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Space and Defense Power Systems Program Update

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Topics

- Update on Preparations for Mars 2020 Mission
- Improvements to Existing Capabilities
- New Pu-238 Production Project Update
- Opportunity for Pu-238 production process improvements
- DOE approach to supporting cost-capped, competed NASA missions
- Summary

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RPS Production Progress for Mars 2020

- **Heat Source Manufacturing (LANL) – started in FY 2015**
  - Existing Pu-238 inventory is being used; new production not required
  - 20 fueled clads needed by 2018 for in-specification power
  - 3 FCs made last year; work has started on 7 more for completion in FY16.
- **Balance of generator (Aerojet Rocketdyne, Teledyne)**
  - 2 Flight units are in storage (only 1 will be used for this mission)
  - These require cooling tube installation and emissive coating (planned for FY17)
- **Fueling and testing operations (INL)**
  - Procedures, tooling, facilities remain in place since MSL
  - Addition of staffing is underway, to be complete end of March, 2016
- **Mission Support**
  - Provided risk assessment for NEPA process (complete)
  - Safety analysis and other mission interactions are in preliminary stages

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FY16 Reliability Improvements (not related to Pu-238 production)

Los Alamos National Laboratory

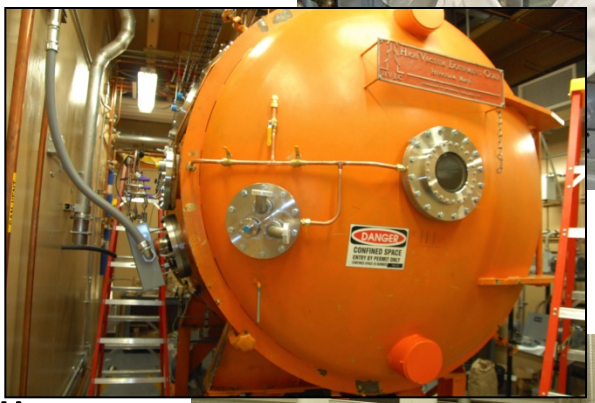
- New furnaces, hot press (continues into 2018)
- Welder upgrade

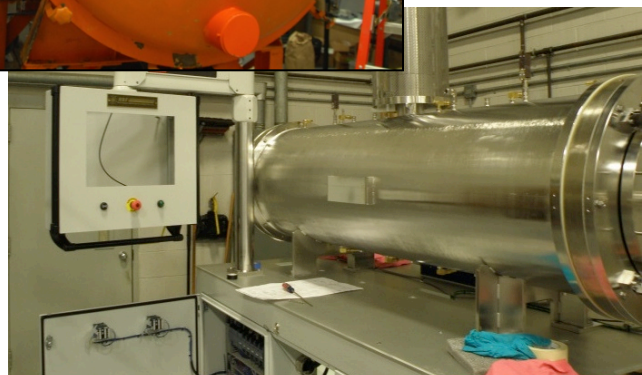
Idaho National Laboratory

- Thermal vacuum chamber mechanical system
- Facility Monitoring System control

Oak Ridge National Laboratory

- Complete Carbonization furnace install, started last year
- Alloy characterization furnace





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Pu-238 Supply Project Update

- First new US Pu-238 production since the late 1980s
  - ~ 50 gm total ^{238}Pu was produced
  - A small sample has been shipped to LANL to compare analytical results
- Successful Preliminary Design Review held in December
- Target production already well underway for second demonstration
  - Goals are to demonstrate larger batch sizes, make any changes/optimization indicated from first demo and improve operational throughout predictions
- The first shipment of NpO_2 from INL to ORNL has occurred in November.

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Pu-238 Production Process Improvement

- **Baseline process design is based on fastest/lowest cost path to assured supply**
- **At last OPAG meeting, we introduced a concept being considered to change target design**
  - Increase yield in a given irradiation position (~ 2 X)
  - High assay products (~ 92%, versus ~88% for baseline)
  - Eliminate aluminum from waste
  - Decrease number of targets
  - Most existing target fabrication equipment is compatible
- **Work has been funded for FY16 and is proceeding in parallel with base project**

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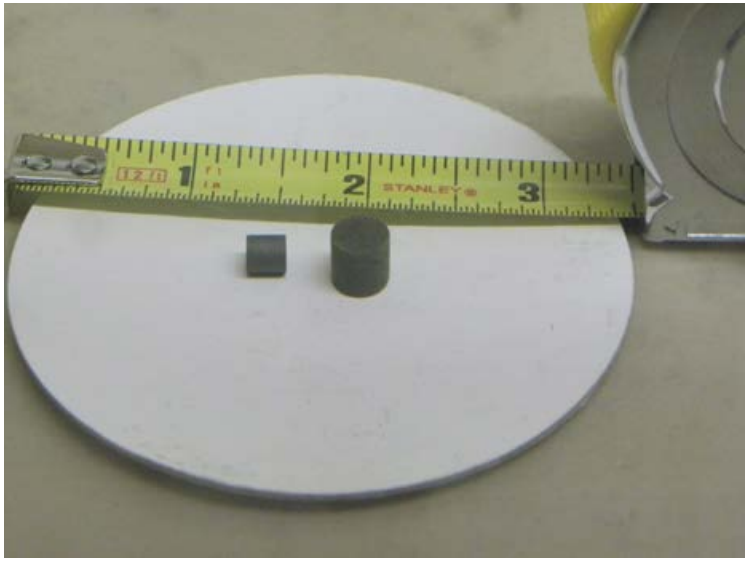
The Alternate Target Design Uses a Pure Neptunium Dioxide Pellet Clad in Zircaloy



- Materials and processes are similar to nuclear fuels work also done at ORNL
- Neptunium recycle processes would be the same as baseline
- Pellets would be pure NpO_2 (baseline uses NpO_2 with aluminum)
- Current work is investigating pellet manufacturing methods, along with modeling and analysis
- Pellets will be manufactured and irradiated this year and next to verify predictions and determine whether to continue
- Preliminary results will be used to plan an “on ramp” process if successful

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DOE Approach to Supporting Cost-capped Competitive NASA Missions

- RPS have historically been used on flagship-class (or equivalent) missions, but not because of Pu-238 supply
  - Nuclear cost tended to drive use on big budget missions
  - Duration – typically at least 6 years to manufacture systems and plan for their use
- Pluto New Horizons
  - Mission used an existing unfueled generator spare from a past project
  - Project start to launch date was ~5 years; extremely difficult pace
- Discovery AO that Offered ASRG
  - Concept to demo new technology on a more risk-tolerant mission class
  - DSMCE study examined potential science value
  - Interagency agreement for long-lead work at risk to support ASRG flight
  - The idea also introduced exciting potential for using RPS on cost-capped missions, but requires resolution of issues not addressed for Discovery 12

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DOE Approach to Supporting Cost-capped Missions (continued)

- These are only the DOE considerations – nothing should be inferred about NASA intent or its own considerations
- Schedule
  - Nuclear mission projects typically take ~6 years (Mars 2020 work started in FY14, with the unfueled generator on the shelf)
  - For some mission classes, if mission timeline is not adjusted, heat source manufacturing and NEPA work need to start before mission selection
- Cost
  - Investment phasing would need to support work before a mission is selected
- Examples
  - ASRG fueled clads produced at risk and not used; future missions will use these with reduced power.
  - New Frontiers Community Announcement just released requires an extra year for production schedule, allowance for other mission work and alignment of investments with mission decisions (community announcement to first possible launch ~9 years)

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Summary

- New Pu-238 has been produced!
- Currently planned missions are on track
- Reliability improvements to DOE capabilities are progressing alongside mission production
- Pu-238 Supply Project is proceeding on cost and schedule, with limited production expected later this decade
- Process improvement studies are being funded, with the potential to increase production and reduce cost
- DOE and NASA will continue to collaborate and address other challenges to support the use of RPS on a broad class of missions

Questions?