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Paper Session II-B - International Space Station Stage Integration Reviews

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International Space Station (ISS) Stage Integration Reviews

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Biography:

Ms. Cerrato is currently the Technical Assistant for Integration of the Element & Stage Integration Branch of the ISS Program Vehicle Office. She has been working in the ISS Program Office since July 1995. Prior to working in the ISS Program Office, she worked at Kennedy Space Center as a Launch Site Support Manager in the Payloads Processing Directorate from July 1989 through July 1995. She graduated from General Motors Institute in June 1989 with a Bachelor of Science in Industrial Engineering. While working for NASA at KSC, she acquired a Masters of Science in Engineering Management from the University of Central Florida in June 1993.

International Space Station (ISS) Stage Integration Reviews

by
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1.0 Introduction

Because of the complexity of the International Space Station (ISS) in that it is incrementally built over several years and establishes varying degrees of functionality and performance as it is built, it is necessary to perform integration reviews of the design insuring that the ISS is safe, operable, and survivable through the on-orbit assembly. An approach to reviewing the integrated design and incremental build of the Space Station was established in the early phases of the ISS Program. The approach was titled "Incremental Design Reviews (IDRs)" and was first implemented in March 1995.   The philosophy behind IDRs was to review large groups of ISS flights (between 10 to 12) for physical, functional, performance and operational design conformance with requirements across the flights.   Flights were grouped and reviewed based on two levels of maturity - preliminary design and critical design.   The review was an "in-process" type of review that extended over several months concluding with an outbriefing of results.   Three IDRs were conducted - IDR 1 (Outbriefing in March 1995), IDR 2A (Outbriefing in March 1996) and IDR 2B (Outbriefing in September 1996).

The Incremental Design Review (IDR) philosophy was utilized for the early design and development phases of the ISS Program, but, as the Program has transitioned to manufacturing, test and operational phases of the hardware and software, the Program design review approach required a new focus. The new review philosophy recently approved by ISS Program Management and titled "Stage Integration Reviews (SIRs)" follows a more classical design review approach derived from military standards and NASA System Engineering guides. The SIRs will review smaller groups of flights (between 2 and 4) instead of the larger flight groups that were assessed at IDRs. This will allow a more focused review accomplishing the objective of evaluating hardware and software functionality, performance, and operations plans against the established baseline requirements. The first SIR will review Stage 2A which includes Flights 1A/R (the FGB) and Flight 2A (Node 1, PMA 1, and PMA 2). This SIR will be held in February 1997.

2.0 Overall ISS Review Process

Figure 1.0 illustrates the current review process for the ISS. It includes both ISS unique reviews as well as joint reviews with the Space Shuttle Program. The timeframe for conducting the SIRs is optimally launch minus 20 +/- 2 months. Because this philosophy has been implemented within that window for the first few launches, the first SIRs will be conducted closer to launch than the template.

The SIR is conducted based on a logical sequence of technical events which allows a baseline to be established prior to the SIR. This accommodates the objective of reviewing products against a baseline. The hardware and software design baselines are established at the major end-item critical design reviews, an operations baseline is established at the Stage Assessment Review, and an Assembly Integration Requirements Document has been completed. Also, the SIR process makes use of integrated performance data resulting from the design analysis cycle process. This is accomplished by scheduling the SIR to commence as soon as feasible after the completion of the design analysis cycle. This provides analysis products based on current design data and configuration. These baselines and analysis products flow into the SIR and, at the SIR, integration products are reviewed for consistency with the baseline.

The result of the SIR is a validated set of integration products for the stage(s). This insures readiness to proceed with hardware/software development and auditing, operational planning, test and verification activities, entering into the Shuttle Program integration template, and initiates a monthly review process for the flights/stages. The monthly flight reviews - Readiness to Proceed (RTP) reviews - track and close all issues resulting from the SIR. These reviews are held to review the status of all aspects of the flight (design, manufacturing, test, integration, operations, safety, shuttle integration, etc). The RTP reviews are held monthly following the SIR and, beginning at L-12 months, are held weekly.

Figure 1.0 - ISS Review Process
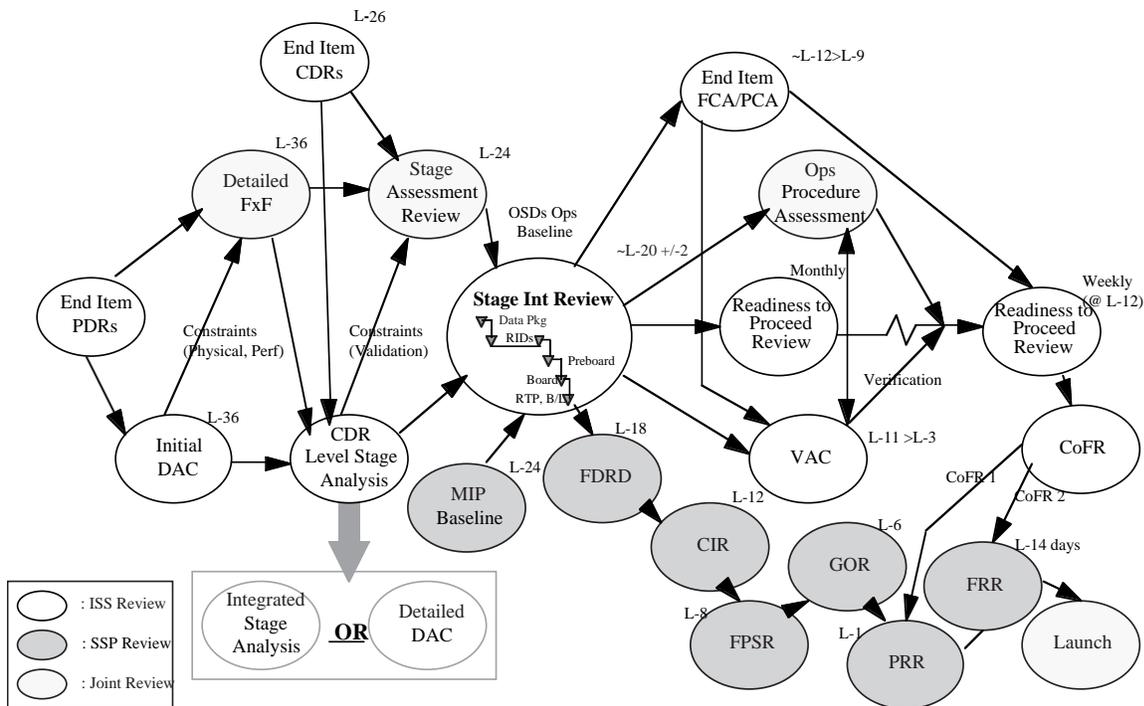
3.0 SIR Objectives

The primary objective of the SIR is to evaluate integrated hardware and software functionality, performance and plans against the baseline requirements for the Stages being reviewed.   This includes emphasis on the inter-element and inter-system functionality of elements and subsystems for current and future Stage interfaces. Also, validation of the equipment and operations in support of the successful launch, on-orbit assembly, activation, and operation of each Stage is accomplished. The SIR establishes that Stage equipment and the associated operations will support the integration of follow-on Stages through assembly complete. And finally, the SIR demonstrates that Launch Package end-item designs, supporting documentation, analysis products, and plans are at the maturity level necessary for mission integration.

4.0 SIR Groundrules

The ISS SIR is based on the design review requirements defined in MIL-STD-1521B (Technical Reviews and Audits for Systems, Equipment, and Computer Software), NHB 7120.5 (NASA Handbook for Management of Major Systems and Projects), and SSP 50108 (ISS Certification of Flight Readiness). These documents are used only as guidelines for conducting the SIR. SIRs recognize the constraints and potential hardware and software delivery incompatibilities (e.g., inability for multiple, time-phased, program-wide designs to be at the same level of maturity) associated with performance of Stage integration reviews, and therefore, provides an adaptable approach allowing for large complex projects such as the ISS. To the extent practical, the SIR is facilitated by prior completion of product group end-item CDRs, design analysis cycles, product group deliverables and other analysis performed by prime and non-prime participants.

5.0 SIR Activities

The flow of activities for the SIR is depicted in Figure 2.0.

The SIR commences with the development of a specific SIR Plan including a data product list, success criteria, screening board membership definition and detailed schedule. This plan is released 30 days prior to the start of the actual SIR.

The SIR, initiated by a kick-off presentation, is conducted over a period of three weeks. The kick-off presentation provides a detailed functional and performance overview of the integrated hardware, software, and operations; a description of the products available for review; the process and specific procedures to be followed during the course of the review; and the review success criteria.

Following the kickoff meeting, subsystem splinter meetings are conducted for each subsystem. Subsystem splinter meetings focus on detailed end-to-end functional and performance aspects of the Stages and also provide in depth discussion of operations, requirements implementation, and interface connectivity between systems. Other aspects of the splinter meetings include test and verification, and safety.

Subsequent to the subsystem splinter meetings, time is allocated for additional review of the SIR data products by SIR participants. The data products are available for review beginning with the kickoff meeting and throughout the subsystem splinter sessions. Subsystem focal points and/or data product owners are on call to answer questions regarding the data products. If issues arise,

an issue form is completed for each issue and submitted for consideration. Issues are processed as they are submitted to expedite disposition by daily Issue Screening Boards (ISBs). Following the week of data product review, the ISBs prepare for pre-board proceedings by summarizing all issues submitted and the disposition of the issues.

The Preboard is conducted and chaired by the ISSP Program managers where ISB chairpersons present their findings to the board. Following the Preboard, a Board is conducted which is chaired by the JSC Center Director.   As determined by the Preboard, top level issues from the SIR are brought to the Board for review.
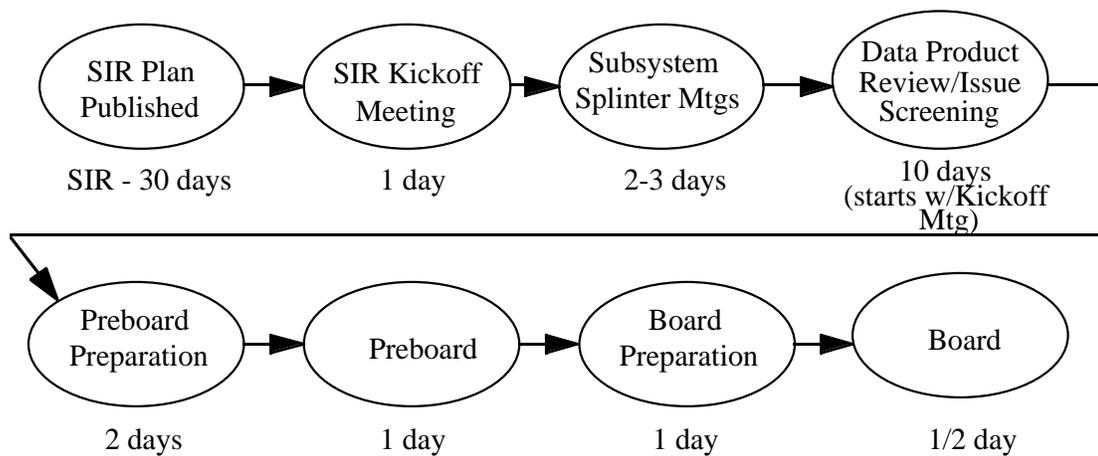
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┌─────────────┐   ┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│  SIR Plan   │→  │ SIR Kickoff │→  │  Subsystem  │→  │Data Product │
│  Published  │   │   Meeting   │   │Splinter Mtgs│   │Review/Issue │
└─────────────┘   └─────────────┘   └─────────────┘   │  Screening  │
                                                        └─────────────┘
 SIR - 30 days        1 day            2-3 days            10 days
                                                        (starts w/Kickoff
                                                             Mtg)

┌─────────────┐   ┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│  Preboard   │→  │  Preboard   │→  │    Board    │→  │    Board    │
│ Preparation │   │             │   │ Preparation │   │             │
└─────────────┘   └─────────────┘   └─────────────┘   └─────────────┘
    2 days            1 day             1 day            1/2 day
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Figure 2.0 - SIR Activities

6.0 Summary

In summary, the new concept of Stage Integration Reviews provides a more focused, working design review for the ISS Program. It insures that integration across hardware and software for multiple flights has been successfully planned and implemented. It also provides an opportunity for all program participants to objectively review products associated with the design, assembly, and integration of the Stages. Providing an objective review of the products may result in issues being identified which may have been overlooked by those who work closely with the products on a daily basis.   In following a more classical design review approach, the SIR will also insure that the level of maturity of the integration products is sufficient to progress into test and verification, launch package integration, and preparation for launch. As we are now within one year of our first launch, the ISS Program believes that this review approach is essential to the successful assembly, integration, launch and operation of the International Space Station.
7.0 References

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(5) D684-10261, ISS Stage Integration Review Plan, December 1996

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