TABLE OF CONTENTS

- Introduction
- Overview of Activities at Dasa-RI (since last workshop) concerning testing of wires (sponsored by ESA-ESTEC, The Netherlands)
  - Test Facilities
  - Arc-Tracking
  - Testing of Wires
  - Standardization
- Future Activities

INTRODUCTION

- Electrical wires are considered as EEE-parts and are covered within the ESA SCC specification series (ESA SCC 3901/XXX).
- Specifications define the principal properties of the wires including insulation/lay-up, electrical properties etc.
  Some additional space related materials requirements also included such as outgassing and silver plating thickness.
- If a project has additional materials requirements over and above those covered by the relevant SCC specification then additional testing is required.
  This is especially the case for manned spacecraft.
INTRODUCTION

Additional requirements for manned spacecraft:

- The following additional properties, specific to manned spacecraft (i.e. Columbus and Hermes) require evaluation of:

1. Flammability Test Method ESA-PSS-01-721 Issue 2
2. Offgassing Test Method ESA-PSS-01-729 Issue 2
3. Arc-tracking Test Method under evaluation by Dasa-RI in conjunction with Technical University, Darmstadt (see also separate presentation)
4. Thermal Decomposition Test Method defined based on that originating from CERTSM, France
5. Microbial Surface Growth Test Method defined based on that originating from SINTEF/Sl, Norway

Note: 4. and 5. are Test Methods derived in the frame of the Columbus Project (Critical Technologies Program)

- In addition, the effects of ageing on certain of these properties require investigation.

OVERVIEW OF ACTIVITIES AT DASA-RI (since last Workshop)

- Establishment of test facilities at Dasa-RI
  - Arc-tracking test of wires
  - Flammability test of wires
- Arc-tracking: Technical University Darmstadt / Dasa-R' activities
  - Extension of database (see also presentation of THD)
  - Design of test equipment to assess effects of microgravity
- Performance of wiring testing at Dasa-RI
- Performance of studies, e.g. ageing of wires, different angles of wire inclination of flam-of-wires test
- Performance of wiring testing in the frame of Columbus Critical Technologies Program (CTP)
- Activities concerning standardization of test methods (British Standard, ISO)
Arctracking Test of Wire at Dasa-R1
Electrical Wire Insulation Flammability Test at Dasa-RI
Arc-Tracking Test Equipment / Test Method

- Two test equipment's are existing (at THD and at Dasa-RI)
- Test method developed by THD (already presented)
  Work has led to a new approach to assessing degree of susceptibility of wires to arcing failure
- Lot of testing has been performed (see separate presentation by THD)

Microgravity Test

- Test equipment is being designed, procurement and manufacturing started
- Parabolic flight is scheduled during 1996

ARC-TRACKING: MICROGRAVITY TEST EQUIPMENT
WIRING TESTING AT DASA-RI

First Test Results [AWG 20]

<table>
<thead>
<tr>
<th>Wire Specification</th>
<th>Insulation</th>
<th>Performance of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCC-3901-001</td>
<td>PI/PI/PI</td>
<td>Upward propagation test ) Prior and after ageing</td>
</tr>
<tr>
<td>SCC-3901-007</td>
<td>PI/PI/PTFE</td>
<td>Flam of wire test ) of 60 days in air</td>
</tr>
<tr>
<td>SCC-3901-009</td>
<td>PTFE/PI/PI</td>
<td>Arc-tracking test ) at 150° C</td>
</tr>
<tr>
<td>MIL-W-22759</td>
<td>ETFE</td>
<td></td>
</tr>
</tbody>
</table>

- All wires (new and aged) passed the upward propagation and flam of wire test according to ESA-PSS-01-721, Issue 2
- Arc-tracking test results using Dasa-RI inhouse test procedure PSP 0121 009 showed clear differences between different wire types. Accept/Reject Criteria have to be reconsidered.

WIRING TESTING IN THE FRAME OF COLUMBUS CRITICAL TECHNOLOGIES PROGRAM (CTP)

- 10 different wire/cable types have been subjected to different tests, selected from the so called "Columbus EEE Preferred Parts List"

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Sample Name</th>
<th>Chemical Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>1871-1-20</td>
<td>PI (2 tapes)/ PI coating</td>
</tr>
<tr>
<td>1903</td>
<td>FA 3901-1-120</td>
<td>PI (2 tapes)/ PI coating</td>
</tr>
<tr>
<td>1904</td>
<td>FA 3901-2-120</td>
<td>PI (1 tape)/ PI coating</td>
</tr>
<tr>
<td>1908</td>
<td>SPA-10-24-9</td>
<td>PI/PUPTFE</td>
</tr>
<tr>
<td>1909</td>
<td>SPB-10-20-6</td>
<td>PTFE/PI/PI/PTFE</td>
</tr>
<tr>
<td>1910</td>
<td>SPC 10-24-N</td>
<td>PTFE/PI Pl</td>
</tr>
<tr>
<td>1911</td>
<td>MTV 1 20-A</td>
<td>PTFE (ext) PI coating</td>
</tr>
<tr>
<td>1912</td>
<td>Coaxial Cable 50 CIS</td>
<td>PTFE/Ag/Al</td>
</tr>
<tr>
<td>1913</td>
<td>Coax Cable R59</td>
<td>PI/ext. FEP</td>
</tr>
<tr>
<td>1914</td>
<td>1872-1-20</td>
<td>PI (1 tape)/ PI coating</td>
</tr>
</tbody>
</table>

- Cables/Wires passed the following tests: - Upward propagation test ) performed
- Flammability of wire ) according to Odor
- Offgassing ) ESA-PSS-Specs.
- Outgassing )
WIRING TESTING IN THE FRAME OF COLUMBUS CRITICAL TECHNOLOGIES PROGRAM (CTP)

- Additional tests have been performed
  - Microbial Growth (Fungi) (short duration test up to 4 weeks)

<table>
<thead>
<tr>
<th>Material No.</th>
<th>Chem. Nature</th>
<th>Class</th>
<th>Rating: (Growth of fungi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>PI, PI Coating</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1903</td>
<td>PI, PI Coating</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1904</td>
<td>PI, PI Coating</td>
<td>4</td>
<td>0 + 1 No constraints on materials (no growth)</td>
</tr>
<tr>
<td>1909</td>
<td>PTFE/PI/PI/PTFE</td>
<td>4</td>
<td>2 + 3 Materials to be used in dry accessible areas (cleaning)</td>
</tr>
<tr>
<td>1910</td>
<td>PTFE/PI</td>
<td>0</td>
<td>4 + 5 Materials should not be used in manned closed space habitat (heavy growth)</td>
</tr>
<tr>
<td>1911</td>
<td>PTFE/PI Coating</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>1912</td>
<td>PTFE/Ag/PI</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1913</td>
<td>PI/FEP</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1914</td>
<td>PI/PI Coating</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

WIRING TESTING IN THE FRAME OF COLUMBUS CRITICAL TECHNOLOGIES PROGRAM (CTP)

- Additional tests have been performed
  - Thermal Decomposition (at 200° C or max. operating temperature and at 500° C; Atmosphere 24.5 Vol % O₂)

<table>
<thead>
<tr>
<th>Material Group or Form</th>
<th>Mat. Ident. No.</th>
<th>Tradename</th>
<th>Toxicity Class at 200° C</th>
<th>Toxicity Class at 500° C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wires</td>
<td>1901</td>
<td>Wire Type: 1871</td>
<td>T0</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>1903</td>
<td>Wire Type: 3901/1</td>
<td>T0</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>1904</td>
<td>Wire Type: 3901/2</td>
<td>T0</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>1908</td>
<td>Wire Type: SPA 2110</td>
<td>T0</td>
<td>T3</td>
</tr>
<tr>
<td></td>
<td>1909</td>
<td>Wire Type: SPB 2110</td>
<td>T0</td>
<td>T3</td>
</tr>
<tr>
<td></td>
<td>1910</td>
<td>Wire Type: SPC 2110</td>
<td>T0</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>1911</td>
<td>Wire Type: MTV</td>
<td>T0</td>
<td>T3</td>
</tr>
<tr>
<td></td>
<td>1912</td>
<td>Coax Cable 50 C-IS</td>
<td>T0</td>
<td>T2</td>
</tr>
<tr>
<td></td>
<td>1913</td>
<td>Coax Cable R 59</td>
<td>T0</td>
<td>T3</td>
</tr>
<tr>
<td></td>
<td>1914</td>
<td>Wire Type: 1872</td>
<td>T0</td>
<td>T2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical Quantity of Materials - QCM (g/m²)</th>
<th>TOXICITY CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.10</td>
<td>T5</td>
</tr>
<tr>
<td>0.10 - 1</td>
<td>T4</td>
</tr>
<tr>
<td>1 - 10</td>
<td>T3</td>
</tr>
<tr>
<td>10 - 100</td>
<td>T2</td>
</tr>
<tr>
<td>100 - 1000</td>
<td>T1</td>
</tr>
<tr>
<td>&gt; 1000</td>
<td>T0</td>
</tr>
</tbody>
</table>
ACTIVITIES CONCERNING STANDARDIZATION

Arc-Tracking and Flam of Wire Test Methods

- Methods will be proposed to
  ISO Technical Committee TC 20, Aircraft and Space Vehicles, SC 14, Working Group 1

- Flam of wire test method acc. to ESA-PSS-01-721
  - is under evaluation by British Standard for incorporation into their aircraft wire spec.,
  - now being incorporated into ESA SCC 3901 series of spec's.

Space Systems -
Arc Tracking Test,
Cables and Wires

Space Systems -
Wire Flamm Test,
Electrical Wire Insulation
FUTURE ACTIVITIES

- Further investigations (ongoing) to flame of wire test, e.g. angle of wire inclination
- Extension of database on arc-tracking tests, e.g. test of fungi contaminated wires, variation of test parameters (current, voltage, etc.)
- Reconsideration of Accept/Reject Criteria for arc-tracking test method
- Standardization of test methods
- Request from Russia to perform arc-tracking tests with 4 polyimide insulation wires delivered by RSC-Energia, Moscow (comparison of test methods / test results)
- Performance of Parabolic Flight (1996): Influence of microgravity on arc-tracking