

Initial Summary of Human Rated Delta IV Heavy Study

Briefing to the Review of U.S. Human Space
Flight Plans Committee

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Background

- EELV Human Rating Study, Mar-Aug 2005
- Architecture Strategic Analysis Task, Jul-Dec 2008
- Architecture Strategic Analysis Task Forward Action Plan,
Dec 2008-May 2009



Study Scope

- Study examines technical and programmatic feasibility of replacing Ares I with a human-rated Delta IV Heavy and associated impacts on existing Constellation architecture
- Study did not include:
 - *Alternate Constellation architectures*
 - *Confidence of Ares I cost and schedule*



Options

- Six configurations studied:
 1. *Delta IV Heavy (H) baseline (not human rated)*
 2. *Human Rated (HR) Delta IV H with Ares I upper stage including J-2X engine*
 3. *HR Delta IV H with resized J-2X upper stage*
 4. *HR Delta IV H redesigned upper stage with 4 RL-10 derivative engines*
 5. *HR Delta IV H with no upper stage*
 6. *HR Delta IV H with single RL-10 engine derivative*
- Atlas V Heavy not considered due to design maturity relative to Delta IV Heavy



Technical Findings (1 of 2)

- Implementation of Human Rating Requirements (Safety and Reliability), commensurate with Ares I approach, is technically feasible for HR Delta IV H
- New upper stage configurations with J-2X or four RL-10 derivatives are technically feasible and exceed Ares I performance to ISS and LEO targets
- Human rated version of upper stage with one RL-10 derivative may match Ares I gross performance
 - *More detailed examination of trade space required*
- The no upper stage configuration using Orion Service Module shows feasible performance to ISS target, but not Lunar target



Technical Findings (2 of 2)

- Industrial capacity can accommodate increases in production and hardware transportation for HR Delta IV H
 - *Viability of SRM industrial base needs further study by joint civil and military team*
- HR Delta IV H can utilize some Ares I hardware and ground processing infrastructure elements
 - *Processing at OPF/SLC-39 is most effective option*
- Aerospace's recommended option includes a redesigned upper stage with four RL-10 derivatives to increase performance and ability to meet human rating requirement
 - *Added benefit of engine out capability*
 - *SRM and J-2X development would need to be carried by Ares V program*



Cost Impact Relative to Cx Program of Record

- Crew Launch Function and 14 flights to ISS
 - *Approximately \$6B less with redesigned upper stage with one RL-10 derivative or with no upper stage option*
 - Reduced performance or no access to lunar target
 - *Approximately \$3B less with redesigned upper stage with four RL-10 derivatives*
 - *No cost impact: Use Ares upper stage and J-2X engine*
- Increased DDT&E costs to Ares V
 - *Estimates range from \$1.1B to \$3.6B*
- NASA estimates carry forward costs of \$14.1 - 16.6B for these areas:
 - Aerospace has not independently verified these costs***
 - *Ares V for required capabilities developed under Ares I but not required for HR Delta IV H*
 - *Orion design impact evaluation*
 - *Industrial and government capabilities*
 - *Delay in start of production for J-2X and SRBs requires sustainment of industrial and technological capabilities in these areas*



Schedule Findings

- Nominal HR Delta IV H development time is estimated to be on the order of 5.5 to 7 years
 - *No comparative or feasibility analysis performed for the Ares I planned IOC*
- Ground facilities and launch vehicle developments compete for critical path
- Impact to Ares V schedule could be minimal
- Impact to Orion schedule could be minimal, provided:
 - *12 month period for architecture design and second stage re-competition*
 - *These activities need to start immediately following Ares I cancellation*



National Security Space Impacts

- Significant Risks and Opportunities exist for NSS
- Increased production rates should have positive effects on ULA hardware cost and reliability, as well ULA vendor industrial base
- Competing NASA and NSS requirements and interests could have negative consequences if not carefully managed
- Pad and Range issues seen as a manageable risk



Conclusions

- Constellation program is an architecture
- Technically acceptable alternatives exist to access low earth orbit
- HR Delta IV H is less expensive for humans to ISS only
- Total cost depends on carry forward costs

