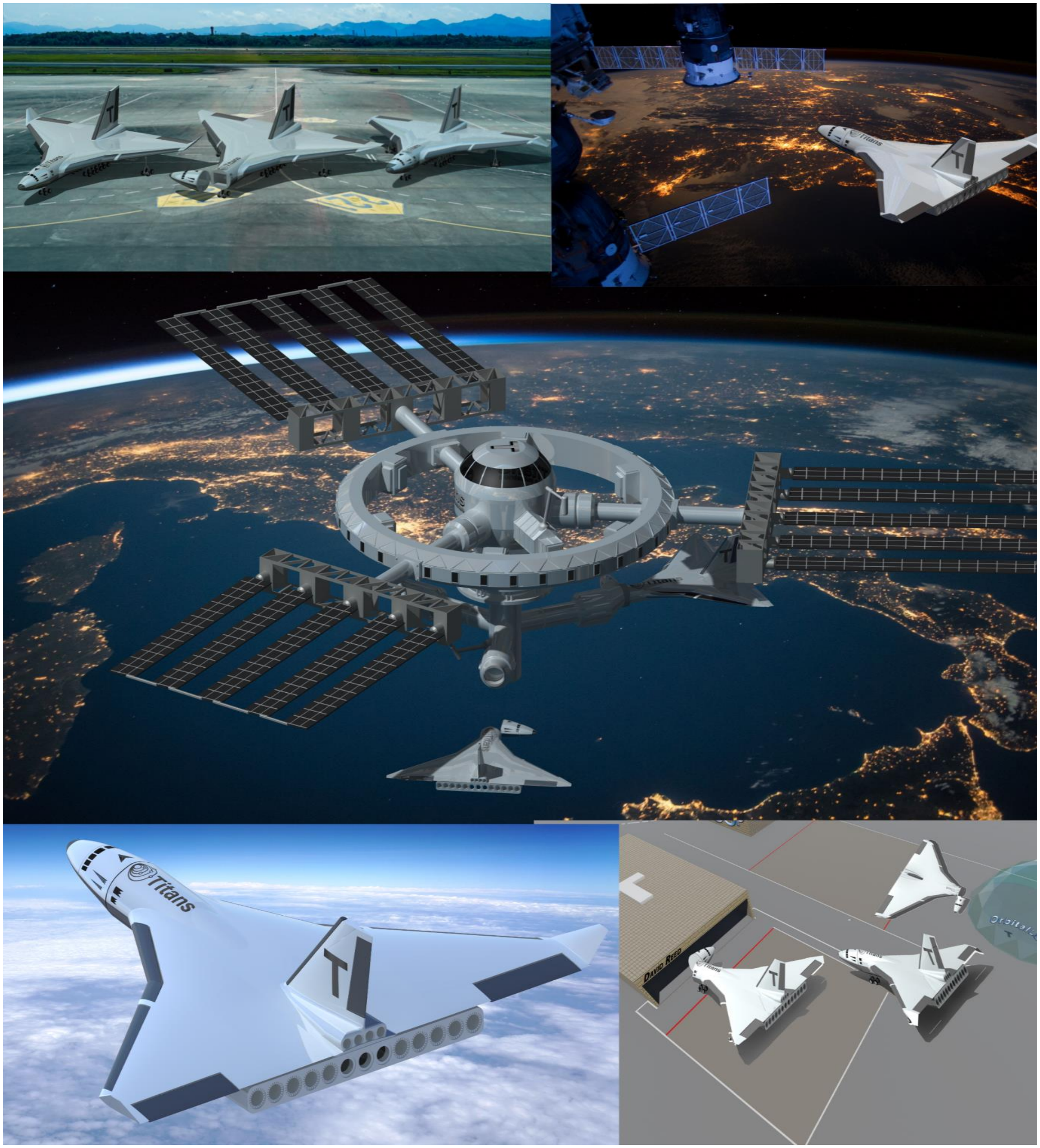
Titans Spaceplanes | Design & Project Summary



Notice and Disclaimer **3**
INTRODUCTION **4**
Titans Spaceplanes Design Specs 5
Titans Spaceplanes at a spaceport 5
Titans Spaceplane in orbit 6
Titans spaceplane on landing approach 6
AIRFRAME CONSTRUCTION **7**
WINGS **7**
Comparison of Titans spaceplane to Boeing 747 8
THERMAL PROTECTION SYSTEM (TPS) **8**
Metallic TPS Panel 9
AIR-BREATHING PROPULSION **9**
Airliner/Transport High Bypass Turbofan 10
Turbofan Engine Components 11
Nord Griffon with jet engine inside ramjet duct 11
Nord Griffon with jet engine inside ramjet duct 12
Concorde Ramp Inlets 12
Concorde Ramp Inlets 13
ROCKET PROPULSION **13**
V-2 Self-Contained Turbopump Cutaway View 14
V-2 Self-Contained Turbopump 14
Pintle Injector 15
Pintle Injector And Motor Head 15
X-15 Hypersonic Spaceplane 16
Me-163B Komet Fighter 16
Comparable: Spaceplane Construction **17**
Some specific factory roles 17
Shuttle forward fuselage under construction 17
Soviet Buran shuttles under construction 18
Space Shuttle under construction 19
Space Shuttle crew cabin being fitted in forward fuselage 20
Space Shuttle crew cabin being fitted in fuselage 21
Space Shuttle payload bay door being installed 22
Space Shuttle fuselage with crew cabin installed 23
Space Shuttle’s windscreen panes 24
Soviet Buran’s smaller windscreen panes 25

Soviet Buran Interior 26
Machine/Engine Shop 27
Example of Modern CNC Machine Shop 27
Example CNC Machining Systems 28
Machine shop with CNC machining systems 28
Factory production floor with CNC machining systems 29
Industrial sheet metal roller machines 29
Unique Space & Aerospace Research & Development Opportunity 30
Airbreathing Engines in Flight 30
Wings in Flight 31
Rocket Engines in Flight and Orbit 31
Science 32
Dual-Use Disaster Relief/Military Logistics Supply 32
Military 32
Contact Details 32

Notice and Disclaimer

I. This document contains information about NSL & Co. LLC, (NSL&Co – a Bosnian limited liability corporation currently being restructured as a (USA) limited liability corporation) and its affiliated companies, including Titans Universe, Titans Spaceplanes & Space Technologies (TSST), and Titans Space Industries ("Associates" – soon to be incorporated in the United States), their project plans, business strategies, and technologies.

II. We reserve the rights to add, modify, or delete any information about projects, business models, strategies, requests, questionnaires, projections and estimates in this and any forthcoming documents, attachments and appendices at any time, without previous warning.

III. This document and any references to projects, plans, and strategies are provided 'as is' without any warranty or implied term of any kind.

IV. The contents of this document can only be made available to third parties under acceptance of this notice.

V. As of the date of first publication, October 17, 2023, the information herein is accurate. We have compiled this document in good faith. However, no representation is made as to the completeness or accuracy of the information herein. In particular, the reader should be aware that though NSL&Co deems the information accurate to date, this information (or portions hereof) may be incomplete, may contain errors, or may have become out of date.

VI. Use of this document by any third party for whatever purpose should not, and does not, absolve such third party from using due diligence in verifying the document's contents. Any use which a third party makes of this document, or any reliance on it, or decisions made or not made based on it, are the responsibility of such third party. We accept no duty of care or liability of any kind whatsoever to any such third party, and no responsibility for damages, if any, suffered by any third party as a result of decisions made, or not made, or actions taken, or not taken, based on this document.

All methods of reproduction are expressly prohibited. No portion of this document, in whole or in part may be disclosed and/or duplicated without prior, written approval.

© 2023 NSL & Co. LLC – Titans Universe | Titans Space Industries | Titans Spaceplanes & Space Technologies

INTRODUCTION

Summarized in this document are the major design elements of:

* Airframe Construction
* Wings
* Thermal Protection System (TPS)
* Air-Breathing Propulsion
* Rocket Propulsion

The Titans Spaceplanes will be a combination airbreather/rocket-powered horizontal takeoff single-stage-to-orbit system drawing on the mini- and full-scale Star-Raker large delta-wing aircraft designs that were being developed at the Rockwell Corporation in the mid-seventies as part of the NASA Solar Power Satellite project. The mini-Star-Raker was about half the size of the full-scale version.

Rockwell engineers concluded it was feasible to build aircraft that could take off from a runway like a conventional plane and then proceed to orbit using a mix of airbreathing and rocket propulsion systems. This multiple propulsion systems design allows the spaceplane to take off with no more noise than an airliner and stay subsonic until it reaches high altitude, eliminating the noise issues associated with conventional vertically-launched booster rockets. Drag chutes will augment wheel brakes for landing on wet runways or in other adverse conditions.

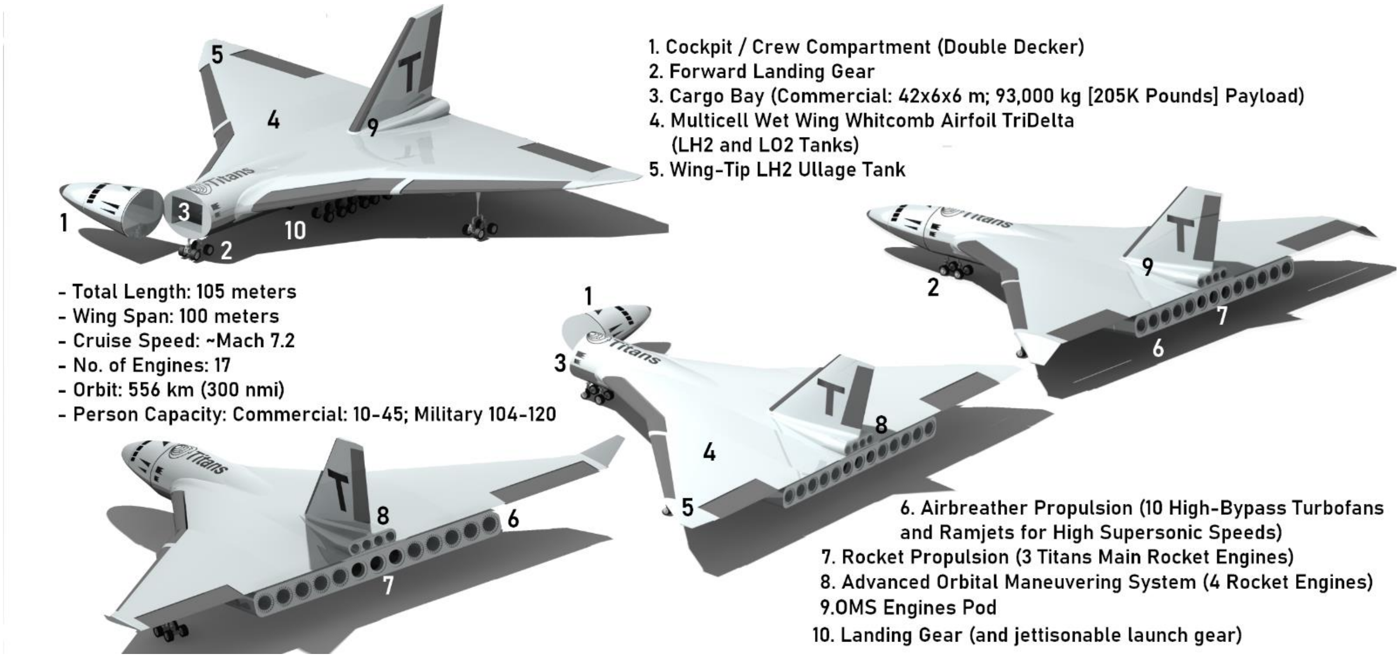
The Titans Spaceplanes will be designed to meet the following objectives:

* Total vehicle reusability
* Rapid turnaround
* Ferry capability with cargo between airfields
* High reliability of delivery
* Ability to reach any LEO orbital plane from alternate launch sites
* Orbital services (transfers, launches, refueling etc.)

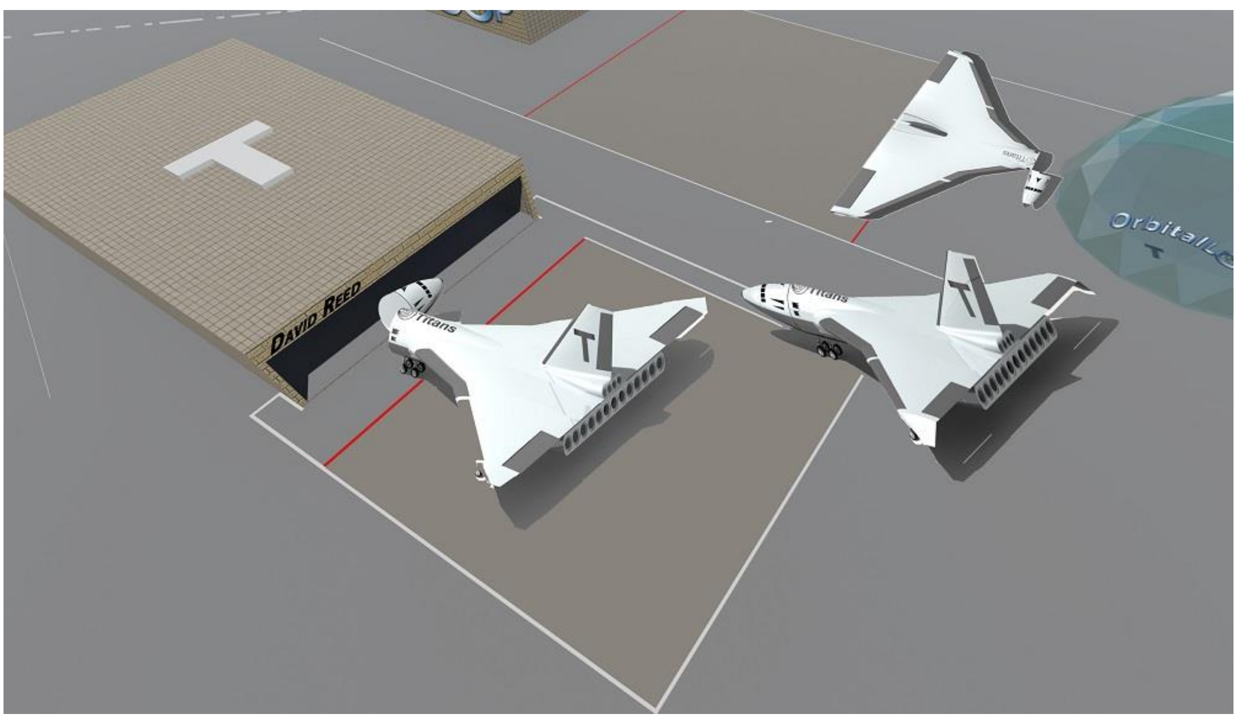
The Titans Spaceplane's principal operational objective is to provide economical, reliable transportation of large numbers of passengers and/or large quantities of material between Earth and low earth orbit (LEO) at high flight frequencies with routine logistics operations and minimal environmental impact.

This document can be read in conjunction with the Titans Spaceplanes – Spaceport Buildings & Facilities.

Titans Spaceplanes Design Specs



Titans Spaceplanes at a spaceport



Titans Spaceplane in orbit

Titans spaceplane on landing approach

AIRFRAME CONSTRUCTION

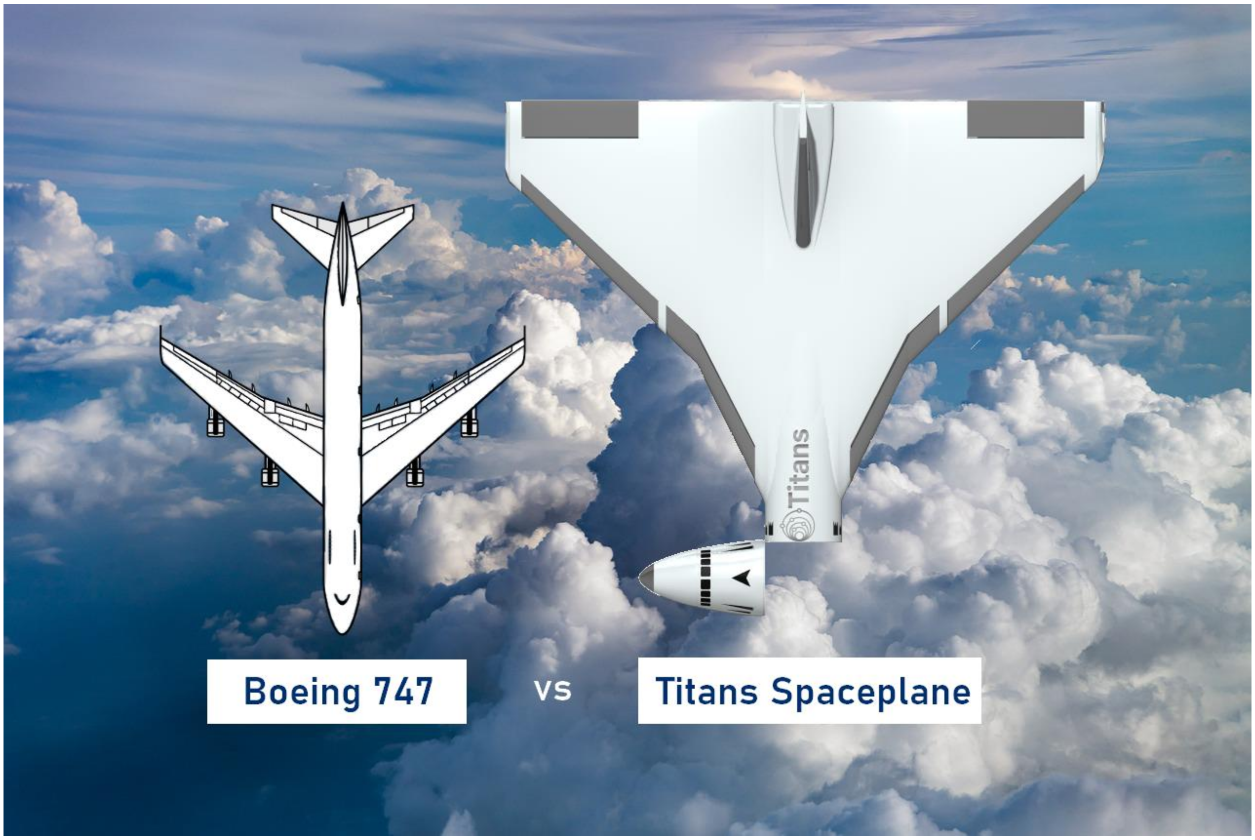
The full-scale spaceplane will be approximately 310 feet long, using a blended fuselage-wing (flying wing) design. The fuselage and wings will be predominantly aluminum alloy fabricated using conventional large aircraft methods. The airframe structure will consist of bulkheads, longerons, and spars with riveted skins on the fuselage and wings, with most of the cargo bay side walls provided by the root-rib bulkheads of the wing LH2 tanks. The rudder and control surfaces will use machined skins fastened with screws.

WINGS

The wings will house carbon fiber tanks for the liquid hydrogen and the liquid oxygen (LOX). The pressure in the wing tanks (32 psi LOX, 22 psi hydrogen) will be used to stiffen the wings, allowing a much lighter structure than conventional wing construction.

The tri-delta wing planform used in the Star-Raker design study was originally one of fifteen candidate planforms with low center of pressure excursions selected for further study and had the best center of pressure versus Mach number behavior. The airfoil section selected was part of the Whitcomb family of supercritical airfoils that are, for most of their length, flat on the top and flat on the bottom. The tri-delta planform provides an efficient aerodynamic shape and high propellant volumetric efficiency.

Comparison of Titans spaceplane to Boeing 747

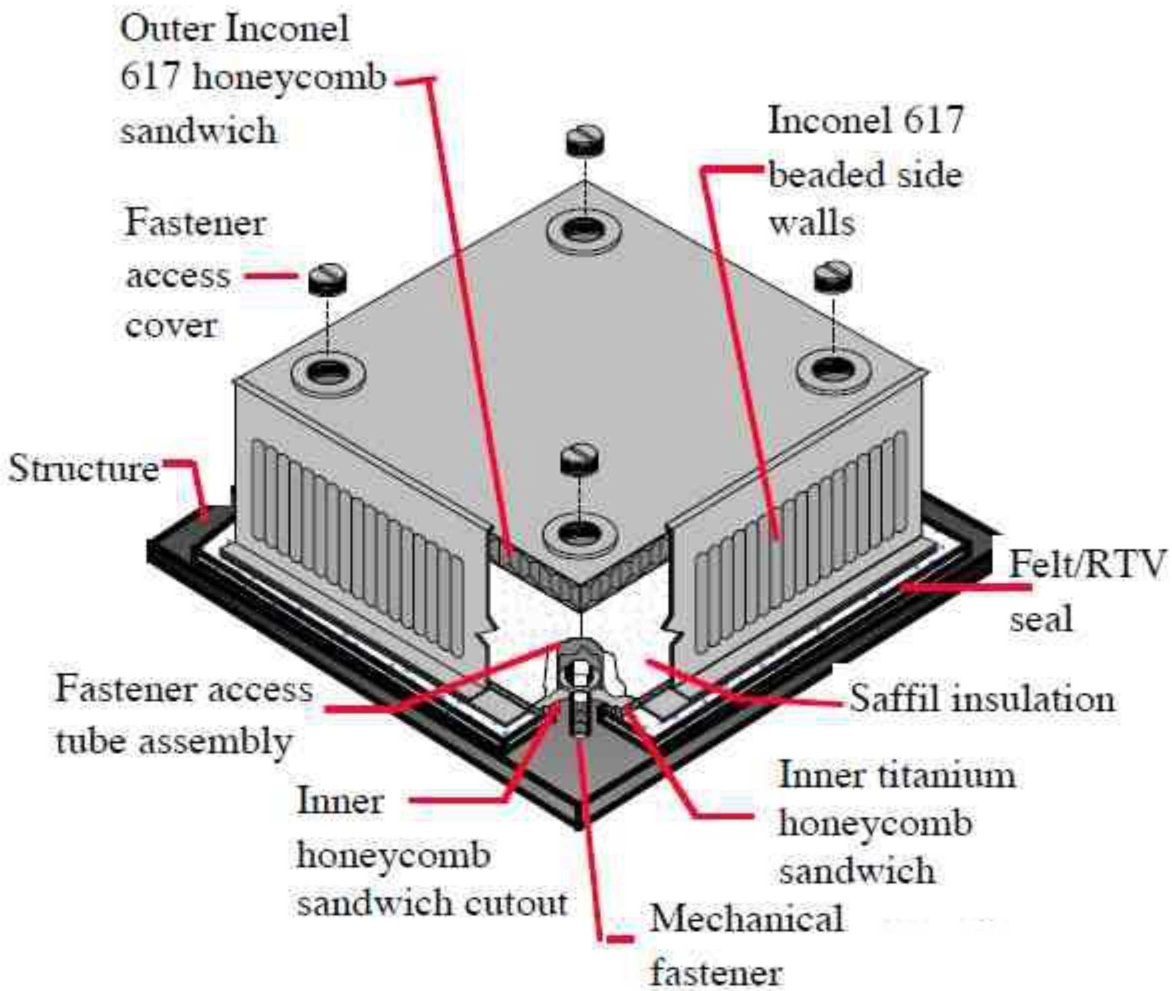


THERMAL PROTECTION SYSTEM (TPS)

The Titans spaceplane will use TUFROC ceramic tiles licensed from a NASA patent. Also being investigated is a metallic system incorporating titanium and superalloys. This would build on previous work by NASA and NASA contractors.
[redacted]REDACTED FOR CONFIDENTIALITY
[redacted] ___REDACTED FOR CONFIDENTIALITY
[redacted]REDACTED FOR CONFIDENTIALITY
[redacted]

The TPS would be superalloy sandwich panels that are attached to the spaceplane structure with mechanical fasteners. Materials such as titanium-zirconium-molybdenum (TZM) will be investigated for the wing leading edges instead of the carbon-carbon used in the Space Shuttle.

Metallic TPS Panel



Superalloy Honeycomb Sandwich (SA/HC) TPS (Source: NASA)

AIR-BREATHING PROPULSION

The airbreathing mode of propulsion will be used to get the spaceplane off the runway and up to an altitude of approximately 100,000 feet at a speed of about Mach 5 before the rocket engines are ignited and the airbreathing system shutoff. At that point, the inlet ducts will be closed.

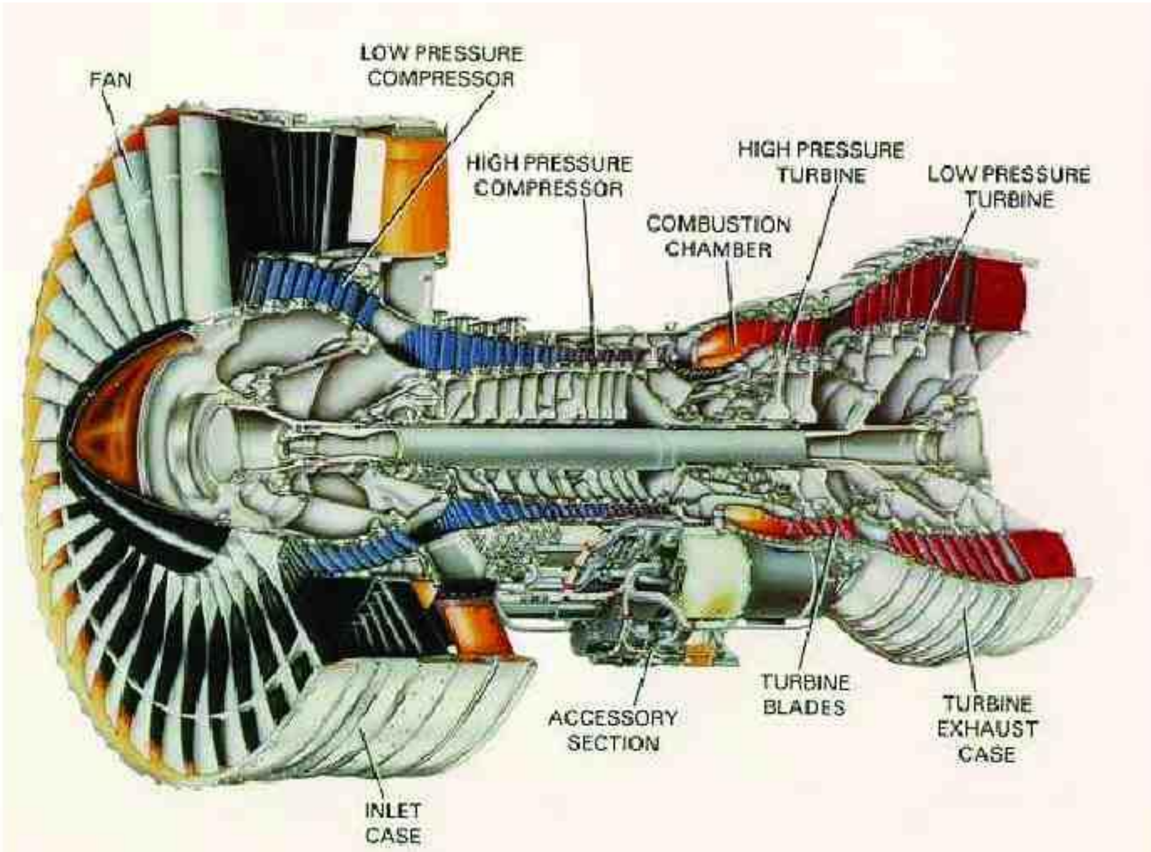
The airbreathing system will be a turbofan/ramjet system consisting of airliner high bypass turbofans that share individual ducts with ramjets located underneath the turbofan. The duct will be designed so that at an appropriate Mach number the turbofans can be shut down and isolated, with the air then bypassing the turbofan while the ramjets continue to burn. The ducts will be of a variable multi-ramp inlet design similar to ones used on the Mach 2 Concorde SST and Mach 3 XB-70 Valkyrie, but made out of alloys such as Rene 41 or Inconel that will allow operation at speeds up to about Mach 5[redacted]REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] Both the afterburners and the ramjets will burn hydrogen.

Shutdown of the turbofans and transition to pure ramjet mode will likely be at speeds of around Mach 3. The duct inlets will slow the air in the ducts down to subsonic speed so that the turbofans can keep running while the spaceplane itself is at supersonic speed.

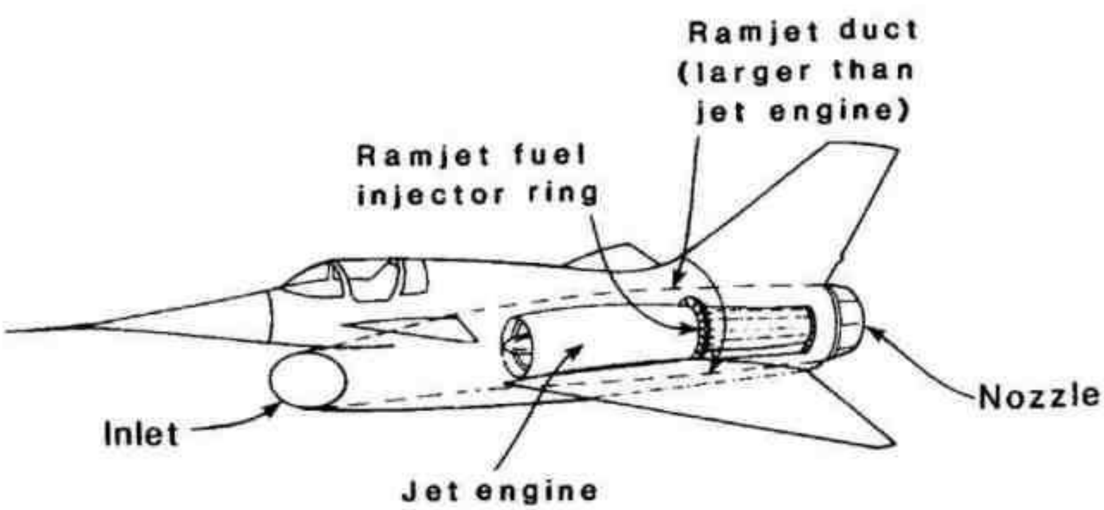
Mass Injection Pre-Compressor Cooling (MIPCC) using liquid oxygen (LOX) and water injection will be used to cool air temperatures in the intet ducts down to temperatures at which the turbofans are normally designed to operate. MIPCC can also be used to augment ramjet thrust. [redacted]REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] Closing of the ramps will fair in the bottom of the spaceplane, creating a smooth surface during rocket-powered flight.

Airliner/Transport High Bypass Turbofan

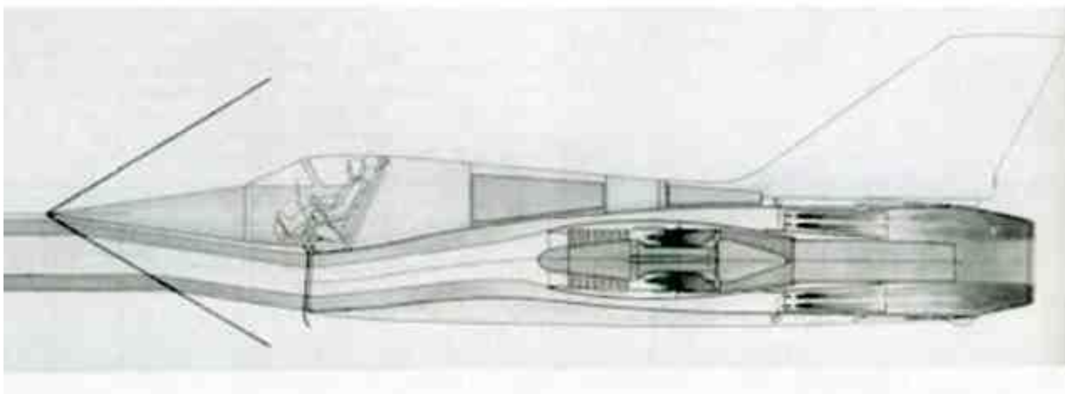
Turbofan Engine Components



Nord Griffon with jet engine inside ramjet duct

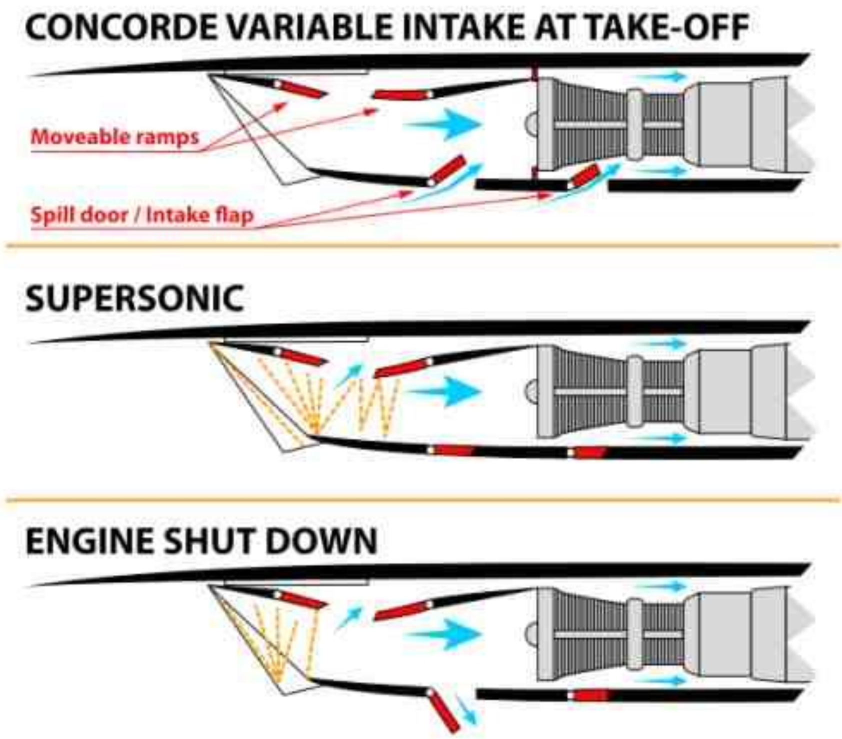


Nord Griffon with jet engine inside ramjet duct



Concorde Ramp Inlets

Concorde Ramp Inlets



ROCKET PROPULSION

The rocket engines (Titans Main Rocket Engines TMREs) will burn LOX and hydrogen. Hydrogen was selected by the Rockwell engineers for Star-Raker due to its high efficiency (high specific impulse) that makes SSTO (Single-Stage-to-Orbit) possible.

The total combined thrust for the spaceplane's three TRMEs will be around three million pounds. The TRMEs will be developed in-house using a low-tech approach focused on durability, reliability, and a minimum development period. The TRME design envisioned uses two combustion chambers per engine to minimize combustion chamber size, [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] a pintle injector, and a self-contained turbopump assembly located separately from the combustion chambers but feeding both chambers.

The turbopump assembly has its own propellant supply, is physically separate from the combustion chambers, [redacted] REDACTED FOR CONFIDENTIALITY [redacted] REDACTED FOR CONFIDENTIALITY [redacted] The pintle injector produces highly stable combustion and eliminates the complicated plate injector used in many rocket engines. The approach of a physically separate self-contained turbopump was used in the Me163B Komet rocket fighter, the V-2 rocket, the Redstone rocket, and the X-15 hypersonic rocket plane. This approach to turbopump design allows the turbopumps to be spun up on the ground and tested without igniting the combustion chambers.

Potentially patentable [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] [redacted]REDACTED FOR CONFIDENTIALITY
[redacted] Additional patents might be obtained [redacted]REDACTED FOR CONFIDENTIALITY [redacted]REDACTED FOR CONFIDENTIALITY [redacted]

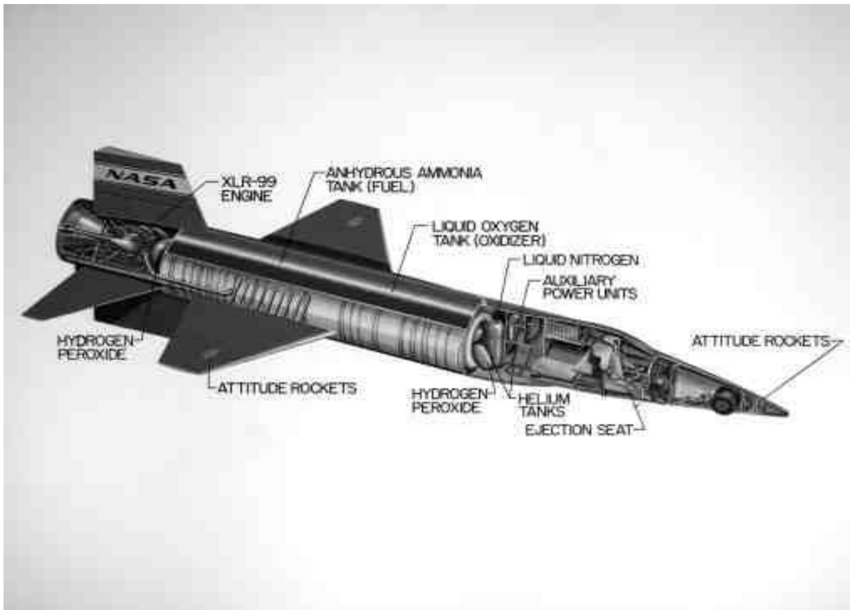
V-2 Self-Contained Turbopump Cutaway View

V-2 Self-Contained Turbopump

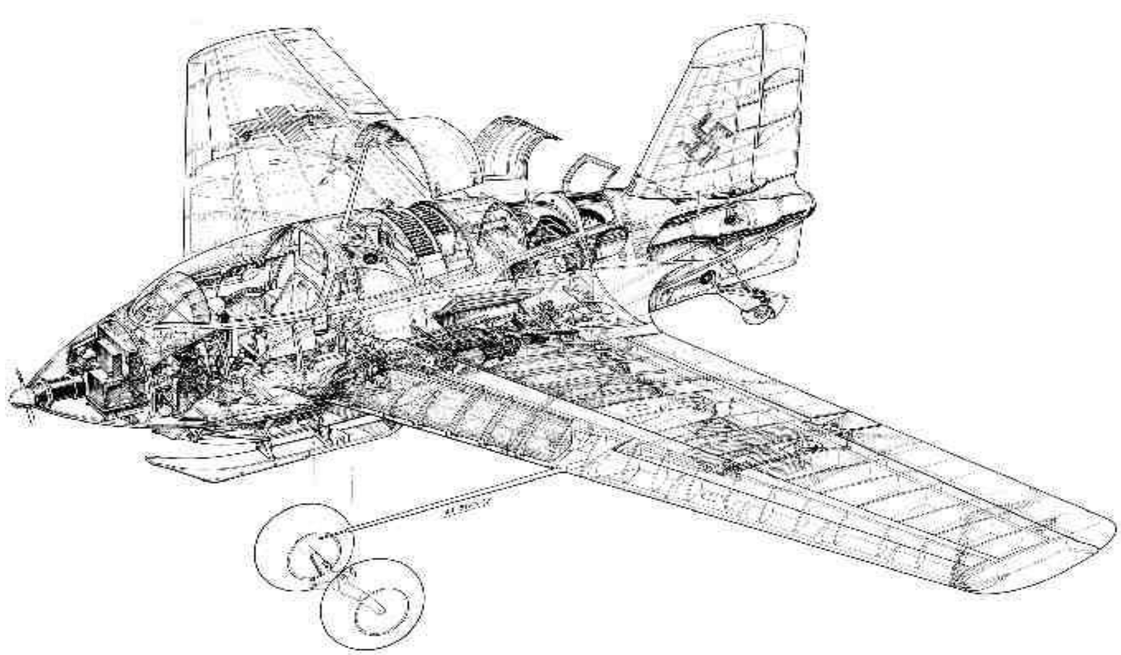
Pintle Injector

Pintle Injector And Motor Head

X-15 Hypersonic Spaceplane



Me-163B Komet Fighter



Comparable: Spaceplane Construction

This document can be read in conjunction with the Titans Spaceplanes – Spaceport Buildings & Facilities.

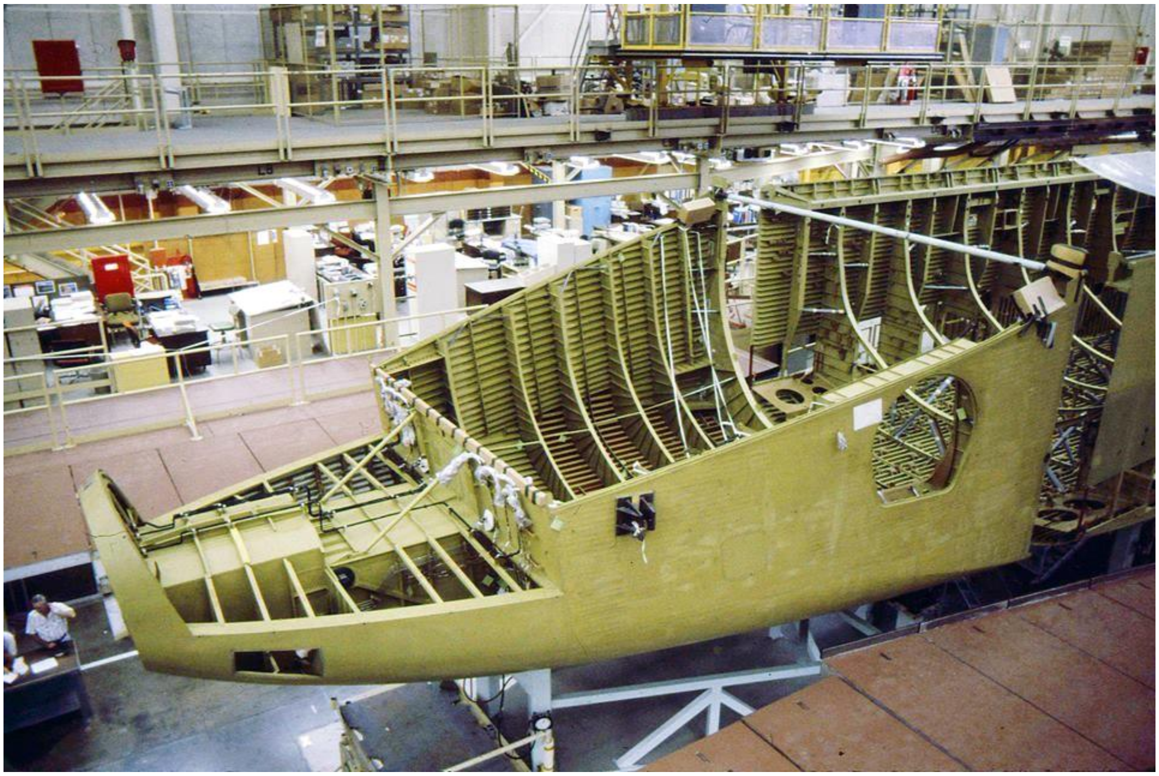
The two manufacturing buildings (factories) will be home to approximately 500-700 highly paid specialists (in two shifts), ranging from technicians to Structural Design Engineers to Electrical Engineers. (For comparison, the Learjet factory in Kansas employed 250 people).

Some specific factory roles

Aeronautical engineers; Aerospace engineers; Aircraft assemblers/installers; Civil engineers; Electrical engineers; Electrical installers/technicians; Information systems specialists; Inspectors (quality control); Machine tool operators; Manufacturing engineers; Mechanical engineers; Operations supervisors; Quality control technician; Sheet metal fabricators; Technicians (avionics/electronics); Test pilots; Tool, jig, and fixture maker.

Shuttle forward fuselage under construction

Like the shuttle the basic construction of Titans Spaceplanes fuselages will be aluminum with the skin riveted to ribs and stringers.

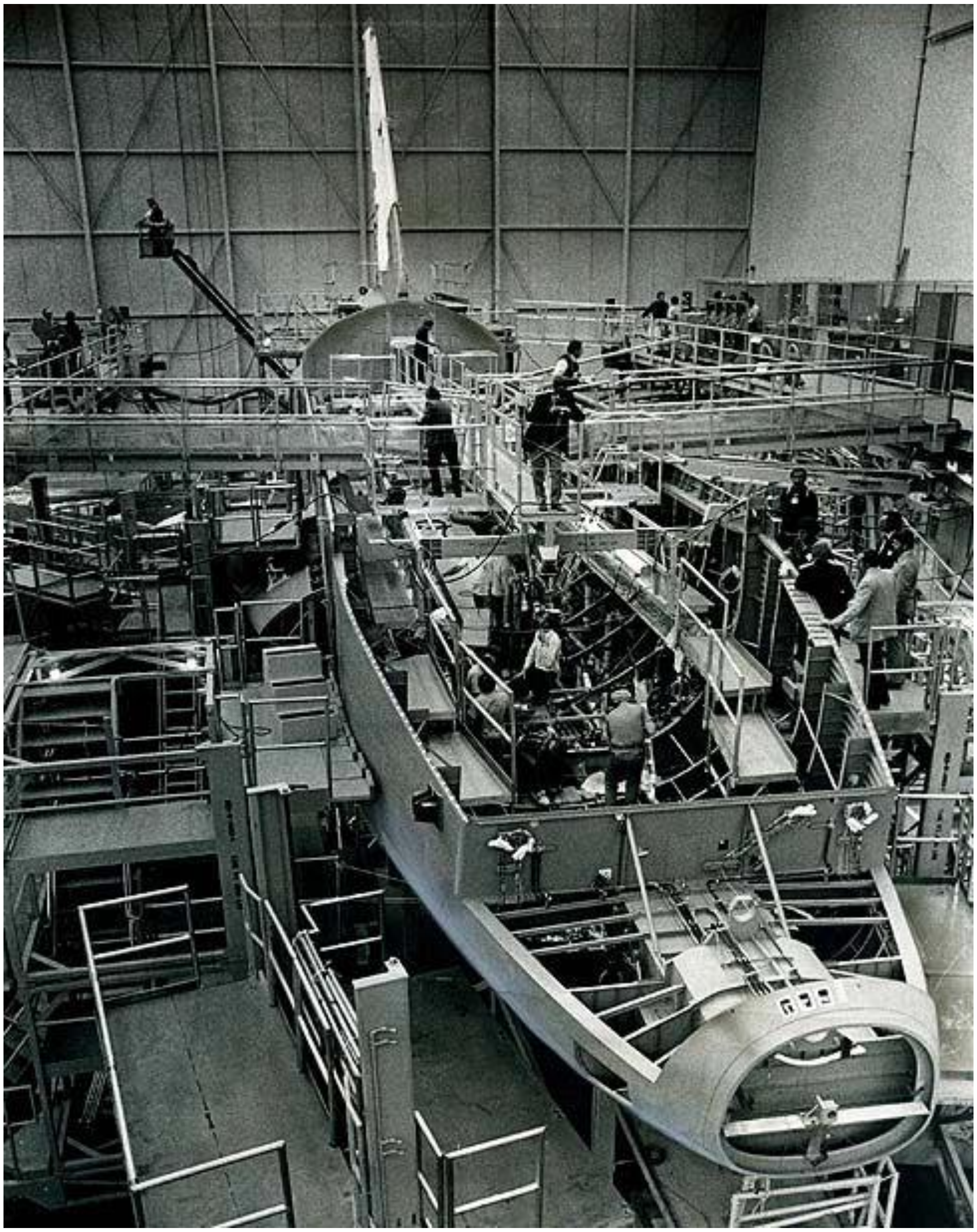


Soviet Buran shuttles under construction

The factory floor for assembling Titans Spaceplanes will look similar to this photo of Soviet Buran shuttles being constructed.

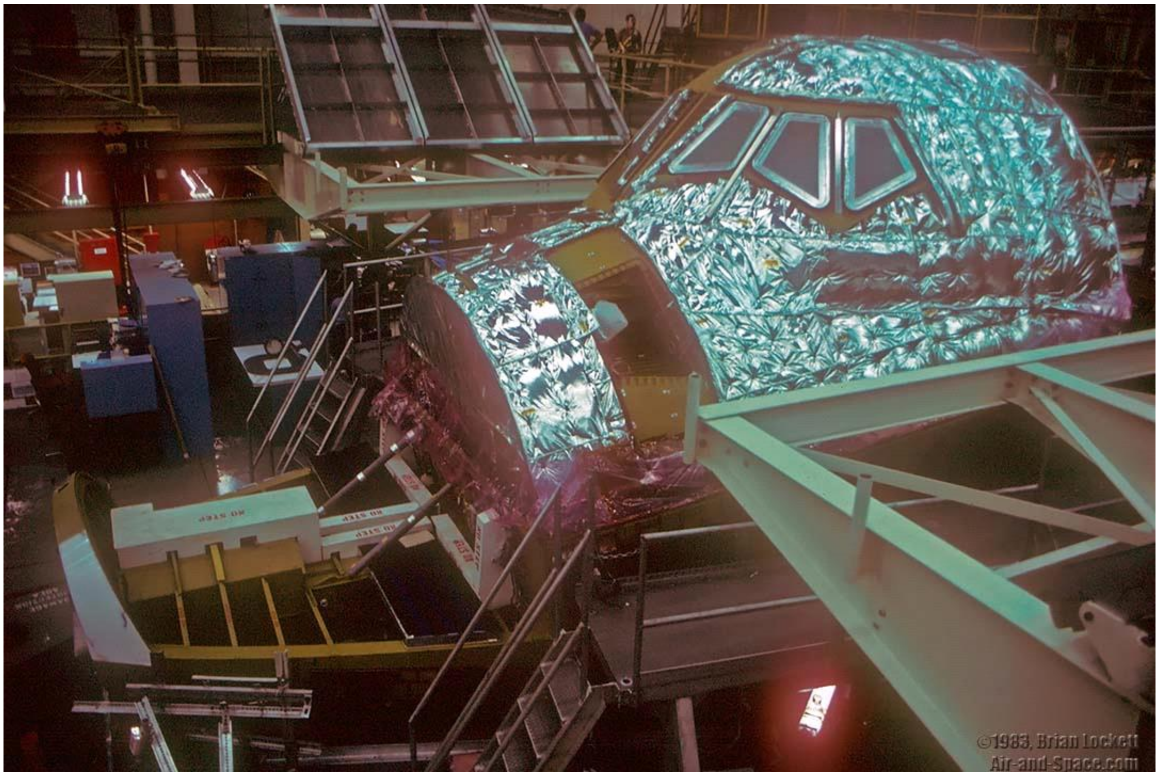
Space Shuttle under construction

Although the shuttle fuselage was a hybrid of different construction methods, the forward fuselage was conventional aluminum aircraft construction very similar to what Titans Spaceplanes will be using.



Space Shuttle crew cabin being fitted in forward fuselage

In this photo you can see the fixture used to precisely position the shuttle crew cabin while it was being fitted into the forward fuselage.



Space Shuttle crew cabin being fitted in fuselage

This photo shows the shuttle crew cabin being hoisted by crane into the forward fuselage. When people look at the front of a completed shuttle what they're actually seeing is the aeroshell that encloses the crew cabin.

Space Shuttle payload bay door being installed

Instead of clamshell doors like the shuttle payload bay Titans Spaceplanes will use a hinged nose that swings open.

Space Shuttle fuselage with crew cabin installed

The nose of the Titans Spaceplanes will use a similar approach where the cockpit/crew cabin is an insulated pressure vessel mounted inside the aeroshell.

Space Shuttle's windscreen panes

The enormous windscreen panes on the shuttle required a two-year development effort by Corning Glass. Titans will be sizing the windscreen panes so that off-the-shelf aluminum ceramic ballistic glass can be used.

Soviet Buran’s smaller windscreen panes

The Soviet Buran used much smaller windscreen panes than those on the American shuttle.

Soviet Buran Interior

This photo of the interior of a Soviet Buran shows how small the windscreen panes were relative to those on the American shuttle. The Titans spaceplane will be using a "glass" cockpit similar to modern airliners where the cockpit instruments are largely replaced by video displays.

Machine/Engine Shop

The Machine/Engine shop would be home to 25-30 high-paying jobs (2 shifts; CNC machinists and welders etc.) and could be at a separate location than the two hangars/manufacturing buildings. It will also have offices for the engine/propulsion engineers because of our desire to co-locate them with where the engines are being built.

The sound suppression building will be used for engine tests. We will, for example, conduct tests involving the afterburners. The sound suppression building suppressing the exhaust noise means we could do tests during most times of the day without risking being a nuisance to the area and without any restrictions.

In CNC machining systems after parts are designed using CAD programs the files are imported into the CNC machine where the part is machined.

Example of Modern CNC Machine Shop

Example CNC Machining Systems

Machine shop with CNC machining systems

Factory production floor with CNC machining systems

Industrial sheet metal roller machines

Industrial sheet metal roller machines will be used to make the ramjets and afterburners for the airbreathing engines in the plane's propulsion system.

An example of the kind of industrial sheet metal roller machine that will be used in Titan's Engine Shop for making ramjets and afterburners.

Unique Space & Aerospace Research & Development Opportunity

The Titans Spaceplanes project offers unique R&D opportunities to the Space & Aerospace industry. This concerns opportunities in the pre-manufacturing phase (present situation) as well as in the operational phase (from 2026/2027 onward).

TSI intends to pursue these R&D projects on a stand-alone as well as joint effort basis. Institutions, government agencies and entities are welcome to contact us to initiate a dialogue.

Airbreathing Engines in Flight

- High bypass turbofans in variable ramp inlets in the subsonic regime
- High bypass turbofans in variable ramp inlets in the transonic regime

- High bypass turbofans in variable ramp inlets in the supersonic and high supersonic regimes
- High bypass turbofans in variable ramp inlets using LOX/water mass injection precompressor cooling (MIPCC) in the supersonic and high supersonic regimes
- High bypass turbofans with duct heating afterburning
- Hydrogen burning afterburners
- Hydrogen burning afterburners supercharged by hot gaseous oxygen injection from rocket motors using catalytic decomposition of nitrous oxide
- Hydrogen burning ramjets
- Hydrogen burning ramjets supercharged by hot gaseous oxygen injection from rocket motors using catalytic decomposition of nitrous oxide
- Multimode/mixed fuel airbreathing propulsion system using duct heating afterburning high bypass turbofans and ramjets sharing a single variable ramp inlet with LOX/water mass injection precompressor cooling (MIPCC) and supercharging of the afterburners and ramjets using hot oxygen injection from rocket motors catalytically decomposing nitrous oxide

Wings in Flight

- Thick tridelta wings with Whitcomb airfoil sections in the subsonic regime
- Thick tridelta wings with Whitcomb airfoil sections in the transonic regime
- Thick tridelta wings with Whitcomb airfoil sections in the supersonic and high supersonic regimes
- Thick tridelta wings with Whitcomb airfoil sections in the hypersonic regime
- Thick tridelta wings with Whitcomb airfoil sections during orbital reentry

Rocket Engines in Flight and Orbit

- Low chamber pressure (75 psi to 100 psi) LOX/hydrogen engines of 500,000 to 1,000,000 lbs thrust
- LOX and hydrogen turbopumps of low output pressure (300 psi) powered by gas

generators using catalytic decomposition of nitrous oxide

- OMS class (5,000 lbs thrust) rocket motors using catalytic decomposition of nitrous oxide
- RCS class (1,000 lbs thrust) rocket motors using catalytic decomposition of nitrous oxide

Science

- Crewed orbiting observatory for infrared astronomy
- Crewed orbiting laboratory for short and longer term microgravity experiments

Dual-Use Disaster Relief/Military Logistics Supply

- Rapid on-demand delivery of supplies to disaster areas or remote mobile military bases using uncrewed single-use lenticular reentry vehicles which guide themselves to the target area then descend under parafoil to a precision landing

Military

- The Titans Hypersonic Reentry Light Fighter Jet, a lifting body fighter that can be deployed from orbit by the spaceplane and dropped directly into the battle zone, then after performing their mission descend by parafoil to a mobile base where they can be rearmed, refueled, and launched again with a zero length launch system. Further information about the Titans fighter jet and the R&D opportunities, please visit this link.

Contact Details

For extensive information, please visit TitansSpace.com/Titans-Spaceplanes and TitansSpace.com/FAQ.

For further communications, please contact

Zoe Güvener, Chief Communications Officer, Zoe@TitansU.com
Marcus Beaufort, Director of Operations, Marcus@TitansU.com