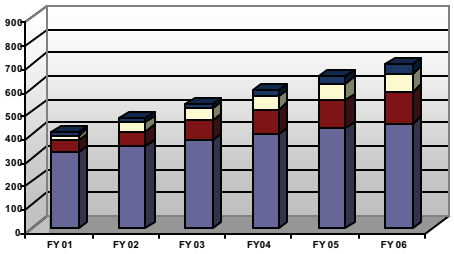
Report

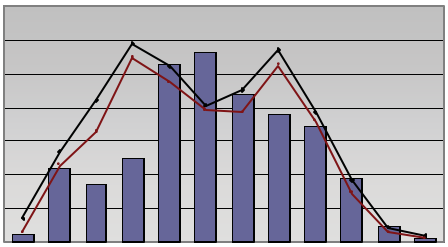
by the

International Space Station (ISS)

Management and Cost Evaluation (IMCE)

Task Force





to the

NASA Advisory Council

November 1, 2001

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PREFACE

A primary mission of the National Aeronautics and Space Administration (NASA) is

> "To advance human exploration, use, and development of space."

We have developed this report upon this premise. The International Space Station (ISS) objectives require the establishment of a long-term human presence in space. A clear articulation of the mission of ISS within the broader context of the human exploration of space would greatly benefit the setting of research priorities for the station.

Although the configuration of the Space Station has been modified, the fundamental purposes remain scientific research and international cooperation. Specific objectives are:

- To provide the means to sustain humans during extended space flight. This will require a primary research focus on discovering any adverse effects of long-term human presence in space.
- Perform "world class" scientific research that requires low gravity and is enhanced by astronaut interaction.
- Enhance international cooperation and U.S. leadership through international development and operations of ISS.

A critical element required for the overall ISS Program is a commitment to a long-term plan for transporting astronauts to and from the ISS.

We offer this report in response to the Terms of Reference (Appendix A) jointly established by NASA and the Office of Management and Budget (OMB). We believe the recommendations contained in this report will enhance the probability that a credible ISS core complete program can be established. We also believe a responsible plan is offered to move beyond core complete to a fully capable ISS if justified by NASA performance.

The International Space Station Management and Cost Evaluation Task Force (IMCE) commends the many dedicated NASA, international partners, support teams, and contractor personnel who contributed to this report. While these individuals provided constructive comments and suggestions, responsibility for the content of the final report rests entirely with the IMCE. Further, the findings and recommendations in this report are those of the IMCE.

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1.0 Executive Summary

The International Space Station (ISS) Management and Cost Evaluation Task Force (IMCE) was chartered to conduct an independent external review and assessment of the ISS cost, budget, and management. In addition, the Task Force was asked to provide recommendations that could provide maximum benefit to the U.S. taxpayers and the International Partners within the President's budget request.

The Task Force has made the following principal findings:

- **The ISS Program's technical achievements to date, as represented by on-orbit capability, are extraordinary.**
- **The existing ISS Program Plan for executing the FY 02-06 budget is not credible.**
- **The existing deficiencies in management structure, institutional culture, cost estimating, and program control must be acknowledged and corrected for the Program to move forward in a credible fashion.**
- **Additional budget flexibility, from within the Office of Space Flight (OSF) must be provided for a credible core complete program.**
- **The research support program is proceeding assuming the budget that was in place before the FY02 budget runout reduction of $1B.**
- **There are opportunities to maximize research on the core station program with modest cost impact.**
- **The U.S. Core Complete configuration (three-person crew) as an end-state will not achieve the unique research potential of the ISS.**
- **The cost estimates for the U.S.-funded enhancement options (e.g., permanent 7-person crew) are not sufficiently developed to assess credibility.**

The Task Force has the following primary recommendations:

- **Actions required to develop and implement a credible U.S. core complete program within the President's FY02 Budget Blueprint (Appendix B):**
  - **Major changes must be made in how the ISS program is managed**
  - **Additional cost reductions are required within the baseline program**
  - **Additional funds must be identified and applied from the Human Space Flight budget**

- **A clearly defined program with a credible end - state, agreed to by all stakeholders, must be developed and implemented**

- **Actions required to maximize research within the President's FY02 Budget Blueprint:**

  - **Scientific research priorities must be established and an executable program, consistent with those priorities, must be developed and implemented**

  - **Additional crew time must be allocated to support the highest priority research**

  - **Science leadership must be established at the highest level within the ISS Program Office**

2.0 Specific Findings

In performing an independent external review and assessment of cost, budget, and management of the ISS, the IMCE Task Force (Appendix C) has made the following specific findings:

The ISS Program, while taking a conservative approach and making safety paramount, has achieved excellent progress in integration of diverse international technologies.

Assembly of the ISS began in November 1998 with the launch of the Russian Zarya module. To date there have been 21 missions, including assembly and logistics/utilization. All have been successful, with no major anomalies. Having completed the ISS phase that has enabled early research, a three-person permanent crew has been established and the keystone elements of three of the five international partners have been successfully deployed. The assembly, integration, and operation of the complex systems have been conducted with extraordinary success, proving the competency of the design and the technical team. The ISS has been assembled, outfitted with tons of equipment and supplies for the health and safety of future crews, and initial research is underway. Twenty kilowatts of renewable electric power is being produced, more than ever generated in space. The elements that will comprise the 300 foot ISS truss structure are being readied for launch in 2002 and early 2003. The risk in design and development of the vehicle has been largely retired.

NASA has not accomplished a rigorous ISS cost estimate. The program lacks the necessary skills and tools to perform the level of financial management needed for successful completion within budget.

NASA cannot rationalize the cost estimating variances in the FY02 budget formulation process by merely suggesting that it is largely due to the complexity of the program. The underestimation of remaining development and operations costs, along with the continued escalation of cost estimates even into the IMCE review period, is a clear indication of inadequate methodology, tools, and controls. There is no common guideline for the generation of estimates across the program. There are multiple budgeting techniques and multiple reporting techniques. NASA ISS support and ISS contractors estimate and report in a myriad of methods. Financial forecasting and strategic planning suffer from insufficient "forward" analysis and planning due to division of financial authority and responsibility, lack of experienced financial personnel and modern tools, diverse and often incompatible accounting systems, and uneven and non-standard cost reporting capabilities.

The cost to achieve comparable expectations at assembly complete has grown from an estimate of $17.4B to over $30B. Much of this cost growth is a consequence of underestimating cost and a schedule erosion of 4+ years.

Much of the cost growth is attributable to clearly delineable areas such as: inadequate initial requirements definition, added content, late element delivery, development problems leading to cost variance, inadequate understanding of international integration

requirements, and increased institutional charges on the program. In addition, imposition of annual budget caps forced the program to an inefficient spend profile and reinforced the management's focus on meeting annual budgets rather than on total cost management.

A cost of $8.3B (FY02-06) is not credible for the core complete baseline without radical reform.

The Task Force unanimously concluded that the current program plan is not credible. Task Force concerns included management and program control deficiencies as well as overly optimistic cost avoidance initiatives. Additionally, the Task Force thought the remaining development and integration risk, including research facilities, is underestimated and the level of unencumbered program reserves is inadequate.

The NASA/Office of Management and Budget (OMB) agreement for the FY02 budget (FY02-06) was $8.3B, including a NASA management challenge (shortfall) of $484M and unencumbered reserves of $750M. During the review, new cost increases totaling $366M were identified. Additional, but uncosted, concerns were identified in the area of contractor rates, International Partner cost implications stemming from scaling back the baseline to the U.S. core configuration, the risk of research development activities, and inadequate Preplanned Product Improvement funding. Offsets in the amount of $440M from within the program were identified. The major portion of these offsets came from projected program staff reductions in operations and sustaining engineering. Approximately $1B of potential additional savings from within OSF were later identified by NASA. These estimates result from both a shuttle flight rate revision and the on-going Strategic Resources Review (SRR)/institutional savings effort. Part of the projected savings come from reducing civil service staffing across OSF. Successful completion of the core complete program is dependent on increased funding flexibility and savings within the program and other OSF activities, as well as management reform and a credible program roadmap. The latter two issues are discussed elsewhere in this report.

The Task Force expressed concern with respect to the required budget flexibility , including validity of the original $8.3B cost estimate and the probability of achieving all the projected savings. There was consensus however, that given the other steps recommended in this report, there is a reasonable chance of successfully executing the core program.

The management focus is on technical excellence and crew safety with emphasis on near- term schedules, rather than total program costs.

Human Space Flight programs have historically been focused on protecting crew safety; this is particularly true during the crucial launch phase when issues must be acted upon in an instant. A large percentage of employees working on the ISS program have gained their skills and experiences on the Shuttle and earlier manned programs. There are many indications this experience base and culture have been transferred to the ISS program. As an example, a substantial sustaining engineering function has been established separate from the operations structure.

The Task Force believes this approach is not necessary and it is possible to "dual-use" engineer-operators to reduce overall cost. Since the ISS is a crewed vehicle, many of the anomalies can be stabilized by the crew and addressed with technical expertise on the ground that is "on-call" and not "on-tap." While this may reduce ISS availability somewhat, it could substantially reduce required manpower. As the Shuttle-Mir Program has proven, a space station has much different attributes that would allow for lower staffing levels. While the currently planned ISS staffing levels will enable continued high levels of response, the Task Force considers them to be unnecessary.

The Program is being managed as an " institution" rather than as a program with specific purpose, focused goals and objectives, and defined milestones.

The institutional needs of the Centers are driving the Program, rather than the Program requirements being served by the Centers. The impact of institutional management is clearly indicated in the overall staffing levels of the program. The institution, not the program, controls the majority of these resources and timely destaffing is significantly hindered. At this phase of the ISS program, deleting more hardware saves very little money since the bulk of the expenditures are in the "people" category.

The financial focus is on fiscal year budget management rather than on total Program cost management.

At the time the Space Station was redesigned in 1994, annual budget caps of $2.1B were levied on the program as a means to control costs. In general, such caps establishing level annual funding on a major program are counterproductive to controlling total program cost. Total cost and schedule became variables as NASA's focus became one of executing the program within the annual budgets. Additional funding was requested and provided for the Russian Program Assurance and Crew Return Vehicle (CRV) efforts. To stay within the annual budget caps, basic program content slipped and the total program cost grew. The final ISS cost estimate at completion has not been a management criterion within NASA.

Lack of a defined program baseline has created confusion and inefficiencies.

The President's FY02 Budget Blueprint and the subsequent NASA/OMB agreement relative to the "U.S. Core" program allow for NASA to maintain critical skills necessary to build additional content. At the start of the IMCE review, it appeared the ISS Program was still assuming the "Program Manager's" Recommended Program ($8.3B + $2.5B) was the baseline and that the core complete program was an option. The research support element of the ISS is still being implemented according to the original program and has been unable to take action in FY01 to terminate certain research activities. The scientific community is confused and considers the reduction to a three-person crew, from the seven-person crew baseline, to have a significant adverse impact on science. The International Partners believe the U.S. cannot unilaterally change the previously existing baseline assembly sequence.

Current research support funding represents a 40-percent reduction in buying power from that originally planned.

When the Space Station Program was redesigned in 1993, the research support budget of $3.8B through assembly complete was programmed for research facilities and for recurring utilization. Between 1993 and 2001, the ISS Program experienced major delays, which resulted in slippage of the program schedule. As deviations in the program schedule occurred, the research support budget was realigned to keep synchronicity with the program. Consequently, the funding was taken out of the near-term years and was reinstated in the out years. During this process, the design, development, and fabrication of the research facilities were being delayed and experienced a cost inefficiency. This inefficiency in combination with 4.5 years of inflation and $0.4B funding for Mir has reduced the buying power of research funds by 40 percent. The total budget of $3.8B has not changed appreciably, but has been spread over a 13-year period for less capability. Discounting for the above factors (40 percent), the buying power of the current budget ($1.6B budget through FY02 – FY06) is approximately $2.3B.

The Office of Biological and Physical Research (OBPR) is not well coordinated with the Office of Space Flight (OSF) or the program office for policy and strategic planning. The scientific community representation is not at an effective level in the program office structure.

The transfer of research support budget responsibility to OBPR underscores the need for increased and continuing coordination with OSF. Some progress had been made through the inclusion of OBPR in the OSF management council. The recommendation for a realignment of the program office reporting chain, addressed later in the report, would alleviate this issue. Additionally, the recommendation to establish a Deputy for Science in the program office reverts to an earlier structure and will provide appropriate visibility for the science community.

A centrifuge is mandatory to accomplish meaningful biological research. Availability as late as FY08 is unacceptable.

The centrifuge facility is essential for performing the most promising ISS "world class" biological research. It is critical for fundamental space biology and for the foundation of biomedical research because it provides the control needed for the interpretation of experimental results. This Task Force (and other science groups) has said that this type of research cannot be done without a centrifuge and adequate crew time. The centrifuge is now being constructed by the National Space Development Agency of Japan (NASDA) as part of a barter agreement. Because of budget and technical issues the centrifuge delivery has been delayed until Calendar Year (CY) 08.

There are opportunities to maximize scientific research on the core station with modest cost impact.

The crew time available with a permanent crew of three persons can be effectively doubled by extending sortie mission crew time aboard the ISS. This can be accomplished

by overlapping planned Soyuz exchange periods so that the visiting crew is aboard ISS for a period of 30 days every 5 months. Using existing Extended Duration Orbiter (EDO) capability could allow for Shuttle docked time of up to 14 days. The increased research benefit derives primarily from offloading ISS maintenance tasks to the visiting Shuttle crew. However, there will be significant microgravity constraints due to the Shuttle being docked to the station, as well as crew transfer and maintenance operations.

Cost estimates for the U.S.- funded enhancement options need further development to assess credibility.

The proposed enhancement options consist of various combinations of habitation, life support, and crew return capability. There is inadequate current costing information associated with the non-U.S. components (Enterprise, ASI Hab, and additional Soyuz). The CRV cost estimate of $1.3B is plausible, with several development and acquisition assumptions that have yet to be verified. Project interruptions will have cost impact on all of the elements under consideration.

3.0 Specific Recommendations

Establish the ISS Program Office separate from, but residing at JSC, reporting to a new Associate Administrator (AA) for the ISS.

The new Associate Administrator's office would combine the ISS-related functions of OSF and OBPR and have program oversight responsibility. It is imperative this new office ensures continuity of program checks and balances in quality and technical oversight. ISS offices at other supporting Centers would report to the ISS Program Manager, who would own all ISS personnel.

Consolidate prime and non-prime contracts into a minimum number of resulting contracts all reporting to the program office.

Currently, there are over 30 contracts supporting the ISS Program. Consolidate these contracts to achieve a minimum number of resulting contracts, with clearly defined cost performance reporting requirements.

Develop a life cycle technical baseline and manage the ISS Program to total cost and schedule as well as fiscal year budgets.

A life cycle technical baseline must be developed that can be used as the basis for a formal cost estimate. Use the Department of Defense cost assessment approach as a model and develop a full ISS cost estimate. Develop an Integrated Program Management Plan delineating the work to be accomplished; the work breakdown structure; the roles and responsibilities of performing organizations; required resources; schedules; and the management techniques, tools, and reports to be used in implementing the Program. Establish a state-of-the-art management information system. Establish a state-of-the-art planning and control system, including independent cost estimating capability. Finally, the financial and project control function needs to be strengthened significantly in the ISS Program office and NASA Headquarters (AA level).

Consider revising the ISS crew rotation period to 6 months and reducing the Space Shuttle flight rate accordingly. The result would be a delay in U.S. Core complete assembly sequence by up to 2 months. Target cost savings: $668M,

and

Continue to examine Strategic Resources Review (SRR) and Institutional cost reductions. Target cost savings: $350M-$450 M.

These recommendations represent one approach to provide a portion of the required budget flexibility. NASA should continue to refine these estimates and examine other options.

The first two actions would incorporate a 6-month crew rotation cycle starting in FY03. This would result in U.S. core complete moving 2 months to April 2004, and reduce

Space Shuttle annual flight rate required to support ISS to four a year. The resulting cost savings (FY02-06) from this change in assembly sequence and Space Shuttle flight rate reduction would provide an estimated $188M in ISS savings and $480M in Shuttle savings.

NASA must also move forward to implement cost savings identified in the Fall 2001 Strategic Resources Review and other institutional savings. This includes items such as facility and lab closures, and civil service staffing reductions needed to realize the $350M-$450M cost savings target.

Develop a credible program road map starting with core complete and leading to an end state that achieves expanded research potential. Include gate decisions based on demonstrated ability to execute the program

and

Identify funding to maintain critical activities for potential enhancement options.

The existing U.S. core complete program should not be established as an "end-state" condition. It presents significant research and International Partner implications that could be avoided by implementing a performance-gate approach that would allow increasing research capability based on realized performance to plan. Metrics for evaluating performance should be developed in conjunction with the Administration (OMB). The opportunity to realize the high research potential that many dedicated employees have worked years to achieve will maintain motivation in achieving the cost savings necessary to accomplish the core.

The initial performance gate would be to implement changes required to establish credible/executable ($8.3B + additions from Human Space Flight) Program by June of 2002. During this period, the IMCE recommends providing (within existing budgets) the minimum funding necessary to keep enhancements viable to return to the fully capable program with minimum cost impact.

The end state should be defined in terms of the science priorities recommended below.

Establish research priorities. The Task Force is unanimous in that the highest research priority should be solving problems associated with long-duration human space flight, including the engineering required for human support mechanisms,

and

Provide the Centrifuge Accommodation Module (CAM) and centrifuge as mandatory to accomplish top priority biological research. Availability as late as FY08 is unacceptable,

and

Establish a research plan consistent with the priorities, including a prudent level of reserves, and compliant with the approved budget.

These are fundamental steps toward maximizing the research benefits of the ISS. The phased implementation of capability envisioned in the "end state" plan must incorporate science priorities, research facilities, and utilization as primary considerations. The Task Force also noted the significance of research in physical and microgravity sciences, and urged they be strongly considered when establishing priorities.

Provide additional crew time for scientific research through the use of extended duration shuttle and overlap of Soyuz missions.

The high-priority fundamental biological research necessary to demonstrate feasibility of future human exploration requires significant ISS crew interaction. Extended Soyuz sortie missions can be implemented in the near future and coupled with Shuttle EDO missions can measurably increase crew time to conduct this research.

Create a Deputy Program Manager for Science position in ISS Program Office. Assign a science community representative with dual responsibility to the Program and OBPR.

The Task Force noted that ISS research objective considerations are not generally given full representation in programmatic decision forums. The creation of a Deputy Program Manager for Science will provide increased and coordinated representation of the scientific communities interest at a high programmatic level.

4.0 IMCE Organization and Process

In July 2001, the NASA Administrator established the IMCE Task Force consisting of experts in the fields of science, engineering, finance, and business to assess the budget, management, and research utilization challenges on the ISS Program and to provide advice to NASA and the administration in this regard. The team was chaired by Mr. A. Thomas Young, with Rear Admiral Tom Betterton serving as deputy chairman. The Task Force's primary objectives were to assess cost estimates for the core U.S. program and potential U.S.-funded enhancements. The Task Force was also asked to identify opportunities for maximizing capability to meet priority research program needs within the planned ISS budget and International Partner contributions.

Because of the international nature of the ISS partnership, the Task Force also extended an invitation to NASA's international partners, (the Canadian Space Agency (CSA), the European Space Agency (ESA), Russian Space Agency (RSA), and the National Space Development Agency of Japan (NASDA)) to have representation as observers.

The official kick-off meeting of the IMCE Task Force was held at the NASA Headquarters, Washington DC on August 21-22, 2001 and since then, the members of the Task Force have meet on a regular basis. The IMCE Task Force was granted access to all aspects of the ISS program. The Task Force also conducted fact finding trips to meet with the ISS Program management, the organizational support personnel, and the prime contractor. The fact finding concentrated on the trends of past, current, and projections of estimated performance of the ISS Program.

The IMCE Task Force was provided independent assessment support from two teams. The Cost Analysis Support Team (CAST) was directed at cost analysis; the Financial Management Team (FMT) concentrated on performance management systems in the ISS Program. While supporting the IMCE Task Force, these subteams conducted their own independent assessments and provided reports to the Task Force for consideration. The CAST provided a final report (Appendix D). Their findings and recommendations have been incorporated into the body of the IMCE report. The FMT provided only preliminary assessments (Appendix E). Its final findings will be submitted directly to NASA for consideration at a later date.

The Task Force collected information through briefings (program status and special topics), interviews, conversations, other governmental review committees, and from reviewing applicable documentation. These inputs were interpreted and the findings and recommendations formed were then reviewed by the entire Task Force. The main observations and recommendations are presented in the balance of this summary.

5.0 IMCE Task Force Report

IMCE Task Force Report

International Space Station Management and Cost Evaluation Task Force Report

November 1, 2001

Outline

- Charter
- Definitions
- Membership
- Methodology
- Schedule of Activities
- General Observations
- Cost Credibility
- Requirements to Achieve Credibility
- Maximize Research
- Enhancements
- Summary

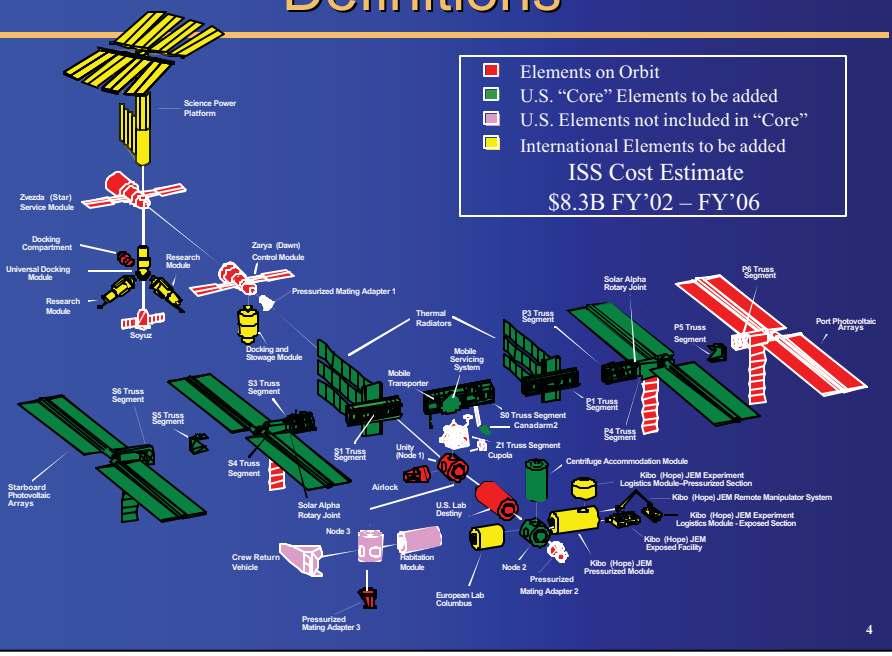
2

Charter

- Assess the credibility of the International Space Station (ISS) cost estimate for the approved ISS program, including risks and mitigation strategies.
- Assess program assumptions and requirements and identify options for smaller growth and/or budget savings and efficiencies.
- Identify opportunities for maximizing research within the planned ISS budget.
- Assess cost estimates for potential U.S.-funded enhancements to the core station and recommend refinements as necessary to achieve high confidence estimates.
- Review ISS Program and financial management, tools, and identified reforms, and make recommendations for improvements.
- Provide report to NASA Advisory Council by November 1, 2001.

3

Definitions



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Membership

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RADM. Thomas Betterton, Vice Chair
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Kent Black
Peter Bracken
Gregory Canavan
Michael DeBakey
Anthony DeMarco
Susan Eisenhower Z
William Friend
Robert Grady
Sidney Gutierrez
Bradford Parkinson
ADM. Paul Reason
Robert Richardson
Richard Roberts
Rae Silver
Roger Tetrault
Peter Wilhelm
Brig. Gen. Simon Worden

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Staff Support:

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Steven Schmidt, Executive Assistant
NantelSuzuki, Executive Assistant
Yvonne Kellogg, Technical Editor

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Methodology

- Structured Reviews
- Independent Reports
  - Cost Analysis Support Team
  - Financial Management Team
- Executive Sessions
- Scientific Research Session
- Team Discussions

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Schedule of Activities

Date	Location	Activity
Aug. 20, 21	NASA Headquarters	Kickoff, review plan, fact finding
Sept. 11, 12	Johnson Space Center	Fact finding (Subgroup of total Task Force)
Sept. 25, 26, 27	Johnson Space Center	Fact finding, interviews
Oct. 9,10	NASA Headquarters	Fact finding, interviews, scientific research review, International Partner presentations
Oct . 22, 23, 24	NASA Headquarters	Fact finding, interviews, findings and recommendations
Oct. 30, 31	NASA Headquarters	Report preparation
Nov. 1	NASA Headquarters	Draft Report to NASA Administrator
Nov. 1		IMCE Report Delivered to the NASA Advisory Council (NAC)
Nov. 6	NASA Headquarters	NAC meeting to review IMCE Report

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General Observations

- Outstanding technical accomplishments
  - Operational system in orbit
  - Fully functioning 3-person crew
  - Integration of diverse international technologies
  - Progress, Shuttle, and Soyuz support as required
  - Additional elements progressing toward launch
- Significant schedule delay
  - FY94 Program
    Assembly complete 6/02
  - FY02 Program (before revisions)
    Assembly complete 11/06
- Significant cost increase
- Significant reduction in expected science return

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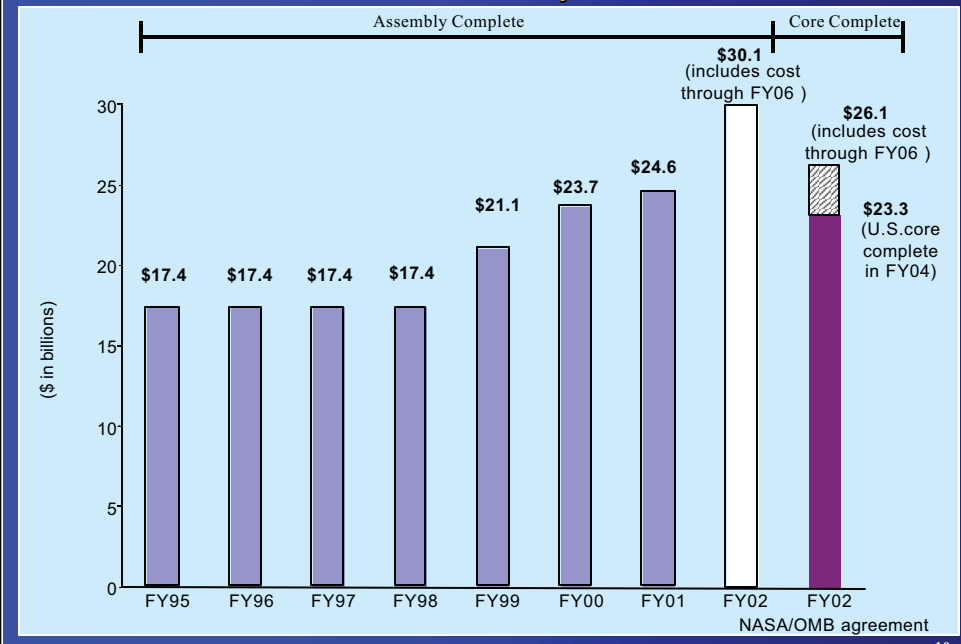
Cost History



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Cost Credibility

Charter

Assess the credibility of the ISS cost estimate for the approved ISS Program including risks and mitigation strategies.

Finding

Judgment of the ISS Management and Cost Evaluation Task Force (IMCE) is that a cost of $8.3B (FY 02-06) is **not** credible for the core complete baseline without radical reform.

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Cost Credibility, cont.

Rationale

- ISS program management approach
- General observations on ISS management
- IMCE cost review results
- Cost Analysis Support Team results

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Cost Credibility, cont.

Rationale

- ISS program management approach
- General observations on ISS management
- IMCE cost review results
- Cost Analysis Support Team results

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Current ISS Program Management Approach

- Focus on technical excellence and crew safety
- Considerable attention on near-term schedules
- Manage expenditures to ensure FY budget is not exceeded
- Total cost is not a management metric that is used
- Work that cannot be accomplished within FY budget moves to a future FY with little recognition of contribution to total cost growth (schedule becomes a reserve)
- Inadequate management information system and tools being used for program control
- No rigorous cost estimate exists
  - Š Recent Nbottoms upÓ budget estimate helpful but not sufficient
- Science program is not integrated in the ISS management

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General Observations on ISS Management

- Priority on Fiscal Year management
- Institutional management approach as opposed to project management approach
- Different program baselines being used by various elements of the program

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ISS Staffing and Reporting

	FY02		
	Total Civ Serv	ISS Civil Serv	ISS Contractors
Mission Ops Directorate	454	265	1557
Engineering	814	403	783
Space & Life Sciences	184	31	241
EVA Project	27	19	188
Kennedy Space Center	1835	322	643
Marshall Space Flt Ctr	2692	144	159
ISS Program Office	238	238	3426
Other JSC Organizations	1287	122	790
Glenn Research Center			28
Goddard Space Flt Ctr			15
TOTAL	7531	1544	7828

Program Direct Reporting

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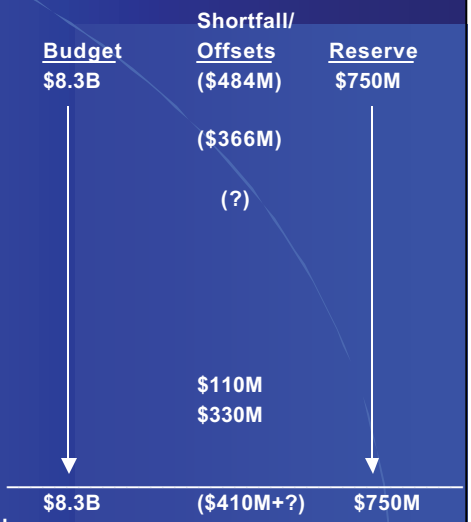
IMCE Cost Review Results

- NASA estimate (FY02-06) required for core complete at start of review
- Probable increases identified during review
- Additional concerns
  - Contractor rates
  - International Partner costs
  - Research
  - No common baseline
- Offsets
  - Content changes and rates
  - Operations and sustaining engineering



Note: P3I assumed to be separately funded

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Cost Analysis Support Team Results

- ISS Program Office does not have a robust process to develop cost estimates independent of contractor proposals
- ISS business practices must change to meet OMB budget

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Requirements to Achieve Credibility

Charter

- Assess program assumptions and requirements and identify options to smaller growth and/or budget savings and efficiencies
- Review ISS Program and financial management, tools, and identified reforms, and make recommendations for improvements.

Findings

Judgment of the IMCE is that the core complete baseline could be accomplished if:

- Major changes are made in how the ISS Program is managed
- Additional cost reductions are achieved in ISS core complete program
- Additional funds are applied to ISS from non-ISS parts of the Human Space Flight budget
- A clearly defined program baseline with a credible Nend stateÓ is established

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Required Management Changes

- Maintain mission success as Number 1 Priority
- Manage ISS as a program, not an institution
  - All ISS manpower included in program office
  - ISS program manager controls staffing requirements
  - Streamline management reporting and control
  - Program management approach applies to all involved NASA Centers
  - Maintain Nchecks and balancesÓ to ensure mission success

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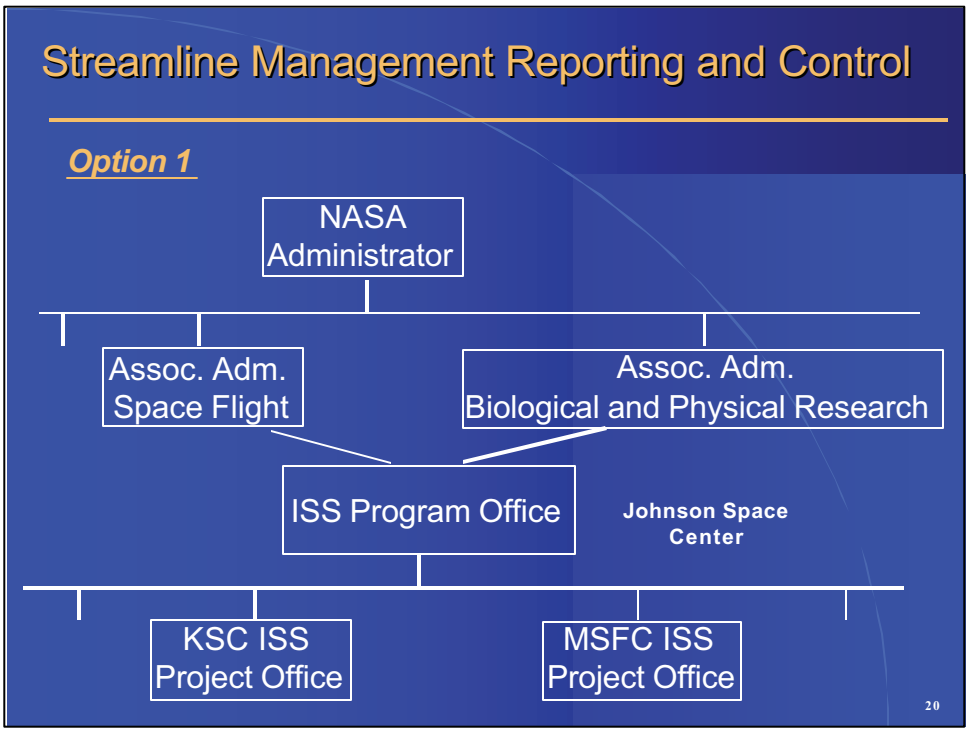
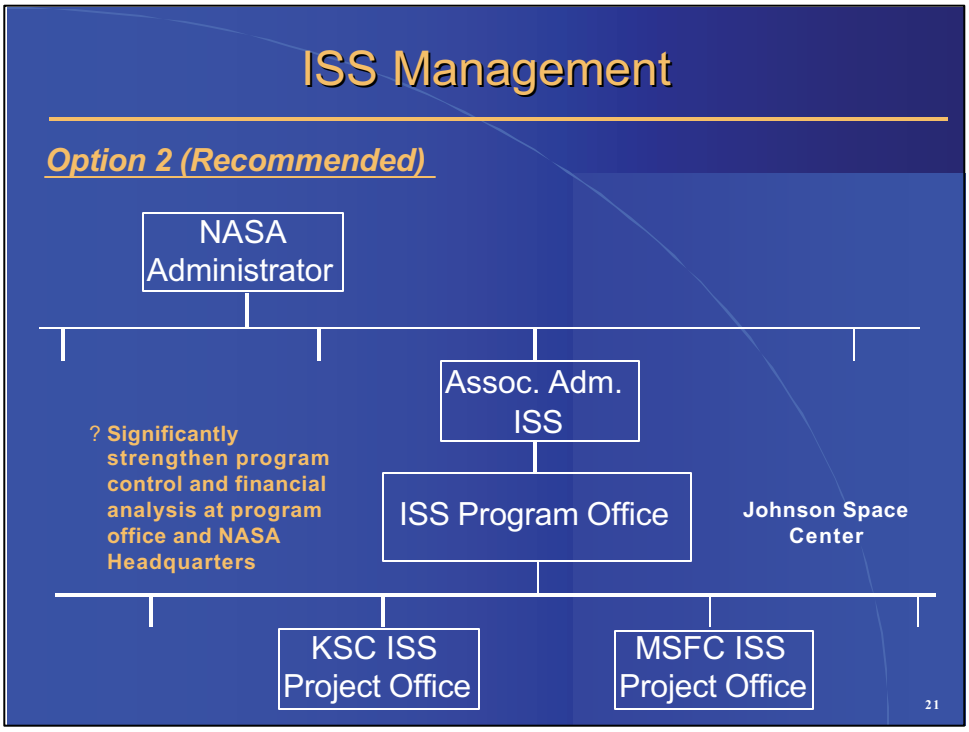

Streamline Management Reporting and Control
Option 1
NASA Administrator
Assoc. Adm. Space Flight
Assoc. Adm. Biological and Physical Research
ISS Program Office
Johnson Space Center
KSC ISS Project Office
MSFC ISS Project Office
20


ISS Management
Option 2 (Recommended)
NASA Administrator
Assoc. Adm. ISS
? Significantly strengthen program control and financial analysis at program office and NASA Headquarters
ISS Program Office
Johnson Space Center
KSC ISS Project Office
MSFC ISS Project Office
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Required Management Changes

- Consolidate prime and non-prime contracts into minimum number of resulting contracts all reporting to the program office
- Manage to total program cost and schedule as well as FY budgets
  - Develop a technical baseline that can be costed
  - Develop a NASA total cost estimate
  - Use DoD approach
  - Establish management accountability
- Establish a state-of-the-art management information system
  - Existing program control system is highly inadequate
  - No credible plan
  - Ineffective actual vs. plan system
- Strengthen financial and project control function at ISS Program office and NASA Headquarters Associate Administrator

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Contract Consolidation

Current

Boeing - Prime Contract
26 Non-Prime Contracts

Consolidate to the minimum number of resulting contracts

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Additional Funding Sources

- Incorporate 6-month ISS crew rotation in FY03
- Resulting change in assembly sequence delays U.S. core complete two months to April 2004 and International Partner elements up to one year
- Reduced Space Shuttle flight rate required to support ISS

	FY02	FY03	FY04	FY05	FY06
Current budgeted flight rate	7	5	6	6	6
Revised	7	4	5	4	4
Flights reduced	0	1	1	2	2

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Additional Funding Sources, cont.

- Cost savings (FY02-06) from change in Space Shuttle flight rate reduction

ISS	$188M	$668M
Shuttle	$480M	

- Potential savings (FY02-06) from Strategic Resources Review (SRR)/Institutional reductions

Å$350M - $450M

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IMCE Cost Review Results

	Budget	Shortfall/Offsets	Reserve
NASA estimate (FY02-06) required for core complete at start of review	$8.3B	($484M)	$750M
Probable increases identified during review		($366M)	
Additional concerns		(?)	
Offsets			
Content changes and rates		$110M	
Operations and sustaining engineering		$330M	
	$8.3B	($410M+?)	$750M
Additional resources		Å$1.0B	
Assembly sequence and Shuttle flight rate change			
SRR/Institutional reductions	$8.3B	$600M-?	$750M

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Program Baseline

- Lack of a NdefinedÓ program baseline causing confusion and inefficiencies
  - ISS Program was (start of IMCE review) assuming NProgram ManagerÕsÓ Recommended Program ($8.3B + $2.5B) was baseline and core complete was an option.
  - Research hardware element of ISS being implemented as original program.
  - Office of Biological and Physical Research and science community are uncertain.
    - 3-person vs. 7-person crew
    - Centrifuge module ranges from top-priority to cancellation
    - Many assuming 3-person plan is temporary

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Program Baseline, cont.

- Lack of a NdefinedÓ program baseline causing confusion and inefficiencies (concluded)
  - International Partners believe they have been told original program is the baseline and they have NTreaty levelÓ commitments.
  - Crew Return Vehicle (CRV) team assuming funding to continue at a reduced level
  - Etc.

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Program Baseline, cont.

- Options
  - Core complete as Nend stateÓ
    - 3-person permanent crew for life of ISS
    - Adverse science implications
    - Adverse International Partner implications
  - Original program as Nend stateÓ
    - Provides unique research potential of ISS
    - Requires additional NASA funding
    - Inconsistent with OMB and Congressional ISS credibility issues with NASA
  - Core complete with NASA performance gates leading to Nend stateÓ
    - End state defined by science priorities to achieve expanded research potential
    - NASA performance becomes critical to future of ISS
    - Opportunity provided to achieve unique research potential of ISS

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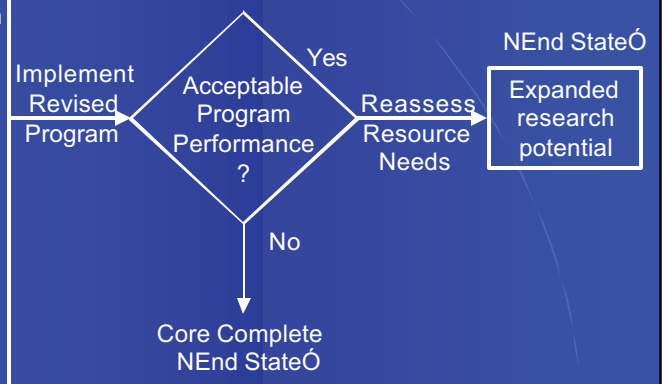
ISS NEnd StateÓ

11/01 - 6/02

- Establish credible/executable program ($8.3B + additions from Human Space Flight)
- Establish science priorities
- Provide minimum funding necessary to keep enhancements viable to return to full research potential (within existing budgets)



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Maximize Research

Charter

Identify opportunities for maximizing research within the planned ISS budget.

Findings

Research management requires significant changes to maximize return within a given budget.

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Maximize Research, cont.

Current Status

- Research (facilities, utilization, operations, and Mir) budget
  - FY 2002 $4.0B
  - FY 1994 $3.8B
  - Buying power reduced 40%
- Science program is not effectively integrated in the ISS management
- Research implementation is proceeding assuming original program
  - No defined science priorities
  - Critical hardware very late
  - Insufficient research reserve
  - 3-person crew has adverse impact on science that can be performed

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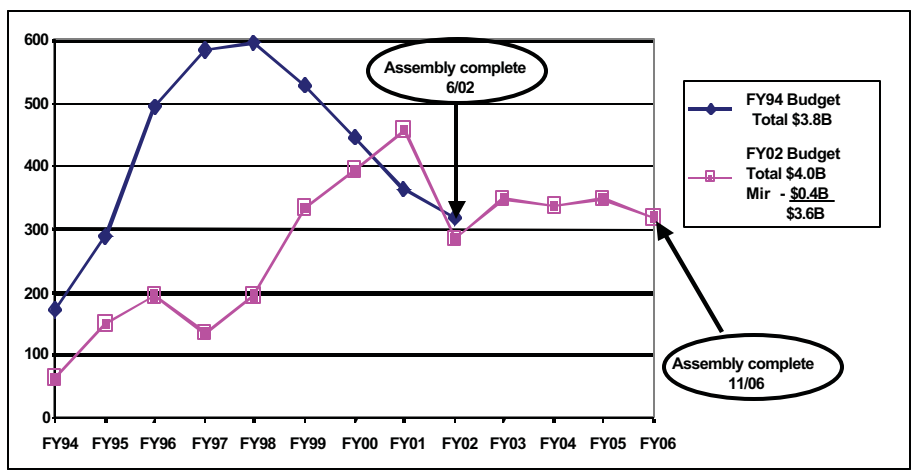
ISS Research Budget History

Excluding Mir Support Funding
($M)



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Maximize Research, cont.

Recommendations

- Establish science priorities
  - Give highest priority to research directed at solving problems associated with long-duration human space flight including engineering required to support humans in long-duration space flight.
  - The centrifuge is mandatory to accomplish top priority fundamental biology research. Availability as late as O08 is unacceptable.
  - Research in the physical sciences of utmost importance can be accomplished on the ISS.

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Maximize Research, cont.

- Establish a plan allocating available financial resources consistent with science priorities, including a prudent reserve
- Augment 3-person crew
  - Extended duration shuttle (requires adding shuttle flights if 4 per year flight rate option implemented)
  - Overlap Soyuz missions
- Strengthen science management within the ISS Program

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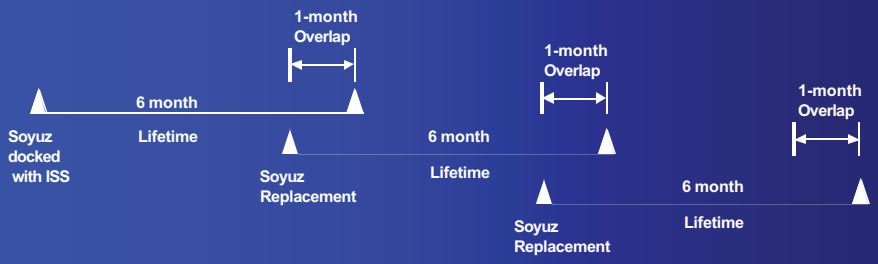
Maximize Research, cont.

- Extended duration shuttle
  - Docked time of at least 14 days is feasible
- Overlap Soyuz missions
  - 30 days of 6-person crew every 5 months
  - Cost impact TBD



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Science Management

ISS Program

- ISS Deputy Program Manager for Science
  - Equal to other deputies
  - Jointly report to Program Manager and AA OBPR
  - Highly respected member of science community with management skills

ISS Program Manager
Deputy for Science
Deputy for Technical
Deputy for Operations

- Science Steering Group (SSG) Chaired by Deputy Program Manager for Science
  - Members from ISS-related science disciplines
  - Meets frequently (at least monthly)
- Science Teams
  - Chaired by member of SSG
  - Members from the science community

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Enhancements

Charter

Assess cost estimates for potential U.S.-funded enhancements to the core station and recommend refinements as necessary to achieve high confidence estimates

Enhancement options to sustain 6 or 7 person crew

A- Node 3, US ECLS, 2nd Soyuz
B- Enterprise (RS ECLS, 2nd Soyuz)
C- Node 3, US ECLS, ASI Hab, CRV

Findings

Cost estimates for U.S.-funded enhancement options are not sufficiently developed to assess credibility

- CRV estimate of $1.3B is plausible with following assumptions:
  - **Assumes FY02 start (program interruption could have significant cost impact**
  - **Existing component and subsystem contracts remain valid**
  - **3-year on orbit lifetime is not a significant problem**
  - **Prime contractor accepts X-38 contributions**

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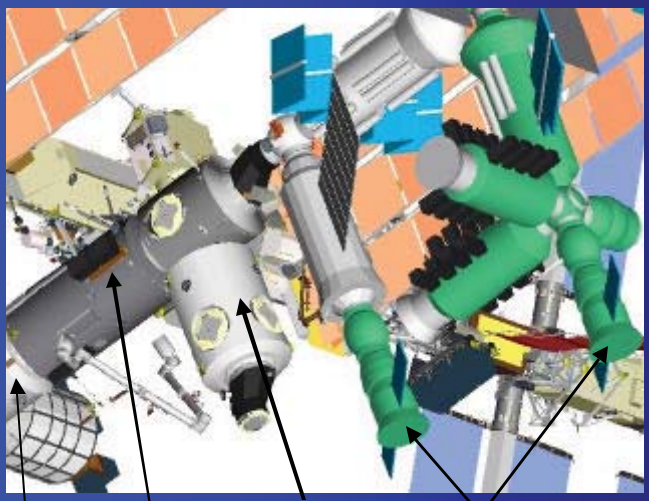
A - Node 3, US ECLS, 2nd Soyuz



FY 02-06
$0.5B

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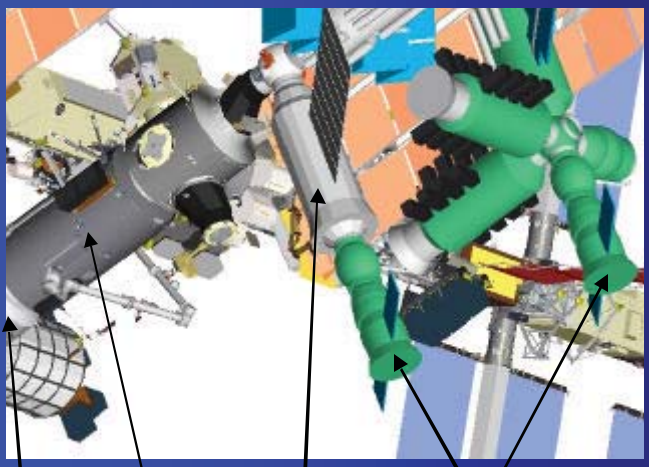
B - Enterprise (RS ECLS, 2nd Soyuz)



Node 2
Crew Quarters

Lab
Galley

Enterprise
Russian ECLS
Oxygen Generation (Electron)
Carbon Dioxide Removal (Vozdukh)
Toilet

Soyuz

FY 02-06
Â$0.5B

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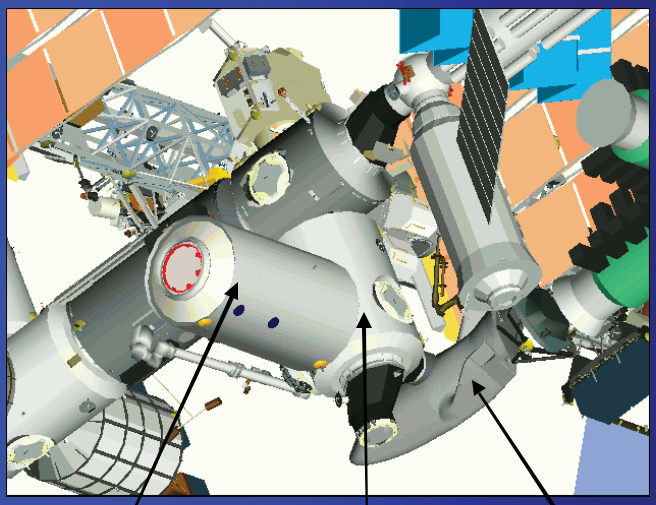
C - Node 3, US ECLS, ASI Hab, CRV



ASI Hab
Crew Quarters
Galley

Node 3
US ECLS
Oxygen Generation (O2 gen.)
Carbon Dioxide Removal (ARS)
Toilet (WHC), Water/Urine Processors

CRV

FY 02-06
Â$1.1 B

Assumes

? Italians fund ASI Hab

?ESA funds $0.5B for CRV

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Summary

- ISS core complete program is not credible for cost of $8.3B (FY02-06).
- ISS core complete program could be credible with major changes including significant staff reductions.

  Caution: NASA Human Space Flight Nway of doing businessÓ will be difficult to change to the degree required.
- Research management requires significant changes to maximize return within a given budget.
- A program baseline that includes expanded research potential as the Nend stateÓ maintains the unique research potential of ISS.

  Requires: NASA to demonstrate credibility as a prerequisite to proceeding beyond the core complete program.

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For Appendices to this report, go to:

ftp://ftp.hq.nasa.gov/pub/pao/reports/2001/imce_appdx.pdf