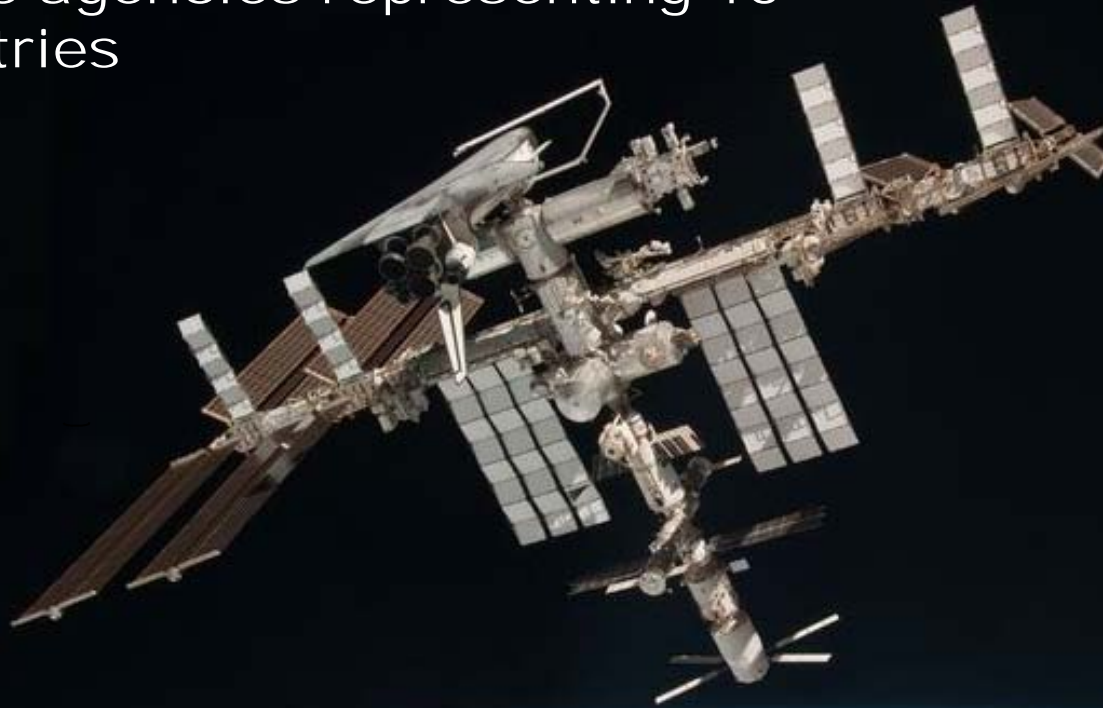
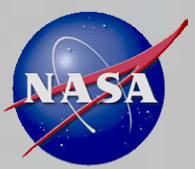


# International Space Station

Safely developed by a partnership of 5  
space agencies representing 15  
countries

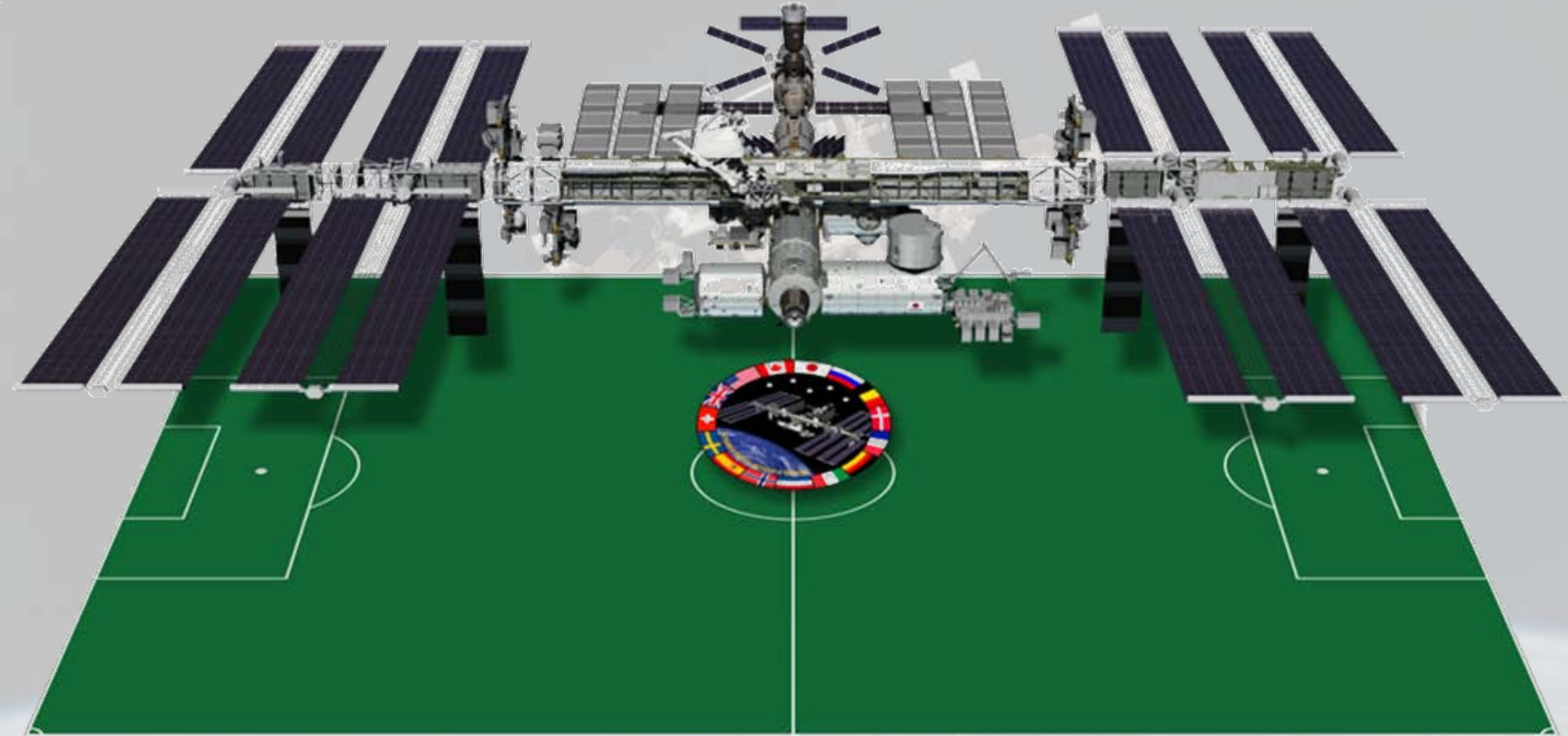


Kirk Shireman  
Deputy Manager, ISS Program



# International Space Station

Second Brightest Object in the Night Sky



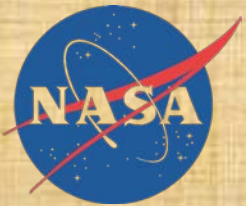
- **Spacecraft Mass :** 409,194 kg (902,119 lb)
- **Spacecraft Pressurized Volume:** 917 m<sup>3</sup> (32,333 ft<sup>3</sup>)
- **Velocity:** 28,164 km/h (17,500 mph) = 7823.2 m/s (a bullet from a high powered rifle travels at ~1500 m/s)
- **The solar array surface area:** 3567 m<sup>2</sup> (38,400 ft<sup>2</sup>) = 0.88 acre
- **Science Capability:** Laboratories from four international space agencies – US, Europe, Japan, and Russia
- **On-orbit construction:** Began in 1998, 37 space shuttle flights, 4 Russian assembly launches, and over 150 spacewalks



211 people have safely  
visited or lived aboard ISS  
as of 10/01/11



# U.S. Led International Operations



United States



Russia



Canada



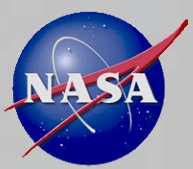
Europe



Japan



# Crew and Cargo Capability



Space Shuttle (retired in 2011)

Capacity: Up to 7 Crew

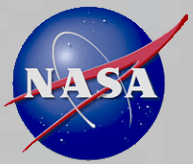


Soyuz

Capacity: 3 crew



# Cargo Capability



Proton  
*Progress*

Ariane 5  
*ATV*

H-IIB  
*HTV*

Falcon 9  
*Dragon*

Taurus II  
*Cygnus*

Future launch vehicles



SpaceX

Orbital

*An International fleet of space vehicles that delivers propellant, supplies, and research experiments*

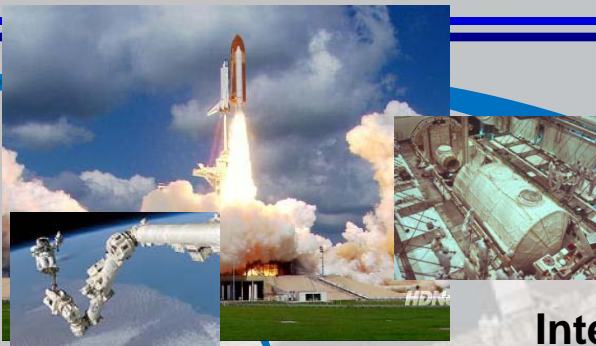
# Human Space Flight Safety Heritage



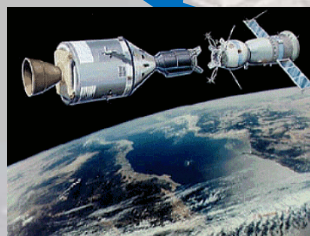
Mercury, Gemini, Apollo



Skylab



Space Shuttle



Apollo-Soyuz Test Project



Mir and Shuttle



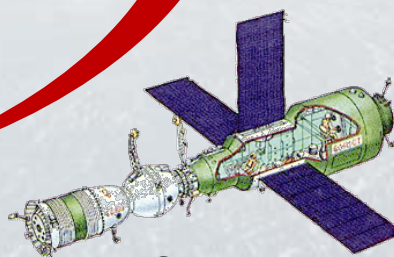
International Space Station



Vostok



Soyuz



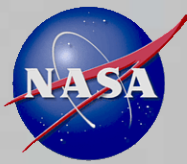
Salyut



Progress



# ISS Safety-By-Design



## **NASA ISS Program Mission Statement**

Safely build, operate, and utilize a permanent human outpost in space through an international partnership of government, industry, and academia to advance exploration of the solar system, scientific research, and enable commerce in space.



## **NASA Safety & Mission Assurance/Program Risk Office Mission Statement**

Continue safe operations of the ISS by developing and sustaining sound processes, providing quality safety analysis, and risk assessments that enables informed programmatic decisions. Share lessons learned and key processes with exploration programs.



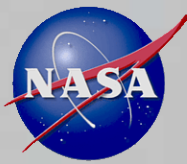
## **Multilateral Safety and Mission Assurance Control Board (MS&MACB)**

- Multilateral, delegated authority from the Space Station Control Board
- Develops and implements ISS Program safety and mission assurance requirements
- Ensures compliance for Certification of Flight Readiness (CoFR) via SSP50108
- Promotes cooperation amongst International Partner (IP) safety certification authorities
- Communicates and disseminates lessons learned and best practices for future programs

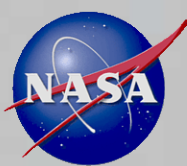




# ISS Safety-By-Design



- **Foster a Life Cycle Safety Culture – from concept through design, development, testing, operations and sustaining engineering**
  - All stakeholders embrace safety as a critical component of their job
  - Engineering teams are committed to safety, reliability, maintainability and quality
  - Safety team serves as expert advisors and provide policing function, serving at all levels from technical teams to control boards
- **Whenever possible, “design out” safety risks**
  - Identify, control and document hazards
  - Minimize risk and mitigate loss by reducing likelihood and severity
  - Maximize operations and utilization capability
- **Safety, Reliability, Maintainability and Quality can be tailored for each program or project but it directly affects Risk**
- **Create international safety standards, processes and practices**
  - Leverage International Partner expertise, taking the best from each Partner
  - Enhance robustness through interoperability (cross-compatibility of ground systems), redundancy (flight systems), dissimilar redundancy (life support systems) and standardization (International Docking System Standard)

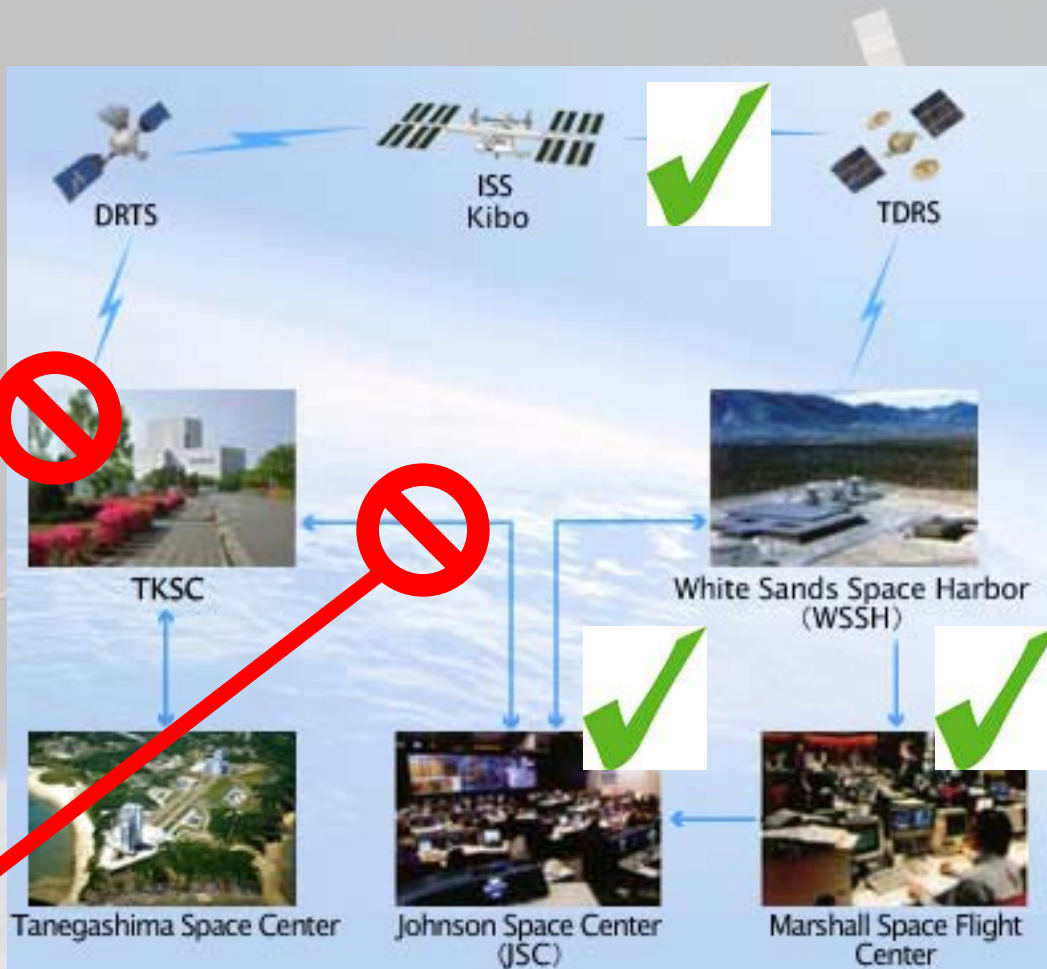


# Interoperability and Redundancy

SSIPC damaged.  
Staffing reduced to  
skeleton crew.



Undersea cable to  
MCC-Houston  
severed -- no  
command or video.



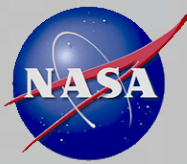
**Kibo operations continue due to Safety-By-Design flight and ground segments, including redundancy of flight systems, interoperability of ground systems, and robust multi-lateral processes**

JAXA quickly switches to the Backup Control Center capability at MSFC for voice and telemetry.

Three JAXA Flight Directors fly to Houston to join a small group of JAXA flight controllers visiting Houston.



# ISS Safety-By-Design Example: Dissimilar Redundancy



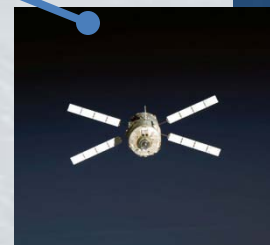
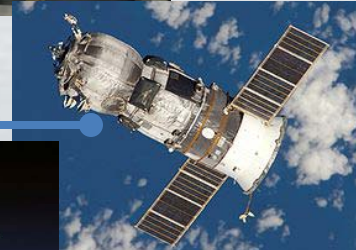
## CO2 Removal Systems

1. Lab Carbon Dioxide Removal Assembly (CDRA)
2. Node 3 CDRA
3. Russian Vozdukh
4. NASA Lithium Hydroxide (LiOH) Canisters



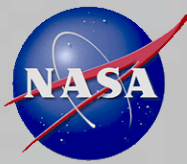
## Atmosphere Control and Supply (ACS) Oxygen Supply Systems

1. US Oxygen Generation System
2. Russian Elektron
3. US Airlock High Pressure Gas Tanks
4. Visiting Vehicle Resupply (Progress, ATV)

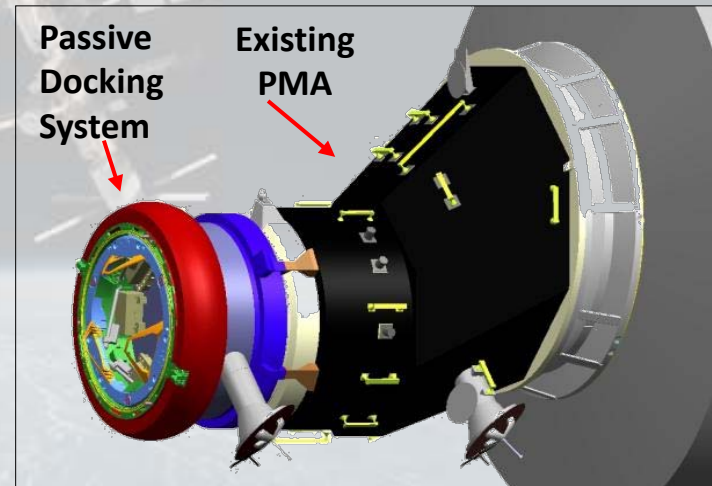
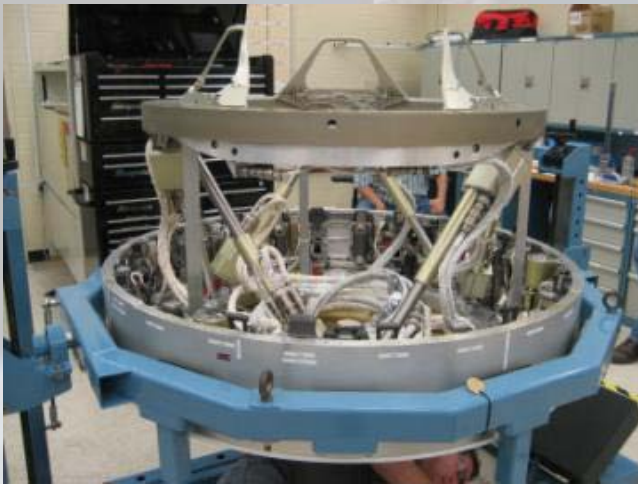




# ISS Safety-By-Design Example: Standardization



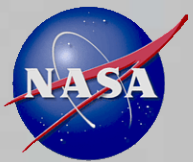
- The International Docking System Standard (IDSS) establishes a universal method for attaching to the ISS (<http://internationaldockingstandard.com/>)
- IDSS-compatible systems can be used on any vehicle coming to ISS and ensure interface commonality (physical features, design loads, etc.) without dictating any particular design behind the standard interface
  - Standardizes exchange of crew and cargo
  - Facilitates assembly of spacecraft on orbit
  - Enables the possibility of international crew rescue missions



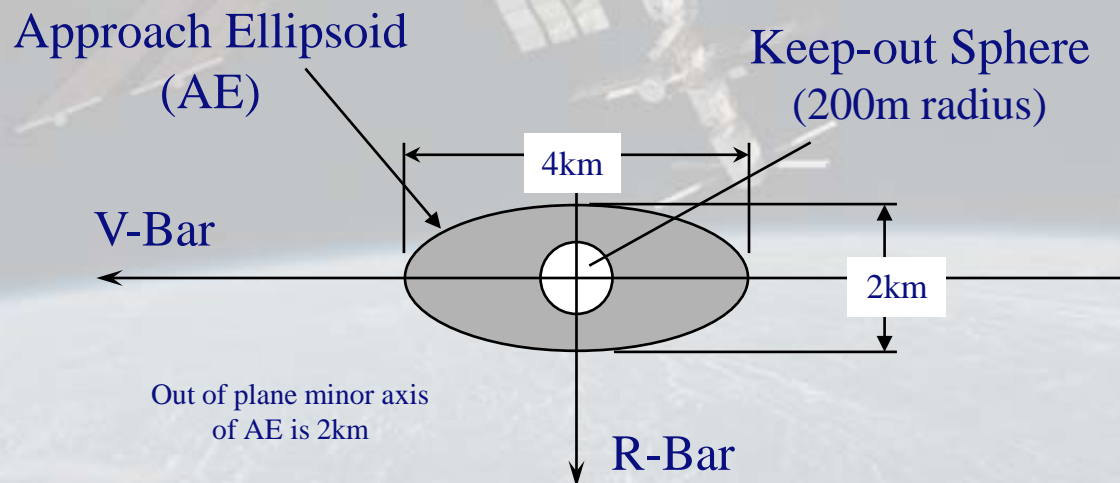
- IDSS represents a design standard that is a key step in international cooperative missions and brings collaborative exploration transportation policy one step closer



# Commercial Services Paradigm Change



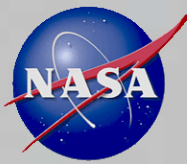
- New paradigm for commercial resupply services focuses on procurement of delivery services versus procurement of vehicles
- NASA levies integration requirements for rendezvous, proximity operations and attached phase via SSP 50808, "ISS to Commercial Orbital Transportation Services Interface Requirements Document"
- Commercial contractors must verify all ISS integration requirements have been met. NASA co-signs Verification Compliance Notices (VCNs).



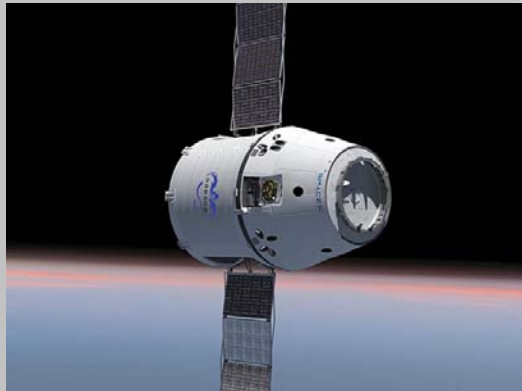
- Safety critical interface for insight and approval is within the approach ellipsoid.



# Commercial Resupply Safety-By-Design



- ISS Program safety requirements utilize a proven approach for control philosophy for catastrophic and critical hazards, as well as the design for minimum risk approach



SpaceX  
Dragon

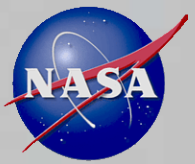


Orbital  
Cygnus

- **NASA reviews all Visiting Vehicles with the same rigor and utilizes the phased Safety Review Panel (SRP) process documented in SSP 50021, “ISS Program Safety Requirements Document”**
- All Visiting Vehicle to ISS must:
  - Comply with SSP 30599, “ISS Safety Review Process” for phased safety reviews
  - Perform safety analyses in accordance with SSP 30309, “Safety Analysis and Risk Analysis Requirements”
  - Provide hazard analyses to the SRP for approval of all ISS-related mission phases



# ISS Future



## ➤ **Utilization and Research**

- Now that ISS is assembled, utilization and scientific return are paramount
- More resources, including crew time, launch and return mass, and electrical power are dedicated to research for all Partners
- NASA has designated the US Segment as a US National Laboratory to further strengthen relationships amongst NASA, other US government entities and the private sector for the advancement of science, technology, engineering and mathematics

## ➤ **Future Capabilities for Crew Launch and Return**

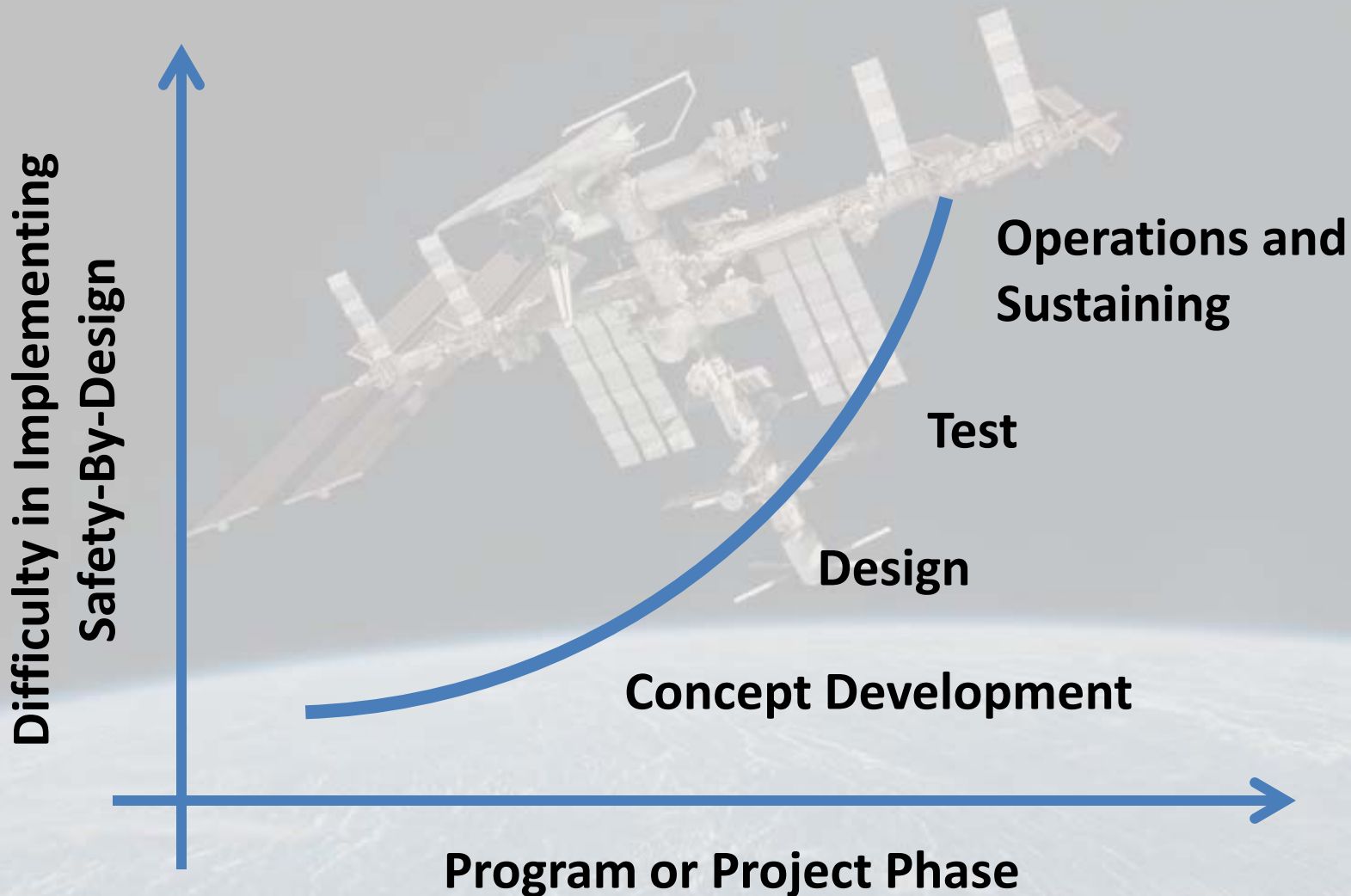
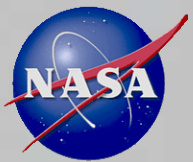
- Working with NASA's Commercial Crew Planning Office and Multi-Purpose Crew Vehicle (MPCV) Office to develop core requirements, joint processes and responsibilities
- Developing the International Docking Adapter with delivery to orbit in 2014

## ➤ **Partner Safety Franchises**

- Expansion of Partner Safety Franchises based on the very successful experiences with ESA and JAXA for delegation of safety review responsibilities



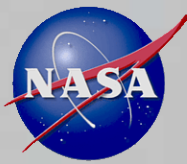
# Start with Safety-By-Design







# Our Future



## ➤ ISS is a stepping stone to future human exploration

- Testing human endurance, equipment reliability, technologies, and life support systems essential for space exploration.
- The global partnership, which constructed the space station, represents the foundation for the international technological collaboration needed to further humankind's reach into space.

