A
Maximum distance from rack: N/A
Operational requirements: N/A
Special installation constraints: N/A

f. Equipment Covering/Shields

Description: None
Operational requirements: N/A
Special installation constraints: N/A

g. Special Equipment None

List any other equipment required: N/A

5. **Aircraft Power Requirements**

Power (Volts, phase, cycles, Amps, Watts): 12 volt, ??? Hertz
Load name: IPM
Start current: 14 amps
Run current:7 amps
Regulation:
N/A

III. OPERATIONS (state desired, acceptable, or unacceptable)

1. Aircraft Interior Environmental Conditions (where applicable)

Temperature range: N/A
Humidity range: N/A
Undesirable conditions: Condensing
Maximum vibration: TBD

2. Aircraft Access

Pre-flight time required at aircraft: 1 hour
In-flight warm up time required: 1 hour.
Post-flight power/button-up time required:1 hour (in the hanger on ground power)
No fly-day time required at aircraft: TBD
Ground support equipment required: TBD (ISGA cal unit)

3. Aircraft Maneuvers

Describe in-flight calibration maneuvers: 1 per campaign (wing wags)
Describe flight attitudes (pitch/roll limits): Straight and level
Describe airspeed/Mach regime: 60 Knots
Describe required flight altitudes: below 10,000 MSL
Describe airspeed/Mach limitations:
Undesirable flight conditions: Clouds below or at flight level, Clouds above Ok, No night science data flying

Appendix D Installation Airworthiness Review Process

PURPOSE:

This procedure is applicable to all NASA/GSFC Controlled Program aircraft or UAS that are bought, borrowed, chartered, rented, or otherwise procured or acquired. This includes aircraft/UAS which are acquired with the aid of NASA funding, regardless of cost, from any source for the purpose of conducting NASA science, research, or other missions, and which are operated or whose operation is managed or facilitated by GSFC. In addition, this shall include any other aircraft/UAS designated by the Director of Suborbital and Special Orbital Projects Directorate (SSOPD).

A wide variety of aircraft and UAS are utilized by GSFC to facilitate a vast spectrum of research, logistic, scientific, and flight test programs. Accordingly, the AFSRB Chairperson is given authority and responsibility to perform reviews that vary depending upon the complexity and the criticality of the project under consideration. To aid in such consideration and enable a thorough and expeditious airworthiness process, the AFSRB Chairperson shall maintain a standing sub panel specifically dedicated to this purpose.

1. Engineering and Risk Analysis (ERA) Panel

The ERA Panel consists of the GSFC Aviation Safety Officer, the Configuration Manager, and the WFF Quality Assurance Manager. When required, any single member of this panel may be represented by a designated alternate. This panel reports directly to the AFSRB Chairperson advising to the required depth and scope of each review. The ERA Panel has the authority to obtain assistance from additional sources as necessary to ensure that the project will be reviewed in the safest manner.

The level of review required will be based on the aircraft mission, complexity of the modifications, and the inherent hazards associated with the operation. The ERA Panel may conduct its review in any manner it deems appropriate for the prescribed project, however, at a minimum, the review shall address: aircraft modifications including aircraft configuration, loads, flight envelope, aircraft weight and balance data, reference to applicable mechanical and electrical design documents, reference to applicable software version description documents, a listing of associated computer software configuration, operating instructions and procedures, operating limitations and restrictions, and specific maneuvers or operations for which the aircraft is cleared.

1.1 The ERA Panel has three primary functions:

a. Establish engineering requirements of non-NASA aircraft/UAS projects prior to contract competition/award (in accordance with NPD 7900.4). This allows for specific engineering requirements to be included and/or excluded from the Statement of Work (SOW), thus defining the project's overall AFSRB engineering oversight. The ERA Panel shall make every effort to alleviate engineering requirement

uncertainty. These engineering requirements shall be presented in memorandum format to the AFSRB Chairperson and the applicable Contracting Officers Technical Representative (COTR) for incorporation into the project SOW, as required. The ERA Panel shall make every effort to eliminate costly and redundant duplication of engineering efforts by government agencies.

b. Provide a comprehensive instrument and/or aircraft risk analysis (in accordance with NPD 7900.4) to the Chief, Aircraft Office and the AFSRB Chairperson. This risk analysis should establish instrument to vehicle compatibility and provide an approximate requirement for instrument laden vehicle performance capabilities. The comprehensive risk analysis shall be presented in memorandum format to the Chief, Aircraft Office and the AFSRB Chairperson. The ERA Panel shall make every effort to match scientific instruments only to an appropriately capable platform.

c. Gather and present to the AFSRB Chairperson Non-NASA generated certificates of airworthiness and applicable documentation. Airworthiness may be established sufficiently via an alternate agency such as the DOD, the FAA, foreign military, or any federal or state agency with a formally recognized aviation program (in accordance with NPD 7900.4). If the airframe has been altered from the accepted condition when the certificate was issued, a Safety of Flight Release (SOFR) is required. The ERA Panel shall evaluate and accept non-NASA aerial vehicles based upon existing vehicle airworthiness certification, provided such certification is not in conflict with any existing NASA standard, procedure, or directive.

ERA panel process utilization is delineated in Appendix H.

2. Requirements for Flight

Two separate documents are utilized by the GSFC airworthiness process.

2.1 Issuance of a Certificate of Airworthiness

Also referred to as a Type Certificate for continuity, this document may be issued by NASA (NPR 7900.3), the DoD, the FAA, foreign military, or any federal or state agency with a formally recognized aviation program.

The certificate pertains to the particular airframe for which it was issued, including only those modifications and/or installations outlined within the certificate. It certifies that the identified airframe has been inspected and found to be maintained in a condition for safe operation.

2.2 Issuance of a Safety of Flight Release (SOFR)

Upon satisfaction of the applicable airworthiness process, the AFRSB Chairperson will issue a Safety of Flight Release (SOFR) memorandum that permits conduct of the flight evolution as prescribed therein. The SOFR is addressed to the Chief, Aircraft Office (Code 830), and is approved by signature of the AFSRB Chairperson or his/her alternate, and any attending board/panel members or their alternates.

A SOFR shall be issued with an expiration date that best suits the application. In the event that an SOFR expires during an aircraft/UAS flight operation or field deployment, the SOFR is considered valid until the completion of such operation. The AFRSB Chairperson on an exceptional basis may extend the date of an expired GSFC issued SOFR for extenuating circumstances provided all members of the Engineering and Risk Analysis Panel concur. However, in no case may a SOFR expiration date extend beyond 2 years from the date of issuance.

In the event one or more board/panel members are not in concurrence with the "best effort" resolution of airworthiness, the AFSRB Chairperson will notify the Director, SSOPD that he/she is unable to issue an SOFR. If the AFSRB is unable to issue a SOFR, the Director, SSOPD may be presented with a request for a waiver. The request shall outline the specific circumstances under which the SOFR was not issued and outline precisely the conditions of the requested waiver. The request shall be signed by the AFSRB Chairperson, the Chief, Aircraft Office, and the ASO. Each signatory shall indicate clearly he/she recommends, or does not recommend, the issuance of the waiver. The Director, SSOPD has final approval authority of all airworthiness waivers.

3. Issuance of the Readiness Review Memorandum

Readiness reviews are split into two review categories; a Flight Readiness Review (FRR) and a Mission Readiness Review (MRR). The FRR focuses on flight operational safety. The MRR focuses on mission operational safety using multiple aircraft and multiple activities to ensure mission success. The MM shall assign a Chairperson to conduct an MRR when multiple aircraft operations are to be conducted. Readiness reviews, when applicable, pertain to both aircraft and UAS. Unless otherwise addressed in this document, prior to conducting any readiness reviews, each airframe involved in the flight or campaign shall have an approved Certificate of Airworthiness.

Appendix E NASA Mishap Reporting Information Sheet

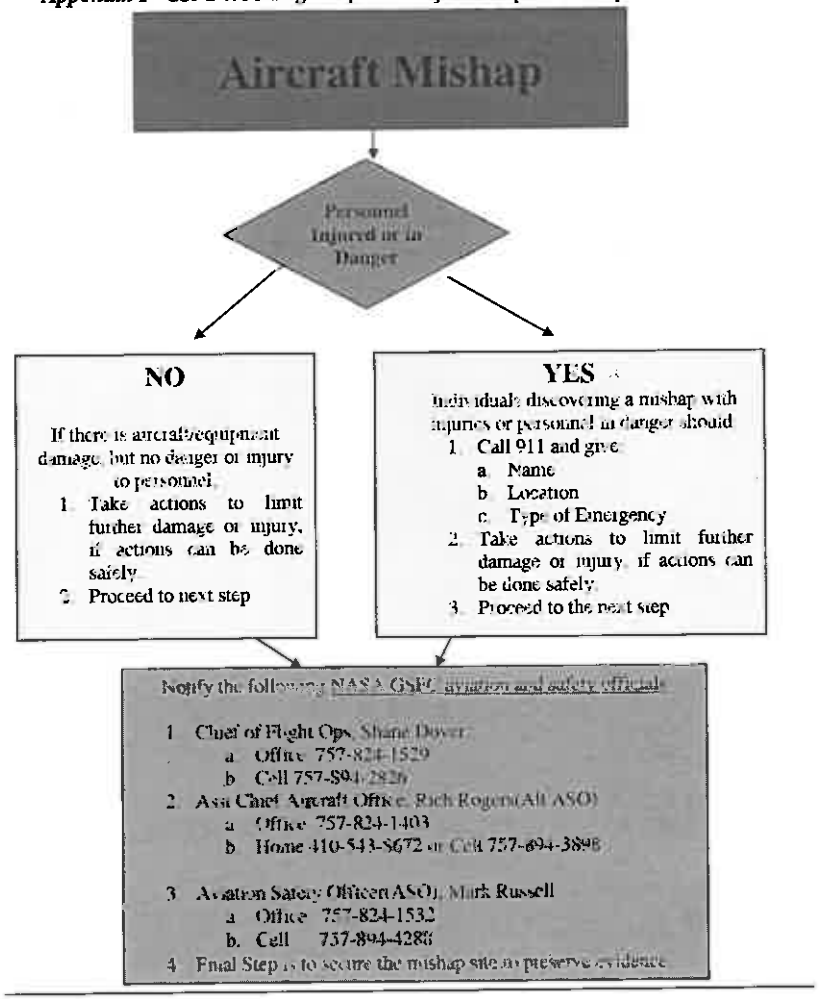
Provide as much of the following information as possible when reporting a mishap to the NASA ASO.

1. Person Reporting Accident/Mishap_____
   a. Telephone numbers_____
   b. Location for follow up questions_____
2. List fire, rescue, medical, and security personnel on scene
3. List others who have been notified, if any.
4. Date and Time of Mishap_____
5. Location – give:
   a. General area (building, etc)_____
   b. Exact location(room number, etc) _____
6. Description of Mishap
7. Personnel Injuries – describe each person and their level of injury
8. Aircraft, Equipment, or Property Damage description – describe type and level of damage for each
9. Persons Involved - include names, duties, employer, and contact info (address/phone number).
10. Aircraft Involved – list all type and tail numbers

11. Witnesses - provide name, address, phone numbers, & location during accident.
12. Weather Conditions
13. NTSB reportable data – may be required for certain mishaps(See NASA NPR **8621.1B, see http://nodis.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8621&s=1B**)

1. Type, nationality, and registration marks of the aircraft.
2. Name of owner and operator of the aircraft.
3. Name of the pilot in command.
4. Date and time of the mishap, malfunction, or failure.
5. Last point of departure and point of intended landing of the aircraft.
6. Position of the aircraft with reference to some easily defined geographical point.
7. Number of persons aboard and number killed or seriously injured.
8. Nature of the mishap or occurrence, the weather, and the extent of damage to the aircraft, so far as is known.
9. A description of any explosives, radioactive materials, or other dangerous articles carried.

Appendix F GSFC WFF Flight Ops Aircraft Mishap First Response



Appendix G CONTRACT AIRCRAFT QUESTIONNAIRE

- Please respond to each item. If an item does not apply or is yet to be determined, indicate so with "Not Applicable (N/A)" or "To Be Determined (TBD)".
- Please provide a separate questionnaire for each aircraft.
- Please provide a new or updated questionnaire for major changes to the aircraft.

II. REQUIRED DOCUMENTATION

Please provide copies of documentation for the items listed below:

a. Copy of current Airworthiness Certificate (both sides) with limitations
b. Copy of log book page containing entry of total aircraft time
c. Most recent weight and balance form
d. Aircraft manufacturer's weight and balance envelope graph/chart (if one exist)
e. Copy of last aircraft inspection
f. Forward, aft, right and left side looking pictures of the aircraft
g. Pictures of the experimenter port/protrusion to be used (internal and external)
h. Pictures of each type of instrument rack to be used
i. Pictures of proposed experimenter installation installed in aircraft
j. Copy of log book entry of last altimeter and static pressure system inspection
k. All 8110-3, 337, STC or aircraft modification documentation, used for experimenter/instrument purposes
l. Copy of Flight Manual (if available)
m. Copy of pilots/operators licenses, medical certification, currency and training records
n. Copy of Flight Test Plan (if available)
o. Copy of Training Plan/Manual (if available)

III. GENERAL INFORMATION

1. Aircraft Description

Overall dimerisions (length, wing span, tail height, etc.):
Maximum number of passengers capable of carrying:
Maximum altitude:
Maximum and cruise airspeeds:
Stall airspeed:
Maximum takeoff gross weight:
Maximum zero fuel weight:
Maximum allowable payload weight:
Maximum endurance:
Maximum range:
Rate of climb:
Minimum runway lengths required for takeoff and landing:
Engine type and manufacturer:
Performance limitations (i.e. cross winds, etc.):
Describe any icing protection capability:

2. Points of Contact

Name of aircraft owner/company:
Address:
Phone:
Fax:
E-mail:

Location of the aircraft:
Contact name at this location:
Address:
Phone:
Fax:
Email:

II. EXPERIMENT SUPPORT INFORMATION

1. Experiment Ports

Number of existing experiment ports available:
Fuselage location of each existing port:
Size of each existing port:
How is installation mounted to use each existing port (cabin seat tracks, seat tracks mounted around port, each installation custom, etc.):
Does an FAA form 337, 8110-3 or STC exist for each experimenter port?

2. Power

Type of power available to experimenters (115VAC, 28VDC, etc.):

Maximum amount of power available for experimenter use:
Type of circuit protection provided between aircraft power and experiments:
Does the aircraft have a way to disable experimenter power in the event of an emergency requiring all experimenter power to be disabled immediately? If so, explain setup/process. This can be in the form of a master electrical control switch or approved powers disconnect procedure.

3. Instrument Racks

Are instrument racks used?
Type of instrument racks used for experimenter use:
Size of racks:
Maximum allowable weight per rack for experimenter hardware:
Maximum allowable tip over moment per rack (when populated):

III. SAFETY EQUIPMENT

1. Life Rafts

Number of life rafts available:
Type of life rafts available:
Maximum number of people per life raft:
Location of rafts in the aircraft:

2. Passenger Smoke Hoods/Masks

Total number of units available:
Location of units in the aircraft:
Amount of useable time for unit:
Are the units full-face covering?

3. Oxygen Bottles (Firefighting and Medical)

Total number of bottles available for firefighting:
Total number of bottles available for medical use:
Location of bottles in the aircraft:

4. Supplemental Oxygen

Type of supplemental oxygen available for decompression emergencies (, oxygen generators, etc.):
Number of units available:
Location of units in the aircraft:

5. Fire Extinguishers

Number of fire extinguishers available:
Type of fire extinguishers available:
Location of fire extinguishers in the aircraft:

6. **Personal Floatation Devices**

Total number of units available:
Location of units in the aircraft:

7. **Arctic Wear (if applicable)**

Number of arctic clothing sets available:
Types of arctic clothing are available:
Location of arctic clothing in the aircraft:

8. **Immersion Suits (if applicable)**

Number of immersion suits available:
Location of immersion suits in the aircraft:

9. **Signal Kits**

Number of signal kits available:
Type of signal kit available:
Location of signal kits in the aircraft:

10. **First Aid Kits**

Number of first aid kits available:
Location of first aid kits in the aircraft:

11. **TCAS/TAWS**

Is the aircraft equipped with FAA-approved TCAS and TAWS systems for the specific type of aircraft to be used?

IV. ENGINEERING INFORMATION

1. Does all experiment installation engineering work use a DER and comply with the FAA process resulting in a signed 8110-3 form: Yes or No? If YES, then ignore section IV.

2. **Aircraft Design Emergency Landing Loads (g's)**

Forward:
Aft:
Sideward:
Upward:
Downward:

3. **Aircraft Design Gust/Inertia Loads (g's)**

Maximum upward:
Maximum downward:
Maximum sideward:

Provide copy of a chart depicting gust/inertia loads versus fuselage locations (if applicable).

4. **Pressure Relief Valve Settings (PSI)**

Maximum cabin differential pressure:
Maximum emergency relief pressure:

5. **Ground Clearance (Inches)**

Minimum ground clearance:
Location of minimum ground clearance:

6. **Seat Tracks and Isles (If applicable)**

Ultimate seat track strength:
Ultimate seat track mounting stud strengths:
Ultimate cabin floor strength:
Minimum isle width used:

V. MAINTENANCE INFORMATION

1. **History**

Describe the history of the aircraft from the date of manufacture to present, include: accidents, mishaps, damage, major repairs, modifications and/or alterations.

2. **Inspection Program**

Is the manufacturer's recommended inspection program used to maintain the aircraft in an airworthiness condition? If not, explain why and what inspection program is used.

3. **Overhaul and Replacement**

Is the manufacturer's or FAA approved overhaul intervals and recommended replacement times (aircraft engines, propellers, etc.) used to maintain the aircraft? If not, explain why and what program is used.

4. **Airworthiness Directives**

Is the aircraft maintained in accordance with all applicable FAA airworthiness directives?

5. **Weight and Balance**

Is the weight and balance and equipment list revised each time equipment is installed or removed?

6. **Altimeter and Static Pressure Systems Inspection**

If the aircraft is subject to flight under instrument flight rules (IFR) are the altimeters and static systems tested and inspected in accordance with 14 CFR 91?

7. **Transponder Inspections**

If the aircraft is equipped with an Air Traffic Control transponder, is it tested and inspected in accordance with requirements of 14 CFR 91?

For transponder equipped VFR aircraft with automatic pressure altitude reporting capabilities, is it tested and inspected in accordance with 14 CFR 43 Appendices E and F?

8. **Maintenance Records**

Are aircraft maintenance records maintained in accordance with 14 CFR 43 and 91?

Are entries made in the aircraft maintenance records performed by a person authorized by 14 CFR 65 for return to service?

9. **Maintenance Manuals**

Is the aircraft maintained in accordance with factory approved and current maintenance manuals?

10. **Maintenance Personnel**

Is the aircraft maintained by persons authorized in accordance with 14 CFR 65?

VI. OPERATIONS

Policies

1. Does an operations and procedure manual exist for the company owning the aircraft?

Flight Plan

2. Are flight plans required to be filed for project flights?

3. **Crew Complement**

Describe the crew compliment intended to be used when NASA personnel are onboard.

4. **Qualifications**

Describe requirements for Pilot and Copilot qualifications.

5. **Currency**

Describe the company policy on pilot and copilot currency.

6. **Crew**

Describe operating policies concerning crew duty, rest, and flight time limitations.

7. **Medical**

What are the company medical requirements for Pilots and Crewmembers?

8. **Training**

Is there an established Pilot and Crewmember training program?

What are your training requirements for Pilots and Crewmembers?

Appendix H *CONTRACT AIRCRAFT EXPERIMENT INSTALLATION ENGINEERING REQUIREMENTS*

1. **Provide a floor plan layout depicting the location of experiment equipment inside and outside the aircraft (this includes rack and operator seats). This drawing can be CAD or hand drawn.**
2. **Provide proof of an electrical load analysis performed.**
3. **Provide proof of an electro-magnetic interference check performed with avionics (email confirmation acceptable).**
4. **If a DER performed experiment installation engineering work and the FAA process was followed then provide a signed 8110-3 form for each item requiring this form. One form may cover all installations.**
5. **If no 8110-3 form is provided, then contact NASA for further engineering requirements. In this case, NASA will become the review and approval authority for all engineering work.**