Geostationary Operational Environmental Satellite (GOES) – R Series

SEISS Beta, Provisional and Full Validation Readiness, Implementation and Management Plan (RIMP)

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SEISS Beta, Provisional and Full Validation
Readiness, Implementation and Management Plan (RIMP)

Revision Prepared by:

Electronically signed by: Katherine Pitts
GOES-R Product Readiness and Operations Cal/Val Support

Submitted by:

Electronically signed by: Matthew Seybold
GOES-R Product Readiness and Operations Manager

Concurred by:

Electronically signed by Laurel Rachmeler for: Robert Redmon
NCEI Solar & Terrestrial Physics Section Lead

Electronically signed by: Melissa Dahya
GOES-R Flight PLT Director

Approved by:

Electronically signed by Monica Todirita for: Candace Carlisle
GOES-R Flight Project Manager

Electronically signed by: James Valenti
GOES-R Ground Segment Project Manager

Electronically signed by: Pamela Sullivan
GOES-R Series System Program Director

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## Document Change Record

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PREFACE

The Readiness, Implementation, and Management Plans (RIMPs) have been created to document the analysis techniques, methodology, duration, tools, data, resources, staffing, and schedule of the Post-Launch Product Tests (PLPTs) to be used by the calibration and validation (cal/val) science teams to demonstrate the different levels of product maturity. The primary purpose of the RIMPs is to act as a planning resource for the cal/val teams as they prepare for Launch. Additionally, the RIMPs can be used by other members of the GOES-R Program to prepare for cal/val activities, to assess the suitability of the cal/val test plans, and to understand the science teams’ data and resource requirements. Cal/val testing is likely to reveal necessary algorithm and look-up table (LUT) changes to evolve the product quality through the maturity levels. The Algorithm Change Management Plan (ACMP) will be used to track and implement these software changes.

The evolving cal/val maturity of GOES-R products is described by three levels: Beta, Provisional, and Full Validation. The Flight Project is responsible for producing the Level 1b (L1b) products according to the GOES-R Level III requirement documents. Once Beta maturity of the L1b products is achieved, validation activities for Level 2+ (L2+) products can begin. Further levels of maturity (Provisional and Full Validation) require additional and often long-term activities. A detailed description of the three product maturity levels is given in Figure 1, but a brief description of the three maturity levels are:

**Beta:** the product is minimally validated based on product quick looks using the initial calibration parameters and may still contain significant errors. Product is made available to users to gain familiarity with data formats and parameters.

**Provisional:** product performance has been demonstrated through a select number of independent measurements and periods. The analysis is sufficient to communicate known product performance and issues to end users, and the product is ready for operational use.

**Full:** product performance has been demonstrated over a large and wide range of representative conditions, with comprehensive documentation of product performance, including known anomalies and their remediation strategies. The product is operational.

Product quality assessment and declaration of maturity levels is performed during Peer Stakeholder–Product Validation Reviews (PS-PVRs). At each PS-PVR, the status of products will be presented by members of the cal/val science teams. For GOES-16 and GOES-17 L1b products, Beta maturity PS-PVRs are held once each instrument’s Post-Launch Tests (PLTs) have been successfully completed by the GOES-R Flight Project and the instrument vendors. For GOES-18 and GOES-19, Beta maturity will leverage early PLT results and the performance and characterization needed for the first public image/data release. After an L1b product has achieved Beta maturity, the product is added to the GOES Rebroadcast (GRB) stream, so that operational users can begin familiarizing themselves with the product format and parameters. Beta PS-PVRs for ABI L2+ products were only held for GOES-16; for subsequent satellites,
ABI L2+ Beta maturity is assumed when the L1b product is Beta due to the maturity of the Ground Processing Algorithms (GPAs). After an L1b or L2+ product has achieved Provisional maturity, the product is approved for distribution from Product Distribution and Access (PDA) and Comprehensive Large Array-data Stewardship System (CLASS). The review panel at the PS-PVRs will include the GOES-R Operational Readiness Working Group (GORWG), GOES-R Program System Engineering (PSE), NOAA Office of Satellite and Product Operations (OSPO), National Weather Service (NWS), Calibration Working Group (CWG; L1b products) and/or Algorithm Working Group (AWG; L2+ products), NESDIS Office of Satellite Ground Services (OSGS), NESDIS Scientist, GOES-R Scientist, and GOES-R Product Readiness and Operations (PRO). The outcome of the PS-PVR is determined by the panel Chair. PS-PVR artifacts will be publicly available at https://www.noaasis.noaa.gov/GOES/product_quality.html.

The introspection necessary to create these RIMPs has led to extensive consultations between the cal/val teams and other groups within the GOES-R Program, including Program System Engineering, the Flight Project and the Ground Segment. Figure 2 below describes the responsibilities and accountability of each of the main parties involved in the creation of the RIMPs. This delineation is required because GOES-R operations are to be handed over from the GOES-R Program to NOAA OSPO at the end of the PLT period, yet the process of validating product maturity will continue. This changing nature of accountability during the process must be acknowledged. Accountability of the RIMPs changes at Operations Handover from NASA to NOAA and is aligned with the level of each RIMP’s validation maturity objective. Accountability describes which organization owns documentation, process, and procedures. Responsibility describes which organization creates, executes, and maintains specific activities.
## GOES-R Product (L1b and L2+) Maturity Levels

### Beta Validation

**Preparation Activities**
- Initial calibration applied (L1b).
- Rapid changes in product input tables, and possibly product algorithms, can be expected.
- Product quick looks and initial comparisons with ground truth data (if any) are not adequate to determine product quality.
- Anomalies may be found in the product and the resolution strategy may not exist.

**End State**
- Products are made available to users to gain familiarity with data formats and parameters.
- Product has been minimally validated and may still contain significant errors.
- Product is not optimized for operational use.

### Provisional Validation

**Preparation Activities**
- Validation and quality assurance (QA) activities are ongoing, and the general research community is now encouraged to participate.
- Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.
- Incremental product improvements may still be occurring.
- Users are engaged in the Customer Forums (L2+ products only), and user feedback is assessed.

**End State**
- Product performance (L1b or L2+) has been demonstrated through analysis of a small number of independent measurements obtained from selected locations, periods, and associated ground-truth/field program efforts.
- Product analysis is sufficient to communicate product performance to users relative to expectations.
- Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, tested, and shared with the user community.
- Testing has been fully documented.
- Product ready for operational use and for use in comprehensive calibration/validation activities and product optimization.

### Full Validation

**Preparation Activities**
- Validation, QA, and anomaly resolution activities are ongoing.
- Incremental product improvements may still be occurring.
- Users are engaged and user feedback is assessed.

**End State**
- Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground-truth and validation efforts.
- Products are operationally optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations.
- All known product anomalies are documented and shared with the user community.
- Product is operational.

---

**Figure 1. GOES-R product maturity levels.**

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**Delineation of RIMP Execution Accountability**

*Accountability for RIMP changes at Operations Handover and is aligned with the level of product validation maturity within the RIMP.*

---

**Pre-Ops Handover**

**GOES-R Accountability**

- L1b RIMP & Product Maturity: Beta, Provisional
- L2+ RIMP & Product Maturity: Beta

**Post-Ops Handover**

**CWG/AWG Accountability**

- L1b RIMP & Product Maturity: Full
- L2+ RIMP & Product Maturity: Provisional, Full

---

**Responsibilities**

- **GOES-R PRO:** On behalf of GOES-R Program Systems Engineering, PRO is responsible for facilitating the preparation of RIMPs, including interactions between CWG/AWG and GOES-R Flight, Ground, etc., ensuring the CWG and AWG have the data necessary for PLPT analysis, and coordinating PS-PVRs.

- **Calibration Working Group (CWG):** CWG includes STAR, NASA MSFC & NCEI-CO and is responsible for providing data resources and content for L1b RIMPs, executing PLPT analyses, and presenting results at L1b PS-PVRs.

- **Algorithm Working Group (AWG):** Like CWG, AWG is responsible for providing data resources and content for L2+ RIMPs, executing PLPT analyses, and presenting results at L2 PS-PVRs.

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**Figure 2. Delineation of RIMP execution accountability between GOES-R and CWG/AWG.**

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1. **SEISS VALIDATION OVERVIEW**

The Space Environment In-Situ Suite (SEISS) gives a more comprehensive view of charged particle (electron and ion) radiation at geostationary orbit than that granted by prior generations of GOES satellites. The SEISS includes the following sensors:

- Magnetospheric Particle Sensor (low energy) – MPS-LO
- Magnetospheric Particle Sensor (high energy) – MPS-HI
- Solar and Galactic Proton Sensor – SGPS
- Energetic Heavy Ion Sensor – EHIS

Pictures of the SEISS sensors, along with the SEISS Data Processing Unit (DPU), are shown in Figure 3. The SEISS performance characteristics are described in
Table 1.

Figure 3. SEISS instruments
Table 1. SEISS performance characteristics

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Species</th>
<th>Energy Range</th>
<th>Channels</th>
<th>Angular Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPS-LO</td>
<td>Ions</td>
<td>0.03-30 keV</td>
<td>15</td>
<td>180° fan in Body Reference Frame (BRF) yz-plane centered on –Z axis;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12 unique angular zones separated by 15°</td>
</tr>
<tr>
<td>MPS-LO</td>
<td>Electrons</td>
<td>0.03-30 keV</td>
<td>15</td>
<td>180° fan in BRF yz-plane centered on –Z axis;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12 unique angular zones separated by 15°</td>
</tr>
<tr>
<td>MPS-HI</td>
<td>Protons (H+)</td>
<td>80-10,000 keV</td>
<td>11</td>
<td>180° fan in BRF yz-plane centered on –Z axis;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 telescopes separated by 35°; 15° half-angle conical Field of Views (FOVs)</td>
</tr>
<tr>
<td>MPS-HI</td>
<td>Electrons</td>
<td>50-4000 keV and &gt;2000 keV</td>
<td>11</td>
<td>180° fan in BRF yz-plane centered on –Z axis;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 telescopes separated by 35°; 15° half-angle conical FOVs</td>
</tr>
<tr>
<td>SGPS</td>
<td>Protons (H+)</td>
<td>1-500 MeV and &gt;500 MeV</td>
<td>11</td>
<td>Two SGPSs, +X and –X look directions;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;45° half-angle conical FOVs</td>
</tr>
<tr>
<td>SGPS</td>
<td>Alphas (He+)</td>
<td>1-500 MeV/nucleon and &gt;500 MeV/nucleon</td>
<td>11</td>
<td>Two SGPSs, +X and –X look directions;</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;45° half-angle conical FOVs</td>
</tr>
<tr>
<td>EHIS</td>
<td>Ions (H through Ni, separately resolved)</td>
<td>10-200 MeV/nucleon</td>
<td>5 per species</td>
<td>One 28° half-angle conical FOV along –Z axis</td>
</tr>
</tbody>
</table>

Post-launch Testing (PLT) provides a qualitative and limited quantitative validation of SEISS L1b product integrity. It also includes validation of Ground Segment (GS) calibration/L1b product processing and data storage, monitoring, and distribution functions. During this time, operational calibration and L1b algorithms will more than likely be updated before system functioning would be considered nominal. Once this nominal state has been reached, Post-Launch Product Testing (PLPT) begins which represents a continuation of the SEISS L1b product science validation. It is also composed of further in-depth analysis of SEISS calibration that establishes a beginning-of-life snapshot of SEISS calibration in the satellite on-orbit environment. This snapshot can be used as an initial benchmark for long-term trending of SEISS performance.

Only PLTs support SEISS Beta maturity, and those tests are listed in Table 2 with details in Appendix C. The PLPTs required for Provisional and Full Validation are listed in
Table 3 and Table 4, respectively, with each test’s details provided in Appendix A. Within each entry in Appendix A, the entry “Reference MRD” gives the reference numbers from the Mission Requirements Document (MRD). The performance baseline given by Massachusetts Institute of Technology – Lincoln Laboratory (MIT LL) demonstrates how these MRD requirements were verified pre-launch. The objective of the testing described in this RIMP is to determine through instrument and product characterization if the deliverable products satisfy their intended use in the intended environment, which also permits certification of the on-orbit performance against the pre-launch performance baseline. Therefore, the expectation is for the SEISS science team at NCEI to execute PLPTs necessary and sufficient to perform both objectives to the best of their ability. The references to specific MRD requirements are provided as justification for including each PLPT in the cal/val effort. These references are based on the analysis and recommendations of MIT LL and The Aerospace Corporation subject matter experts, with modifications by the NCEI instrument scientists. The listing of MRD items does not fully enumerate the possible results from each PLPT, including those that may address other performance baseline results, but are the priority items according to the science team. Due to the limitations of post-launch testing, it may be difficult, if not impossible, to characterize some products or product characteristics to the same precision and accuracy as the performance baseline.

Beta Maturity Activities

PLTs are led by the GOES-R Flight Project and the SEISS instrument vendor, Assurance Technology Corporation (ATC). Some PLTs are transitional, meaning they are initially assigned to ATC and are then transitioned to National Centers for Environmental Information – Colorado (NCEI-CO) to continue the calibration activities for Mission Life. SEISS PLTs are listed in Table 2 with details in Appendix C (final approved list available in Operations Configuration Management System).

For GOES-16 and GOES-17, all PLTs were run before a Beta PS-PVR was held to determine that the product had reached Beta maturity. For GOES-18 and GOES-19, the minimum general criteria for SEISS Beta product maturity is that all sensors are producing science data. This can be achieved after running PLTs G*-C-SEI-001 through G*-C-SEI-006 without the IFC table uploads, as agreed upon by a working group of Subject Matter Experts (SMEs) from CWG, Flight, ATC, and MIT LL.
Table 2. SEISS PLTs that support Beta maturity for each satellite in the GOES-R Series (16, 17, 18, and 19). Table also indicates which PLTs are transitional. The star (*) in each ID represents the satellite number (i.e., 16, 17, 18, or 19). Blue color denotes test was / will be done. Gray shading indicates test was not / will not be done, or is a reserve test.

<table>
<thead>
<tr>
<th>Test ID</th>
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<th>18/19</th>
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<tr>
<td>G*-C-SEI-001</td>
<td>EHIS Initial In-Flight calibration (IFC) Verification</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>G*-C-SEI-002</td>
<td>EHIS On-Orbit Execution</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*-C-SEI-003</td>
<td>MPS-HI Initial IFC Execution</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*-C-SEI-004</td>
<td>MPS-LO Initial IFC Execution</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*-C-SEI-005</td>
<td>MPS-LO Initial Turn-On of Electron and Ion Microchannel Plate High Voltage (MCP HV)</td>
<td>Yes</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>G*-C-SEI-006</td>
<td>SGPS Initial IFC Execution</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*-C-SEI-007</td>
<td>Cross-Calibration of SGPS +/-X</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>G*-C-SEI-008</td>
<td>SGPS D3-D1 Logic Circuit Test</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>G*-C-SEI-009</td>
<td>Yaw Flip Instrumentation Cross-Calibration (SGPS +/-X)</td>
<td>Yes</td>
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Provisional Maturity Activities

PLPTs that support Provisional maturity are listed in

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Table 3, with detailed descriptions in Appendix A. In some SEISS PLPT descriptions, “continuous data” are indicated as required for some period of time. This means that multiple days with nearly complete time series at all local times are required in order to complete the test. A few short gaps lasting much less than an hour are acceptable. However, if multiple hours are lost during a given day (whether from the GOES-R Series satellite being checked out or the satellite being cross-calibrated), the data collection period will be extended by a full day until the required amount of data is collected. See Section 2 and Appendix A for further clarification on data collection criteria.
Table 3. SEISS PLPTs that support Provisional maturity for each satellite in the GOES-R Series (16, 17, 18, and 19). Purple color denotes test was / will be done. Gray shading indicates test was not / will not be done, or is a reserve test.

<table>
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<th>Test Title</th>
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<th>17</th>
<th>18/19</th>
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<tbody>
<tr>
<td>PLPT-SEI-002</td>
<td>MPS-HI Telescope Cross-Comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-003</td>
<td>MPS-LO Zone Cross-Comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-004</td>
<td>SEP Channel Cross-Comparison&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-005</td>
<td>Cross Satellite Comparison of Trapped Particles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-006</td>
<td>Backgrounds Trending</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> PLPT-SEI-004 was planned for GOES-17 but was not able to be executed prior to the Provisional PS-PVR due to lack of a Solar Energetic Particle (SEP) event.

Full Maturity Activities

The PLPTs that support Full maturity are extensions of the Provisional PLPTs, plus the addition of PLPT-SEI-001. The Full PLPTs are listed in Table 4; details are in Appendix A.

Table 4. SEISS PLPTs that support Full maturity for each satellite in the GOES-R Series (16, 17, 18, and 19). Green color denotes test was / will be done.

<table>
<thead>
<tr>
<th>Test ID</th>
<th>Test Title</th>
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<th>17</th>
<th>18/19</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLPT-SEI-001</td>
<td>SGPS D3-D1 Contamination Correction</td>
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<td></td>
</tr>
<tr>
<td>PLPT-SEI-002</td>
<td>MPS-HI Telescope Cross-Comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-003</td>
<td>MPS-LO Zone Cross-Comparison</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-004</td>
<td>SEP Channel Cross-Comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-005</td>
<td>Cross Satellite Comparison of Trapped Particles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLPT-SEI-006</td>
<td>Backgrounds Trending</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The validation processes and procedures, monitoring and analysis methods, tools, and expected output artifacts are described in the following sections. The details of each PLPT are contained in Appendix A and each reference data set is listed in Appendix B. The details of each PLT are in Appendix C and any tools used in the validation process are listed in Appendix D.

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2. SCHEDULE OF EVENTS

Figure 4 shows the high level post-launch science product validation schedule\(^1\). The schedule for PLT is owned by the GOES-R Flight Project and under configuration management. The details should be expected to change up to Launch and possibly even during the PLT period if major anomalies are found.

Once PLPTs begin, SEISS tests will be conducted simultaneously according to the criteria listed within each PLPT description (see Appendix A) for each maturity level. The historical and projected maturity schedules for each SEISS instrument are summarized by satellite in Table 5.

---

Table 5. Post-launch science product validation schedule for each instrument on SEISS. The first column shows the nominal schedule in time from launch (L) plus months. The second column shows the same for days. The GOES columns with colored cells denote actual date, while the white cells denote expected date; the values in parentheses show L+days.

<table>
<thead>
<tr>
<th>Nominal (months)</th>
<th>Nominal (days)</th>
<th>Instrument</th>
<th>GOES-16</th>
<th>GOES-17</th>
<th>GOES-18</th>
<th>GOES-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launch</td>
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<td>All</td>
<td>11/19/16 (L+0)</td>
<td>3/11/18 (L+0)</td>
<td>12/7/21</td>
<td>4/1/24</td>
</tr>
<tr>
<td>Outgas complete</td>
<td>L+2</td>
<td>All</td>
<td>1/8/17 (L+50)</td>
<td>4/24/18 (L+54)</td>
<td>2/7/22</td>
<td>6/1/24</td>
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<td>Beta</td>
<td>L+4</td>
<td>All</td>
<td>2/10/17 (L+83)</td>
<td>8/10/18 (L+162)</td>
<td>4/7/22</td>
<td>8/1/24</td>
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<tr>
<td>Provisional</td>
<td>L+6</td>
<td>EHIS</td>
<td>7/11/18 (L+600)</td>
<td>5/21/19 (L+446)</td>
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<tr>
<td></td>
<td>L+180</td>
<td>MPS-LO</td>
<td>3/29/19 (L+860)</td>
<td>9/20/19 (L+568)</td>
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<tr>
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<td></td>
<td>MPS-HI</td>
<td>12/18/17 (L+394)</td>
<td>12/18/18 (L+292)</td>
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---

\(^1\) See also the GOES-R Series Calibration and Product Validation Strategy (410-R-CALVAL-0192) section on the GOES-R Calibration and Product Validation Schedules.

Check the GOES-R Portal at [https://goesportal.ndc.nasa.gov](https://goesportal.ndc.nasa.gov) to verify correct version prior to use.
The following subsections describe the nominal SEISS product schedule on the assumption that a satellite is going to Operations. The goal is for Beta and Provisional Validation to be completed before Handover at L+6 months, at which point the satellite will either go into Operations or storage mode.

### 2.1 BETA MATURITY TESTING

For GOES-16 and GOES-17 a Beta PS-PVR was held to show the results of the PLT activities and determine if the product demonstrates on-orbit performance adequate to begin detailed product testing. In lieu of a Beta PS-PVR, for GOES-18 and GOES-19 the results from a subset of the PLTs necessary for science data to flow from each sensor will be used for a Beta certification. A cross-collaborative working group, including the cal/val team, GOES-R Program, and the Flight vendor, have defined the criteria for SEISS Beta Certification as all sensors are producing science data, which can be achieved after running PLTs G*-C-SEI-001 through G*-C-SEI-006 (without the IFC table uploads).

#### 2.1.1 Beta Entrance Criteria:

Completion of launch, orbit raising, and outgassing, expected by L+60 days.

#### 2.1.2 Duration of Beta Testing:

The Flight- and vendor-led PLT activities begin during the Beta phase and for GOES-16 and GOES-17 Beta maturity has been achieved by L+83 and L+162 days, respectively. However, for GOES-18 and GOES-19 the prerequisites and activities leading up to the Beta maturity declaration will be streamlined and are expected to be achieved by L+120 days. Although Beta Certification will be given before all PLTs have been completed, the PLT activities will continue beyond this point into the PLPT period.

#### 2.1.3 Beta Testing Artifacts:

The PLT reports will be generated by the Flight and vendor teams. These will be discussed at the Post Test Data Review (PTDR) meetings and stored on the GOES-R portal. There will be a summary report in the form of a README that will describe the instrument and L1b data status.
2.1.4 Exit Criteria and Readiness for Beta Certification:

The general criterion for Beta product maturity is that the product has demonstrated on-orbit performance adequate to begin detailed product testing. Specific criteria for completing the PLTs necessary for establishing Beta maturity are described in the PLT forms.

2.2 PROVISIONAL MATURITY TESTING

2.2.1 Provisional Entrance Criteria:

PLPT activities begin during Flight-led PLT activities - after the first public image release.

2.2.2 Duration of Provisional Testing:

Data collection for PLPTs must start as soon as the respective sensors are commanded into their nominal operating mode in order to achieve Provisional maturity prior to Handover. The target completion times for each PLPT are as follows:

- PLPT-SEI-002: MPS-HI Telescope Cross-Comparison - 1 month of continuous data
- PLPT-SEI-003: MPS-LO Zone Cross-Comparison - 1 month of continuous data
- PLPT-SEI-004: SEP Channel Cross-Comparison - 1 Solar Energetic Particle (SEP) event
- PLPT-SEI-005: Cross Satellite Comparison of Trapped Particles - 1 month of continuous data
- PLPT-SEI-006: Backgrounds Trending - 2 months of continuous data

Provisional testing is scheduled for completion and the Provisional PS-PVR presented by L+180 days. In the event that a SEP event does not occur, or less than the nominal amount of time for data collection is available beyond Beta Certification, the Provisional PS-PVR will still be held prior to L+180 days and the risks and caveats from those PLPTs that did not meet their success criteria must be described.

2.2.3 Provisional Testing Artifacts:

A slide deck that documents the results of the Provisional PLPTs with tables and figures to substantiate the conclusions will be created. The success criteria for each individual Provisional PLPT are listed in the PLPT descriptions within Appendix A. There will also be a summary report in the form of a README that will describe the instrument and L1b data status.

2.2.4 Exit Criteria and Readiness for Provisional PS-PVR:

All PLPTs supporting Provisional Validation need to be summarized in a slide deck and presented at a PS-PVR prior to Handover.

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
2.3 FULL MATURITY TESTING

2.3.1 Full Entrance Criteria:

Data are Provisionally mature. If the satellite has gone into storage immediately after Provisional Validation, Full maturity PLPTs will start after the satellite is moved out of storage location.

2.3.2 Duration of Full Testing:

One year of testing with Provisional data is the scheduled duration for Full maturity validation. During this Full testing period, the nominal target completion times for the Full PLPTs are as follows:

- PLPT-SEI-001: SGPS D3-D1 Contamination Correction - 180 days of continuous data
- PLPT-SEI-002: MPS-HI Telescope Cross-Comparison - 3 months of continuous data
- PLPT-SEI-003: MPS-LO Zone Cross-Comparison - 3 months of continuous data
- PLPT-SEI-004: SEP Channel Cross-Comparison - 2 SEP events
- PLPT-SEI-005: Cross Satellite Comparison of Trapped Particles - 3 months of continuous data
- PLPT-SEI-006: Backgrounds Trending - 4 months of continuous data

2.3.3 Full Testing Artifacts:

A slide deck that documents the results of the Full PLPTs with tables and figures to substantiate the conclusions will be created. The success criteria for each individual Full PLPT are listed in the PLPT descriptions within Appendix A. There will also be a summary report in the form of a README that will describe the instrument and L1b data status.

2.3.4 Exit Criteria and Readiness for Full PS-PVR:

Product performance is defined, product is operationally optimized, and all known product anomalies are documented and shared with the user community. Full Validation is expected by L+545 days if the satellite is not placed into storage. However, two SEP events are included in the criteria for Full Validation, and lack of such phenomena prior to L+545 days may delay Full Validation.

2.4 NOTES FOR CLARIFICATION ON DATA COLLECTION

1. The PLT G*-C-SEI-002 (EHIS On-Orbit Calibration) drives the conclusion of the SEISS PLT period. Other SEISS instruments will reach Beta status earlier. For example, SGPS reaches Beta status after conclusion of G*-C-SEI-007 (Cross Calibration of SGPS +X & -X) on PLT day 44 (L+59).

2. PLPT-SEI-001 (SGPS D3-D1 Contamination Correction) can start at the conclusion of PLT G*-C-SEI-007. This PLPT can be executed using the background galactic cosmic ray (GCR)

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proton fluxes. Since the GCR count rate is very low, the required integration time is long – 180 days as planned. There will be enough information to give a preliminary assessment at Handover, but the final assessment will only be possible during the Full Validation period.

3. PLPT-SEI-004 (SEP Channel Cross-Comparison) can only be performed completely if there is an energetic, strong-to-severe (NOAA Space Weather Prediction Center [SWPC] Solar Radiation Storm scale S3-S4) SEP event during PLT. Absent such an SEP event, a definitive complete statement on SGPS performance is not possible. A moderate or minor SEP event will permit testing of the lower energy SGPS channels, while in the absence of an SEP event only the lowest 1-2 energy channels can be tested (using trapped radiation belt proton fluxes). Because these fluxes support NOAA SWPC’s Solar Radiation Storm alerts issued for human safety purposes, Provisional maturity is not recommended until SGPS has observed an energetic, strong SEP event and the cross-comparison PLPT can be performed fully.

Some historical illustrative examples are provided here. SEP events do not occur at a regular, predictable rate. The final SEP event of Solar Cycle (SC) 23 occurred during the GOES-13 PLT period, in December 2006. Moreover, this was a strong and energetic SEP event that was observed in all GOES solar proton channels with adequate signal to noise ratio (SNR). This was about 10.5 years into SC23. The SEP events during SC24 were less energetic than those during SC23, and SC24 was determined to be the weakest cycle in 100 years. The last strong SEP event of SC24 occurred in September 2017 and was used for GOES-16 instrument testing. A strong SEP event has not occurred since then, and thus the GOES-17 instrument testing has not yet been able to be fully performed. SC25 began in December 2019 and peak sunspot activity is expected in July 2025, but SC25 is also forecast to be a weak cycle.
3. ROLES AND RESPONSIBILITIES

The GOES-R Calibration/Validation Plan Volume 1: L1b Data (cal/val plan) is the governing document defining organizational responsibilities for GOES-R product testing, including the analysis, review, approval, and anomaly resolution processes required for product validation. The cal/val plan takes precedence over the following summary of specific post-launch test responsibilities.

PLT assessments of SEISS instrument functionality, non-nominal operations, and initial data quality are conducted by the Mission Operations Support Team (MOST) with vendor support by ATC. SEISS will achieve Beta Validation during these early PLT assessments. Subsequent PLPT activities to advance product maturity to Provisional Validation involves detailed data analysis conducted under guidance of the CWG and GOES-R Program management by members of the cal/val team at NOAA, NASA, and industry. The roles and responsibilities of specific individuals and organizations during each satellite’s PLT period are listed in Table 6 (names and affiliations subject to change).

<table>
<thead>
<tr>
<th>Role</th>
<th>GOES-16</th>
<th>GOES-17</th>
<th>GOES-18/19</th>
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<tr>
<td>SEISS PLPT Lead</td>
<td>Brian Kress (CIRES, NCEI)</td>
<td>Brian Kress (CIRES, NCEI)</td>
<td>Brian Kress (CIRES, NCEI)</td>
</tr>
<tr>
<td>GOES-R Product Quality Lead</td>
<td>Jon Fulbright (PRO)</td>
<td>Elizabeth Kline (PRO)</td>
<td>Elizabeth Kline (PRO)</td>
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<tr>
<td>Ground Segment Product Readiness and Operations Calibration/Val Coordination</td>
<td>Jon Fulbright (PRO); Alternate: Elizabeth Kline (PRO)</td>
<td>Jon Fulbright (PRO); Alternate: Elizabeth Kline (PRO)</td>
<td>Jon Fulbright (PRO); Alternate: Elizabeth Kline (PRO)</td>
</tr>
<tr>
<td>PLT Test Engineering(s)</td>
<td>Melissa Dahya (MOST)</td>
<td>Melissa Dahya (MOST)</td>
<td>Michael Otero (MOST)</td>
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<tr>
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<td>Ryan Williams (PRO); Jon Fulbright (PRO)</td>
<td>Janet Larson (PRO)</td>
<td>Janet Larson (PRO)</td>
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<tr>
<td>PASS/eGRES Requests</td>
<td>Wayne Mackenzie (PRO)</td>
<td>Stephen Superczynski (PRO)</td>
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<td>Dan Flanagan (Flight)</td>
<td>Cindy Merrow (Flight)</td>
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<tr>
<td>PLT SOE CR Contact</td>
<td>Mike Otero (Flight)</td>
<td>Andrew Lyashko (Flight)</td>
<td>Denis Pinha (Flight)</td>
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</table>

Check the GOES-R Portal at [https://goesportal.ndc.nasa.gov](https://goesportal.ndc.nasa.gov) to verify correct version prior to use.
4. TOOLS

For transitional PLTs and the PLPTs, the tools planned for use are described in Appendix D. Transitional PLTs are initially assigned to ATC and are then transitioned to NCEI-CO to continue the calibration and trending activities for Mission Life. Flight Project is responsible for the acquisition of these transitional tools.

The tools were first demonstrated in June 2016. In February 2020, ATC traveled to NCEI-CO to train the SEISS instrument scientists to install, run, and analyze output from the SEISS on-orbit trending and calibration tools being delivered by ATC. The tools were not able to be installed on NCEI-CO systems at the time of the training due to IT security restrictions. These issues are expected to be resolved and the tools installed and running on the NCEI-CO systems during the summer of 2021.
5. PRE-LAUNCH

For SEISS, the Data Operations Exercises (DOEs) will validate the data flows rather than exercise the functionality of the L1b algorithms across a wide range of environmental conditions. The DOEs will run live data from either GOES-EAST or GOES-WEST through a GOES-18 or GOES-19 configured GS. DOE-2 for GOES-18 pre-launch testing has the option of running old GOES-R Series data (e.g., an energetic solar event). To mitigate risks, inconsistencies in the format and content of each L1b test product will be noted and tracked within the Algorithm Action Review Team (AART). Any discrepancies found during the rehearsals will be entered into the Work Request (WR)/Algorithm Design Review (ADR) process. The SEISS rehearsals are finished when all discrepancies are documented.
6. REFERENCES

The following government documents have information relevant to this RIMP document. Unless otherwise noted, all documents with a “410-R” or “417-R” prefix are located in the GOES-R Library (in the Windchill repository). All other program documents can be found in the GOES-R Program Portal at https://goesportal.ndc.nasa.gov/.

Unless otherwise noted, the current versions of the following documents apply.

- 410-R-ALGCMP-0285, GOES-R Series Algorithm Change Management Plan (ACMP)
- 410-R-CONOPS-0008, GOES-R Series Concept of Operations (CONOPS)
- 410-R-CALVAL-0192, GOES-R Series Calibration and Product Validation Strategy
- 410-R-MRD-0070, GOES-R Series Mission Requirements Document (MRD)
- 410-R-PLN-0101, GOES-R Series Calibration/Validation Plan Volume 1: Level 1b Data
- 417-R-PLN-0246, GOES-R Series Post-Launch Testing (PLT) Plan
- 417-R-SEISSPORD-0030, GOES-R Series Space Environment In-Situ Suite (SEISS) Performance and Operational Requirements Document (PORD)
- GOES-R PLT and Active PLPT Forms on the GOES-R Program Portal: Repository > 01 GOES R > 02 GOES R - Flight Project > 04 Mission Operations > 900 CM Docs > 935 PLT - GOES-R
  Repository > 01 GOES R > 02 GOES R - Flight Project > 04 Mission Operations > 900 CM Docs > 936 PLT - GOES-S
  Repository > 01 GOES R > 02 GOES R - Flight Project > 04 Mission Operations > 900 CM Docs > 937 PLT - GOES-T
- GOES-R Passive L1b PLPT Forms on the GOES-R Program Portal:
  Repository > 01 GOES R > 02 GOES R - Flight Project > 04 Mission Operations > PLT > GOES-18 Passive PLPT forms

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use.
A. APPENDIX A: POST-LAUNCH PRODUCT TESTS

Unless otherwise noted in the individual test description, each PLPT is performed for each satellite of the GOES-R Series, and the point of contact (POC) is the SEISS PLPT Lead (see Table 6).

A.1 PLPTs that support BETA maturity

None – only PLTs support Beta maturity.

A.2 PLPTs that support PROVISIONAL maturity

A.2.1 MPS-HI Telescope Cross-Comparison [PLPT-SEI-002]

Objective: To perform a sanity check of the Pitch Angle Distributions (PADs) and to determine the relative sensitivity/response among MPS-HI telescopes.


Start Time: As soon as the respective sensors are commanded into their nominal operating mode.

Duration: One month of continuous data.

Mode: Nominal operational mode.

GOES-R Data Type(s): MAG L1b and MPS-HI L1b data.

Provisional Success Criteria: PADs (flux distributions in pitch angle) match science expectations as a function of local time and activity. Initial analysis indicates that telescopes agree to within 25%.

Dependencies: Continuous data during all geomagnetic conditions.

Procedural References: Similar to Rowland and Weigel, 2012.

- The pitch angle for each telescope/angular zone is calculated for every time step. If the pitch angles of two zones match to within a pre-configured amount, the count rates are saved. When a large enough sample of these matches are collected which span all zones, it is possible to compute inter-calibration coefficients which correct the responses of the various zones separately for each energy channel [Rowland and Weigel, 2012].

- Measurements during spacecraft maneuvers (e.g., yaw flips, magnetometer calibration maneuvers) will be used to supplement the comparisons achieved through the natural variability of the magnetic field orientation.

- No special commanding of the SEISS instruments is required. The method will account for inter-telescope variability in the energy responses of a given channel. This variability is greatest in the lowest energy channels of MPS-HI. Ingests MAG L1b magnetic field vectors expressed in spacecraft Body Reference Frame coordinates as well as SEISS L1b fluxes.

Comparison/Reference Data: None.

Monitoring & Analysis Method: Time-series averaging; pitch angle calculation; inspection of pitch-angle plots; spectral retrieval; non-linear minimization; bootstrap error analysis.

Tools Needed: mpshi_pitch_angles, mpshi_pad_plot, mpshi_telescope_intracal.
A.2.2 MPS-LO Zone Cross-Comparison [PLPT-SEI-003]

Objective: To perform a sanity check of PADs, determine the relative sensitivity/response among MPS-LO zones and determine relative inter-calibration factors for zone Z6L vs. Z6R and Z7L vs. Z7R, for each of 15 energies and for both electrons and ions.


Start Time: As soon as the respective sensors are commanded into their nominal operating mode.

Duration: One month of continuous data.

Mode: Nominal operational mode.

GOES-R Data Type(s): MAG L1b and MPS-LO L1b data.

Provisional Success Criteria: PADs (flux distributions in pitch angle) match science expectations as a function of local time and activity. Initial analysis indicates that zones agree to within 25%, absent spacecraft charging similar to or greater than channel energy.

Dependencies: Continuous data during all geomagnetic conditions.


- MPS-LO is comprised of two similar electrostatic analyzers (ESAs) back-to-back. Their configuration is designed such that two pairs of zones overlap in angular space: Z6L and R, and Z7L and R. Ideally each pair should measure the same flux. In reality there will be small differences due to (1) uncertainties in the calibrations, (2) slightly different look angles in body reference frame coordinates (2.1 degrees difference between Z6R and Z6L, 0.6 degree difference between Z7R and Z7L) and (3) slight differences in channel energies between L and R (0.1-10%). When these small differences are accounted for, a direct validation of the ratio of the geometry-energy factors is possible.

- In addition, it may be possible to check whether the first or second versions (from CDRL 79) of the ion geometry-energy factors in the lowest 5 energy channels are better. The first and second versions of the MPS-LO calibration data book predicted Z6R/Z6L and Z7R/Z7L ion zonal counts ratios that differed by as much as a factor of 10.

- In this test, statistics on the flux and counts ratios (means and standard deviations) will be calculated and trended, including stratification for quiet and disturbed conditions.

- No special commanding is required.

Comparison/Reference Data: None.

Monitoring & Analysis Method: Time-series averaging; pitch angle calculation; inspection of pitch-angle plots; spectral retrieval; non-linear minimization; bootstrap error analysis; identification of s/c charging conditions.

Tools Needed: mpslo_pitch_angles, mpslo_pad_plot, mpslo_z6_z7_overlap, mpslo_zone_intracal.

A.2.3 SEP Channel Cross-Comparison [PLPT-SEI-004]

Objective: On-orbit cross-calibration of EHIS with SGPS above 10 MeV and MPS-HI with SGPS 1-12 MeV protons, and all SEISS sensors with operational GOES-R Series SEISS sensors.


Start Time: As soon as the respective sensors are commanded into their nominal operating mode.

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
Duration: One Solar Energetic Particle (SEP) event.
Mode: Nominal operational mode.
GOES-R Data Type(s): MAG L1b data, EHIS, MPS-HI, and SGPS L1b and L0 data.
Provisional Success Criteria: Differences quantified on data taken through validation phase.
Dependencies: Continuous data during all geomagnetic conditions. If an SEP event is predicted by SWPC (NOAA warnings WARPC0 or WARPX1), do not interrupt SEISS science telemetry for one week.
Procedural References: Similar to Rodriguez et al., 2014 and Rowland and Weigel, 2012.
- SGPS measures solar protons from 1 to >500 MeV and alpha particles from 1 to 125 MeV/n in two directions, westward (W) and eastward (E) fluxes, as do the heritage EPEAD instruments on GOES 13-15. EHIS measures solar protons from 10 to 180 MeV and alpha particles from 10 to 194 MeV/n radially-outward (R). The five MPS-HI proton telescopes measure solar protons in four channels from 1 to 12 MeV in a fan with the center telescope pointing radially outward (R) and the outermost telescopes pointing nearly southward (S) and nearly northward (N).
- Inter-calibration of solar energetic particle channels looking in different directions, including on different satellites, will be performed using a linear regression when the solar wind dynamic pressure is greater than 10 nPa (5 nPa for higher energy channels) [Rodriguez et al., 2014]. In order to compare the different channel sets it will be necessary to interpolate to a common set of energies using a curve fit.
- No special commanding of the instruments or spacecraft maneuvers are necessary. The level of trapped radiation belt protons in the lowest energy channels of SGPS and in the ~1 MeV channels of MPS-HI need to be determined in the absence of SEP events. In the absence of an SEP event, energy channels SGPS P1 & P2 (in the same energy range as MPS-HI P8 & P9) can be tested using their observations of trapped radiation belt proton fluxes. This approach uses the same method as PLPT-SEI-002 (A.2.1) and has a dedicated tool (sgps_t1_intracal). The MPS-LO equivalent is included under A.2.2.
Comparison/Reference Data: Operational GOES-R Series SEISS sensors; GOES 13-15 EPEAD, if available and deemed necessary; ACE SIS, if no SEP event has occurred during PLT/PLPT period.
Monitoring & Analysis Method: Filter on solar wind conditions; retrieve spectra; perform linear regression; bootstrap error analysis.
Tools Needed: sgps_pitch_angles, sgps_t1_intracal, sep_cross_compare.

A.2.4 Cross Satellite Comparison of Trapped Particles [PLPT-SEI-005]
Objective: To inter-calibrate MPS-LO and MPS-HI with the same measurements on other operational GOES-R Series satellites. The MPS-HI inter-calibration part of the test is critical for establishing the consistency of the NOAA real-time >2 MeV electron flux alerts between operational GOES-R Series satellites.
Reference MRD: 1992, 2001
Start Time: As soon as the respective sensors are commanded into their nominal operating mode.
Duration: One month of continuous data.
Mode: Nominal operational mode.
GOES-R Data Type(s): MAG L1b data, MPS-LO and MPS-HI L1b data.

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
**Provisional Success Criteria:** Differences quantified on data taken through validation phase.

**Dependencies:** Continuous data during all geomagnetic conditions.

**Procedural References:** Similar to Meredith, 2015.

- Identify time periods when two or more GOES-R Series satellites should be measuring the same population, and compare results. To reach Provisional maturity, comparisons involve plots of fluxes vs. energy in order to look for gross inconsistencies between sensors.
- In order to compare the different channel sets it will in general be necessary to interpolate to a common set of energies using a curve fit. The default MPS-LO and MPS-HI inter-satellite comparisons will be between SEISS sensors on GOES-R Series satellites. If available and deemed necessary, a comparison can be made with GOES 13-15 instruments: the finer energy- and angular-resolution MPS-HI channels will be integrated over the broad EPEAD responses; the GOES-R Series MPS-LO 30 keV channel can be compared to the GOES 13-15 MAGED 30-50 keV channel with some spectral extrapolation.
- No special commanding of the instruments or spacecraft maneuvers are necessary.

**Comparison/Reference Data:** Operational GOES-R Series SEISS sensors; GOES 13-15 EPEAD and MAGED, if available and deemed necessary.

**Monitoring & Analysis Method:** Compare when satellites are ~1 hour separated in local time (e.g., 75W and 90W); take advantage of near-conjunctions (e.g., during station changes); plots of spectra from GOES-R Series and GOES 13-15 (if available) particle detectors. If it is necessary, comparisons can be performed when satellites are further apart (e.g., 30 degrees) but the results will be less accurate because differences will be exaggerated.

**Tools Needed:** mps_near_conjunction.

### A.2.5 Backgrounds Trending [PLPT-SEI-006]

**Objective:** (1) To trend daily/weekly minima from MPS-LO ion and electron background zones (ZGR and ZGL). (2) To correlate orbital variations in MPS-LO backgrounds with MPS-HI and SGPS measurements. (3) To evaluate MPS-HI, SGPS, and EHIS backgrounds in terms of expected galactic cosmic ray (GCR) fluxes.


**Start Time:** As soon as the respective sensors are commanded into their nominal operating mode.

**Duration:** Two months of continuous data.

**Mode:** Nominal operational mode.

**GOES-R Data Type(s):** MPS-LO, MPS-HI, SGPS, EHIS L0 and L1b data.

**Provisional Success Criteria:** If dark noise can be observed above natural backgrounds, decreases with time. Natural backgrounds preliminarily correlated with MeV electrons, solar protons and GCRs.

**Dependencies:** Continuous data during all geomagnetic conditions.

**Procedural References:**

- MPS-LO incorporates “dark” background zones which should only pick up the contamination from higher energy particles penetrating the instrument and striking the MCPs or from interzonal crosstalk. The self-generated dark noise is expected to decay with time in vacuum. This PLPT will determine whether the dark noise can be observed in the presence of backgrounds from penetrating electrons and protons or from interzonal crosstalk, and if so, whether the dark noise decreases post-launch as expected.
This PLPT will compare the fluxes measured by these background zones with in-band fluxes measured by higher energy instruments to correlate the two.

Model GCR spectra (e.g., NASA JSC Badhwar-O’Neill 2014) will be put through a forward model derived from MPS-HI, SGPS, and EHIS instrument response functions documented in CDRLs 74 and 79 to estimate MPS-HI, SGPS, and EHIS channel fluxes for comparison with observations. The analysis of EHIS heavy ion data will require long-term averages of L0 histograms. The analysis of EHIS proton and alpha particle rates as well as rates from the other two instruments could convert L1b fluxes back to counts, but it would be less ambiguous simply to average the L0 count rates.

No special commanding of the instruments is necessary, nor are special maneuvers.

Comparison/Reference Data: Published GCR models; MPS-HI MeV electrons; SGPS solar protons.

Monitoring & Analysis Method: Time-series averaging.

Tools Needed: mpslo_background_trend, mpshi_background_trend, sgps_background_trend, ehis_background_trend.

A.3 PLPTs that support FULL maturity

A.3.1 SGPS D3-D1 Contamination Correction [PLPT-SEI-001]

Objective: To determine the performance of the SGPS on-orbit contamination correction that is turned on when the D3-D1 logic is enabled, and to test the associated data quality factors (DQFs).

Reference MRD: 2010

Start Time: As soon as the respective sensors are commanded into their nominal operating mode.

Duration: 180 days of continuous data.

Mode: D3-D1 circuits enabled/disabled by command, otherwise normal.

GOES-R Data Type(s): SGPS L1b and L0 data.

Full Success Criteria: Magnitude of D3-D1 correction consistent with <10% residual contamination (PORD).

Dependencies: Successful completion of PLT G*-C-SEI-008. Continuous data during all geomagnetic conditions. If an SEP event is predicted by SWPC (NOAA warnings WARPC0 or WARPX1), do not interrupt SEISS science telemetry for one week.

Procedural References: Active PLPT Form G*-C-SEIPLPT-001

Two of the SGPS proton channels (P7 and P8C) are corrected for contamination on-orbit using a differencing between the D3 and D1 detectors in their respective telescopes. This differencing is enabled and disabled separately for each channel by command (Enable DIFF31).

The correction is assumed to be fully enabled in both the +X and –X SGPS instruments after the completion of PLT G*-C-SEI-008; the D3-D1 correction is disabled for all the channels in one SGPS and kept enabled for the other SGPS for the next 45 days; then the enabling/disabling is switched for the next 45 days.

Before handover, a decision is made whether to re-enable the D3-D1 logic in both SGPS units.
Comparison/Reference Data: Published GCR models.
Monitoring & Analysis Method: Time-series averaging & arithmetic comparisons; filter on solar wind conditions.
Tools Needed: sgps_diff31

A.3.2 MPS-HI Telescope Cross-Comparison [PLPT-SEI-002]
Unless otherwise noted below, see the Provisional test description for PLPT-SEI-002.
Duration: Three months of continuous data.
Full Success Criteria: Telescopes agree to within 25%.
Tools Needed: mpshi_pitch_angles, mpshi_telescope_intracal

A.3.3 MPS-LO Zone Cross-Comparison [PLPT-SEI-003]
Unless otherwise noted below, see the Provisional test description for PLPT-SEI-003.
Duration: Three months of continuous data.
Full Success Criteria: Zones agree to within 25% absent spacecraft charging similar to or greater than channel energy.
Tools Needed: mpslo_pitch_angles, mpslo_z6_z7_overlap, mpslo_zone_intracal

A.3.4 SEP Channel Cross-Comparison [PLPT-SEI-004]
Unless otherwise noted below, see the Provisional test description for PLPT-SEI-004.
Duration: Two Solar Energetic Particle (SEP) events.

A.3.5 Cross Satellite Comparison of Trapped Particles [PLPT-SEI-005]
Unless otherwise noted below, see the Provisional test description for PLPT-SEI-005.
Duration: Three months of continuous data.
Procedural References: Similar to Meredith, 2015.
- Identify time periods when two or more GOES-R Series satellites should be measuring the same population, and compare results. Comparisons can be based on: (1) the satellites being nearby (within 15 degrees in geomagnetic longitude), (2) using data from adiabatic invariant conjunctions, or (3) using a very long time period. Method (1) can take advantage of storage-mode operations of MPS-LO, MPS-HI, and MAG.
- In order to compare the different channel sets it will in general be necessary to interpolate to a common set of energies using a curve fit. The default MPS-LO and MPS-HI inter-satellite comparisons will be between SEISS sensors on GOES-R Series satellites. If available and deemed necessary, a comparison can be made with GOES 13-15 instruments: the finer energy- and angular-resolution MPS-HI channels will be integrated over the broad EPEAD responses; the GOES-R Series MPS-LO 30 keV channel can be compared to the GOES 13-15 MAGED 30-50 keV channel with some spectral extrapolation.
- No special commanding of the instruments or spacecraft maneuvers are necessary.
Monitoring & Analysis Method: Compare when satellites are ~1 hour separated in local time (e.g., 75W and 90W); take advantage of near-conjunctions (e.g., during station changes); linear regression; bootstrap error analysis.

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
A.3.6 Backgrounds Trending [PLPT-SEI-006]

Unless otherwise noted below, see the Provisional test description for PLPT-SEI-006.

Duration: Four months of continuous data.

Full Success Criteria: Perform analysis during validation phase.
B. APPENDIX B: GOES-R SERIES AND VALIDATION REFERENCE DATA

B.1 Data set 1: Name: MPS-LO L0 data  
Storage Location: LZSS  
Access Process: Through SPADES  
Spatial Coverage: 180° full-angle FOV  
Temporal Coverage: Every second  
Contingency: NCEI FTP (ftp://ftp.avl.class.noaa.gov/ddt/NCEI-NC/)  
Special Considerations: N/A

B.2 Data set 2: Name: MPS-HI L0 data  
Storage Location: LZSS  
Access Process: Through SPADES  
Spatial Coverage: 170° full-angle FOV  
Temporal Coverage: Every second  
Contingency: NCEI FTP (ftp://ftp.avl.class.noaa.gov/ddt/NCEI-NC/)  
Special Considerations: N/A

B.3 Data set 3: Name: SGPS L0 data  
Storage Location: LZSS  
Access Process: Through SPADES  
Spatial Coverage: 60° (T1 and T2) and 90° (T3) full-angle FOVs  
Temporal Coverage: Every second  
Contingency: NCEI FTP (ftp://ftp.avl.class.noaa.gov/ddt/NCEI-NC/)  
Special Considerations: N/A

B.4 Data set 4: Name: EHIS L0 data  
Storage Location: LZSS  
Access Process: Through SPADES  
Spatial Coverage: 60° full-angle FOV  
Temporal Coverage: Every 3 seconds for the H and He ions and every minute for the heavier ions  
Contingency: NCEI FTP (ftp://ftp.avl.class.noaa.gov/ddt/NCEI-NC/)  
Special Considerations: N/A

B.5 Data set 5: Name: MAG L1b data  
Storage Location: PDA  
Access Process: Through SPADES  
Spatial Coverage: Magnetic field at spacecraft  
Temporal Coverage: Every 0.1 second  
Contingency: N/A  
Special Considerations: N/A
B.6 Data set 6: Name: MPS-LO L1b data  
   Storage Location: PDA  
   Access Process: Through SPADES  
   Spatial Coverage: 180° full-angle FOV  
   Temporal Coverage: Every second  
   Contingency: N/A  
   Special Considerations: N/A

B.7 Data set 7: Name: MPS-HI L1b data  
   Storage Location: PDA  
   Access Process: Through SPADES  
   Spatial Coverage: 170° full-angle FOV  
   Temporal Coverage: Every second  
   Contingency: N/A  
   Special Considerations: N/A

B.8 Data set 8: Name: SGPS L1b data  
   Storage Location: PDA  
   Access Process: Through SPADES  
   Spatial Coverage: 60° (T1 and T2) and 90° (T3) full-angle FOVs  
   Temporal Coverage: Every second  
   Contingency: N/A  
   Special Considerations: N/A

B.9 Data set 9: Name: EHIS L1b data  
   Storage Location: PDA  
   Access Process: Through SPADES  
   Spatial Coverage: 60° full-angle FOV  
   Temporal Coverage: Every 5 minutes for all species  
   Contingency: N/A  
   Special Considerations: N/A

B.10 Data set 10: Name: Published GCR model (Matthiae)  
   Storage Location: Stored locally at NCEI-CO  
   Access Process: Request from author  
   Point of Contact: Daniel Matthiae (daniel.matthiae at dlr.de)  
   Spatial Coverage: ~1 AU, above geomagnetic cutoff  
   Temporal Coverage: 1997-2014 (based on ACE carbon (68.3-194.4 MeV/n) GCR observations); 1964-present (based on Oulu neutron monitor observations)  
   Contingency: N/A  
   Special Considerations: N/A
B.11 **Data set 11**: Name: Published GCR model (BO)  
Storage Location: Stored locally at NCEI-CO  
Access Process: Request from author  
Point of Contact: Patrick M. O'Neill (patrick.m.oneill@nasa.gov)  
Spatial Coverage: ~1 AU, above geomagnetic cutoff  
Temporal Coverage: 1749-2020 (based on sunspot numbers, observed + predicted)  
Contingency: N/A  
Special Considerations: N/A

B.12 **Data set 12**: Name: GOES 13-15 data  
Storage Location: NCEI-CO archive  
Spatial Coverage: Various FOVs  
Temporal Coverage: 2006 to 2020  
Contingency: N/A  
Special Considerations: Used for GOES-16 and GOES-17 comparisons only

B.13 **Data set 13**: Name: ACE Science Center Level-2: SEP, GCR, and ACR Intensities: SIS  
Storage Location: Stored locally at NCEI-CO as needed  
Spatial Coverage: Measurement at a discrete point (Ace is at L1 point)  
Temporal Coverage: One-hour average fluxes  
Contingency: N/A  
Special Considerations: This dataset is only needed in the event that there is no SEP event

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
C. APPENDIX C: PLT DETAILS

Approved final list and details can be found in the individual PLT forms. The list is repeated here for convenience and is not necessarily the final approved list. The stars (*) in the Test IDs are place holders for the GOES-R Series satellite number (i.e., 16, 17, 18, or 19). Unless otherwise specified, each PLT is run for each satellite in the GOES-R Series.

C.1 Test ID: G*-C-SEI-001
   Test Name: EHIS Initial IFC Verification
   Test Duration: Test Execution: Part 1-01:25, Part 2-02:00, Part 3-01:25; Analysis will take 1 month; CM controlled activities will take 1 week.
   Objective: To begin the on-orbit EHIS IFC trend process and upload new EHIS IFC based on the results of the initial IFC.
   Success Criteria: The EHIS IFC runs and the on-orbit IFC data is compared with the pre-launch trend data and with on-orbit operational EHIS. The temperature dependencies are comparable between on-orbit EHIS. The EHIS IFC tables are updated successfully for on-orbit conditions and verified by a follow-up IFC data collection and data analysis, if needed.
   Prerequisites/Dependencies: The DPU and EHIS have been powered on and checked out for correct operation.
   Data Requirements: Real-time housekeeping and engineering data for the DPU and EHIS will be needed while the test is run. EHIS IFC data, telemetered in EHIS Normal Mode, will be required for analysis after the test has been completed. ATC performs the analysis using in-house software. Data for analysis are extracted from LZSS.

C.2 Test ID: G*-C-SEI-002
   Test Name: EHIS On-Orbit Execution
   Test Duration: 4 months 1 week (3 months passive data collection, followed by 1 month analysis, followed by 1 week CM controlled activities for updated science configuration upload)
   Objective: To verify that the EHIS is correctly calculating charge (Z) for all ions, H through Ni, in all five energy bands. Begin checkout of the alpha-kappa values for high energies, beyond those available in ground calibration and upload new science configuration tables if needed.
   Success Criteria: 50 to 100 ions (minimum of 50) of each major elemental species: H, He, C, N, O, Ne, Mg, Si and Fe must be acquired in each energy band. The results are in-family to the pre-flight model, there is accumulation of enough data to accurately set parameters for the higher energy particles not available from ground calibration, and new science configurable successfully loaded.
   Prerequisites/Dependencies: The DPU and EHIS have been powered on and checked for correct operation.
   Data Requirements: Normal mode EHIS telemetry shall be used. It is estimated that, in the absence of a Solar Particle Event, the time for such accumulation of data will be: ~1 day for H and He, ~1 week for C, N and O, ~1 month for Ne, Mg and Si, ~3 months for

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
C.3  **Test ID:** G*-C-SEI-003  
**Test Name:** MPS-HI Initial IFC Execution  
**Test Duration:** Test Execution: Part 1-00:10, Part 2-00:10, Part 3-00:15; Analysis will take 1 month; CM controlled activities will take 1 week.  
**Objective:** To begin the on-orbit MPS-HI IFC trend process and upload a new IFC table.  
**Success Criteria:** The MPS-HI IFC runs and the on-orbit IFC data is compared with the pre-launch trend data and with on-orbit operational MPS-HI. The temperature dependencies are comparable between on-orbit MPS-HI. The MPS-HI IFC tables are updated successfully for on-orbit conditions and verified by a follow-up IFC data collection and data analysis, if needed.  
**Prerequisites/Dependencies:** The DPU and MPS-HI have been powered on and checked for correct operation.  
**Data Requirements:** Real-time housekeeping and engineering data for the DPU and MPS-HI will be needed while the test is run. MPS-HI science data from the test period will be required for analysis after the test has been completed. ATC performs the analysis using MPS-HI IFC Analysis Tool (offline). Data for the analysis are extracted from the LZSS.

C.4  **Test ID:** G*-C-SEI-004  
**Test Name:** MPS-LO Initial IFC Execution  
**Test Duration:** Test Execution: Part 1-00:10, Part 2-00:10, Part 3-00:10, Part 4-00:10; Analysis will take 1 month.  
**Objective:** To begin the on-orbit MPS-LO IFC trend process.  
**Success Criteria:** Initial IFC is successfully executed with the MPS-LO high voltage supply disabled and enabled. Initial IFC results are in-family with pre-launch results and with on-orbit operational MPS-LO. The temperature dependencies are comparable between on-orbit MPS-LO.  
**Prerequisites/Dependencies:** The DPU and MPS-LO have been powered on and checked for correct operation. Parts 1 and 2 of this PLT will be performed before MPS-LO HV is turned on, i.e. before G*-C-SEI-005 MPS-LO Initial Turn-On of Electron and Ion MCP HV has been executed. Parts 3 and 4 of this PLT will be performed AFTER the MPS-LO HVs have been turned on and optimized, i.e. AFTER G*-C-SEI-005 MPS-LO Initial Turn-On of Electron and Ion MCP HV has been completed.  
**Data Requirements:** Real-time housekeeping and engineering data for the DPU and MPS-LO will be needed while the test is run. MPS-LO science data from the test period will be required for analysis after the test has been completed. ATC performs the analysis using in-house software. Data for the analysis are extracted from the LZSS.

C.5  **Test ID:** G*-C-SEI-005  
**Test Name:** MPS-LO Initial Turn-On of Electron and Ion MCP HV  
**Test Duration:** Test Execution: 02:30; Analysis will take 2 days.  
**Objective:** Optimize the Electron Micro Channel Plate (EMCP) and Ion Micro Channel Plate (IMCP) bias levels. Note: The optimum operating voltage is known from ground
testing. However, any time MPS-LO is turned on after a long duration in storage the MCP
voltages must be stepped up slowly in case there are species being desorbed from the MCPs
themselves. Rapid turn-on of the voltage can lead to excessive noise, and potential arcing,
which might damage the instrument. Once it’s been established that we can operate at the
optimum voltage on orbit, there will be no additional changes (unless there is instrument
degradation over the life of the mission).

**Success Criteria:** The Electron and Ion MCP High Voltages are successfully turned on
and the bias level for each is optimized.

**Prerequisites/Dependencies:** The DPU and MPS-LO have been powered on and checked
out for correct operation. Parts 1 and 2 of G*-C-SEI-004 MPS-LO Initial IFC shall be
performed before this PLT, i.e. the first MPS-LO IFC shall be executed with the MPS-LO
HV supplies turned OFF. Parts 3 and 4 of G*-C-SEI-004 MPS-LO Initial IFC shall be
performed after both parts of this PLT have been completed; i.e. the second MPS-LO IFC
shall be executed after the MPS-LO HV supplies have been turned on and optimized. The
MPS-LO EMCP and IMCP voltage supplies should dwell at bias step 24 for EMCP and 25
for IMCP for at least 7 days immediately prior to beginning this procedure to allow the
MCPs to outgas. The EMCP and IMCP voltage supplies should be stepped up slowly over
the course of approximately 15 days from an initial bias step of 20 to the dwell bias levels
of 24 for EMCP and 25 for IMCP. The ATC MPS-LO Subject Matter Expert (SME) will
direct each bias voltage step increment. This is done with G*_SEI_MPSLO_EMCP_IMCP_init_turnon_script. Electron and ion count rates should
be less than 1-2 per accumulation at the initial bias voltage step of 20 (final decision to be
made by SME).

**Data Requirements:** Real-time housekeeping and engineering data for the DPU and MPS-
LO and real-time science data for the MPS-LO will be needed while the test is run. MPS-
LO science data from the test period will be required for analysis after the test has been
completed. ATC performs analysis using in-house software. Analysis may be done in near
real time. Data for analysis extracted from LZSS.

C.6 **Test ID:** G*-C-SEI-006
**Test Name:** SGPS Initial IFC Execution
**Test Duration:** Test Execution: Part 1 – 00:20, Part 2-00:20, Part 3-00:30; Analysis will
take 1 month; CM controlled activities will take 1 week.
**Objective:** To begin the on-orbit SGPS IFC trend process and upload new IFC tables for
both SGPSs.

**Success Criteria:** The +X SGPS and the –X SGPS IFCs run and the on-orbit IFC data are
compared with the pre-launch trend data and with on-orbit operational SGPS. The
temperature dependencies are comparable between on-orbit SGPS. The SGPS IFC tables
are updated successfully for on-orbit conditions and verified by a follow-up IFC data
collection and data analysis, if needed.

**Prerequisites/Dependencies:** The DPU and SGPS +X and SGPS –X have been powered
on and checked out for correct operation.

**Data Requirements:** Real-time housekeeping and engineering data for the DPU and SGPS
will be needed while the test is run. SGPS science data from the test period will be required
for analysis after the test has been completed. ATC performs the analysis using the SGPS
IFC Analysis Tool (offline). Analysis may be done in near real time. Data for analysis are extracted from LZSS.

C.7 Test ID: G*-C-SEI-007
Test Name: Cross-Calibration of SGPS +X and SGPS -X
Test Duration: Test Execution: 10 days of data acquisition in normal configuration; Analysis will take 2 weeks; CM controlled activities will take 2 weeks.
Objective: To confirm the counts in the P8 through P11 channels of the SGPS +X and SGPS -X are consistent with on-orbit predictions. To resolve any discrepancy between the two units due to initial calibration uncertainty.
Success Criteria: The counts in the P8, P9, P10, and P11 channels of the SGPS +X and SGPS –X are in family with on-orbit operational SGPS measurements and that the uncorrelated counts for each SGPS are within ±25% accuracy. If a large discrepancy between counts for the two SGPSs exists, then a GPA coefficient table update to normalize the fluxes has also been completed.
Prerequisites/Dependencies: The DPU and SGPS +X and SGPS –X have been powered on and checked out for correct operation. The D3-D1 logic circuits for channels P8CF and P7 have been enabled for both SGPSs.
Data Requirements: Real-time housekeeping and engineering data for the DPU and SGPS will be needed while the test is run. SGPS science data from the test period will be required for analysis after the test has been completed. ATC performs analysis using in-house software. Data for analysis are extracted from LZSS.

C.8 Test ID: G*-C-SEI-008
Test Name: SGPS D3-D1 Logic Circuit Test
Test Duration: Test Execution: 02:30; Analysis will take 2 weeks
Objective: To confirm the functionality and performance of the SGPS +X and SGPS –X D3-D1 logic circuits.
Success Criteria: The SGPS +X and –X D3-D1 circuits are successfully disabled and re-enabled by command. The performance of the D3-D1 circuit depends on the energy distribution of high energy protons on orbit; therefore, the success criteria is qualitative. The before and after measurements enable only an assessment of the energy distribution change and its effect on the D3-D1 performance.
Prerequisites/Dependencies: The DPU and SGPS +X and SGPS -X have been powered on and checked out for correct operation. The D3-D1 circuits for channels P8CF and P7 for both SGPSs have been enabled during the sensor unit activation to allow for science data collection during high particle activity should it occur prior to executing this test.
Data Requirements: Real-time housekeeping and engineering data for the DPU and SGPS and real-time science data for the SGPS will be needed while the test is run. SGPS science data from the test period will be required for analysis after the test has been completed. ATC performs the analysis using in-house software. Data for analysis are extracted from LZSS.
The test results combined with similar test results from PLPT will be used to determine final decision regarding use of D3 – D1 circuit.
C.9 Test ID: G*-C-SEI-009  
*Required for GOES-R Series satellites: 17, 18, 19  
Test Name: Yaw Flip Instrumentation Cross-Calibration (SGPS +/- X)  
Test Duration: Test Execution: A minimum of 1 day (goal of 5 days) of data acquisition pre and post yaw maneuver; Analysis will take 2 weeks; CM controlled activities will take 2 weeks.  
Objective: To compare the counts in the P1 through P5 channels of the SGPS +X and SGPS –X units. These energy channels exhibit anisotropy on orbit and therefore can only be directly compared by analyzing data collected before and after a yaw flip is performed on any GOES spacecraft with comparable SGPS +X and SGPS -X units.  
Success Criteria: The counts in the P1 through P5 channels of the SGPS +X and SGPS –X are in family with other on-orbit GOES-R Series spacecraft and the pre- and post-measurements are in family with each other. Each SGPS is within +/- 50% of the other sensor. If a large discrepancy between counts for the two SGPSs exists, then a Ground Processing Algorithm (GPA) coefficient table update to normalize the calibration coefficients has also been completed.  
Prerequisites/Dependencies: The DPU, SGPS +X and SGPS -X have been powered on and checked out for correct operation. The D3-D1 logic circuits for channels P8CF and P7 have been enabled for all SGPSs units under analysis. A GOES spacecraft with comparable SGPS +X and SGPS -X units performs a yaw flip.  
Data Requirements: Real-time housekeeping and engineering data for the DPU and SGPS +/- X will be needed while the test is run. SGPS +/- X engineering and science data from the test period will be required for analysis after the test has been completed. ATC performs analysis using in-house software. Data for analysis are extracted from Level Zero Storage System (LZSS).
D. APPENDIX D: TOOLS

D.1 Tool #1: In Flight Calibration Analysis Tool (EHIS)
Location: ATC/UNH (University of New Hampshire)
Description: Tool to analyze EHIS In-Flight Calibration
Developer: Clifford Lopate (UNH)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: EHIS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: UNH

D.2 Tool #2: DPU and Sensor Data Processing/Assessment Tool (EHIS)
Location: ATC/UNH
Description: Tool to process and assess DPU and EHIS sensor data
Developer: Clifford Lopate (UNH)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: EHIS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: UNH

D.3 Tool #3: Level-0 Retrieval and Ingestion Tool
Location: ATC/UNH
Description: Tool to retrieve and ingest L0 data
Developer: Bill Graham (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: SEISS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

D.4 Tool #4: In Flight Calibration Analysis Tool (MPS-HI)
Location: ATC/UNH
Description: Tool to analyze MPS-HI In-Flight Calibration
Developer: Elizabeth Dawson (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: MPS-HI L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house
POC: ATC

D.5 Tool #5: DPU and Sensor Data Processing/Assessment Tool (MPS-HI)
Location: ATC/UNH
Description: Tool to process and assess DPU and MPS-HI sensor data
Developer: Frank Mascuilli (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: MPS-HI L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

D.6 Tool #6: In Flight Calibration Analysis Tool (MPS-LO)
Location: ATC/UNH
Description: Tool to analyze MPS-LO In-Flight Calibration
Developer: Elizabeth Dawson (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: MPS-LO L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

D.7 Tool #7: DPU and Sensor Data Processing/Assessment Tool (MPS-LO)
Location: ATC/UNH
Description: Tool to process and assess DPU and MPS-LO sensor data
Developer: Frank Mascuilli (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: MPS-LO L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

D.8 Tool #8: In Flight Calibration Analysis Tool (SGPS)
Location: ATC/UNH
Description: Tool to analyze SGPS In-Flight Calibration
Developer: Elizabeth Dawson (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: SGPS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

D.9 Tool #9: DPU and Sensor Data Processing/Assessment Tool (SGPS)
Location: ATC/UNH
Description: Tool to process and assess DPU and SGPS sensor data
Developer: Frank Mascuilli (ATC)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: SGPS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: ATC

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
D.10 Tool #10: EHIS PHA Data Processing/Assessment Tool
Location: ATC/UNH
Description: Tool to process and assess EHIS PHA data
Developer: Clifford Lopate (UNH)
Development schedule & handover plan: Delivered to NCEI-CO in February 2020
Data Dependencies: EHIS L0 data from LZSS
Testing accomplished or planned: Sensor vendor in-house testing complete. NCEI-CO installation and testing planned to be complete by summer 2021.
POC: UNH

D.11 Tool #11: mpslo_mcp_bias_adjust
Location: NCEI-CO
Description: Tool to adjust MPS-LO MCP bias
Developer: Juan Rodriguez
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: MPS-LO L0 data from LZSS
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a commercial off the shelf (COTS) platform complete
POC: NCEI-CO

D.12 Tool #12: sgps_diff31
Location: NCEI-CO
Description: Compare P7 and P8C channels from the two SGPS with the D3-D1 function enabled on both, disabled on one, and disabled on both, and determine how the correction compares to the PORD 10% residual contamination requirement
Developer: Brian Kress
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: SGPS L1b data from PDA, SGPS L0 data from LZSS
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete
POC: NCEI-CO

D.13 Tool #13: mpshi_pitch_angles
Location: NCEI-CO
Description: Calculates MPS-HI pitch angles at MAG L1b cadence (0.1 s), then averages to match MPS-HI L1b cadence (1.0 s)
Developer: Juan Rodriguez
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: MAG L1b and MPS-HI L1b data from PDA
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete

Check the GOES-R Portal at https://goesportal.ndc.nasa.gov to verify correct version prior to use
POC: NCEI-CO

D.14  **Tool #14:** mpsi_pad_plot  
**Location:** NCEI-CO  
**Description:** Plots mosaics of MPS-HI pitch-angle distribution (PAD, flux vs. pitch angle) plots with magnetic local time identifications  
**Developer:** William Rowland  
**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.  
**Data Dependencies:** MAG L1b and MPS-HI L1b data from PDA  
**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete  
**POC:** NCEI-CO

D.15  **Tool #15:** mpsi_telescope_intracal  
**Location:** NCEI-CO  
**Description:** Compares responses of MPS-HI telescopes when they have the same central pitch angle  
**Developer:** William Rowland  
**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.  
**Data Dependencies:** MAG L1b and MPS-HI L1b data from PDA  
**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete  
**POC:** NCEI-CO

D.16  **Tool #16:** mpslo_pitch_angles  
**Location:** NCEI-CO  
**Description:** Calculates MPS-LO pitch angles at MAG L1b cadence (0.1 s), then averages to match MPS-LO L1b cadence (1.0 s)  
**Developer:** Juan Rodriguez  
**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.  
**Data Dependencies:** MAG L1b and MPS-LO L1b data from PDA  
**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete  
**POC:** NCEI-CO

D.17  **Tool #17:** mpslo_pad_plot  
**Location:** NCEI-CO  
**Description:** Plots mosaics of MPS-LO pitch-angle distribution (PAD, flux vs. pitch angle) plots with magnetic local time identifications  
**Developer:** Juan Rodriguez  
**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.
**Data Dependencies:** MAG L1b and MPS-LO L1b data from PDA

**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete

**POC:** NCEI-CO

**D.18 Tool #18:** mpslo_z6_z7_overlap

**Location:** NCEI-CO

**Description:** Compares responses of MPS-LO overlapping zones Z6L vs. Z6R and Z7L vs. Z7R

**Developer:** Juan Rodriguez

**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.

**Data Dependencies:** MAG L1b and MPS-LO L1b data from PDA

**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete

**POC:** NCEI-CO

**D.19 Tool #19:** mpslo_zone_intracal

**Location:** NCEI-CO

**Description:** Compares responses of MPS-LO zones when they have the same central pitch angle, absent spacecraft charging similar to or greater than channel energy

**Developer:** Juan Rodriguez

**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.

**Data Dependencies:** MAG L1b and MPS-LO L1b data from PDA

**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete

**POC:** NCEI-CO

**D.20 Tool #20:** sgps_pitch_angles

**Location:** NCEI-CO

**Description:** Calculates SGPS pitch angles at MAG L1b cadence (0.1 s), then averages to match SGPS L1b cadence (1.0 s)

**Developer:** Juan Rodriguez

**Development schedule & handover plan:** Development of in-house tool complete; no handover necessary.

**Data Dependencies:** MAG L1b data from PDA, EHIS, MPS-HI and SGPS L1b data from PDA, EHIS, MPS-HI and SGPS L0 data from LZSS

**Testing accomplished or planned:** Testing of NCEI-CO in-house scripts on a COTS platform complete

**POC:** NCEI-CO
D.21 Tool #21: sgps_t1_intracal
Location: NCEI-CO
Description: Compares responses of the two SGPS Telescopes 1 (P1-P2B) when they have the same central pitch angle
Developer: Brian Kress
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: MAG L1b data from PDA, EHIS, MPS-HI and SGPS L1b data from PDA, EHIS, MPS-HI and SGPS L0 data from LZSS
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete
POC: NCEI-CO

D.22 Tool #22: sep_cross_compare
Location: NCEI-CO
Description: Compares responses of solar proton and helium channels in SGPS, MPS-HI (1-12 MeV) and EHIS, and in GOES 13-15 EPEAD
Developer: Brian Kress
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: MAG L1b data from PDA, EHIS, MPS-HI and SGPS L1b data from PDA, EHIS, MPS-HI and SGPS L0 data from LZSS
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete
POC: NCEI-CO

D.23 Tool #23: mps_near_conjunction
Location: NCEI-CO
Description: Cross-compares MPS-LO and MPS-HI with similar measurements on other satellites when they are in near-conjunction
Developer: Juan Rodriguez
Development schedule & handover plan: Development of in-house tool complete; no handover necessary.
Data Dependencies: MAG L1b data from PDA, MPS-LO and MPS-HI L1b data from PDA
Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete
POC: NCEI-CO

D.24 Tool #24: mpslo_background_trend
Location: NCEI-CO
Description: Trends MPS-LO backgrounds vs. likely background sources (MeV electrons & SEPs, dark noise)
Developer: Juan Rodriguez

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Development schedule & handover plan: Development of in-house tool complete; no handover necessary.

Data Dependencies: MPS-LO L0 data from LZSS, MPS-LO L1b data from PDA

Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete

POC: NCEI-CO

D.25 Tool #25: mpsihi_background_trend
Location: NCEI-CO
Description: Trends MPS-HI backgrounds vs. likely background sources (GCRs and SEPs)
Developer: Brian Kress; Juan Rodriguez

Development schedule & handover plan: Development of in-house tool complete; no handover necessary.

Data Dependencies: MPS-HI L0 data from LZSS, MPS-HI L1b data from PDA

Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete

POC: NCEI-CO

D.26 Tool #26: sgps_background_trend
Location: NCEI-CO
Description: Trends SGPS backgrounds vs. GCRs
Developer: Brian Kress

Development schedule & handover plan: Development of in-house tool complete; no handover necessary.

Data Dependencies: SGPS L0 data from LZSS, SGPS L1b data from PDA

Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete

POC: NCEI-CO

D.27 Tool #27: ehis_background_trend
Location: NCEI-CO
Description: Trends EHIS backgrounds vs. GCRs
Developer: Brian Kress

Development schedule & handover plan: Development of in-house tool complete; no handover necessary.

Data Dependencies: EHIS L0 data from LZSS, EHIS L1b data from PDA

Testing accomplished or planned: Testing of NCEI-CO in-house scripts on a COTS platform complete

POC: NCEI-CO
E. APPENDIX E: ACRONYMS

The acronym list below covers a select set of acronyms associated with SEISS and general GOES-R procedures. To see a more comprehensive list of acronyms used within the GOES-R Program, see the GOES-R Series Acronyms webpage at https://www.goes-r.gov/resources/acronyms.html.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AART</td>
<td>Algorithm Action Review Team</td>
</tr>
<tr>
<td>ACMP</td>
<td>Algorithm Change Management Plan</td>
</tr>
<tr>
<td>ADR</td>
<td>Algorithm Design Review</td>
</tr>
<tr>
<td>ATC</td>
<td>Assurance Technology Corporation</td>
</tr>
<tr>
<td>BRF</td>
<td>Body Reference Frame</td>
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<tr>
<td>cal/val</td>
<td>Calibration and Validation</td>
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<tr>
<td>COTS</td>
<td>Commercial off the Shelf</td>
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<tr>
<td>CR</td>
<td>Change Request</td>
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<tr>
<td>DOE</td>
<td>Data Operations Exercise</td>
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<tr>
<td>DPU</td>
<td>Data Processing Unit</td>
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<tr>
<td>eGRES</td>
<td>electronic GOES-R Export Service</td>
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<tr>
<td>EHIS</td>
<td>Energetic Heavy Ion Sensor</td>
</tr>
<tr>
<td>EMCP</td>
<td>Electron Micro Channel Plate</td>
</tr>
<tr>
<td>EPEAD</td>
<td>Energetic Proton, Electron, and Alpha particle Detector</td>
</tr>
<tr>
<td>ERB</td>
<td>Engineering Review Board</td>
</tr>
<tr>
<td>ESA</td>
<td>Electrostatic Analyzer</td>
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<tr>
<td>FOV</td>
<td>Field of View</td>
</tr>
<tr>
<td>GCR</td>
<td>Galactic Cosmic Ray</td>
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<tr>
<td>GORWG</td>
<td>GOES-R Operational Readiness Working Group</td>
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<tr>
<td>GRB</td>
<td>GOES Rebroadcast</td>
</tr>
<tr>
<td>GRE</td>
<td>Ground Readiness Exercise</td>
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<tr>
<td>GS</td>
<td>Ground Segment</td>
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<tr>
<td>IMCP</td>
<td>Ion Micro Channel Plate</td>
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<tr>
<td>L0</td>
<td>Level 0</td>
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<tr>
<td>L1b</td>
<td>Level 1b</td>
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<tr>
<td>L2</td>
<td>Level 2</td>
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<tr>
<td>MAGED</td>
<td>Magnetospheric Electron Detector</td>
</tr>
<tr>
<td>MCP HV</td>
<td>Microchannel Plate High Voltage</td>
</tr>
<tr>
<td>MIT LL</td>
<td>Massachusetts Institute of Technology – Lincoln Laboratory</td>
</tr>
<tr>
<td>MOST</td>
<td>Mission Operations Support Team</td>
</tr>
<tr>
<td>MPS-HI</td>
<td>Magnetospheric Particle Sensor (high energy)</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>MPS-LO</th>
<th>Magnetospheric Particle Sensor (low energy)</th>
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<tbody>
<tr>
<td>MRD</td>
<td>Mission Requirements Document</td>
</tr>
<tr>
<td>MVTDS</td>
<td>Mission Validation Test Data Sets</td>
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<tr>
<td>NCEI</td>
<td>National Centers for Environmental Information</td>
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<tr>
<td>OSPO</td>
<td>Office of Satellite and Product Operations</td>
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<tr>
<td>PAD</td>
<td>Pitch Angle Distribution</td>
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<td>PAL</td>
<td>Product Area Lead</td>
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<td>PASS</td>
<td>Product Algorithm Science Support</td>
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<td>Product Distribution and Access</td>
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<td>Post-Launch Product Test</td>
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<tr>
<td>PLT</td>
<td>Post-Launch Test</td>
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<tr>
<td>POC</td>
<td>Point of Contact</td>
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<tr>
<td>PRO</td>
<td>Product Readiness and Operations</td>
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<tr>
<td>PSE</td>
<td>Program System Engineering</td>
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<tr>
<td>PS-PVR</td>
<td>Peer Stakeholder–Product Validation Review</td>
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<tr>
<td>PTDR</td>
<td>Post Test Data Review</td>
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<tr>
<td>RIMP</td>
<td>Readiness, Implementation, and Management Plan</td>
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<tr>
<td>SC</td>
<td>Solar Cycle</td>
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<tr>
<td>SEISS</td>
<td>Space Environment In-Situ Suite</td>
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<tr>
<td>SEP</td>
<td>Solar Energetic Particle</td>
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<tr>
<td>SGPS</td>
<td>Solar and Galactic Proton Sensor</td>
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<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
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<tr>
<td>SNR</td>
<td>Signal to Noise Ratio</td>
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<tr>
<td>SOE</td>
<td>Sequence Of Events</td>
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<tr>
<td>SPADES</td>
<td>Satellite Product Analysis and Distribution Enterprise System</td>
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<td>SWPC</td>
<td>Space Weather Prediction Center</td>
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<tr>
<td>UNH</td>
<td>University of New Hampshire</td>
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<tr>
<td>WR</td>
<td>Work Request</td>
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