Factors in International Space Station Integration Feasibility Assessments

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The International Space Station, ISS, is a growing vehicle. The ISS configuration changes internally and externally with each ISS flight. Each flight adds resources and capabilities such as docking/berthing ports, power, stowage volume, heat rejection, and data processing capability. The configuration, capabilities and performance characteristics of the vehicle will be in flux until assembly complete. At the same time the knowledge about what is required to support humans involved in long duration space flight is also being greatly expanded. In addition to the changes occurring on-orbit, the situation on the ground is also very dynamic. Proposals for new ISS elements, proposed deletions of elements, changes to the ISS requirements, and changes to the planned configuration are always under evaluation. Furthermore, budgetary issues have driven the need to explore alternative options for the ISS. This environment has made the role of the technical integrator in the ISS program unique in that the baseline against which proposals are evaluated is always changing. The nature of the International Space Station Program adds another dimension to the integrators task. ISS program activities are spread across several centers: KSC, MSFC, GRC, DFRC, ARC and JSC. There are six International Partners/participants each with their own unique organizations. The prime contractor is in Texas, California and Alabama. And, the Space Shuttle Program as the launch vehicle provider is another major interface.

In spite of the fluidity of the technical baseline, projections and organizational complexity, in the course of evaluating proposals and producing feasibility assessments there are factors, which frequently emerge as significant. These factors tend to be the limiting conditions when they come into play. The finite resources, which tend to limit the options for ISS are: upmass, life support and crew rescue capability, crew time, utilities, exercise equipment, and docking/berthing ports.

Upmass requirements need to be developed for each option proposed. Short term and long term impacts to upmass are the result of the implementation and long term operations. The upmass requirements need to be met by the existing launch vehicles and any change in flight rate will be a significant cost driver. In addition, when any item is brought to the ISS careful consideration must be given to the on-board stowage and crew time available to unpack, transfer, stow and use these items. If stowage is not available then something must be returned, use of non-standard stowage negotiated or the item in question stays on the ground. Additional crew time requirments will impact available utilization time or crew off-duty time.

When the human element is affected, such as, by increasing the number of crew members or changing the duration of the crew stay (longer or shorter) there is an additional set of factors that come into play. The main considerations are: rescue capability, exercise requirements and availability of equipment, resupply, and life support capability.

When an on-orbit internal configuration change is proposed, a thorough assesment of the available utilities and capabilities is required. Utilities such as power, heat rejection, data

connectivity, airflow required and the available volume are key constraints. Similar considerations exist for on-orbit external configuration changes. Utilities such as power, heat rejection, data connectivity, and the available volume are again key constraints. Vehicle docking, and element berthing, is limited by the available docking, and berthing ports.

This is not meant to be a compehensive listing and discussion of all, or even most of the factors considered in a feasibility assessment . This is a discussion of those factors primarily rsources and capabilities that most constrain ISS options. Beyond the scope of this document are other major factors that drive decisions such as: schedules, costs, International Partner (barters), risk, NASA headquarters position, budget cuts and program changes.