MR0093 In-flight Radiation Monitoring with Intravehicular Tissue Equivalent Proportional Counter (IV-TEPC) for Long Duration Flights

3.2 Medical Requirements Overview

<table>
<thead>
<tr>
<th>TABLE 3.2: MEDICAL REQUIREMENTS OVERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MRID# and Title:</strong> MR0093 In-flight Radiation Monitoring with Intravehicular Tissue Equivalent Proportional Counter (IV-TEPC) for Long Duration Flights</td>
</tr>
<tr>
<td><strong>Sponsor:</strong> Space and Clinical Operations</td>
</tr>
<tr>
<td><strong>Discipline:</strong> Radiation</td>
</tr>
<tr>
<td><strong>Category:</strong> Medical Requirements</td>
</tr>
<tr>
<td><strong>References:</strong> SSP 50260 ISS Medical Operations Requirements Document</td>
</tr>
<tr>
<td><strong>Purpose/Objectives:</strong> The purpose of the activity is to collect radiation environment data that will document crew exposure to radiation, perform risk assessment, and manage crew exposures during flight, especially during radiation contingencies. IV-TEPC collects the surrogate linear energy (y) data for the required linear energy transfer (LET) data and the absorbed dose. The Radiation Health Officer (RHO) will apply physical corrections to convert linear energy (y) spectra obtained with the IV-TEPC to LET –spectra for use in determining crew exposures. These corrections must account for the impact parameter distribution, energy straggling, delta-ray effects, and wall effects from both delta-rays and nuclear reactions.</td>
</tr>
<tr>
<td><strong>Measurement Parameters:</strong> Radiation exposures at the tissue-cell level y-spectra data.</td>
</tr>
<tr>
<td><strong>Deliverables:</strong> SRAG is responsible for archiving all cyclic telemetry, raw dumped data, and processed data of the IV-TEPC. The cyclic telemetry is stored on the SRAG SQL servers for operational usage and monitoring crew exposures. The processed data is archived on the SRAG internal website. Deliverables include characterization of the radiation environment for updating exposure records for occupational health risk assessments, real-time data for use during radiation contingencies, and onboard crew alarm for contingency radiation events. Elements of the processed data are included in a comprehensive report that is delivered to the NASA Radiation Health Officer (RHO) following a crewmember’s expedition. The archived data is also used for projecting crew mission exposure levels for future expedition flight readiness reviews.</td>
</tr>
<tr>
<td><strong>Flight Duration:</strong> ≥ 30 days</td>
</tr>
<tr>
<td><strong>Number of Flights:</strong> All flights</td>
</tr>
<tr>
<td><strong>Number and Type of Crew Members Required:</strong> Designated crewmembers will be assigned as operators. All U.S. crewmembers’ medical records will be updated based on IV-TEPC data.</td>
</tr>
<tr>
<td><strong>Other Flight Characteristics:</strong> N/A</td>
</tr>
</tbody>
</table>
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3.3 Preflight Training

| Preflight Training Activity Description: | Training will be covered in the following Environmental Health System (EHS) lessons and documents: EHS Radiation Operations. Training classes will introduce the EHS radiation hardware & procedures and review the radiation environment in space. The location and function of each piece of hardware is detailed. Hands on training will also be provided. Long-duration crewmembers will be trained to initially deploy and to replace detectors on the IV-TEPC. Relocation procedures will be covered to provide an understanding of what is involved in the monthly relocate activities on ISS. |

| Ground Support Requirements Hardware/Software | Preflight Hardware: Intravehicular Tissue Equivalent Proportional Counter (IV-TEPC) | Preflight Software: IV-TEPC Software on SSC | Test Location: U.S. |

| Training Facilities | Minimum Room Dimensions: 8’ x 10’ | Number of Electrical Outlets: 2 | Temperature Requirements: Ambient | Special Lighting: N/A |
| | Hot or Cold Running Water: N/A | Privacy Requirements: N/A | Other: 1 Table, 4-6 Chairs |

| Constraints/Special Requirements: | N/A |
| Launch Delay Requirements: | Training will be repeated if requested by the crewmember. |
| Notes: | N/A |

3.4 Preflight Activities - None
3.5 In-Flight Activities

**TABLE 3.5.1: IN-FLIGHT ACTIVITIES**

<table>
<thead>
<tr>
<th>In-Flight Activity</th>
<th>Description</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV-TEPC Initial Deployment</td>
<td>IV-TEPC will operate continuously to provide radiation measurements of tissue effective dose and dose equivalent. The IV-TEPC will be relocated periodically throughout the habitable modules of the station to analyze the internal radiation environment. Space Radiation Analysis Group (SRAG) will define a relocation plan to determine how long and at which locations the IV-TEPC will be deployed. Nominal deployment sites will be within the cable reach of the CHeCS Power/Data ports. Measured spectra will be telemetered approximately weekly on demand. There may be instances when SRAG defines a specific location that precludes access to a CHeCS Power/Data port, in which case real-time telemetry will not be available, but will either be telemetered the next time IV-TEPC is plugged into a CHeCS Power/Data port, or transferred to an SSC for downlink by the crew.</td>
<td>Crew will deploy once in orbit</td>
</tr>
<tr>
<td>IV-TEPC Relocate</td>
<td>Linear Energy Transfer (LET) spectra data shall be used to provide an estimate of average quality factor for the mission.</td>
<td>Once every 4 weeks +/-1 week</td>
</tr>
</tbody>
</table>

Procedures:

- All in-flight procedures are developed in-house and contained within the System Operations Data file (SODF) MedOps book.
  - IV-TEPC Activation and Data Checkout
  - IV-TEPC Alarm
  - IV-TEPC Data Collection
  - IV-TEC Power Down/Power Up
  - IV-TEPC Data Transfer to SSC
  - IV-TEPC Relocate (one-time use procedures for each module relocate)

Constraints / Special Requirements:

- Scrub turnaround = N/A
- IV-TEPC will be secured within the designated modules via Velcro or seat track interface.
- The IV-TEPC alarm is tied into the station caution and warning system (class 3 alarm). The IV-TEPC does not contain a local alarm.
- Deployment locations must not impede rapid egress or block access to any rack.

Photo / TV Requirements:

- Photos of IV-TEPC are required when IV-TEPC is relocated. Photos are necessary to document the position and orientation of the detector heads, surroundings of IV-TEPC, and to ensure the prime detector is not shielded more than expected.

Cold Stowage Requirements:

- N/A

Mission Extension Requirements:

- N/A

Landing Wave-Off Requirements:

- N/A

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Approved X05/08/2014
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<table>
<thead>
<tr>
<th>Data Delivery</th>
<th>Data/Report to Designated Recipients (Nominal/Contingency):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Notes</strong></td>
<td><strong>Cyclic Data (minute-by-minute data):</strong> This data will be obtained via the ISS S-Band telemetry resource. SRAG will use this data and provide weekly summary notes to the Crew Surgeon. This data will also be used to help make real-time risk management, operational decisions to meet the As Low As Reasonably Achievable (ALARA) principle for the protection of the crew from ionizing radiation during space weather events.</td>
</tr>
<tr>
<td></td>
<td><strong>IV-TEPC Dump Data:</strong> Ground control will dump data from the IV-TEPC once per week. If the capability to command the IV-TEPC from MCC-H is lost, meaning data dumps cannot be performed, it is advisable that IV-TEPC data be transferred to the SSC approximately once per to prevent data loss due to the possibility of new data recording over previous data.</td>
</tr>
<tr>
<td></td>
<td><strong>Instrument Health/Status Data:</strong> The hardware sustaining organization will review and analyze the engineering data files, and provide a periodic summary of the IV-TEPC’s health &amp; status to SRAG. These status reports will not be forwarded to the Crew Surgeon nominally.</td>
</tr>
<tr>
<td></td>
<td><strong>SRAG is responsible for archiving all cyclic telemetry, raw dumped data, and processed data of the IV-TEPC. The cyclic telemetry is stored on the SRAG SQL servers for operational usage and monitoring crew exposures. The processed data is archived on the SRAG internal website. Elements of the processed data are included in a comprehensive report that is delivered to the NASA Radiation Health Officer (RHO) following a crewmember’s expedition.</strong></td>
</tr>
</tbody>
</table>
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In-Flight Activities, (cont.)

**TABLE 3.5.2: IN-FLIGHT HARDWARE**

<table>
<thead>
<tr>
<th>Hardware/Software Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-Vehicular Tissue Equivalent Proportional Counter (IV-TEPC) Assembly:</td>
</tr>
<tr>
<td>Spectrometer</td>
</tr>
<tr>
<td>Small Detector</td>
</tr>
<tr>
<td>Large Detector</td>
</tr>
<tr>
<td>Power Cable</td>
</tr>
</tbody>
</table>

3.6 Postflight Activities

**TABLE 3.6: POSTFLIGHT ACTIVITIES**

<table>
<thead>
<tr>
<th>Postflight Activity</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Submittal of final mission expedition report.</td>
</tr>
<tr>
<td>Constraints/Special Requirements:</td>
<td>N/A</td>
</tr>
<tr>
<td>Early Destow / Early Return:</td>
<td>N/A</td>
</tr>
<tr>
<td>Notes:</td>
<td>Crewmember radiation exposure from each mission and their accumulated radiation exposure will be recorded in crewmembers’ medical records and will also be used for occupational health risk assessment.</td>
</tr>
<tr>
<td>Data Delivery</td>
<td>Elements of the processed data are included in a comprehensive report that is delivered to the NASA Radiation Health Officer (RHO) following a crewmember’s expedition.</td>
</tr>
<tr>
<td>Mission Summary Report:</td>
<td>Approx. R+90 days</td>
</tr>
<tr>
<td>Data Archives:</td>
<td>Approx. R+90 days</td>
</tr>
</tbody>
</table>
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3.7 Summary Schedule

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DURATION</th>
<th>SCHEDULE</th>
<th>PERSONNEL REQUIRED</th>
<th>CONSTRAINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preflight Training:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EHS Radiation Operations</td>
<td>90 min.</td>
<td>NLT L-6 months</td>
<td>Crewmembers/Instructors</td>
<td>None</td>
</tr>
<tr>
<td><strong>Preflight: N/A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>In-Flight Activity:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV-TEPC Initial Deployment</td>
<td>40 min.</td>
<td>Crew will deploy once in orbit</td>
<td>1 ISS crewmember</td>
<td>None</td>
</tr>
<tr>
<td>IV-TEPC Relocate with Photodocumentation</td>
<td>20-25 min. depending on whether RAM install is required</td>
<td>Once every 4 weeks +/-1 week</td>
<td>1 ISS crewmember</td>
<td>-Payload MDM (Multiplexer and De-multiplexer) is active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wheels-Stop: N/A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Postflight:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Mission Expedition Report</td>
<td>~R+90 days</td>
<td>Radiation Team</td>
<td>Report provided to Radiation Health Officer (RHO) to provide to crewmembers postflight.</td>
<td></td>
</tr>
<tr>
<td><strong>Postflight Debrief:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debrief</td>
<td>No extra time</td>
<td>~R+30 days</td>
<td>Crewmembers/Radiation Team</td>
<td>Included as part of the Med Ops overall debrief.</td>
</tr>
</tbody>
</table>

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