JAXA Approach for Mission Success
~close coordination with contractors~

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1. Recent JAXA Space Flights

Currently-operating JAXA’s satellites on-orbit

<table>
<thead>
<tr>
<th>CY2000</th>
<th>CY2005</th>
<th>CY2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>2005</td>
<td>2009</td>
</tr>
<tr>
<td>Kodama (DRTS: Data relay)</td>
<td>Daichi (ALOS: Land observation)</td>
<td>Ibuki (GOSAT: Greenhouse gas observation)</td>
</tr>
<tr>
<td>2006</td>
<td>2006</td>
<td>2008</td>
</tr>
<tr>
<td>2005</td>
<td>2005</td>
<td>2010</td>
</tr>
<tr>
<td>Suzaku (Astro-Ell: X-ray Astronomy)</td>
<td>Azukari (Astro-F: Infrared Imaging)</td>
<td>Akatsuki (Planet-C: Venus Climate)</td>
</tr>
<tr>
<td>2006</td>
<td>2006</td>
<td>2010</td>
</tr>
<tr>
<td>Hinode (SOLAR-B: Solar Physics)</td>
<td></td>
<td>Ikaros (Solar Power Sail)</td>
</tr>
<tr>
<td>2003</td>
<td>2007</td>
<td></td>
</tr>
</tbody>
</table>
| Hayabusa (asteroid explorer) | | }

Kaguya (Lunar observation)
1. Recent JAXA Space Flights

Japanese Launch vehicles

<table>
<thead>
<tr>
<th></th>
<th>H-2A (Standard)</th>
<th>H-2B</th>
<th>Epsilon (under development)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTO</td>
<td>4.0ton</td>
<td>8ton</td>
<td></td>
</tr>
<tr>
<td>LEO</td>
<td>10ton</td>
<td>16.5ton (ISS orbit)</td>
<td>1.2ton</td>
</tr>
</tbody>
</table>
1. Recent JAXA Space Flights

International Space Station Program

“KIBO”
Japanese Experience Module (JEM)

“HTV”
Transportation Vehicle

ISS

©NASA

Wakata
2009.3 – 2009.7

Noguchi
2009.12 – 2010.6

Yamazaki
2010.4

Furukawa
2011.Spring -
2. JAXA’s Role and Responsibility

✓ Emphasizing upstream process and front-loading
  • Apply Systems Engineering (SE) that emphasizes upstream process management in the project lifecycle
  • Allocate adequate resource to upstream process (front-loading)

✓ Define appropriate level of JAXA responsibilities and roles in development projects
  • JAXA is responsible for requirements/specification definition, and flight operations.
  • A manufacturer is responsible for detailed design, fabrication and testing.

✓ To implement front-loading, JAXA S&MA disseminates information that are obtained from all JAXA’s activities to JAXA and contractors.
2. JAXA’s Role and Responsibility

Re-establishment of Project Lifecycle Process

- Previous Process

<table>
<thead>
<tr>
<th>Pre-project activity</th>
<th>Mission Definition</th>
<th>Project Approval</th>
<th>Check &amp; Balance</th>
<th>(Termination)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Studies</td>
<td>MDR</td>
<td>SRR</td>
<td>SDR</td>
<td>PDR</td>
</tr>
<tr>
<td>Concept Development</td>
<td>Project Formulation</td>
<td>Preliminary Design</td>
<td>Final Design</td>
<td>Production &amp; Testing</td>
</tr>
</tbody>
</table>

- New Process

- Newly Established

- Shifted
3. Major S&MA Activities

JAXA S&MA Organization and Major Activities

Reliability Evaluation Committee
-Third party evaluation
-Reports to President

Reliability Promotion Committee
• Review policies and action plans

NASA S&MA
Tri-S&MA Meeting
TRISMAC
IAASS

Reliability Planning Sub-committee
• Draft policies and action plans
• Confirm team activities
• Disseminate information within JAXA

Industries

High Level S&MA Meetings
-Informal meetings for top-level S&MA managers

S&MA Department

Senior Chief Officer S&MA

Senior Chief Engineer

System Engineering Office

Space Transportation Executive Director

Space Applications Executive Director

Space Transportation S&MA

Space Applications S&MA

Quality Meeting
-Information sharing between projects and S&MA

Space Transportation Program, Project

Space Applications Program, Project

S&MA Community Meeting
• S&MA activities by TEAMS
• Status report
3. Major S&MA Activities
Nonconformance Analysis

Categorized by Nonconformance event

- Hardware (Anomalies): 86 cases (46.7%)
- Software: 25 cases (13.6%)
- Operation: 35 cases (19.0%)
- Others (Ground system): 6 cases (3.3%)

Total 184 cases

Categorised by probable cause of Hardware nonconformances

- Inadequate Design Activities: 51.7%
- Under Investigation: 11.9%
- Random Failure: 5.9%
- On-orbit Environment: 15.3%
- Manufacturing Defects: 6.8%
- Unknown: 8.5%

Total 118 cases

✓ two-thirds of nonconformances occurred in hardware.
✓ More than half of hardware nonconformance caused by inadequate design activities

Countermeasure for inadequate design activities

Sample: Visibility improvement in design activities at contractors
JAXA proposed contractors to consider “Mieruka of design activities and improvement of design related activities” to reduce the number of nonconformances caused by inadequate design activities.

(1) Purpose
- To promote the “Mieru-ka (visibility improvement) of design, evaluation for test results” so that a designer and his/her manager can identify risks and concerns at upstream

(2) Flow down of requirements to a prime contractor as a part of the reliability program
- Improvement of descriptions in design evidence documents and careful check and review by organization that has design responsibility.
  - Clear description of such as design philosophy, design parameter with reference source, analysis condition, analysis method and so on
- Development of a process to consult with experts inside contractors and JAXA.
- The designer’s technical review and documentation for evaluation of test result.
Reliability of Column Grid Array (CGA) and Lead Free Parts assembly were evaluated for space application.

<CGA>
CGA is greatly preferred due to high-speed signal processing, availability of numerous I/Os, and reduction in size and weight of components for space application as for BGA. JAXA started to study technical issues of CGA usage for space application.

**Inspection Method (X-ray, CT), New-Criteria for void, etc**

<Lead-free>
Whisker mitigation and evaluation method for space application.
- Conformal coating effects evaluation
- Thermal vacuum test

JAXA S&MA shares these information with the projects and contractors.
3. Major S&MA Activities

Audit and surveys of contractors

**HQ S&MA**

**S&MA Management Audit**
*(for contractor’s QMS)*

(In case of)
- common S&MA trouble affecting multiple Projects
- large-scale change of contractor’s QMS

- Per annual implementation plan or when necessary
  
  (5 major contractors)

**Projects/S&MA offices**

**S&MA Program Audit**
*(for each project)*

(In case of)
- serious S&MA trouble affecting own Project
- drastic change of project’s S&MA program

- when necessary

(3 major contractors and several minor)
3. Major S&MA Activities

Informal opinion exchange meetings with contractors

(1) Purpose and Outline
- Meeting between JAXA S&MA Management and Contractors’ Management
- Understand Contractor Management S&MA policy (difficult to discuss during audits) and introduce JAXA’s S&MA policy
  - Free discussion about S&MA matters including issues and requests.
  - Enhancement of mutual understanding and the Managers’ leadership for S&MA improvement

(2) Information acquired from these meetings (examples)
- Necessity to watch for nonconformance prevention and work site organization, utilizing site inspections.
- More attention should be paid to vendors management.
- Human factors related issues should be resolved.
- Contractors expect JAXA to provide information related to parts and so on.

Meaningful opinion exchanges between Managers
(JAXA plans to continue these meetings.)
Issue:
Multiple parts/components purchased from foreign countries had nonconformances and failures. This caused project schedule delays and led to on-orbit non-conformances.

Major Efforts at JAXA/Prime for Quality Assurance:
(1) Monitor parts manufacturer which may have potential issues for parts performance and schedule.
(2) Survey of manufactures.
(3) Strengthen procurement activity such as process inspection and product data review etc.
(4) Survey of the other source if needed.
(5) Share information among JAXA and contractors.
4. Technical improvement at development projects

(1) Launch Vehicle development (J:JAXA, c:contractors)

- Development policy (J)
  - Risk minimization by minimization of new component development
    - Component commonality of H-2A and H-2B
- Benchmarking from various launch vehicle failures in the world (J)
- Reliability improvement campaign (J/c)
  - Design countermeasure for
    - Oxygen Turbo Pump cavitations, Valves trouble, SRB-A nozzle erosion/corrosion
- To take advice of experts and well experienced personnel (J/c)
- To build high quality into the products in the manufacturing process (c)
  - Thorough evaluation of two sigma deviation from standard value
- Launch operation dry run (c)
  -
  -
  -
4. Technical improvement at development projects

(2) Satellite development (J:JAXA, c:contractors)

- Development policy (J)
  - Ensure satellite Bus system reliability: Minimize newly developed components
  - The first priority on the mission achievement using existing engineering techniques except essential new engineering techniques
- Detailed evaluation of applied techniques (J/c)
- Reinforcement of analysis, test and inspection (Reflection of analysis result on-orbit satellite nonconformance information) (c)
  - Identification and minimization of single failure points
  - Improvement of charge and discharge tolerance and isolation tolerance
    - 
    - 

- [Images of satellite components]
# Launch Plan (Reference)

<table>
<thead>
<tr>
<th>Year</th>
<th>Satellite</th>
<th>ISS Prjt</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>JFY2010</td>
<td>PLANET-C/IKAROS (Launched)</td>
<td>HTV #2</td>
<td>▲ H-2A</td>
</tr>
<tr>
<td></td>
<td>Quasi-Zenith Satellite #1 (Launched)</td>
<td></td>
<td>▶ H-2B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▼ Epsilon (next-generation solid propellant rocket)</td>
</tr>
<tr>
<td>2011</td>
<td>GCOM-W1</td>
<td>HTV #3</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>ASTRO-G</td>
<td>HTV #4</td>
<td>▲ GPM/DPR</td>
</tr>
<tr>
<td>2013 or later</td>
<td>GPM: Global Precipitation Measurement</td>
<td>HTV#5 HTV#6</td>
<td>▶ EarthCARE/CPR</td>
</tr>
<tr>
<td></td>
<td>Epsilon: Next-generation solid propellant rocket</td>
<td></td>
<td>▲ GCOM-C1</td>
</tr>
<tr>
<td></td>
<td>PLANET-C: Venus Climate Orbiter</td>
<td></td>
<td>▲ ALOS-2</td>
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<tr>
<td></td>
<td>IKAROS: Small Solar Power Sail Demonstrator</td>
<td></td>
<td>▲ BepiColombo</td>
</tr>
<tr>
<td></td>
<td>GCOM-W1: Global Change Observation Mission 1st water</td>
<td></td>
<td>▼ Small Scientific Satellites</td>
</tr>
<tr>
<td></td>
<td>ASTRO-G: Radio-Astronomical Satellite</td>
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<td></td>
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<tr>
<td></td>
<td>GPM: Global Precipitation Measurement</td>
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<td></td>
<td>EarthCARE: Earth Clouds, Aerosols and Radiation Explorer</td>
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<tr>
<td></td>
<td>HTV: H-transfer Vehicle</td>
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</table>

### Note:
- ▲ H-2A
- ▶ H-2B
- ▼ Epsilon (next-generation solid propellant rocket)
- ◆ Other