



INL Operations Improvements of Nuclear Enabled Missions for NASA - Presentation

May 2022

Changing the World's Energy Future

Eric S Clarke



INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC

DISCLAIMER

This information was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness, of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

INL Operations Improvements of Nuclear Enabled Missions for NASA - Presentation

Eric S Clarke

May 2022

**Idaho National Laboratory
Idaho Falls, Idaho 83415**

<http://www.inl.gov>

**Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**

INL Operations Improvements of Nuclear Enabled Missions for NASA

Eric Clarke, Stephen Johnson



Mars Exploratory Rovers

- INL delivered 16 Light Weight Radioisotope Heater Units (2003 launches)
- 10CFR830 required a new approach to nuclear safety at KSC
 - Established a HazCat III non-reactor nuclear facility
 - Documented Safety Analysis (DSA) approved by DOE-HQ
 - Unreviewed Safety Question (USQ) process evaluated any operational change
- Lesson Learned:
Need qualified USQ evaluators on-hand to evaluate changes



MER Integration at KSC (courtesy of NASA)

New Horizons

- INL fueled, tested, and delivered a GPHS-RTG (2006 launch)
- RTG process flow required multiple nuclear facilities
 - RTG stored in RTGF
 - Hot-fit check in PHSF before fairing encapsulation
 - Final integration at Vertical Integration Facility
 - Transport between facilities
- DSA concurrence by USAF, NASA-KSC, APL, United Space Alliance with approval from DOE-HQ
- Established short term nuclear facilities based on RTG location reduced USQ demand



Integration of the GPHS-RTG to NH spacecraft at KSC (courtesy of JHUAPL)

- INL assigned cognizant person acting in concert with Launch System Integration Manager responsible for New Horizons nuclear operations
- INL assigned USQ evaluators on-site during day and night shift nuclear operations

Mars Science Laboratory

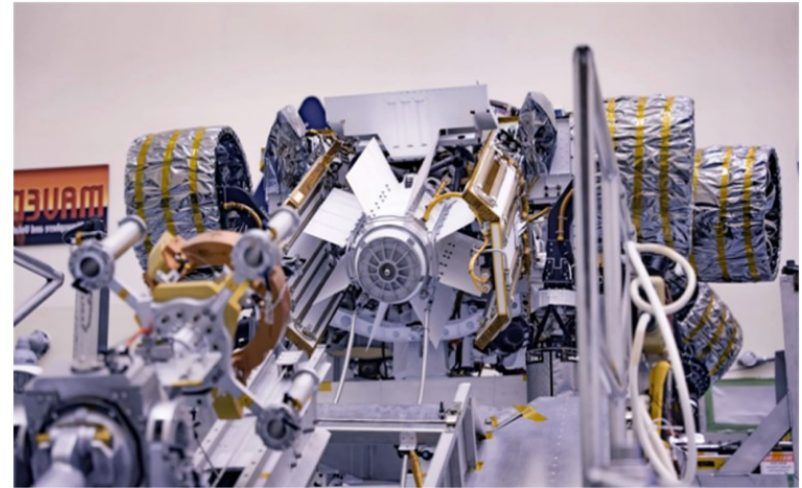
- INL fueled, tested, and delivered a MMRTG (2011 launch)
- Similar multi-facility process flow as New Horizons
- Similar DSA approval strategy; Concurrence by USAF, NASA-KSC, and ULA and approved by DOE-HQ
- Introduced nuclear safety concepts early in Ground Operations Working Group
- Improved procedure flow and flexibility by smaller compartmentalized procedures vs larger front to back procedures
- Added MMRTG system design agency to quickly provide technical support



Hot-fit Check of the MMRTG to Curiosity at PHSF, KSC (courtesy of NASA)

Mars 2020

- INL fueled, tested, and delivered a MMRTG (2020 launch)
- Similar multi-facility process flow as MSL and New Horizons
- Similar DSA approval strategy; Concurrence by USAF, NASA-KSC, and ULA but approved by DOE-ID
- Improved equipment reliability
- Improved Readiness Assessment preparation by instituting an internal Management Review
- Streamlined MMRTG end item data package creation



Hot-fit Check of the MMRTG to Perseverance at PHSF, KSC (courtesy of NASA)

Acknowledgments

Support From:

NASA RPS Program Office (June Zakrajsek)

DOE NE (Tracey Bishop and Mary McCune)

ORNL (Bob Wham, George Ulrich)

LANL (Jackie Lopez-Barlow)

