DIRECT Space Transportation System Derivative
The Jupiter Launch Vehicle Family

www.directlauncher.com

Replacing Ares-I & Ares-V – Delivering More Landed Payload Mass to the Lunar Surface - Sooner

Based on the Works of NASA’s Marshall Space Flight Center
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"As NASA Administrator, I already own a Heavy Lifter (in) the Space Shuttle stack. I will not give that up lightly and, in fact, can't responsibly do so because .... any other solution for getting 100 tons into orbit is going to be more expensive than efficiently utilizing what we already own."

-Dr. Michael D. Griffin, NASA Administrator, May 2005
1 - INTRODUCTION

This proposal defines a high-level alternative to NASA’s current Launch Vehicle plans designed to support the Vision for Space Exploration (VSE). The aim is to replace the pair of expensive Ares-I and Ares-V Launch Vehicles with a single Launcher, named “Jupiter”, directly derived from the existing Shuttle systems.

This “DIRECT” Shuttle-derived launcher exceeds all VSE payload and safety requirements for Crew and Cargo missions to the International Space Station (ISS). It is capable of supporting all of the far larger VSE missions to the Moon, Mars, and Beyond. Compared to Ares, it significantly reduces development costs, schedule and risks, cuts the human spaceflight gap after the Shuttle retires in 2010 from 5 to 2 years, and retains the NASA and contractor workforce.

DIRECT achieves this by minimizing new technology requirements. The Jupiter re-uses the unchanged human-rated Space Shuttle 4-segment Solid Rocket Boosters (SRB), the USAF Delta-IV RS-68 main engines, and converts the current Space Shuttle External Tank (ET) into a Core Stage atop which flies the new Orion spacecraft. In contrast, Ares-I requires development of new 5-segment SRB’s, new J-2X engines, new Upper Stage and all-new manufacturing and launch facilities.

Removing all these key long-lead-time components from the critical development path to fielding Shuttle’s replacement in the short-term and choosing to re-use existing flight hardware as the basis for all major systems, DIRECT will become operational many years sooner – thus “closing the gap” after Shuttle from 5 years, to just 2.

This faster schedule, coupled with lowering development costs from over $30 billion to less than $15 billion, will make retaining the Shuttle workforce an affordable proposition and will prevent a repeat of the disastrous “brain-drain” which occurred during the 6-year hiatus between the Apollo Program and Shuttle in the period 1975-1981.
II - ADVANTAGES OF DIRECT

Safety:

As Figure 2 demonstrates, both of the Jupiter Launch Vehicles in this proposal, Jupiter-120 and Jupiter-232, exceed NASA’s minimum safety requirements for Crew use as determined by NASA’s 2005 Exploration Systems Architecture Study (ESAS).

Like the Space Shuttle, the Jupiter-120 lights all its main engines on the ground prior to liftoff. This enables fault detection software to safely shut-down the main engines prior to liftoff - as has happened 6 times in the Shuttle Program. Ares-I, with its single solid fuel 1st stage does not have this capability, and must rely upon its single Upper Stage engine having no faults in order to be successful.

The Jupiter-232’s Upper Stage provides the same capability with its two-engine EDS allowing Abort To Orbit (ATO) scenarios, which have also occurred in the Shuttle Program. Again, Ares-I cannot provide this safety capability since it has only a single engine.

With so much direct and immediate heritage from STS systems, the Jupiter launchers are able to utilize almost all of the vast wealth of experience which has been gained by flying this same hardware for the last 26 years.

In addition, the extra payload capacity of the Jupiter-120 will allow for safety equipment that has been removed from the Orion design, due to payload limitations of the Ares-I, to be reincorporated into the craft. The spare lift capacity of the Jupiter-120 would even allow additional safety features to be added in the future to provide further protection to crews, equipment and missions. For example, Jupiter-120’s considerable extra performance could be utilized to integrate a large 8m (26ft) diameter Boron-Carbide/Kevlar composite ‘bullet-proof shield’ mounted directly under the spacecraft to provide extra protection in the event of any serious Launch Vehicle failure.

Performance:

ISS and Cargo-only Missions: The US currently operates two vehicles in the 20-25mT lift class, the Atlas-V and Delta-IV. NASA’s Ares-I duplicates the capability of these already existing and successful boosters at a development cost of $14.4 billion. Even after completing the Ares-I, NASA will still have to build the Ares-V at an additional cost of $12.5 billion in order to reach the Moon.

Jupiter-120 provides an immediate lift capability of 38-49mT which is larger than any other booster in the world, and can physically loft much larger diameter payloads than any booster America has operated in the last 30 years. The reduced development costs of the Jupiter-120/232 program translate to being able to support more than double the number of missions than Ares will be able to - at the same cost level.

Lunar Missions: An important feature of the Jupiter launch system is how its performance exceeds that of the Shuttle from day one, but how the same vehicle ultimately evolves to the far more demanding Lunar and Mars missions simply by adding an Upper Stage. DIRECT builds on the Exploration Systems Architecture
Study (ESAS) recommendation of utilizing two launches to achieve the total lunar mission mass objectives. However DIRECT departs from ESAS’ recommendation to utilize two considerably different sized lift vehicles; one small Crew Launch Vehicle (CLV), and one very large Cargo Launch Vehicle (CaLV) in order to place the necessary minimum of 180mT into LEO required for each lunar mission. DIRECT contends that only one new vehicle, flown in both a small and a large configuration, can perform all the missions.

The ESAS approach requires two separate vehicle development programs, two separate operations programs, and two sets of manufacturing and launch infrastructures – all of which add unnecessary cost and delays to the schedule.

The DIRECT STS Derivative approach uses a pair of the same Launch Vehicles to deliver approximately 20% more mass to orbit than NASA’s planned systems will. While at the same time this single vehicle will require only one significantly smaller development program, a single operation support system and one common launch and manufacturing infrastructure based closely upon the STS systems in use today.

**Mars & Beyond:** While no specific architecture has yet been selected for a human Mars mission, most scenarios explored so far require between 400mT to 500mT to be launched initially.

As shown in Figure 3, DIRECT is fully capable of supporting missions to Mars with no additional flights required.

**Growth:** DIRECT quickly and comprehensively secures the STS heavy lift infrastructure base for the future. If required, a number of other STS derivative options will be available for human Mars missions, including but not limited to further expansions of the Jupiter family – or even continuing down the Ares-V baselined approach – if required.

Without securing the existing STS infrastructure soon though, our options for Mars will rapidly diminish after the retirement of the Space Shuttle, severely restricting our options many years into the future – regardless of what future STS expansion options one may prefer.

![Figure 3 – Performance Comparison](image-url)
Schedule:

NASA states, with 65% confidence, that the Ares-I will be operational in March 2015 to carry the Orion spacecraft with a crew for the first time. Current budget constraints and high technology requirements continue to push out this schedule with recent estimates now placing this first flight into 2016. Compounding this, the low performance margins of the Ares-I and Thrust Oscillation issues continue to impose limits on the design of the Orion spacecraft – limits which have seen safety equipment being left out of the Orion’s design. Together, these issues require NASA to invest heavily at a time when funds are scarce. The Government Accountability Office (GAO) confirmed that Ares-I will cost $14.4bn. Yet for these 9 years of work, it will still only duplicate the performance of the existing Delta-IV Heavy.

By contrast DIRECT utilizes the already flight-proven RS-68 engines from Delta-IV, existing STS 4-segment SRB’s from Shuttle and only modifications to the existing STS External Tank structure to create the first variant of the Jupiter family, the Jupiter-120. By utilizing existing production hardware and launch infrastructure in this way, DIRECT is able to re-target all of the ‘long lead time’ items needed for the later lunar phase of the VSE and remove them from the critical path to the first flights. This enables the Jupiter-120 to fly much sooner – within 54 months of a green light.

Additional improvements in schedule, cost and program risk will also occur on the Orion program due to DIRECT. Due in part to the ever-tightening performance specifications of the Ares-I, the Orion is under increasingly stringent mass guidelines. With double the lift performance, the Jupiter-120 removes most of the short-term design pressures. This improves Orion’s development schedule and budget for the nearer term ISS mission, helping to close the “gap” still further. Using Jupiter-120, the schedule for fielding the Orion spacecraft can be brought forward by approximately three years, to September 2012.

Ares-I’s J-2X engines are the current long-pole item dictating the schedule to be operational in 2015/16. DIRECT removes these from the critical path to support initial ISS operations. They are not required until the Jupiter-232 Upper Stage begins flying for lunar operations in 2017. Both the near- and long-term development costs are considerably lower for DIRECT than the Ares-I/V combination, allowing NASA to accelerate the development of other critical elements, such as the Lunar Lander. Accelerating these elements improves the time frame for the first human Lunar Landing too. Thus even within the constraints of the current NASA budget, the objective of returning to the moon by 2020 can be brought forward by two to three years to 2017 via the lower cost DIRECT approach.

Some major contracts are already in place for Ares-I – and Jupiter would plan to modify these to suit the different needs of this configuration. The Upper Stage and J-2X contracts with Boeing and Pratt & Whitney, Rocketdyne can be modified to suit Jupiter-232’s Upper Stage – and the delivery time changed
from 2015 to 2017. The Boeing Instrumentation Unit contract is still required for Jupiter-120. The ATK contract for development of the 5-segment SRB would be re-negotiated into a re-qualification contract for the existing SRB’s on the new configuration, and would be enhanced by a significantly increased production agreement. As can easily be seen in Figure 4, there are many more SRB’s being flown thru 2020 under the DIRECT plan than under the Ares plan – so this would be an excellent opportunity for ATK’s core business.

Cost:

Internal cost assumptions for NASA’s current Ares-I vary wildly between $4 billion and $7.5 billion. But these cost assumptions do not include all of the factors such as administration overheads and the costs to modify manufacturing and launch processing facilities to suit the new system. When totaled together, the GAO pronounced that the comprehensive budget figure for Ares-I was going to total $14.4 billion.

DIRECT uses accepted GAO methodology for cost estimates. The budgetary costs for elements such as the SRB’s, External Tank, the RS-68 engines, general manufacturing, launch processing facilities and costs are well documented already. This enables us to extrapolate reasonably accurate cost estimates for the Jupiter launch vehicle’s production and operations budgets from these existing well known and documented cost structures.

The reductions in development cost should be re-invested to expedite the Orion spacecraft in order to close the “gap” further. They can also be utilized to pay for additional contracts which can be used to retain the existing workforce.

The additional elements, such as the re-development of the ET and the

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human-rating of the RS-68 have been estimated based on internal NASA figures derived during the 2005 NASA Exploration Systems Architecture Study (ESAS), the 1989-1993 “National Launch System” (NLS) effort to create a joint NASA In-Line Shuttle-Derived launch system remarkably similar in concept to the Jupiter-120, and these also include the most up-to-date cost information sourced within the existing Ares development Program.

Operational Costs are drastically cut compared to Ares by the simple expedient of operating one vehicle system instead of two. Lowering Fixed costs and raising flight-rates in order to amortize these costs across a larger number of units makes each unit significantly more cost effective. The comparable results are shown in Figure 6, with approximately a $1 billion savings of the Jupiter approach over that of Ares. This figure equates to the equivalent of flying ten additional vehicles every year – a significant improvement over Ares.

By reducing the impact of development costs, and by bringing forward the schedule so many years, DIRECT provides the necessary cost leverage to allow the workforce to be retained. See Figures 7, 8 & 9. The greater performance of the Jupiter-120 enables a wide variety of new missions in addition to the regular baseline ISS Crew Rotations and Lunar flights. Additional missions provide the means to allow NASA to put all of their trained staff to full use, even as the Shuttle Program winds down and the new Exploration missions are still gaining momentum. DIRECT therefore avoids becoming just another boondoggle and instead becomes a program with an extensive range of both Crew and Cargo mission capabilities which can be put to efficient use.
Solid Rocket Boosters:

The distinctive pair of white 4-segment Solid Rocket Booster (SRB) strap-ons are retained in the DIRECT Architecture completely without change. This choice to reuse the existing man-rated items means there are essentially zero costs and zero schedule impacts for these elements of the new development program. As with STS, these elements can continue to be reused (there are sufficient SRB parts with service life to support over 600 more 4-segment booster flights, or 300 Jupiter missions), so all the existing hardware, current facilities and workforce would be retained without change.

These boosters have a perfect flight record of 194 successful uses on Space Shuttle missions since they were redesigned following the loss of Challenger in January of 1986. Using the SRB’s in an almost identical configuration confers this demonstrated reliability immediately to the Jupiter for all future crew missions to the ISS, Moon, Mars and beyond.

Main Engines:

Like the planned Ares-V, DIRECT proposes to use the low-cost Pratt & Whitney, Rocketdyne RS-68 engine borrowed from the US Air Force’s Delta-IV program.

Unlike the Ares-V, Jupiter uses the unmodified RS-68’s instead of requiring upgraded engines to be operated 106% maximum power. Using the current RS-68 reduces development costs, makes the engine easier to human-rate, and significantly reduces the development schedule for the engine. Indeed, only the process of human-rating, such as adding health monitoring systems and backup actuators and testing is required – a task NASA has already begun to undertake.

Jupiter Common Cores are designed to fly with either two or three of these engines mounted, depending on the payload requirements. To get the maximum performance from the optional Upper Stage, three RS-68’s are used to create maximum thrust earlier in the flight. For smaller payloads, with no Upper Stage, two engines offer sufficient performance to lift the vehicle to orbit and reduce complexity at the same time – thereby also increasing safety.
External Tank / Jupiter Core Stage:

The External Tank (ET) clearly requires some changes to become the Jupiter’s Common Core. However a great deal of the necessary alterations are well within the manufacturing capabilities of the current ET production line based at the Michoud Assembly Facility (MAF) in New Orleans, LA. One isolated example: The Jupiter Core Stage (JCS) requires strengthened sidewalls to the tanks and interstage. This change can be implemented by adjusting the milling machines to mill less metal during construction. This very simple change would create thicker, stronger tank walls and could be done almost instantly at any time, even while the last Shuttle External Tanks are still being built. The fact is that many of the sub-systems in the ET – approximately 70% – can likewise be made using simple procedural changes during manufacturing flow using the existing facilities at MAF today and do not require “all new” tooling hardware at all. Additionally, most of these changes can be performed on the existing manufacturing hardware even while Shuttle ET’s continue to be processed. Figure 12 & Figure 13 show the main elements in common between Shuttle ET and the Jupiter Core Stage.

The key factor is to strategically examine the ET elements which exist today and specifically plan to retain as many as possible during the design phase. By choosing to “use what you have” rather than starting from a blank slate, DIRECT explicitly avoids having to develop all-new and costly hardware throughout the program. Major design changes on the ET should be limited to the forward LOX tank structure and payload shroud, a new LH2 tank aft “Y-ring” for interfacing to an Aft Skirt and the Thrust Structure.
As with the Ares-I and Ares-V, the Jupiter will also require new plumbing. For Jupiter Core Stages the new Aft Skirt region will need to be designed to allow the fitting of either 2 or 3 main engines on any stage as shown in Figure 14. When flying without the center engine, the connections and plumbing are simply capped and closed-off and a protective panel is bolted in place instead of an engine.

Like both Ares vehicles, new avionics systems will be required. It is likely that the avionics system will be the most time-consuming development element of this entire program. Yet even that is assisted by sharing such close commonality with existing STS and EELV programs.

Due to the higher performance margin of the Jupiter-120 for initial ISS missions, many structural elements can be optimized, in an ongoing evolutionary approach. This can support Jupiter-232 being targeted for the Lunar phase of VSE starting in 2017. In addition, the entry level “Block-1” Jupiter-120 and later “Block-2” optimized variants become available for a number of future manned and unmanned missions currently impossible with either existing EELV’s or projected Ares-I launch systems.

### Payload Fairing

The Payload Fairing for Jupiter can come in a multitude of sizes. Initial versions would be designed to match the diameter of the Core and Upper Stages themselves, at 8.41m (331”). These fairings can support a very wide variety of payloads as soon as the Jupiter-120 enters service and both crewed and un-crewed use is supported. Figure 15 demonstrates a small selection of possible uses.

For the Lunar missions, a wider Payload Fairing will be required for the wide-profile new Altair Lunar Lander. Jupiter launchers are capable of utilizing 8.4m, 10m and 12m diameter Fairings. Figure 15 demonstrates both the 8.4m and 10m Fairings.

Also shown is the optional MLAS crew abort system instead of the traditional ALAS system – DIRECT can support either.
Optional Upper/Earth Departure Stage:

The basic Jupiter-120 Launch Vehicle in this proposal can launch payloads massing twice as much as any other launcher in the world today – civilian or military. But that still is not enough to reach the moon. Enabling a two-launch lunar architecture requires the addition of a large Upper Stage to the Jupiter-1xx series, making it a Jupiter-2xx by definition. This Upper Stage will also incorporate a high thrust, efficient, re-startable, vacuum optimized engine for both Ascent and Earth Departure roles.

In some scenarios it will also be important for the Upper Stage to wait in space for long durations until a crew rendezvous can occur. Boil-off is a critical concern for stages loitering in orbit. While Jupiter assumes the same 0.35% loss rate per day as NASA’s systems, there are options for the future which can improve performance. Both Lockheed-Martin and Boeing have completed studies into low boil-off stage designs with as low as 0.1% per day loss with passive systems. Boil-off rates could be reduced to 0.01% per day using active cooling.

DIRECT uses the simpler, lower thrust Pratt & Whitney, Rocketdyne’s J-2XD variant instead of the more complicated and expensive J-2X, that will take until 2015 to qualify. Even with this less costly engine powering the Upper Stage, the J-2XD will increase performance of the Jupiter-120 from 38mT to 103mT - more than enough to support Lunar & Mars missions.

This less costly approach of adding an Upper Stage is all that is required to enable lunar missions with 20% more performance than NASA plans.
Together, all of these elements described above create the “Jupiter” family of Launch Vehicles.

The naming convention used to differentiate between the different configurations is a three-digit number. The first digit represents the number of cryogenic stages used. The second number represents the number of main engines on the core and the third number represents the number of engines on any Upper Stage – or ‘0’ if no Upper Stage is to be flown. A pair of 4-segment SRB’s is always assumed, but the option exists for “Heavy” variants using 5-segments boosters in the future if requirements ever justify the additional expenditure.

Thus, the initial vehicle, “Jupiter-120”, shown in Figure 18, is the designation consisting of one cryogenic stage, with two RS-68 main engines and has no Upper Stage. This vehicle is capable of launching 47.8mT of cargo to orbit (130nm, 29°) every flight, or 38.9mT of Orion plus Cargo to the ISS.

<table>
<thead>
<tr>
<th>Vehicle Concept Characteristics</th>
<th></th>
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<tbody>
<tr>
<td>ISS Crew LV GLOW</td>
<td>4,468,960lb (2,026,900kg)</td>
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<tr>
<td>Crew LV 8.4m Ø Payload Envelope L x D</td>
<td>36.7 x 24.5ft (11.8 x 7.46m)</td>
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<tr>
<td>Crew LV 8.4m Ø Payload Fairing Mass</td>
<td>11,769lb (5,334kg)</td>
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<tr>
<td>Crew LV Launch Abort System Mass</td>
<td>16,072lb (7,290kg)</td>
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<td>CLV LAS Jettison</td>
<td>T+265s</td>
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<td>LEO Cargo LV GLOW</td>
<td>4,475,745lb (2,039,164kg)</td>
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<tr>
<td>Cargo LV 8.4m Ø Payload Envelope L x D</td>
<td>49.5 x 24.5ft (15.1 x 7.46m)</td>
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<tr>
<td>Cargo LV 8.4m Ø Payload Fairing Mass</td>
<td>13,188lb (5,982kg)</td>
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<tr>
<td>Cargo LV 8.4m Ø Payload Fairing Jettison</td>
<td>T+257s</td>
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**BOOSTER (each)**

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<tr>
<th>Propellants</th>
<th>PBAN</th>
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<tr>
<td>Useable Propellant</td>
<td>1,195,546lb (501,467kg)</td>
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<td>Stage pmf</td>
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<td>Burnout Mass</td>
<td>196,050lb (88,927kg)</td>
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<td># Boosters / Type</td>
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<tr>
<td>Booster Thrust (@0.7sec)</td>
<td>2,877,372lbf @ SL (1,305,154kgs / 12,799,188N)</td>
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<tr>
<td>Booster Isp (@0.7sec)</td>
<td>3,331,400lbf @ Vac (1,511,998lbs / 14,818,803N)</td>
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<td>Burn Time</td>
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**CORE STAGE**

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<th>LOX/LH2</th>
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<td>1,604,370lb (728,002kg)</td>
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<td>Propellant Offload</td>
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<td>Stage pmf</td>
<td>0.9147</td>
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<tr>
<td>Dry Mass</td>
<td>136,554lb (61,940kg) - “BLOCK-I” Core</td>
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<tr>
<td>Burnout Mass</td>
<td>151,239lb (68,010kg)</td>
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<tr>
<td># Engines / Type</td>
<td>2 / RS-68 “Ablative” (man-rated)</td>
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<tr>
<td>Engine Thrust (@102%)</td>
<td>655,010lbf @ SL (297,557kgs / 2,919,030N)</td>
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<tr>
<td>Engine Isp (@102%)</td>
<td>375.0 s @ SL</td>
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<tr>
<td>Mission Power Level</td>
<td>409.0 s @ Vac</td>
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<tr>
<td>Core Burn Time</td>
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**ISS CREW DELIVERY ORBIT**

| Maximum Payload (Gross) | 100 x 220.0nm (185.20x407.44km) @ 51.6° |
| Maximum Payload (NET) | 95,393lb (43,209kg) |

**ISS CARGO DELIVERY ORBIT**

| Maximum Payload (Gross) | 80 x 220.0nm (148.20x407.44km) @ 51.6° |
| Maximum Payload (NET) | 109,894lb (49,847kgs) |

**LEO CREW DELIVERY ORBIT**

| Maximum Payload (Gross) | 100 x 130.0nm (155.20x240.76km) @ 29.0° |
| Maximum Payload (NET) | 105,349lb (47,740kgs) |

**LEO CARGO DELIVERY ORBIT**

| Maximum Payload (Gross) | 107 x 130.0nm (198.99x240.76km) @ 29.0° |
| Maximum Payload (NET) | 117,220lb (53,170kgs) |
For Lunar and Mars missions a larger Launch Vehicle is required. Adding an Upper Stage to the original Jupiter-120 configuration and including a third RS-68 main engine on the Core Stage, this “Jupiter-232” configuration is capable of launching 103.4mT of cargo to orbit (130nm, 29°) – in addition to leaving a partially fuelled 19.2mT Upper Stage for the Earth Departure burn needed for Lunar missions.

While only 2 Jupiter variants are discussed here, several other variants are possible – providing mission designers great flexibility in matching Launch Vehicle capabilities to the mission profile, natural breakout of the spacecraft components and mission requirements. Future Growth Options allow for in excess of 150mT of lift performance (Jupiter-244 for example) if there should be any requirement in the future which the Jupiter-232 ~100mT configuration were to be incapable of supporting.
Phase 1: Manned Exploration Transition

Initial implementation from 2012 thru 2017 supporting:-

- First crewed flights of Orion in 2012
- Regular servicing of the International Space Station
- Hubble Servicing Missions
- Other Unmanned & Robotic Exploration Missions
- Apollo-8 Style “Flyby” Mission in 2013 with the use of human-rated Delta-IV Upper Stage

Vehicle: Jupiter-120

Phase 2 Lunar Exploration:

Early Lunar Exploration from 2017 thru 2020 including:

- Robotic Landers – Manned Sortie Precursor
- Robotic Lunar Sample Rovers Rendezvous with Manned Lunar Surface Sortie Missions
- Manned Lunar Surface Sortie, 4 Crew for 7 days, Global Access, Anytime Return
- Manned Lunar Surface Outpost via pre-placed Habitation units, 4 Crew for 90-120 days.

Vehicles: Jupiter-232 CLV and Jupiter-232 CaLV using EOR-LOR profile – 46.8mT LSAM.
Phase 2 Optional and/or Expanded Lunar Exploration:

Optional and/or Evolved Lunar Exploration & Colonization from 2020 thru 2030 supporting:

- Permanent Lunar Base establishment
- Begin ISRU development/deployment
- Extensive Lunar Surface Exploration

Vehicles: Jupiter-232 CLV and Jupiter-232 CaLV using EOR-LOR mission profile – 45-55mT LSAM.

Optional Vehicle Upgrades: Jupiter-244 CLV and Jupiter-232 CaLV using EOR-LOR – 100mT+ LSAM.

This architecture opens the interesting door to a valuable International Partnership Program. By re-using the Propellant Depot, International Partners can launch propellant in return for ‘seats’ on the missions. NASA will operate the Orion CEV and Altair LSAM as well as the Jupiter Launch Vehicles, but International Partners could provide propellant for the missions. This would considerably reduce the cost of missions for the US. 50% of the necessary propellant for a mission delivered to the Depot would ‘buy’ one seat of the four heading for the Lunar Surface. 100% of the propellant would ‘buy’ two seats.

This would enable many nations around the world to offer valuable participation to support the US efforts, but would not put the US in the difficult position of ever being completely dependent upon any other partner.

Finally, Mars architectures are easily enabled with this Jupiter-232 Launch Vehicle also. They are especially enhanced with the Propellant Depot upgrade technology we are recommending herein.
VI – ACKNOWLEDGEMENTS

This current proposal represents a point-in-time summary of the ongoing efforts of many to forward mankind’s exploration space. As such, it is a continually evolving Work-In-Progress.

We thank each and every person who has contributed to this ever-growing grass-roots effort. It is your efforts which have brought this to this point and which will continue to propel us into the future. Your expertise, skill and courage is a testament to the spirit of America’s Human Space Flight Program.

We truly stand upon the shoulders of giants.

VII REVISION HISTORY

v2.0.1 7th May, 2008
1. Fully Revised from v1.1.2 with latest configurations, performance and baseline data

v2.0.1 24th June, 2008
1. Revised charts