NASA WIRING FOR SPACE APPLICATIONS PROGRAM

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NASA Headquarters
Washington, DC

NASA Code XS Overview

- ORGANIZATION
- CHARTER
- PROGRAMS

NASA Strategic Plan

- Enterprises
  - Aeronautics
  - Mission to Planet Earth
  - Space Science
  - Human Exploration
  - Space Technology

- Function
  - Communications
  - Human Resources
  - Physical Resources
Mission

Pioneer, With Industry, the Development and Use of Space Technology to Secure National Economic Competitiveness, Promote Industrial Growth and to Support Space Missions

Space Technology Enterprise Goals

1. Reduce the Cost of Access to Space
   • Reusable Launch Vehicle
   • Expendable Launch Vehicle
   • In-Space Transportation

2. Provide Innovative Technologies to Enable Ambitious, Future Space Missions (ITP)
   • Spacecraft Systems (Power, Propulsion, Structures, etc.)
   • Instrument Technologies
   • Operations

3. Build Capability in the U. S. Space Industry Through Focused Space Technology Efforts
   • Communications
   • Remote Sensing
   • Space Processing

4. Share the Harvest of Space Technology with the U. S. Industrial Community
   • Technology Transfer - “Agenda for Change” (New Way of Doing Business)
Operating Principles!

- Meet the Customers Needs
- Work With Industry
- Reduce the Cost of Access to Space
- Commercialization of Space Is Essential to NASA
- Commercialization and Technology Transfer Is Everybody's Job
- Consider Commercialization at Technology Program Initiation
- Effectively Use Space Station
OFFICE OF SPACE ACCESS AND TECHNOLOGY

Office of Associate Administrator

- Flight Integration Office
- Advanced Concepts Office
- Launch Vehicles Office
- Commercial Development and Technology Transfer Division
- Spacecraft Systems Division
- Space Processing Division
- Space Transportation Division
- Management Operations Division

Foundation for Future Missions

High Performance, Low Cost Science and Commercial Missions

<table>
<thead>
<tr>
<th>Commercial Remote Sensing</th>
<th>Earth Observing Missions</th>
<th>Planetary</th>
<th>Astrophysics</th>
<th>Space Physics</th>
<th>Communications</th>
<th>Education</th>
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</thead>
</table>

- Light-Weight Structures
- On-Board Processing
- Small Low-Power Instruments
- High Pointing Accuracy
- Highly Autonomous Operations

New Mission Capability

- Commercial Practices
- Non-redundant Product Assurance
- Standard Interfaces (Hardware/Software)
- Integrated Bus Payload
- Virtual Design and Manufacturing Environment

Advanced Spacecraft and Instrumentation Technology

Design and Integration Process

Small Spacecraft and Technology Program
NEW MILLENIUM / ESSP

CHALLENGES

• Replace large, multi-instrument spacecraft with multiple small single instrument "sciencecraft"
  – Change focus from "instruments on a spacecraft" to "the instrument is the spacecraft"

• Return information, not data

• Wide, unconstrained interaction with users and information distribution to users

• Low initial cost, low operations cost

Small Spacecraft Tech Initiative

• Lewis
  – Payloads
  • Hyper Spectral (30M, 358 Bands)
  • UV cosmic measurement
  • Cloud detection/editing
  – 20 Technology Demonstrations
  • Integrated Thermal/Structural Design
  • Advanced power concepts
  • Autonomous on-orbit maintenance
  • Advanced C&DH and data bus arch.
  • Data compression

• Clark
  – Payloads
  • 3-meter panchromatic (world view)
  • C detection in atmosphere
  • Room temp. X-Ray detectors
  – 36 Technology Demonstrations
  • Advanced attitude control
  • Advanced photovoltaic concepts
  • Advanced power management and distribution
  • On-board processing
  • No shock release devices
Technology Readiness Levels (TRLs)

- System Test, Launch & Operations
- System/Subsystem Development
- Technology Demonstration
- Technology Development
- Research to Prove Feasibility
- Basic Technology Research

Increasing Technological Readiness

CORPORATE NASA R&D

FOCUSED TECHNOLOGY

EXPLORATORY DEVELOPMENT

DEVELOPMENT

ADVANCED DEVELOPMENT

MISSION CAPABILITIES
TECHNOLOGY ENTERPRISE STATUS

Access to Space
- National Space Transportation Policy Issued, NASA Implementation Plan Approved by OSTP & OMB
- Cooperative Agreement with X-33 & X-34 Signed with Industrial Partners
- 2000 Hour Ground Test of Ion Flight Experiment Prototype Thruster Successfully Completed

Innovative Technologies
- Parallel Contracts for SSTI Awarded, spacecraft construction started, launch date established and launch vehicle selection completed.
- New Millennium Spacecraft Technology Program Defined with Codes S & Y
- Mars Pathfinder Micro-Rover Fabrication Nearing Completion

Space Applications
- ACTS Fully Operational
- Commercial Remote Sensing Program Has Leverage $38.5M of Industry Funding, and Led to the Creation of 25 New Products, Over 140 New Jobs, and Revenues Exceeding $66M and Is Developing Hyperspectral Capability Which Will Enable Movement Into New Markets
- Starting Large Animal Trials on Diabetes Treatment, Based on In-Space Developed Technology of Microencapsulation

Technology Transfer
- Agenda for Change Plan Approved, Agency-Wide Team Established, Performance Measurement Metrics Collected, and Technology Transfer Principle Added to NASA Strategic Plan

SUMMARY IMPLEMENTATION STRATEGY!

- Develop Technology in Cooperation With and Responsive to User Requirements, With Upfront Consideration of Dual Use
- Proactively Transfer Technology to NASA Missions, Other Agencies and Aerospace and Non-Aerospace Industries
**Background**

*SPACE MISSIONS WITH ELECTRICAL WIRING SYSTEM FAILURE*

<table>
<thead>
<tr>
<th>Mission</th>
<th>Cause</th>
<th>Result</th>
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<tbody>
<tr>
<td>Gemini 8</td>
<td>Electrical Wiring Short</td>
<td>Shortened Mission - Near Loss of Crew</td>
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<tr>
<td>Apollo 204</td>
<td>Damaged Insulation, Electrical Spark, 100% O₂</td>
<td>Fire, 3 Astronauts Lost</td>
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<tr>
<td>Apollo 13</td>
<td>Damaged Insulation/Short Circuit/Flawed Design</td>
<td>Oxygen Tank Explosion, Mission Incomplete</td>
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<td>STS - 6</td>
<td>Abrasion of Insulation/Arc Tracking</td>
<td>Wire Insulation Pyrolysis 6 Conductors Melted</td>
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<td>STS - 28</td>
<td>Damaged Insulation/Arc Tracking</td>
<td>Teleprinter Cable Insulation Pyrolysis</td>
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<td>Magellan</td>
<td>Wrong Connection, Wiring Short</td>
<td>Wiring Insulation Pyrolysis - Ground Processing</td>
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<td>Spacelab</td>
<td>Damaged Insulation/Arc Tracking</td>
<td>Wiring Insulation Pyrolysis During Maintenance</td>
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<td>Delta 178/GOES-G</td>
<td>Mechanical or Electrochemical Insulation Damage</td>
<td>Loss of Vehicle</td>
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<tr>
<td>ESA - Olympus</td>
<td>Electrical Wiring Short</td>
<td>Loss of Solar Array</td>
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**NASA Wiring for Space Applications Program**

- **OBJECTIVES:**
  - Improve safety, performance, and reliability of wiring systems for space applications
  - Develop improved wiring technologies for NASA flight programs and commercial applications
ELECTRICAL POWER WIRING PROGRAM

GOAL: TO PROVIDE A TECHNOLOGY BASE FOR THE DEVELOPMENT OF LIGHTWEIGHT, ARC TRACK-RESISTANT AND RELIABLE WIRING SYSTEMS FOR AEROSPACE APPLICATIONS.

APPROACH

- IDENTIFY MISSION REQUIREMENTS AND APPLICATION ENVIRONMENTS
- EVALUATE POTENTIAL WIRING SYSTEMS AND ESTABLISH A DATABASE
- INVESTIGATE ADVANCED TECHNOLOGIES RELEVANT TO WIRING FAILURE PREVENTION, DETECTION, AND ISOLATION.
- ESTABLISH GUIDELINES AND RECOMMENDATIONS

TECHNOLOGICAL DEVELOPMENTS

- NEW INSULATING MATERIALS
- NEW WIRING CONSTRUCTIONS
- IMPROVED SYSTEM DESIGN
- ADVANCED CIRCUIT PROTECTION

APPLICATIONS

- PRESSURIZED MODULES
- TRANS-ATMOSPHERIC VEHICLES
- LEO/GEODYNAMIC ENVIRONMENTS
- LUNAR AND MARTIAN ENVIRONMENTS
## NASA Wiring for Space Applications Program

<table>
<thead>
<tr>
<th>NASA APPLICATIONS REQUIREMENTS</th>
<th>'91</th>
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<td>- First NASA Workshop</td>
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<td>- Interim Report</td>
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<td>- Identify Candidate Wires</td>
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<td>- Complete Wire Testing</td>
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<tr>
<td>- Testing Report</td>
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<td>- Improve Quality Control</td>
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<td>- Advanced Circuit Protection</td>
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<tr>
<th>NASA WIRING RECOMMENDATIONS</th>
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<td>- Issue Final Report</td>
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### ACCOMPLISHMENTS:

- **First Workshop, July 1991:**
  - Wiring system operational experience
  - NASA wiring requirements
  - Wire manufacturing technologies


- **Interim Report, June 1993:**
  - NASA spacecraft environments
  - NASA unique testing requirements
  - Related wiring programs


- **Second Workshop, July 1993:**
  - Program overviews: NASA, AF, NAWC, ESA
  - Space wiring failures
  - Candidate wiring constructions
  - New wiring insulation
  - Test methodology and standardization

NASA Wiring for Space Applications Program

• R & D PROGRAMS:
  - System design
  - Candidate wiring constructions
  - New insulating materials
  - Protection techniques
  - Quality control

• ORGANIZATIONS:
  - NASA
  - DOD laboratories
  - FAA
  - Aerospace Industry
  - ESA
  - Academia
  - Technical committees
NASA Wiring for Space Applications Program

• ACTIVITIES:

- Third Workshop, July 1995:
  • Program status: NASA, AF, NAWC, FAA, ESA
  • Wiring test results
  • Advancements in materials and constructions
  • New system topologies

- Final Report, 1996:
  • Comprehensive test results
  • Recommendations and guidelines

- Transfer Technology to NASA Flight Programs and Aerospace Industry

• CONCLUSIONS:

- Wiring system failures in space and commercial applications have shown the need for arc track resistant wiring constructions

- Preliminary data indicates the performance of the Tensolite and Filotex hybrid constructions are the best of the various candidates

- One construction will be recommended after comprehensive evaluation and analysis of all testing data

- Detailed presentations of the test efforts and results to date will follow
Wiring Workshop Charge

Determine next steps for:

- s/c wiring
- new wiring advances
- circuit protection
- improvement in quality control measures