

# Millennium Airship, Inc. SkyFreighter

Peter Lobner, Updated 3 April 2021

## 1. Introduction

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, 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 well suited for carrying large quantities

of bulk and mixed cargo as well as fully-assembled, oversized cargo. It is designed for point-to-point operations, making deliveries directly to the point of use, thereby avoiding transshipment and cargo size limits of traditional modes of ground and sea transportation. The SkyFreighter does not require any infrastructure for landing or take off, or loading and unloading operations.

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

The SkyFreighter was introduced to the public at the October 2002 *Airships in the Arctic Symposium* in Winnipeg, Manitoba, Canada, where Gil Costin described it as, "the world's first all-weather, amphibious, semi-rigid, multi-mission, ultra heavy-lift ship."



*Rendering of a SkyFreighter SF500T operating in the Arctic. Source: MAS*

Along with other airship manufacturers, MAS pursued opportunities in the early-to-mid 2000s for developing a military version of their heavy lift

airship. In spite of significant interest, no US military service procured a heavy lift airship from any of the candidate manufacturers.

MAS registered the SkyFreighter trademark (#87455368) with the US Patent and Trademark Office (USPTO) in 2017 for use in the following businesses: air freight shipping services and freight transportation by air.

In anticipation of future production, MAS has established the following team of subcontractors to support development, testing and certification of a civil / commercial version of their 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

The SkyFreighter can be configured for a wide range of civil, commercial and military missions, including:

- Logistics supply line for northern communities
- Point-to-point long-haul cargo transport, including international routes
- Oilfield, pipeline and mining construction and operations support
- Logging, especially where there are no roads
- Extended duration maritime patrols
- Search and rescue
- Emergency response / disaster relief
- Fire management

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

In 2018, MAS and “Canadian affiliated companies” defined the charter for an operating consortium for the joint operation of a new Canadian business entity named SkyFreighter Canada, Ltd., which would become a future operator of SkyFreighter airships in Canada.

World Cargo Alliance (WCA), Ltd., is the most well-known and highly regarded facilitator of partnerships among international freight forwarders. In October 2019, WCA President David Yokeum wrote to Gil Costin:

“WCA Ltd., networks and all its members would like to see your program come to fruition, and we will support your progress in any way possible. We also offer this as a powerful endorsement of the SkyFreighter program to our members and in adherence to our mission statement, we will encourage our individual members to explore collaboration and utilization options with you at their discretion.”

The letter here: <http://www.millenniumairship.com/WCALetter2019.pdf>

MAS and SkyFreighter Canada, Ltd. have developed a program plan to be executed with its team of subcontractors to deliver the first production SkyFreighter in 6 – 7 years. Starting this program is dependent on institutional investors being willing to fund the program and then become pioneers in building a commercial airship transportation industry.

In this article, we'll look in detail at the design of the SkyFreighter and the development plans proposed by MAS and SkyFreighter Canada, Ltd.

## **2. Military airships for HULU program & Project Walrus (early 2000s)**

Joint Chiefs of Staff (J-4 Mobility Division) began an investigation into the military utility of hybrid airships in 2001. MAS supported this effort from the beginning with their SkyFreighter airship. By June 2002, Naval Air Systems Command (NAVAIR) had formed their Advanced Development Program Office (ADPO) to directly support J-4 and led the Navy's Hybrid Ultra Large Airship (HULA) program. In mid-2003, the Defense Advanced Research Projects Agency (DARPA) took over the Navy's HULA program and renamed it the WALRUS Global Reach Air Vehicle Program, or simply Project WALRUS, which MAS continued to support. Their main competitors were Lockheed Martin, Aeros and the UK firm Advanced Technologies Group (ATG) / SkyCat. In mid-2005, MAS lost out to Lockheed Martin and Aeros in the Project WALRUS Phase I competition to build a technology demonstrator airship. Project WALRUS was terminated in mid-2006, after completion of Phase I and funding for following years was discontinued.



*A MAS WALRUS heavy lift airship concept. Source: MAS via DARPA*

### **3. SkyFreighter airship general design features**

The SkyFreighter family of semi-rigid, hybrid airships is designed to carry large quantities of bulk and mixed cargo and fully-assembled, outsized cargo in a large internal cargo bay and fly 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.

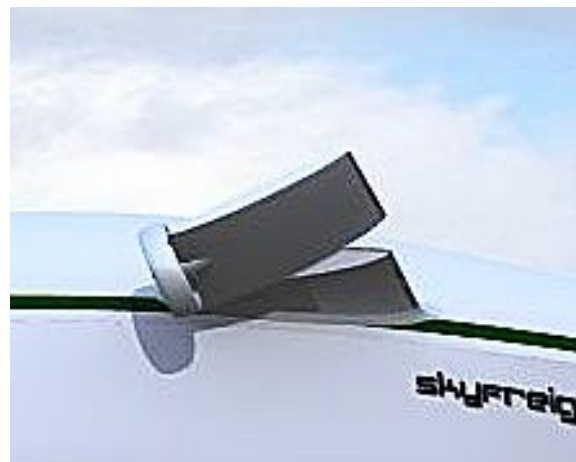
While the SkyFreighter is designed for vertical takeoff and landing (VTOL) operations using aerostatic and propulsive lift, there may be a need for short takeoff and landing (STOL) operations on an air cushion landing system when the airship is heavily loaded. Therefore, the SkyFreighter Canada Ltd. user requirements state a need for a level loading zone measuring about 2,000 feet (610 m) in diameter with surface heights varying by no more than 3 feet (0.91 m). The SkyFreighter also 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 cargo doors on the sides of the airship. Normally, water ballast is used to manage airship buoyancy during a load exchange.



*Bow loading doors. Source: MAS*

The SkyFreighter has a unique Integrated Thrust and Maneuvering Management System (ITAMMS) that controls 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. Each ThrustWing is comprised of a fixed inner stub wing and an outer, movable section that can be rotated 360° about its longitudinal axis. The electrically-driven propulsors are powered from diesel generators located in two engine rooms on either side of the cargo bay. An auxiliary power unit (APU) provides power for avionics and the air cushion landing system. The electrical power distribution system is designed to support all ThrustWings if a single diesel generator becomes unavailable.



*ThrustWing showing the fixed inner stub wing and movable outer section with the propulsor. Source: MAS*



*Rendering of two SkyFreighter SF50T airships in flight, with ThrustWings in cruise position (left) and vectored (right). Source: MAS*

With ITAMMS, the powerful ThrustWing propulsors, and the lifting body hull, a SkyFreighter can operate over a wider range of buoyancy conditions than most other airship types.

- 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/>

## **4. Conducting a 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.”

## **5. SkyFreighter models**

MAS has developed designs for three production models of the SkyFreighter: the SF20T, SF50T and the SF500T.

### **The SF20T and SF50T**

The SF20T is representative of the first Prototype Air Vehicle (PAV) and the SF50T is representative of the first SkyFreighter model that may enter commercial service in the late 2020s. The SF50T 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). The airship has four ThrustWing propulsors.



*Rendering of a SkyFreighter SF50T airship dockside, loading and unloading from a bow door. Source: MAS*

## **The SF500T**



*Rendering of a SkyFreighter SF500T airship in cruise flight. Source: MAS*



This much larger SkyFreighter model could be developed if there is customer demand 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). The airship has six ThrustWing propulsors.



*Rendering of SkyFreighter SF500T airship operating at a remote Arctic mining site. Source: MAS*

## **6. Collaborative agreement and SkyFreighter development plan**

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.

Starting this four phase program is dependent on institutional investors who are willing to step up and fund the program. When the program is adequately funded, MAS and SkyFreighter Canada, Ltd project that delivery of the first production SF50T SkyFreighter could take place as soon as 6 – 7 years later, as outlined in the above plan.

## **7. For more information**

- “Applications for Northern Transportation – Airships to the Arctic Symposium Proceedings,” pp. 140 – 142, Winnipeg, Manitoba, Canada, 22 – 24 October 2002:  
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