AIAA 2001-3411

Potential Future Shuttle Improvements

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37th AIAA/ASME/SAE/ASEE
Joint Propulsion Conference and Exhibit

8 - 11 July 2001
Salt Lake City, Utah

POTENTIAL FUTURE SHUTTLE IMPROVEMENTS

NASA has just recently completed the 104th flight of the Space Shuttle. Each of the four Orbiters in the Shuttle fleet have a design life of 100 flights each. Thus the fleet is capable of almost 300 more flights, and at current flight rates could potentially operate well past 2020 if necessary. This paper addresses some of the potential Shuttle system improvements that could be considered if the decision is made to continue operations of this vehicle for such an extended period.

The national space transportation policy envisions a decision around 2005-2006 concerning readiness to start development of a Shuttle replacement system. Leading up to that decision point NASA is investing in the Space Launch Initiative (SLI) to reduce the development risks associated with key technologies needed for the next generation reusable launch vehicle (RLV). The Shuttle replacement could be a new design RLV or could be based on a Shuttle-derived design: i.e., a vehicle based on the current Shuttle but with major design changes. The technology investment strategy of SLI is supportive of either approach. However, if NASA and industry are not ready to develop a replacement vehicle in the 2006-2012 timeframe, then another option would be to continue to make important , but evolutionary changes, to the existing Shuttle fleet. The overall strategy for next generation RLV planning, including possible Shuttle evolution, is captured in Figure 1.

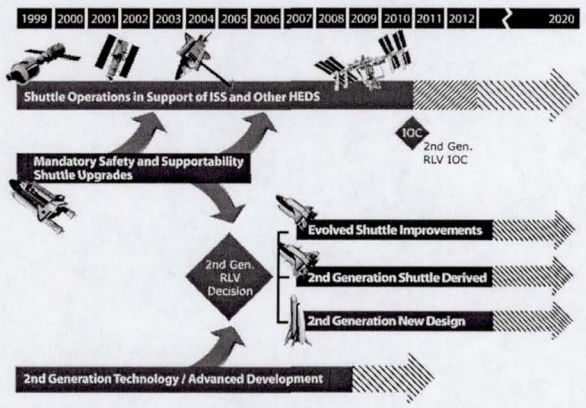

Figure 1. Space Shuttle Development Strategy

NASA is currently planning a set of system upgrades to be developed in the near term. The intent of these near term safety upgrades is to enhance the operational safety of Shuttle by significantly reducing some of the inherent system risks by redesign of certain key systems and subsystems. Longer term, more extensive, safety improvements would be considered for an "evolved" Shuttle or a Shuttle-derived RLV approach, and high priority would be given to elimination of some of the abort modes associated with the current vehicle, and potentially making improvements in crew escape capabilities. These priorities are illustrated in Figure 2.

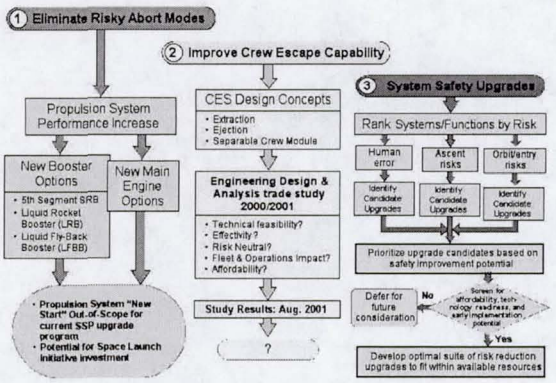

Figure 2. Shuttle Safety Improvement Priorities

The first could be achieved by improving ascent performance enough to enable abort to orbit capability for an engine out off the launch pad and by eliminating contingency abort black zones that would result in loss of vehicle (LOV) for two main engines out. The second would be to implement a crew escape system that would provide a high likelihood of safely recovering the crew following a catastrophic vehicle failure. The third area on systems improvements ranks the high priority systems upgrades that could significantly increase shuttle reliability and safety if implemented. Significant high priority system safety upgrades were identified and conceptually approved in 1999/2000. Several of those upgrades are progressing through early project definition phases, which are developing feasibility assessments and implementation plans for the next 4-5 years.

During the joint MSFC/JSC activities in support of the Space Transportation Architecture Study (1998 – 1999) the following technology needs were identified: advanced crew escape and survivability, highly reliable and long life (LOX/Hydrocarbon) booster engines, a reusable first stage, more reliable and long life (LOX-LH2) main engines (including low cost expendables), low cost external tanks, non-

toxic auxiliary propulsion systems, more durable and reliable thermal protection system (TPS), integrated vehicle health management systems, electro-mechanical actuators and fly back jet engines.

The Space Shuttle Program has defined its goals for potential shuttle evolutionary improvements beyond the 2005 - 2007 upgrade commitment. These not only include the major safety upgrades for abort enhancements, improved systems reliability and crew escape improvements discussed earlier but also include applying the advanced technology infusion from the Space Launch Initiatives into the shuttle and using the shuttle as a demonstration test bed for future RLV's. Advanced space transportation investments in the upgrades being considered support future vehicle as well as the evolved shuttle option.

A summary of the evolved shuttle upgrade candidates is shown on figure 3.

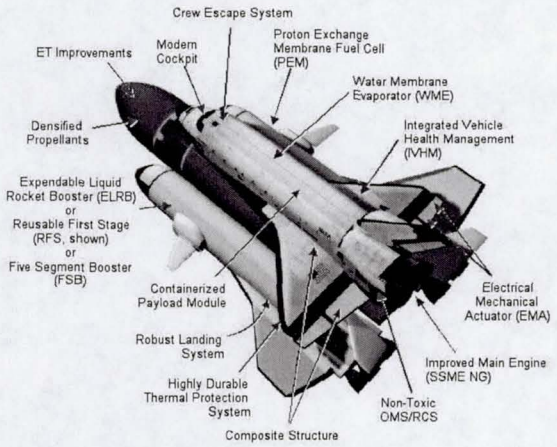

Figure 3. Evolved Space Shuttle Upgrade Candidates

These include those upgrades that will not only improve safety but that would also maintain shuttle supportability and add efficiencies that would significantly reduce shuttle operations cost.