Near Space Corporation (NSC) - High Altitude Shuttle System (HASS)

Peter Lobner, 12 February 2022

1. Introduction

GSSL, Inc. was established by Timothy T. Lachenmeier in October 1994 in Tillamook, OR. GSSL, Inc. operated under the "doing business as" (dba) name Near Space Corporation (NSC) from 2006 to September 2021, when the firm's corporate name was formally changed to NSC. The firm specializes In developing, manufacturing and operating high-altitude balloon systems that provide low cost access to near space. The NSC website is here: https://nsc.aero

NSC has developed high altitude balloons with detachable payload return vehicles (PRV) for several customers, including the National Aeronautics and Space Administration (NASA) and the US Air Force (USAF). The PRVs, containing all airship and mission systems, are recovered at the end of a mission, while the balloon itself is expendable. Their first high altitude balloon mission with a gliding return vehicle flew in 2001, and the first mission with a powered return vehicle flew in 2002. By 2007, the firm had made 35 high altitude return vehicle deployments at altitudes greater than 100,000 ft (30,480 m).

The firm also developed and patented a "tactical launch" system for a "tandem" high altitude balloon, which enables a launch to be made by a small crew in winds up to 26 knots (30 mph / 48 kph). In comparison, a conventional "scientific" high altitude balloon launch typically requires wind speeds of 5 mph (8 kph) or less at the launch site.

NSC was funded by the Department of Defense (DoD) in fiscal year 2009 to develop its high altitude balloon and payload return vehicle systems as an intelligence, surveillance and reconnaissance (ISR)

platform known as the High Altitude Shuttle System (HASS). While DoD funding ended in 2010, NSC received funding from NASA to continue HASS development and conduct flights for commercial applications.

NSC established its Johnson Near Space Center (JNSC) in 2012 at the Tillamook Auxiliary Naval Air Station in Tillamook, OR. Previously, the NSC corporate headquarters were in Tillamook, but their launch sites were elsewhere.

In addition to HASS, NSC supplies engineering, manufacturing and flight operations services from their facilities at JNSC. On its website, NSC reports that it has conducted over 160 stratospheric balloon flights since it started flight operations in 1996. Their stratospheric balloons are capable of carrying suspended payloads of up to 3,000 lbs (1,361 kg) to altitudes up to 130,000 ft (39,624 m). HASS is still offered as one of their currently available stratospheric mission platforms.

In 2014, JNSC was selected by the Federal Aviation Administration (FAA) as one of several sites that comprise the Pan-Pacific Unmanned Aerial System (UAS) Test Range Complex run by the University of Alaska.

This article focuses on NSC's tactical launch system and the HASS stratospheric platform.

2. Patents

In February 2009, Timothy Lachenmeier filed two patent applications for a tactical high altitude balloon launch and payload return system. Both were granted in 2011 as patents US8061648B2 and US2009/0224094A1. The system, as depicted in patent Figure 1, is comprised of the following basic elements:

- Tandem balloon (a small "tow" balloon inflated at launch lifts a much larger, packed "main" balloon that inflates later) (200)
- Payload return vehicle (PRV) (300)
- Tactical launch apparatus (600)
- Ground-based control station (700)

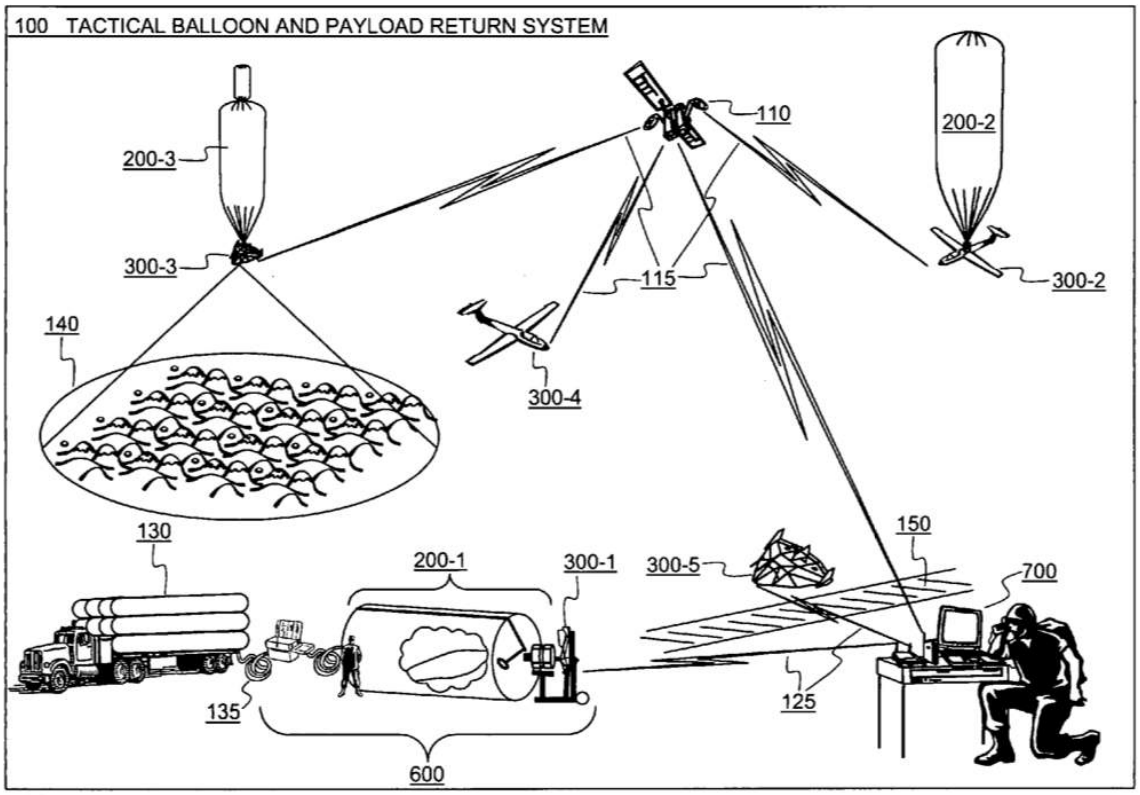
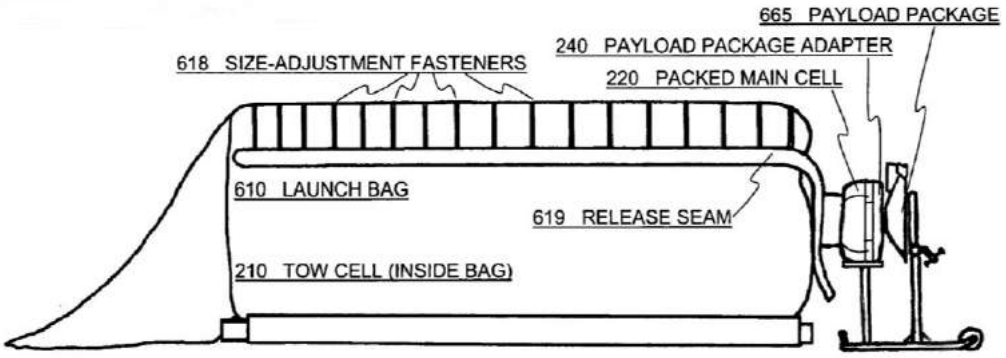


FIG. 1

Source: US8061648B2, Fig. 1

The tactical balloon launch system (TBLS) shown in patent Figure 6A includes a fabric launch bag (610) that protects the tow balloon portion of a tandem balloon from high winds while the tow balloon is being inflated with lifting gas and, subsequently, is opened quickly to release the tow balloon into the air along with its attached packed (uninflated) main balloon (220) and payload return vehicle (665). The volume of the launch bag can be adjusted (618) to match the tow balloon inflated volume needed for a particular mission.



Tactical launch bag. Source: Adapted from US8061648B2, Fig. 6A

As shown in patent Figures 2A and 2B, the tandem balloon is a two-component balloon comprised of a small tow cell (210) and a much larger main cell (220). The tow cell may be made of lightweight film and gores to act as a zero-pressure cell, or of heavier film and stronger gores to act as a superpressure cell.

After launch from the tactical launch bag, the tow cell carries the packed main cell and payload to an intermediate altitude where the main cell (220) is deployed and inflated to near its maximum volume by the expanding lifting gas overflowing from the tow cell (210) through an intercell tube (230). With the main cell deployed, the tactical balloon is capable of reaching altitudes above 100,000 feet (30,480 m) in the stratosphere.

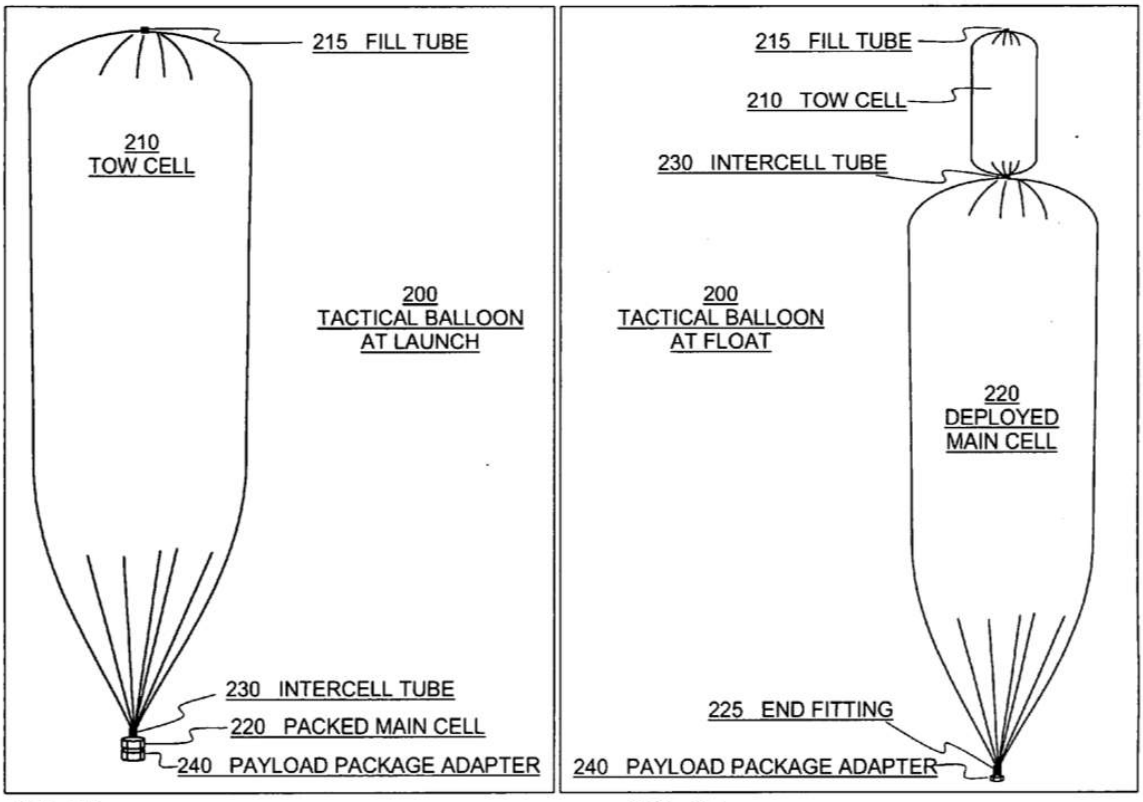
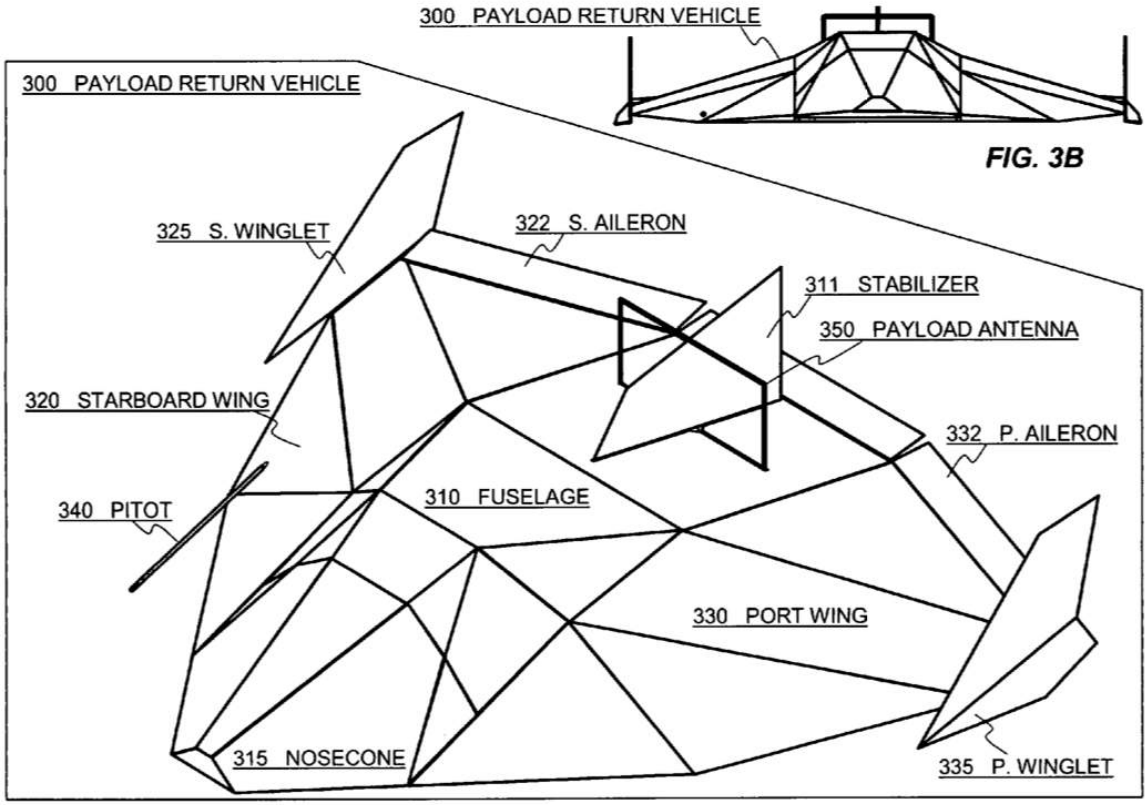


FIG. 2A *FIG. 2B*

Source: US8061648B2

At the end of a mission, the payload return vehicle is detached from the balloon and flies back to a designated landing spot. The balloon is expendable and is not recovered.

The PRV contains all airship and mission systems and can be implemented as a powered or gliding air vehicle. The patent focuses on the faceted, lifting-body glider design shown in patent Figures 3A and 3B, which in some respects, resembles an F-117A Nighthawk stealth fighter. This PRV is designed as a low-cost, easily repairable platform that performs well in atmospheric densities from sea-level to at least 100,000 feet (30,480 m).



PRV glider oblique view (Fig. 3A) and front view (Fig. 3B). Source: US8061648B2

The flight control, avionics suite, ballast system, flight termination system and the mission payload are all integrated into the PRV. An autopilot maintains PRV stability along a programmed flight path to a landing site. The autopilot has a piloted mode in which automatic flight can be overridden by an operator at a ground station.

3. The High Altitude Shuttle System (HASS)

The High Altitude Shuttle System (HASS) combines NSC's Tactical Balloon Launch System (TBLS) and tandem tactical balloon with the high-altitude, gliding payload return vehicle (PRV).

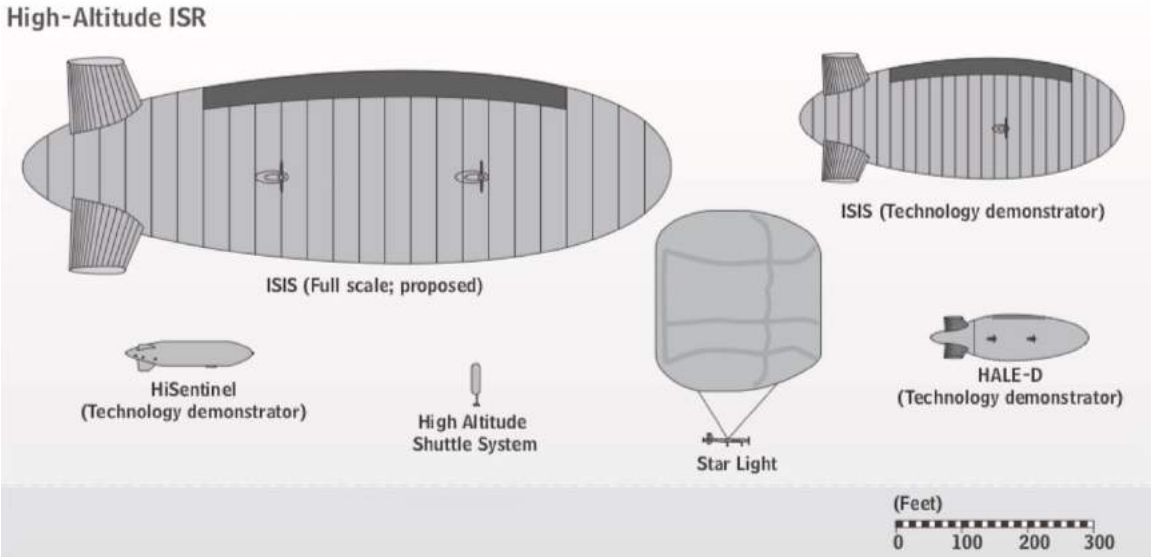
The HASS project was funded by DoD as one of three "steerable" stratospheric balloon projects that were conducted during the period from 2002 to 2011. A 2012 DoD report described these programs as follows:

> "The primary objective of these steerable balloon efforts has been to develop a balloon with station-keeping ability that can provide capabilities similar to those desired from conventional high-altitude airships. None of the DoD programs have successfully fielded a steerable balloon under DoD funding."

Two of the contenders, GNSS's Navy-sponsored StarLight and JP Aerospace's Air Force-sponsored Near-Space Maneuvering Vehicle (NSMV / Ascender 175), had propulsion systems intended for station keeping at high altitude above a designated geo-location. NSC's Army-sponsored HASS had no propulsion system.

Two of the contenders were two-component systems consisting of a balloon and a suspended, detachable PRV containing all airship and mission systems. The PRV was designed to fly back to a designated landing point and be reused on a subsequent mission. The StarLight PRV was powered while the HASS PRV was a glider.

As shown in the following chart, the HASS balloon was the smallest among contemporary high altitude ISR airships (HiSentinel and HALE-D) and the other DoD two-component steerable balloon system (StarLight).

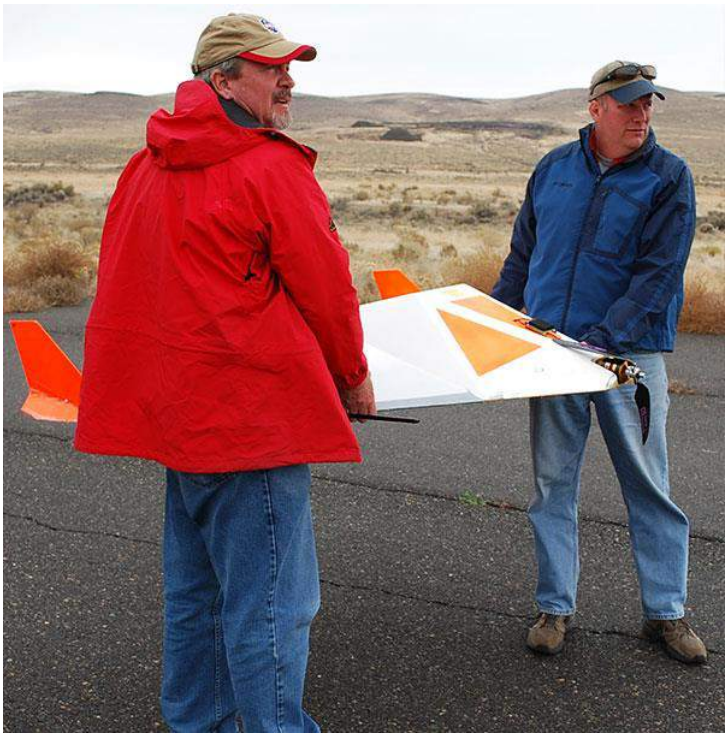


Relative scale of HASS and other US high-altitude ISR airships. Source: Adapted from Congressional Budget Office, Nov. 2011

HASS initially was funded in fiscal year 2009 (started 1 Oct 2008) by the Army Missile Defense Systems and Integration program office, and supported by the Army Space and Missile Defense Command's (SMDC) Space Battle Lab. Army funding ended in 2010, but NSC received funding from NASA to continue HASS development and conduct flights for commercial applications. A total of four HASS balloon flights were made from NSC's integrated balloon facility at JNSC in 2013 (1), 2016 (2) and 2017 (1).

NSC identified the following features of HASS missions:

- The patented Tactical Balloon Launch System (TBLS) allows balloon launch in winds up to 30 knots (30 mph / 48 kph).
- The unique gliding PRV can return payloads from high altitude.
- The PRV has a standard payload bay made of non-conductive and RF transparent materials that can support a variety of payloads.
- PRV payload limits are < 5 kg (11 lb) per payload slot, < 10 kg (22 lb) for a full payload manifest.
- The PRV flight profile is programmable from PRV release thru landing.
- There is a capability for the PRV to fly high quality, reduced gravity, parabolic flight paths during its return flight.



Relative scale of the HASS PRV and ground handling crew. Source: NSC

HASS tactical launch (left). Source: NSC. HASS launch with a conventional zero-pressure balloon (right). Source: NASA

HASS gliding payload return vehicle nearing touchdown.
Source: NSC

Closeup of HASS gliding payload return vehicle in flight.
Source: NSC

NASA's 2017 HASS flight used the PRV as a surrogate for manned spacecraft returning to Earth. NASA reported:

> "The HASS airframe is a 'lifting body' design, which, despite its small size, is capable of closely matching the airspeeds and flight profiles of much larger spacecraft, such as Virgin Galactic's Spaceship 2, as they come down through lower altitudes……A drone released from a high-altitude balloon carried a payload to evaluate how the equipment could help the FAA detect and track commercial spacecraft entering the National Air Space (NAS) as it descends from space."

HASS is still offered as one of NSC's currently available stratospheric mission platforms.

For more information

- Tim Lachenmeier, "NSC - Provider of Near Space Solutions," (Tactical Ballooning & Return Vehicles – A new paradigm for Low Cost Near Space Access & Persistence), corporate presentation, Boulder, CO, 26 – 28 April 2007: https://slidetodoc.com/provider-of-near-space-solutions-tactical-ballooning-return/
- Report to Congress, "Summary Report on DoD Funded Lighter-Than-Air Vehicles," DoD Office of the Assistant Secretary of Defense for Research and Engineering, Appendix A, 1 November 2012: https://apps.dtic.mil/dtic/tr/fulltext/u2/a568211.pdf
- Tim Wright, "The Drone That Mimics Spaceships," Air & Space magazine online, 10 March 2017: https://www.airspacemag.com/daily-planet/catch-falling-drone-180962459/
- "Drone Flight Tests FAA's Technologies for Spacecraft Re-entry," NASA, 19 January 2017: https://www.nasa.gov/feature/drone-flight-tests-faas-technologies-for-spacecraft-re-entry
- "A Guide to Commercial Suborbital Flight Providers for Flight Opportunities," NASA: https://www.nasa.gov/sites/default/files/atoms/files/flight_providers_guide_0.pdf

- “Stratospheric Balloons - Chronological lists of launches worldwide since 1947,” StratCat: https://stratocat.com.ar/globos/indexe.html

Patents

- US8061648B2, “System for tactical balloon launch and payload return,” Inventor: Timothy T. Lachenmeier, Application filed 26 February 2009, Patent granted 22 November 2011: https://patents.google.com/patent/US8061648B2/en?oq=US8061648
- US2009/0224094A1, “System for tactical balloon launch and payload return,” Inventor: Timothy T. Lachenmeier, Application filed 26 February 2009, Patent granted 22 November 2011: https://patents.google.com/patent/US20090224094A1/en?oq=US20090224094

Other *Modern Airships* articles

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    - NAVAIR / GNSS - StarLight
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - JP Aerospace – Near Space Maneuvering Vehicle (NSMV)
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/