NASA WIRING FOR SPACE APPLICATIONS PROGRAM

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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

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**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

New Plateaus of Technical Capability

Mission Enhancement

Increased International Competitiveness

New Products & Services
Foundation for Future Missions
NEW MILLENNIUM / 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 ENTERPRISE STATUS

Access to Space
- National Space Transportation Policy Issued, NASA Implementation Plan Approved by OSTP & OMB
- Cooperative Efforts for 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 Near Completion

Space Applications
- ACTS Fully Operational
- 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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<tr>
<td>STS - 6</td>
<td>Abrasion of Insulation/Arc Tracking</td>
<td>Wire Insulation Pyrolysis</td>
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<td>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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<tr>
<td>Magellan</td>
<td>Wrong Connection, Wiring Short</td>
<td>Wiring Insulation Pyrolysis - Ground Processing</td>
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<tr>
<td>Spacelab</td>
<td>Damaged Insulation/Arc Tracking</td>
<td>Wiring Insulation Pyrolysis - During Maintenance</td>
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<tr>
<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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</table>

**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/GEODE+ ENVIRONMENTS
• LUNAR AND MARTIAN ENVIRONMENTS
NASA Wiring for Space Applications Program

<table>
<thead>
<tr>
<th>NASA APPLICATIONS REQUIREMENTS</th>
<th>'91</th>
<th>'92</th>
<th>'93</th>
<th>'94</th>
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<td>- First NASA Workshop</td>
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<td>- Interim Report</td>
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| INSULATION TESTING & ANALYSIS  |     |     |     |     |     |     |
| - Identify Candidate Wires     |     |     |     | ▲   | ▲   | ▲   |
| - Second NASA Workshop         |     | ▲   | ▲   | ▲   | ▲   | ▲   |
| - Third NASA Workshop          |     |     |     |     | ▲   | ▲   |
| - Complete Wire Testing        |     |     |     | ▲   | ▲   | ▲   |
| - Testing Report               |     |     | ▲   | ▲   | ▲   | ▲   |

| WIRING SYSTEM TECHNOLOGY       |     |     |     |     |     |     |
| - Improve Quality Control      |     |     | ▲   | ▲   | ▲   | ▲   |
| - Advanced Circuit Protection  |     |     | ▲   | ▲   | ▲   | ▲   |

| NASA WIRING RECOMMENDATIONS    |     |     |     |     |     |     |
| - Issue Final Report           |     |     | ▲   | ▲   | ▲   | ▲   |

**ACCOMPLISHMENTS:**

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

  *Proceedings: "First NASA Workshop on Wiring for Space Applications", NASA CP-10145, July, 1994*

- **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
## Tests Performed vs. Wiring Constructions Matrix

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<tr>
<th>Construction</th>
<th>Test</th>
<th>Characteristic</th>
<th>Value</th>
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**Key:**
- Tests performed by DOD programs [11 - 13]
- Some DOD testing, more necessary [11 - 13]
- Tests performed by NASA programs [26, 56, 57]
- Some NASA testing, more necessary [26, 56, 57]
- Tests not required for this program
- Additional tests to be performed
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