



Cobalt-60 Source Reload

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Agenda

- Radiation Effects Testing: Background
- NASA Health Physics (HP) and Radiation Safety
- Cobalt-60 Irradiator Logistics
- Reload Logistics: Transportation, Receiving, and Source Exchange
- Ensuring Safety and Re-Opening the Facility

Radiation Effects Testing

The Jet Propulsion Laboratory (JPL) Radiation Effects Lab:

- Investigates effects of space radiation on microelectronics and optoelectronics.
- Evaluates the risk of using them in space missions.
- Recommends component and design techniques for NASA Programs to reduce Reliability risk from space radiation.

Every NASA space mission (manned or unmanned) relies heavily on electronics parts testing to achieve mission objectives.

The irradiator reload project *increases testing capacity and reduces testing time.*



NASA Health Physics

Radiation, Lasers, and Radio Frequency Safety



2017 NASA HP Triennial Meeting

The NASA HP community is a close-knit, collaborative group.

Regulations for Ionizing Radiation

- **Radioactive Materials:** NASA Centers operate with Nuclear Regulatory Commission (NRC) licenses.
 - Caltech/JPL has a California State license.
 - Department of Energy (DOE) is regulated separately. NASA and DOE collaborate on radioisotope power sources.
- **Radiation-Producing Machines:** State Departments of Health have regulatory authority.
 - NASA Centers are Federal, so States do not have jurisdiction. NASA must provide oversight, which Radiation Safety Officers (RSOs) perform.
- **NPR 1800.1, Chapter 4:**
 - While an RSO is only legally required by an NRC/State Radioactive Materials (RAM) license, each Center is required to appoint an RSO by NPR 1800.1.

RAM Licenses

Types and Why It's Important

- **Licenses of broad scope:**
 - Possession of most any RAM, even small quantities of “special nuclear material” is allowed.
 - Procurement and use controlled by RSO and Radiation Safety Committee.
- **Specific:**
 - Each new source requires a request approved by NRC.
- **General or no license:**
 - Still need an RSO to comply with NASA Procedural Requirements and manage contractor licensees.



Managing Contractor Licensees

Pressure Vessel Systems Requiring Radiography



Radiographers set up to take an X-ray of GN2 line.



Radiography usually requires a 150-foot radius exclusion zone.

Cobalt-60 Irradiator

- JPL operates four Radiation Effects Testing Labs:
 - One machine source—Dynamitron (X-ray, particle accelerator)
 - Three Cobalt-60 laboratories
- Why cobalt-60?
 - Simulates space radiation damage
 - Penetrating nature of gamma rays enables a wide variety of tests
 - Safe against accidental dispersal
 - The industry-wide choice for Total Ionizing Dose testing of Electrical, Electronic and Electromechanical parts
- Cobalt-60 basics:
 - Radioactive metal
 - Emits gamma radiation
 - 5½ year half-life
 - Must be replenished every 8-10 years



Irradiator Reload Logistics

- **Project lead time:**
 - **Production:** The pellets are made by irradiating cobalt 59 with neutrons in a reactor; procurement timed carefully.
 - **Licensing:** RAM license amendment with California Department of Health (minimum turnaround, three months; JPL applied eight months in advance).
 - **Shielding Plan:** No original shielding design/analysis found; went back to original building drawings and recalculated vault shielding.
- **Security:**
 - **Cobalt 60** is on the International Atomic Energy Agency's list of nuclear materials that require enhanced protection.
 - The quantity of Cobalt-60 used by JPL is the second highest in Southern California.
 - **Transportation** required coordination with National Source Tracking System and Los Angeles County Sheriff, and Federal Bureau of Investigation requested notification to shadow the vehicle (outside JPL).
 - **JPL Protective Services** provided additional onsite security support.

Communication and Safety Measures

- Multiple communications to ensure employee awareness
- JPL performed independent radiation surveys:
 - Side of van: 0.7 mrem*/hr
 - Outside wall: 0.2 mrem*/hr
 - Public limit: 2.0 mrem*/hr



* 1 mrem = dose from a single dental bitewing x-ray



**Cobalt shipping container
“bowling ball” and
overpack shipping container**

**Transporting container to
JPL Radiation Effects Lab
underground vault**



Safety Assurance

- In addition to the comprehensive shielding analysis, an independent radiation shielding consultant performed a radiation compliance survey.
- All external measurements were found to be indistinguishable from natural background radiation.



Summary

- Radiation sources and radiation testing are a vital part in achieving successful NASA space missions.
- Replenishing and upgrading irradiator facilities is a continuous process.
- NASA's Health Physicists play an important role in ensuring that these activities take place with minimal risk to the public, employees, and the environment.

