

## **Millennium Airship, Inc. SkyFreighter**

Peter Lobner, 28 July 2019

### **Background**

Millennium Airship, Inc. (MAS), located at Bremerton National Airport in Belfair, WA, was founded in 1997 by Gil Costin to develop a product line of large, long range passenger and cargo carrying semi-rigid, hybrid airships called SkyFreighter Hybrid Heavy Lift Air Vehicles (HHLAV). The large volume of the SkyFreighter's internal cargo bay is intended to give manufacturers the opportunity to ship fully-assembled, outsized and bulky cargo directly to the destination, avoiding transshipment and cargo size limits of traditional modes of ground and sea transportation. MAS claims that the SkyFreighter does not require any infrastructure for landing or take off, or loading and unloading operations.

MAS has identified the following team of subcontractors to support development, testing and certification of the SkyFreighter:

- Alliant Techsystems Inc. (ATK): Carbon fiber structures
- International Latex Corporation (ILC) Dover: Envelope
- ATHENA Controls, Inc.: Flight controls / navigation / software
- AGILIS Engineering, Inc.: Engine / propulsion / diagnostics
- MDS Aero Support Corporation: Engineering testing/certification

MAS reports that they have contingent orders for a large number of airships; contingent on the SkyFreighter receiving certification from the US Federal Aviation Administration (FAA) and Transport Canada Civil Aviation (TCCA).

The MAS website is here: <http://www.millenniumairship.com>

### **Collaborative agreement**

In 2018, an operating consortium was proposed among MAS and "Canadian affiliated companies" in the joint operation of a new Canadian business entity named SkyFreighter Canada, Ltd.

Under the agreement, SkyFreighter Canada Ltd. will purchase and/or lease SkyFreighter HHLVA airships, establish depot and field maintenance facilities and activities, and conduct HHLVA airship operations in Canada to transport equipment, supplies, personnel, and other cargo from southern areas of Canada or northern United States to the far northern areas of Canada. Airship operations will be able to provide logistics support for remote northern communities and customers involved in a broad range of activities in remote sites, potentially including oil drilling, pipelines, mining, logging and firefighting. You'll find more details on the collaborative agreement on the SkyFreighter Canada Ltd. website here: <http://skyfreightercanada.com>



Three different size / capability SkyFreighter models currently are in the concept development phase.

- Prototype Air Vehicle (PAV, ~10 ton lift capability), which will serve as a test bed for current designs and future systems upgrades.
- Model SF50T (~50 ton lift capability), which will be the first SkyFreighter to be certified for commercial cargo operations.
- Model SF500T (~500 ton lift capability), which is a longer-term product development goal.

While an airship the size of the PAV could be configured to perform a variety of missions, such as homeland security surveillance, MAS currently is not planning on sales of the this smaller airship. Their near-term focus is on the SF50T commercial cargo airship.

As part of the collaborative agreement, preliminary user defined technical requirements for the SkyFreighter were defined. They are summarized here: <http://skyfreightercanada.com/aircraft.htm>

The business case for SkyFreighter Canada, Ltd. and their program plan for developing and commercializing the SkyFreighter airship are described here: <http://skyfreightercanada.com/invest.htm>

Their program plan consists of four phases with the following durations and key milestones:

- Phase I: Design, Test and Evaluation (DT&E)
  - Duration: 24 months
  - Key hardware deliverable: Integrated Thrust and Maneuvering Management System (ITAMMS) test bed built and demonstrated successfully
  - Key design deliverable: PAV final production drawings issued
  
- Phase II: Full Scale Engineering Development (FSED)
  - Duration: 15 months
  - Key hardware deliverable: PAV manufactured and flight tested to validate SkyFreighter design and systems
  - Key infrastructure milestone: land secured for the production facility, facility design finalized & initial site preparation done
  - Key administrative milestone: FAA certification process started
  
- Phase III: Certification and Production
  - Duration: 36 months
  - Key infrastructure deliverable: Factory completed & ready
  - Key administrative milestone: FAA certification of PAV done
  - Key design deliverable: final production drawings for the SF50T issued, incorporating lessons learned from the PAV
  - Key hardware deliverable: First two SF50T airships manufactured; flight test program conducted
  - Key administrative milestone: FAA certification of SF50T done
  - Key commercial milestone: first production SF50T delivered

- Phase IV: Development of SF500T
  - A program plan and schedule for this larger airship will be developed based on customer needs and lessons learned from SF50T operation.

No date for starting Phase I has been announced. If the program is launched in 2020, the current program plan projects delivery of the first production SF50T in 2026 – 2027.

### **SkyFreighter airship design**

The SkyFreighter family of semi-rigid, hybrid airships is designed to carry fully-assembled, outsized and bulky cargo in a large internal cargo bay at maximum speeds of 75 - 100 mph (121 - 161 kph) with maximum unrefueled ranges from 2,000 – 6,000+ miles (3,219 – 9,656 km).

The SkyFreighter has wide ellipsoidal fuselage with a flat bottom. It flies with a combination of aerostatic lift from helium, propulsive lift from patent-pending “ThrustWing” propulsors, and aerodynamic lift from the lifting body-shaped fuselage when the airship is in forward flight.

While the SkyFreighter is being designed for vertical takeoff and landing (VTOL) operations, there may be a need for short takeoff and landing (STOL) operations in some cases. Therefore, the SkyFreighter Canada Ltd. user requirements state a need for a level loading zone measuring about 2000 feet (610 m) in diameter with surface heights varying by no more than 3 feet (0.91 m). The SkyFreighter can land on water and ice.

MAS claims load and off-load times of less than one hour. Large cargo bay doors and ramps at the front and rear enable roll-on, roll-off cargo handling, supplemented by large cargo doors on the sides of the airship. Normally, water ballast is used to manage airship buoyancy during a load exchange.



*SkyFreighter SF50T airship concept dockside, loading and unloading from a bow door. Source: Millennium Airship, Inc.*

The SkyFreighter has a unique Integrated Thrust and Maneuvering Management System (ITAMMS) that controls four powerful, vectorable thrusters called “ThrustWings” that are located near the four corners of the airship and are attached to the rigid load-carrying framework within this semi-rigid airship. The electrically-driven propulsors are powered from four gas turbine generators located in the hull. The shipboard electrical power distribution system is designed to support all four ThrustWings if a single gas turbine generator becomes unavailable.

MAS describes the capabilities of the ThrustWings as follows: “This feature allows the pilot to move the airship forward, backward, up, and down, whether the airship is buoyantly light or heavy, and apply additional thrust about the airship’s vertical axis for low to zero airspeed maneuvering, including crosswind landing, take-off, and maneuvering.” With the powerful ThrustWing propulsors and ITAMMS, the SkyFreighter has slow speed maneuvering, vertical takeoff and landing (VTOL) and hovering capabilities over a range of buoyancy conditions.

- A heavy (negatively buoyant) SkyFreighter can takeoff vertically and hover using the power of the ThrustWings to deliver the propulsive lift needed to supplement aerostatic lift. In forward flight, aerodynamic

lift from the hull will reduce or eliminate the need for propulsive lift from the ThrustWings until the heavy airship slows again for a landing or hover.

- A light (positively buoyant) SkyFreighter can be held in hover or driven down to a landing site using the power of the ThrustWings to counteract excess aerostatic buoyancy. In forward flight, the aerodynamic lift generated by the hull further “lightens” the airship. Controlling airship speed will limit the aerodynamic lift in forward flight to a value that can be managed by ITAMMS.

You’ll find a more detailed description of the ITAMMS and ThrustWing here: <http://www.millenniumairship.com/products/i-t-a-m-m-s/>

### **Load exchange**

Approaching a delivery site, a SkyFreighter is likely to be trimmed slightly heavy to provide stability after landing without the need for continuous operation of the ThrustWings. Normally, water ballast would be used to manage SkyFreighter buoyancy during a load exchange at a site that has access to water. Offloading 50 metric tons of cargo can be balanced by loading an equivalent weight of water ballast, about 13,250 gallons.

Some delivery sites may not have access to water for ballast and there may be little or no new cargo to be picked up. To be able to continue operating in this case, the technical requirements for the SkyFreighter HHLAV require the following:

“Once unloaded, the HHLAV should be able to fly very light under altitude controlling vectored thrust to the nearest (ballast) source, which could be many hundreds of miles away where ballast can be collected. At this time, we are anticipating the removal of recyclable materials and waste from environmentally sensitive and remote locations on the return leg of each freight delivery. In the event that this cannot occur, we anticipate the use of water bladders that can be loaded at the remote site via local water sources and stand alone pumping systems.”

## **The SF50T**

This is representative of the first SkyFreighter model that may enter commercial service in the late 2020s. The airship measures 400 ft long with a wingspan of 160 ft (122 x 49 meters). It is designed to carry 50 – 70 tons of cargo in an internal cargo hold measuring 140 ft long x 20 ft wide x 10 ft high (47 x 6 x 3 meters).



*Rendering of SkyFreighter SF50T airships in flight.  
Source: Millennium Airship, Inc.*

## **The SF500T**

This much larger SkyFreighter model depends on customer demand developing for this scale of cargo airship. Even in the best of market conditions, an SF500T likely would not enter commercial service before the 2030s. It is designed to carry 500 tons of cargo in an internal cargo hold measuring 290 ft long x 48 ft wide x 20 ft high (88 x 14.6 x 6 meters). This is 10 times the cargo volume in the SF50T. The SF500T will be a massive airship, measuring 790 ft long with a wingspan of 420 ft (241 x 128 meters).



*Rendering of SkyFreighter SF500T airship in flight.  
Source: Millennium Airship, Inc.*



*Rendering of SkyFreighter SF500T airship operating at a remote Arctic mining site. Source: Millennium Airship, Inc. / Skyfreighter Canada Ltd.*