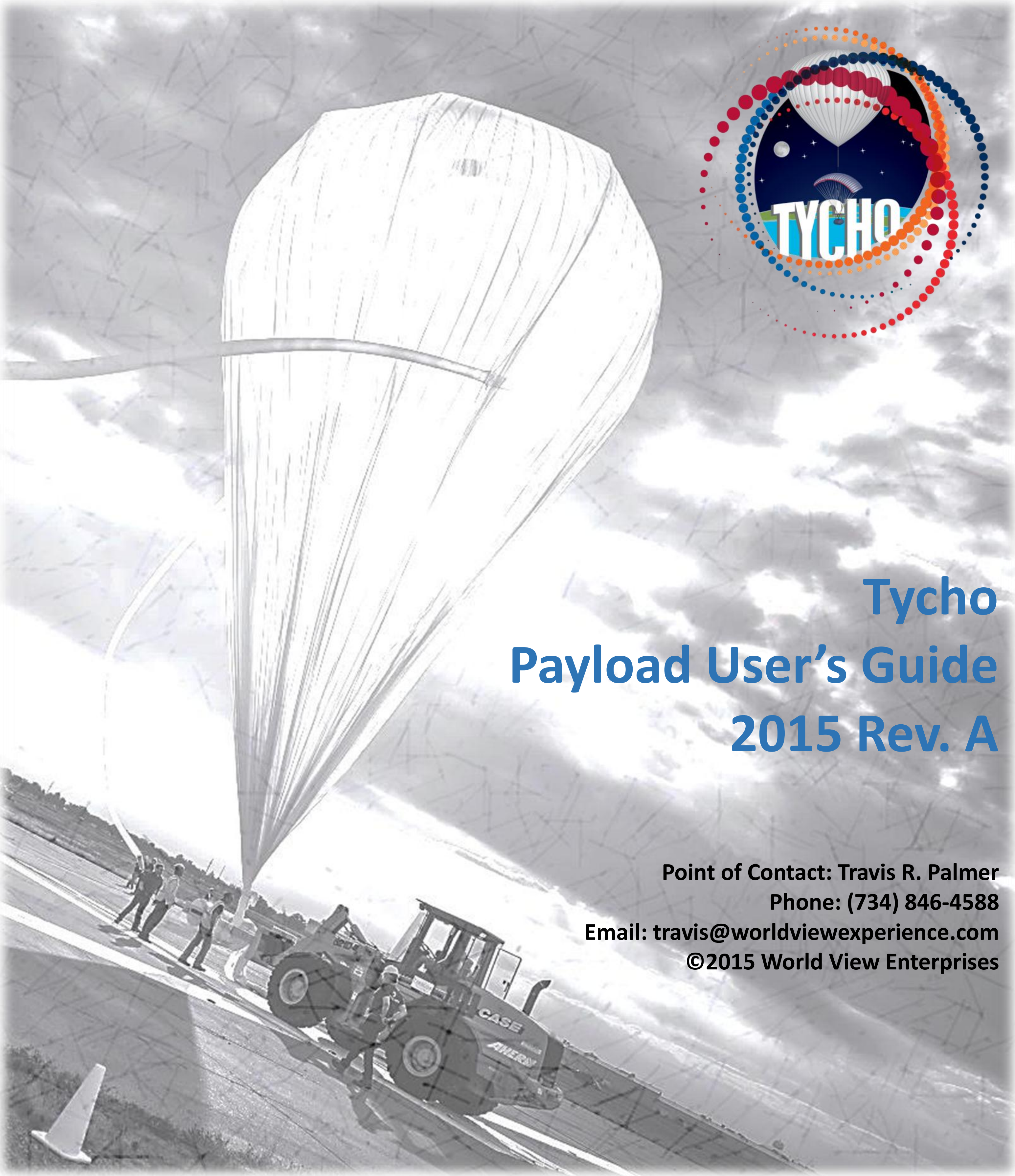

Tycho
Payload User's Guide
2015 Rev. A

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WORLD VIEW

Tycho Payload User's Guide

1 Introduction

Holding world records in manned and unmanned high altitude ballooning, flight operations and aerodynamic descent, World View is uniquely capable of performing a wide range of mission operations and accommodating unique payload requirements. World View is changing how the edge of space is used for research and education, from development of a concept through proposal support and successfully flying your mission on a commercially operated vehicle. If you do not find the capabilities that you are looking for in this document please contact Travis Palmer at (734) 846-4588 or travis@worldviewexperience.com.

This user's guide is intended to inform payload providers who will use one of World View's unmanned Tycho stratocraft to access the Earth's Stratosphere. This guide describes the capabilities and standard process by which payload providers interact with the World View team and prepare their payload for flight on a Tycho stratocraft. This guide also provides useful information regarding stratocraft capabilities, interfaces, flight environments, logistics, and recommended payload design features that will help ensure mission success.

2 Tycho Stratocraft Overview

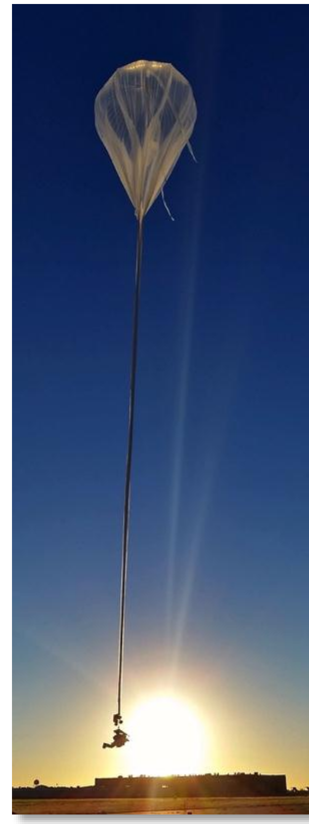

Figure 1. StratEx Flight System

The Tycho stratocraft is named after the Danish astronomer Tycho Brahe (1546 – 1601). As Brahe was the source of data used by others to make powerful discoveries, Tycho stratocraft provide researchers stratospheric access to make new discoveries.

World View has performed flights with the Tycho stratocraft systems with payloads ranging from 2 to 285 kg, with durations ranging from 5 minutes to 12 hours at target float altitudes varying from 15 to 41.5 km. These systems share heritage with those we used for the record setting StratEx manned balloon flights performed in October 2014 (see Figure 1).

World View also has the capability to launch and fly payloads up to 4,500 kg into the stratosphere, and welcomes the opportunity to discuss and plan such missions directly, though many elements in this user's guide apply to payloads of all masses (up to 4,500 kg) and target altitudes (up to 46 km).

Two standard stratocraft platforms are currently offered for specific payload mass ranges. Tycho285, the larger of the two, carries payloads up to 285 kg to altitudes of up to 43 km. Tycho20, the smaller of the two, can launch payloads up to 20 kg to altitudes of 32 km. Tycho20 requires less infrastructure than that needed to launch and operate the much larger Tycho285. However, Tycho20 can also be configured to be launched to higher altitudes up to 46 km. The two-vehicle Tycho stratocraft family provides cost savings for small payload masses while also offering proven heavy-lift capability.

Both Tycho stratocraft share the same avionics, balloon envelope technology, and similar recovery systems stratocraft. Tycho285 allows direct connection of a single payload to the vehicle or via a payload support module (PSM) (see Figure 6) that facilitates payload integration and allows for a number of smaller individual payloads onto a single flight. Tycho20 uses a simple Payload Support Frame (PSF) for payload attachment. A summary of the standard Tycho stratocraft is given in Table 1.

Table 1. Tycho285 and Tycho20 Key Features

Vehicle	Payload				Max Altitude (km)	Max Flight time (hrs)	Payload Data Up/Down (bps)	Post-flight Mission Data
	Attach Method	Max Mass (kg)	Max Volume (m^3)	Power (W)				
Tycho285	PSM	200	1	N/A	43	17	1200	Temperature Pressure Altitude Lat/Lon X,Y,Z Accelerations Video
	Direct Connect	285	10	N/A				
Tycho20	PSF	20	0.563	N/A	46	11	1200	
	Direct Connect	60	Up to 10*	N/A	46	11	1200	

**hook on volume*

On the Tycho20 stratocraft, flight times at float altitude of 2 hours or less can be done during most months in any given year. Typically during the Spring and Fall turnaround periods flight durations at altitude of as much as 7 hours can be accommodated. On the Tycho20 stratocraft, flight times greater than 7 hours at float altitude, and for float times greater than 2 hours at times outside the Spring and Fall turnaround periods may be accommodated as a non-standard service.

2.1 Tycho285

Figure 2. Tycho285 at Launch

Tycho285 consists of a zero pressure envelope, Balloon Equipment Module (BEM) which houses the flight avionics, a payload release interface (PRI), and an aerodynamic descent system (ADS). It can be configured with or without a PSM. The standard PSM supports one or more payloads for a total mass of up to 200 kg and is equipped with a recovery system to return the PSM and payload(s) safely back to the ground. A payload that cannot fit volumetrically into the PSM, is heavier than 200 kg, and/or is an atmospheric descent system, can be directly attached to Tycho285's PRI. The PRI can support up to 285 kg with a similar recovery system that attaches to the payload via a standard interface. Tycho285 is equipped with a standard avionics suite comprised of a flight computer, a flight transponder, video cameras, ground and satellite-based data communication, GPS and flight batteries capable of a 17 hour flight time.

2.2 Tycho20

Tycho20 is a stratocraft configuration for small, high altitude payloads that can be safely launched with minimal crew and infrastructure. Its can fly payloads up to 20 kg to altitudes up to 46 km.

To maximize the useful payload mass, the PSF is used to integrate the payload, avionics, and ADS into a single package. This simple and lightweight frame is made of 80/20 one inch extruded aluminum bar to which the payload can be secured via a hook or by employing a T-slot system. Often times, an interface plate will be loaned to the payload provider at his/her institution to simplify the mechanical interfaces and ensure quick, reliable integration of the payload to the stratocraft PSF. The Tycho20 avionics is a repackaged version of that used in Tycho285 where only required hardware is included to keep weight to a minimum: a flight computer, a flight transponder, video cameras, ground and satellite-based data communication, GPS and flight batteries. The standard Tycho20 is capable of up to 11 hours of flight time.

3 Integrated Payload Preparation & Flight Process

The standard process by which payload providers interact with the World View team and prepare their payload for flight is shown in the flow chart below (see Figure 3). The process begins once a flight contract is in place and concludes with the de-integration and return of the payload/hardware to the payload provider. During this period, once every two week status telecons are held between the World View Team and the payload provider up to integration. These telecons can be more or less frequent as needed. The following subsections describe various aspects of payload integration for our Tycho systems:

3.1 Payload Data Package

The first step in Tycho payload integration involves the Payload Data Package (PDP). The PDP is a standard World View form that the payload provider completes after contract signing to inform World View of various characteristics of the payload (e.g., size, mass, general operation, safety considerations, etc.) so that flight planning and preparations can begin.

3.2 Interfaces

The second step in the process is to agree to all payload-to-Tycho interfaces (mechanical, electrical, data, etc.). Once the interfaces are defined and agreed to, World View produces an Interface Control Document (ICD) that controls the interfaces. Any changes made to the interfaces after the ICD is released must be agreed to and result in a configuration controlled revision to the ICD.

3.3 Payload Safety Package

Following the ICD, the Payload Safety Package is generated from a standard World View form by the payload provider to answer key questions relating to payload ground and flight safety and to describe all safety measures taken to mitigate any safety risks posed by the payload systems/components (i.e., stored energy device containment).

3.4 Interface Plate & Stratocraft Prep

For Tycho20 and select Tycho285 payloads, an interface plate is often provided to the payload provider to simplify the payload integration process and aid the payload providers in the design and implementation of their structural mounting scheme. World View provides this plate shortly after the ICD is released. At this stage in the process, World View begins preparing the stratocraft for payload integration.

3.5 Integration, Test, Operation Plan

Prior to arrival of the payload at the launch site, the payload provider must submit a complete Integration, Test, and Operation plan. A template for this plan is provided by World View. This plan is necessary to ensure the World View team is adequately informed to support the integration, test, and operation of the payload even if the payload provider is available onsite for all these phases of the prep and flight process.

3.6 HRR and Payload Shipment

Following receipt and review of the Integration/Test/Operation Plan a Hardware Readiness Review (HRR) will be performed to confirm that the payload and stratocraft are ready for integration. Upon successful closure of the review, the payload provider will ship the payload to WV. The shipping address and logistics are provided in section 9.1 of this document.

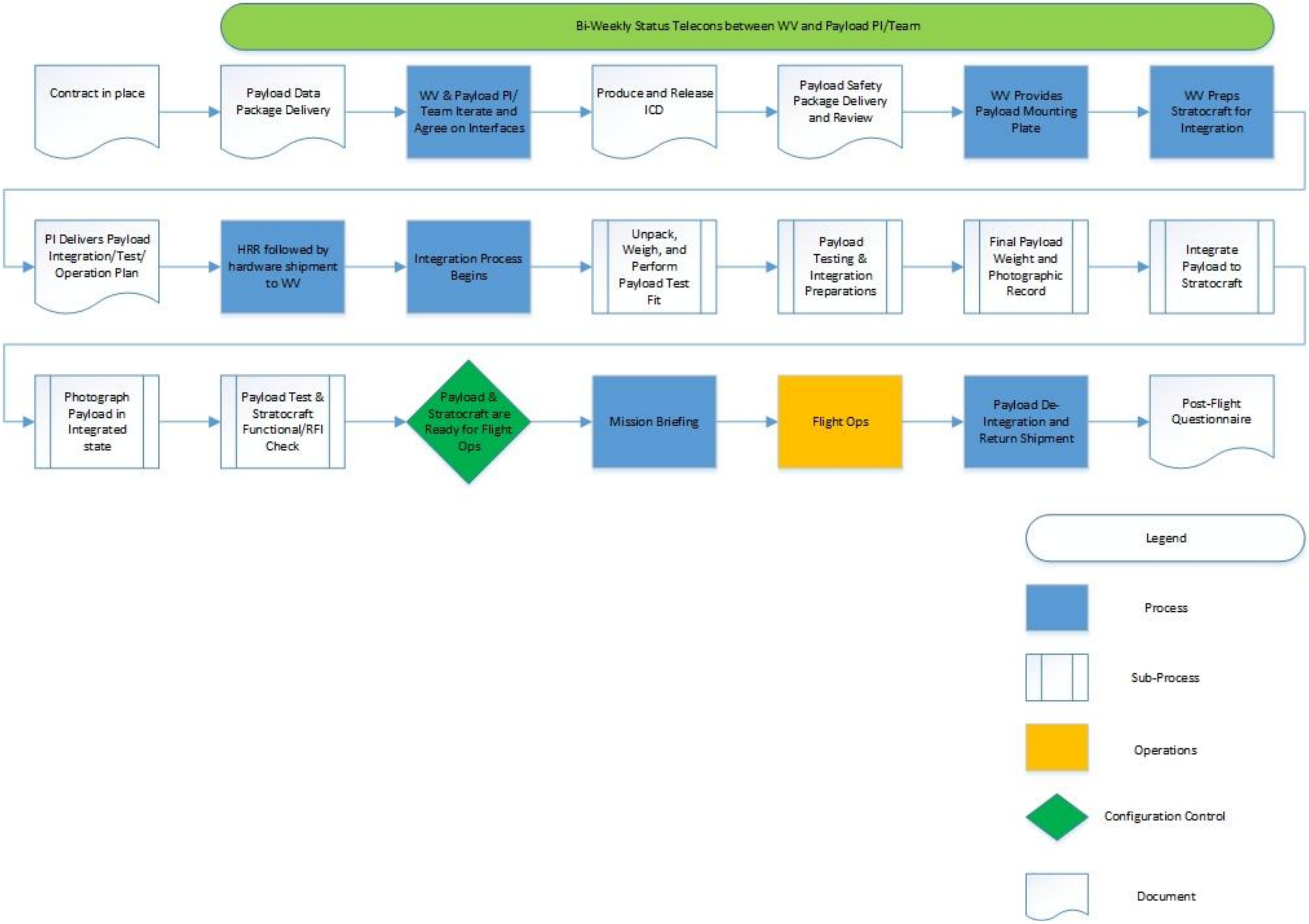

Figure 3. Interactive Payload Prep & Flight Process

3.7 Integration

Once a payload has arrived at the World View integration facility, it is weighed and a test fit in the stratocraft is performed. The payload is then functionally tested and prepared for integration. A final payload specific mass is measured and the payload is photographed. Once the payload is integrated it is again photographed, though now in the integrated state. The payload is then put through a bench-top functional & Radio Frequency Interference (RFI) test in conjunction with the stratocraft systems and any other payloads that are on the stratocraft.

3.8 Flight Ready and Mission Briefing

Successful completion of the RFI test puts the stratocraft and payload(s) under configuration control as they are now considered flight ready hardware. In parallel, all operational equipment and personnel are prepared for flight operations. A Mission Briefing is then performed to formally confirm readiness for flight. Regulatory and airspace operation organizations participate in the Mission Briefing along with the flight operation personnel and payload provider(s) (as available).

3.9 Flight Operations

Flight operations commence once the Mission Briefing is closed out and an acceptable launch window has been identified. Depending on the availability of the payload provider, World View will handle all payload flight operations prior to and during flight. In the event that the payload provider is unable to attend the flight, any data generated by the payload, but recorded by a World View system during the flight will be shared with the payload provider electronically after the flight.

3.10 Payload De-Integration and Return

De-integration of the payload(s) will occur within 48 hours after recovery of the stratocraft. In the event that the payload provider is unable to personally ship the payload and any support hardware, World View will assist in shipping pre-paid packages to the payload provider.

3.11 Milestone Timetable

For planning purposes payload providers should expect the following standard milestone timeline building up to and following the execution of a flight. The durations will vary depending on payload maturity and any other factors such as non-standard services that need to be taken into account. It is also important to note that coordination with airspace controllers, airspace activities, and weather strongly factor into an actual flight date.

Milestone	Timeframe
0. ATP	---
1. Payload Data Package Delivery	ATP + 2 weeks
2. ICD Released	ATP + 4 weeks
3. Payload Safety Package Delivery	ATP + 4 weeks
4. Payload Integration/Test/Operation Plan Delivery	Integration – 4 weeks
5. HRR	Integration – 2 weeks
6. Payload Integration and Testing	Flight – 1 week (start)
7. Weather Window Identified	Flight – 1 week
8. Mission Briefing	Flight – 1 to 3 days
9. Flight	---
10. De-Integration and Return Shipment	Flight + 1 to 2 days
11. Payload Provider Feedback Survey Returned	Flight + 2 weeks

4 Payload Environments

4.1 Acoustics

For both Tycho285 and Tycho20 there are no significant acoustic loads experienced during the mission profile. There are some low-level acoustic loads during balloon inflation but otherwise there are no acoustic loads of note.

4.2 Forces

4.2.1 Transportation Loads

Payloads will experience transportation loads as a function of the means of transport. See MIL-STD-810 for a range of transportation loads.

4.2.2 Launch Loads

Tycho stratocraft launch shock loads will not normally exceed 0.5 g at the moment the payload is released from the launch spool. Worst case launch loads will not exceed 2 g. Once released payloads can be expected to ascend at a rate of approximately 6.3 m/s.

4.2.3 Parachute Opening Load

Opening loads for the parachute can be expected to be between 0 and 5 g's.

4.2.4 Reduced-Gravity Loads

The duration of reduced-gravity can be estimated based on float altitude, payload mass, and drogue characteristics and is therefore a system specification to be defined with the Payload Provider. For example, estimates of 19 to 28 seconds of < 0.1 g's can be achieved for masses 300 kg to 75 kg, respectively, when released from an altitude of 42 km.

4.3 Temperatures

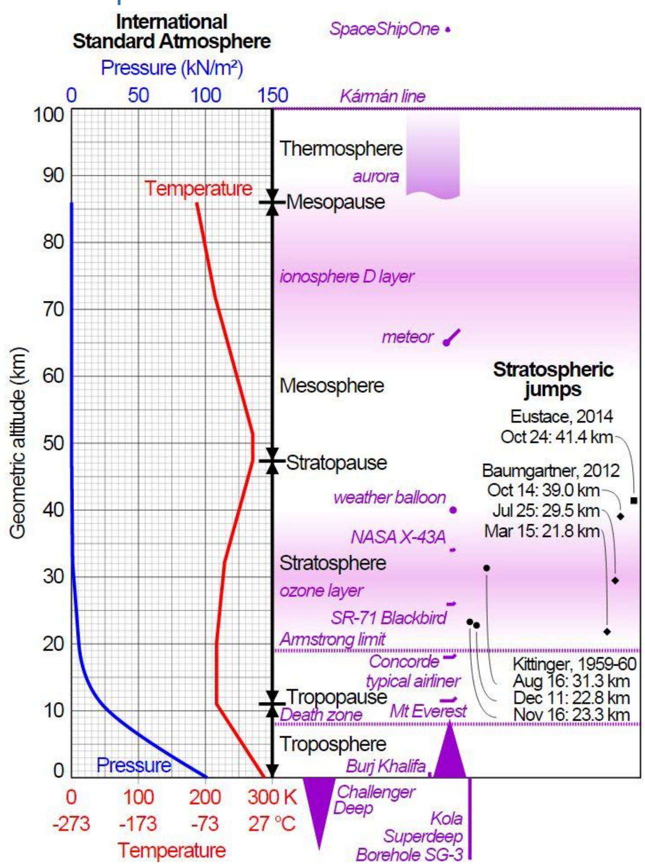

Figure 4. International Standard Atmosphere

Figure 4 shows the International standard atmosphere temperature profile. Payloads should be designed to withstand this temperature profile. If requested World View can provide engineering assistance in the thermal analysis and design of user payloads as a non-standard service.

During ascent, convective losses will dominate the thermal payload environment. At float attitude convective losses are reduced and radiative heat transfer dominates heat transfer mechanics. Uncovered portions of payloads will see 4 degree K (no Earth Albedo, etc.) black space for 360 degrees of azimuth up to an elevation angle determined by balloon size and altitude. Above that elevation angle payloads will see the radiative surface of the balloon itself. It is vital that payloads be properly insulated to survive ascent through the troposphere. For sunrise or sunset launch campaigns, passage through the troposphere is thermally stressful. There are a number of low cost insulating materials which can be used to protect the payload. Open cell or closed cell Styrofoam makes an adequate insulator. Thought has to be given as to how much heat is generated inside the insulated box to prevent accidentally overheating the interior of the insulated box. Consideration also has to be given to the optical properties of the exterior insulating materials or the experiment itself if uninsulated. For sunrise launches arriving at float altitude after local sunrise there will be significant solar heating on the exterior surfaces of the insulator. A good rule of thumb is 1,400 watts of solar radiation will be applied to each square meter of exterior surface. Daytime flights need a first surface with a low absorptivity (alpha) and a high emissivity (epsilon) to prevent surface heating. There are many good materials for this purpose in cost varying over orders of magnitude. Table 2 lists materials that can be used to provide thermal protection for balloon payloads. Figure 5 shows the optical properties of various thermal control materials as a function of wavelength.

Table 2. Optical Properties of Commonly Used Thermal Control Materials

Material	Application	Conductivity Btu/(ft.hr.°F)	Absorptivity	Emissivity
Closed Cell Styrofoam	Conductivity Insulator	0.017	N/A	N/A
Open Cell Styrofoam	Conductivity Insulator	TBD	N/A	N/A
Flat White Exterior House Pain	Low absorptivity optical surface	N/A		>0.9
AZ-93 (AZ Tech. Inc.)	Low absorptivity optical surface finish	N/A	0.15 ±0.02	0.91 ± 0.02

Material	Application	Conductivity Btu/(ft.hr.°F)	Absorptivity	Emissivity
AZW/LA-II (AZ Tech. Inc.)	Very low absorptivity optical surface finish	N/A	0.09 ± 0.02	0.91 ± 0.02
Chemglaze A-276	Low absorptivity optical surface finish	N/A	0.28 ± TBD	0.88 ± TBD
SG121FD	Low absorptivity optical surface finish	N/A	0.20 ± 0.04	0.88 ± 0.03
White Duct Tape	Low absorptivity optical surface finish	N/A	TBD	TBD

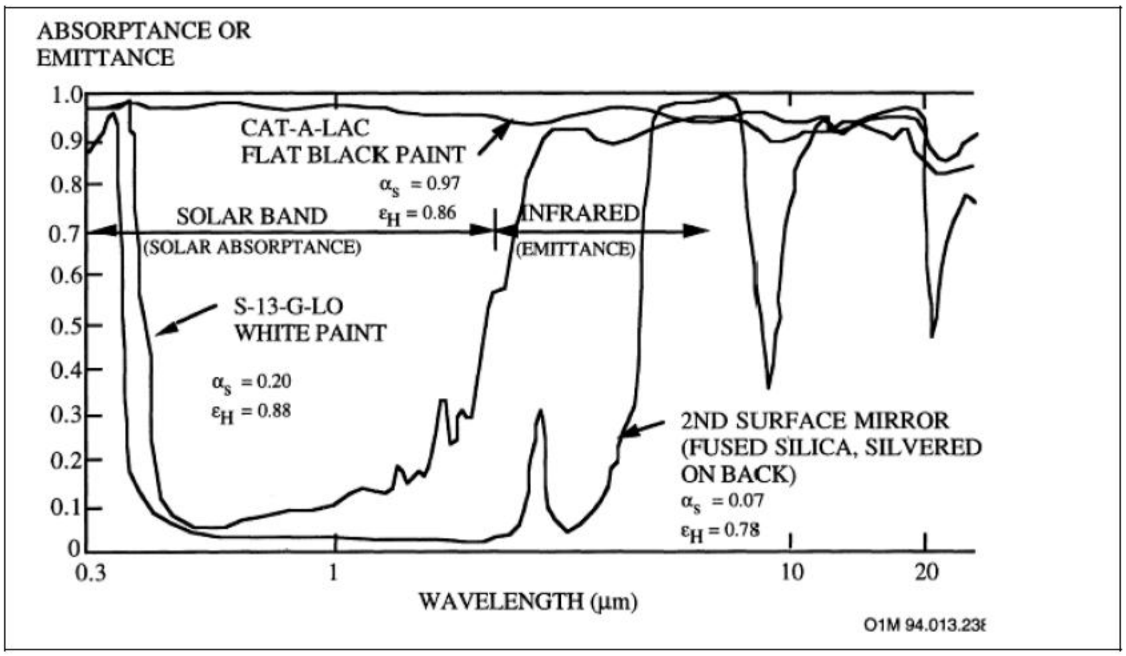

Figure 5. Optical Properties of Thermal Control Materials

A commonly used, low cost approach to balloon thermal insulation is to insulate the item with Styrofoam and cover the Styrofoam with Tyvek™ or similar tape. Although not ideal from a thermal engineering perspective this approach has been used for decades as an inexpensive, easily fabricated, stratospheric balloon equipment thermal insulation technique. Thermal design is one of the most challenging aspects of balloon payload design and care must be given to proper thermal control to ensure the payload is not damaged by the extreme cold of the troposphere and stratosphere, or the solar illumination for day time flight.

4.4 Pressure

Figure 4 shows the pressure vs. altitude profile of the International Standard Atmosphere. The payload must be designed to withstand this pressure profile with an assumed ascent rate approximately 5.2 m/sec. Payloads that contain high voltage (>100V) power supplies must be designed to prevent electric discharge or arcing (Paschen's Law). World View can provide engineering support to payload designers developing high voltage power supplies.

4.5 Humidity

Humidity environments for balloon payloads are driven by local weather conditions at the launch site. There is no on-pad humidity control for payloads. Humidity control within the payload build up area will be approximately 50%. Electrostatic discharge precautions should be taken while working in the WV integration facility and payload providers are encouraged to use the ESD safe work area in the facility.

4.6 Vibration

There are no significant vibration loads on balloon payloads in flight. As discussed earlier there are transportation, launch, chute opening, and landing loads to be considered in payload structural designs but no significant random or sine vibration loads.

For consideration by payloads sensitive to low levels of vibration, there can be very low levels of vibration passed to the payload from the balloon as it passes through regions of high altitude instabilities. This phenomenon has been experienced on payloads with arc-second pointing systems. Unless the payload is extremely sensitive to low levels of vibration there is no need to design for sine or random vibration loads.

4.7 Shock

Payloads will experience low to moderate levels of shock during separation from the balloon, parachute deployment, and landing impact. Levels and durations for shock excitation are listed below;

Balloon separation – less than 0.1 g's for 7 seconds from 28 km.

Primary canopy inflation – less than 4 g's for less than 1 seconds.

Landing impact – less than 7 g's for less than 1 second.

Landing shock loads are significantly mitigated by landing crush pads. Typical shock attenuation using honeycomb cardboard material is shown in Table 3. Payloads not enclosed in the PSF or PSM should consider the addition of crush pads to the bottom of their payload to minimize landing damage.

Table 3. Crushing Properties of Multiple Thickness Honeycomb Cardboard Crush Pad Material

Combination Type	Average Value, kPa	Raising rate, %	Combination Type	Average Value, kPa	Raising Rate, %
10mm	190.30		15mmB	132.80	-4.96
10mmA	130.02	-31.68	15mmAB	146.62	4.93
10mmB	96.79	-49.14	20mm	93.50	
10mmAB	105.19	-44.72	20mmA	101.03	8.05
15mm	139.73		20mmB	109.84	17.48
15mmA	141.11	0.99	20mmAB	99.01	5.89

4.8 Charged Particle Radiation

Charged particle radiation is generally not a concern for high altitude balloon payloads owing in large part to the effectiveness of the Earth's magnetosphere in shielding charged particles from reaching balloon altitudes. There are many excellent publications on the subject of ionizing radiation effects of space mission. Total Ionization Dose (TID) for a 2 day mission is much less than 1k Rad (Si) behind 1/6th inch of aluminum.

For practical purposes only the most sensitive detectors and microelectronics have reason to be concerned with the effects of charged particle radiation on their payloads.

4.9 RF

Table 4 lists the transmitting and receiving components of Tycho20 without payloads. This data should be used by the payload provider to ensure that these components neither interfere with, nor are interfered by the Tycho components that operate at this frequency.

Table 4. Transmitting RF Component List (Reference Only)

Location	Radio Component	Transmit Frequency (MHz)	Receive Frequency (MHz)	Tx Power (Watts)	Transmission Timing
Tycho	Tycho Microhard Modem	902-928	902-928	1	Continuous, FHSS
	Payload Microhard Modem	902-928	902-928	1	Continuous, FHSS
	Bluetooth	2.4 GHz	2.4 GHz	0.0025	Continuous
	u-blox GPS	NA	1575.42	NA	
	Tycho SPOT 1	1610 - 1620	1610 - 1620	0.4	Every 10 / 2.5 minutes
	Tycho SPOT 2	1610 - 1620	1610 - 1620	0.4	Every 10 / 2.5 minutes
	Tycho Iridium SBD Modem	1616 - 1626.5	1617 - 1626.5	0.005	Every 5 minutes and when queried
	Radiosonde (GPS only)	NA	1600	NA	NA
	Mode S Transponder	1090	1030		

5 Stratocraft Interfaces

5.1 Mechanical Interfaces

5.1.1 Tycho285 Mechanical Interfaces

Payloads hosted on a Tycho285 stratocraft weighing less than 200 kg can be mounted inside a framework assembled with aluminum extrusions with angle brackets to form the structure. This Payload Support Module (PSM) (see Figure 6) is an open faced, frame-cubed structure offering approximately 1 m^3 of internal volume. As noted in section 3.2, interfaces are defined and agreed to in an ICD between the payload and World View.

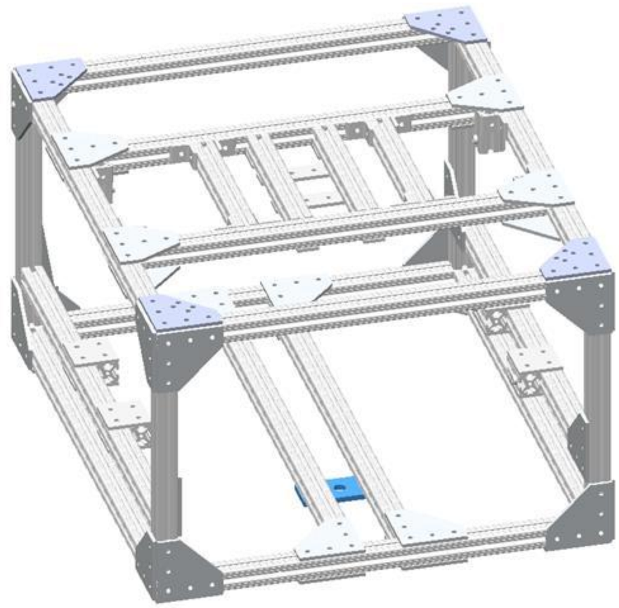

Figure 6. Tycho285 PSM

The ICD will contain bolt hole locations, fastener types and sizes, connector locations, exterior geometry of the experiment, GSE access requirements (e.g. purge, EGSE connections, external stimulus equipment, fields of view, keep-out areas) etc.. After the ICD has been released, World View will fabricate any mission unique mounting hardware required to accommodate the payload. World View will also provide a mounting template to the payload provider that they can use to verify mounting fastener locations.

Payloads too large to be mounted inside the PSM can be mounted directly to the Payload Release Interface (PRI) via the Aerodynamic Descent System (ADS) as long as the experiment does not exceed 2.5 m in height. In this implementation, interface requirements are levied on the payload provider to allow for the installation of the ADS. Payloads not integrated in a PSM must also provide any crush pad protection required to protect their equipment.

5.1.2 Tycho20 Mechanical Interface

Tycho20 payloads are typically attached to a Payload Support Frame (PSF), a simple metal structure consisting of 80/20 aluminum extrusions and corner brackets. Payloads that fall within the 20 kg mass, but do not fit within the Tycho20 PSF can still be flown using a Tycho20 PRI. As with Tycho285, an ICD will be used to document and control the mechanical interfaces between the payload(s) and PSF/PRI.

A single or combination of payloads of 20kg can be accommodated in the standard PSF with dimensions do not exceed any of the 3 following dimensions:

Length: 75cm
Width: 75cm
Height: 25cm

A total hook on volume of up to 10 cubic meters can be accommodated as standard if the payload is configured to be a direct connect configuration that attaches to the PRI as in the case of the Tycho285, but where the total payload mass is no more than 45 kg. Larger volumes and masses can be accommodated as a non-standard service.

5.2 Electrical Interfaces for Tycho20 and Tycho285

5.2.1 Telemetry and Command Interfaces

Both the Tycho20 and 285 platforms offer the same UART serial interface to payload provider's telemetry and command functions. Details of the telemetry and command interfaces are listed here:

- UART 3.3v TTL
- Baud Rate selectable (standard baud rates from 300 to 230400)
- Data bits – 8
- Stop bit – 1
- Start bit – 1
- Parity bit – none

Payload providers can expect a transport lag of their data through the flight and ground system of 2 seconds (nominally) to 10 seconds roundtrip. There is no error checking protocol used in payload communications. Eight bit data words will be delivered to the payload provider in the order received by the flight modem.

5.2.2 Video Interface

Tycho285 and Tycho20 can be outfitted with GoPro cameras to record flight video. As a non-standard service the Tycho285 platform can be outfitted with a video downlink capability to payload providers.Tycho20 does not offer video downlink support at this time.

5.2.3 Power Interface

There is currently no standard power service provided for either the Tycho285 or Tycho20 Stratocraft. Provisions can be made to provide switchable power from mission control 3.3, 5, 15 or 24 VDC up to 20 amp input power to payloads as a non-standard service.

5.2.4 Analog/Discrete Interfaces

There are no analog or discrete interfaces provided with the Tycho285 or Tycho20 stratocraft. Payload providers requiring analog or discrete signal processing should contact us to make arrangements for support of such signals as a non-standard service.

5.2.5 Relay Closure Interfaces

There are currently no relay closure services provided with either Tycho stratocraft. Relay closure services can be instituted as a non-standard service.

5.2.6 Serial Interfaces

One serial data stream can be provided to the payload to transfer up to 1200 bits per second (150 bytes). The RF modem used to implement data communications is half-duplex system transferring both uplink commands and payload downlink data in time sequence. The payload to modem connection is UART 3.3v TTL, however adapters from RS-232 or 5v TTL are readily available. Using the modem's flow control signals to avoid buffer overflow, baud rates can set to any of the standard rates of between 300 and 230,400 BAUD with 115,200 baud as the optimal setting (Figure 6). In mission control a serial connection will be provided on a mission control PC that can be displayed with terminal software such as PUTTY or custom programs such as LabVIEW. A custom software interface can be provided as a non-standard service.

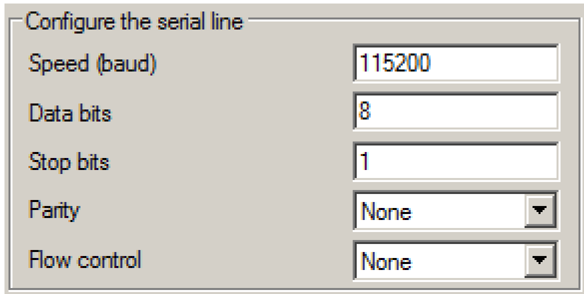

Figure 7: Preferred Serial Settings

5.2.7 Other Data Interfaces

The serial interface described in this section is the only standard service data interface provided with the Tycho285 or Tycho20 stratocraft at this time, however we can offer additional non-standard capabilities upon request.

5.3 Software Interfaces

Generic serial terminal software (PUTTY) is available in mission control to connect to the payload serial stream. There is no other standard service software interfaces provided with either stratocraft. Payload providers requiring in-flight software or ground system software should contact us to discuss flight or ground software support.

6 Stratocraft Service

6.1 Communications

Tycho stratocraft use a 902-928 MHz, frequency hopping, 1 watt output power, spread spectrum modem to communicate telemetry and commands at up to 1200 bps up to a distance of 160 miles.

Line of sight voice communication services to ground crews and recovery crews are provided.

We will also provide Internet, fax, and telephone communications services to payload providers during integration and test as well as launch site operations and payload de-integration.

6.2 Information/Data

Information and data to and from the Tycho stratocraft will be made via the spread spectrum modem mentioned earlier in this section. Ground data exchange will be made via open Internet, phone, and VHF line of sight radios.

7 Payload Design and Safety Requirements

Experience has identified key payload features that World View strongly recommends payload providers design into their payloads to enhance safety while also simplifying and improve payload integration, testing, and operation during flight.

7.1 Shore Power

The payload should be designed with the ability to operate using an external battery pack during non-flight operation. This way flight battery power is not utilized during ground tests such as the functional and RFI tests after integration. This also prevents the need to de-integrate the payload after the RFI test for the purpose of replacing the flight batteries in the event that shore power was not used. The shore power interface on the payload should also be designed to be easily accessible after integration.

7.2 External Power Key Switch

The capability to turn the payload power on and off without de-integration is highly desirable. Standard toggle switches however pose the risk of inadvertently being toggled. Instead one or more key switches (see Figure 8) can be built into the payload to allow for the control of power and other payload functions with minimal risk of inadvertent toggling.

Figure 8. Key Switch

7.3 External Data Access

External access to payload computers and or data storage (SD card, etc.) is also highly advantageous without the need for de-integration. This is often accomplished by having an access panel that is accessible once the payload is integrated with the stratocraft. Position of the access panel should be defined during the interface definition phase of the interactive payload preparation process.

7.4 Payload Safety Requirements

World View's Safety, Quality and Mission Assurance (SQ&MA) organization maintains full responsibility for the development and execution of processes and procedures that ensure compliance with all established operational Flight Safety, Mission Assurance and Environmental requirements.

Payload design and safety standards are tailored to the individual missions depending on the nature of the payloads being performed. Payload safety standards include, but are not limited to the following elements:

- Elimination of sharp edges in locations than endanger the integration or recovery crew
- Fuse protected internal batteries
- Protection from exposed high voltage terminals
- Use of non-explosive actuators unless approved by World View
- Marked lifting and handling fixtures and/or locations
- Control of pressurants
- Containment of stored energy devices
- No toxic materials or consumables unless approved by World View with proper containment

8 Flight Operations

Launch operations are the responsibility of World View as is the safe operation of the stratocraft/payload and coordination of flight operations with the FAA and airport personnel during the entire flight and recovery period.

In the event that the payload provider is available at the launch, payload providers are responsible for monitoring and operating their payloads during flight operations. Payload providers will keep the flight director informed on the status of their payload's operations and any needed changes to pre-planned flight operations. Alternatively, World View can prepare and operate the payload if the payload provider is unavailable. Figure 9 provides a sample flight profile

Figure 9. Sample Flight Profile

8.1 Flight Rules

Prior to launch the Payload provider and World View will develop a set of flight rules. The intent of the flight rules is to lessen the real-time decision making burden on the flight operations team by providing an inviolate set of rules that must be followed under all circumstances. Flight rules will cover such considerations as follows;

- Status and condition of payload warranting a declaration of flight readiness.
- Status and condition of the balloon control equipment (e.g. avionics, GPS systems, transponder status, modem status, etc.) warrant a declaration of readiness to fly.
- Mission control status and conditions.
- Key personnel availability to support flight operations.
- Balloon readiness for flight.
- Recovery crew and resources readiness to recover.
- Flight and ground software build status.
- Key payload measurement parameters with red, yellow and green operating limits.

The above list is not meant to be an all-inclusive list of flight rules. Rules have to be tailored for each mission but the above list illustrates the types of information expected to be included in a list of flight rules. During early mission planning the payload provider and World View will jointly develop the flight rules and place them under configuration control.

9 Payload Provider Logistics

9.1 Shipping Hardware

Payload providers often wish to ship their payload, ground support hardware, batteries, etc. Shipments should be sent to the World View Office at the following address:

World View Enterprises
1840 E. Valencia, Bldg 8, Ste. 123
Tucson, AZ 85706

FedEx, UPS, and USPS facilities are conveniently located near the World View Office for shipping hardware after the flight is complete. In the event that the payload provider is unavailable to execute the return shipment, World View will assist by dropping off the packaged hardware to the appropriate carrier at the payload provider's request. In all scenarios, the payload provider is responsible for shipping charges unless otherwise agreed upon.

9.2 Travel, Accommodations, and Facility Locations

The World View office and Integration Facility are located within 5 and 12 minutes respectively from the Tucson International Airport (airport code: TUS). Payload Providers are encouraged to stay at the Four Points Sheraton at the Tucson Airport (WV discounts available) or at one of the many hotels near the Tucson International Airport located on S. Tucson Blvd. Having a rental car is also strongly recommended during your stay in Tucson to facilitate transportation to and from the WV Office/Integration Facility, and to take advantage of the various restaurants and attractions around the Tucson area.

Given that Stratospheric balloon flights are subject to weather conditions, payload providers are encouraged to purchase one-way tickets initially if they wish to attend integration and flight. This way they can extend their stay if necessary, without incurring additional travel costs for modifying their return date.

9.2.1 WV Office

Figure 10. World View Office Building

The World View Office is located within the Million Air FBO (building #8) at 1840 E. Valencia. Figure 10 provides a view of the building entrance from Valencia. The World View Office is located on the bottom floor, on the North East corner of the building (visible in Figure 10).

9.2.2 WV Hangar

The WV hangar is where the payloads are integrated into the stratocraft and where we perform our various ground tests (including the RFI test) prior to flight operations. The facility is equipped with an Electro Static Discharge (ESD) safe working area along with general computing and working space for payload providers during their stay.

9.3 Recommended Attire & Personal Equipment

Payload providers participating in integration, test, and flight operation activities are strongly encouraged to review the local Tucson weather conditions a few days prior to their arrival. Despite the well-earned perception of being a hot region of the country, the Tucson area can be chilly, particularly at the launch site a few hours before launch during the non-summer months. Payload providers are therefore encouraged to bring long pants and jackets or equivalent warm clothing for these conditions. The summer months can be hot though during the day and light clothing is recommended during these months, though long pants and long sleeve shirts are recommended to protect against the Sun and environment. Because some activities (e.g., Ground Testing) may take place outside payload providers are also strongly encouraged to bring sunglasses, a hat, sunscreen, and a means of carrying water (e.g., refillable water bottle).