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November 11, 2014

The Honorable Mike Simpson
Chairman
Subcommittee on Energy and Water Development
Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515
Fax: (202) 225-1566

The Honorable Marcy Kaptur
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515
Fax: (202) 225-1566

Dear Chairman Simpson and Ranking Member Kaptur:

J.L. Shepherd and Associates is writing as a domestic small business, with contacts in the fields that use high level radioactive sources that will be detrimentally impacted regarding the language contained in Section 402 of the FY 2015 Senate Energy and Water Development Appropriations Bill.

Radioactive materials are used by many sectors of our society, with an unquestionable contribution to the US economy and infrastructure. The most recognizable societal benefits include the healthcare industry, both patient cancer treatment and on-going cancer research to provide new treatment methodologies. Non-destructive Testing (NDT) is widely used in manufacturing to provide quality assurance and on-site integrity inspection of materials; some examples are materials used to construct our highways and bridges, high rise buildings, ships and submarines and nuclear power plants. Both food and medical products are irradiated to kill bacteria and pathogens. Invasive and disease bearing pests are irradiated in sterile release programs; one result is the eradication of pink boll weevil in the US. The oil and gas industry uses radioactive materials for investigating new supplies of energy.

These industries are well represented by associations or users groups and have most likely commented on this legislation. There are other vital applications for radioactive materials, which may not have the public visibility as those listed above. These applications include: 1) infectious disease research - the Biosafety Laboratories who are providing research on Ebola; 2) personnel radiologic health and safety for the Department of Defense, The Department of Homeland Security, first responders, healthcare professionals, laboratories, educational institutions, industry, manufacturing, and for civilian use in times of a radiologic emergency, and; 3) civil, commercial, NASA, military and reconnaissance space programs - satellites, space missions, airplanes and weapons - the Aerospace Industry for radiation hardened electronic and computer components of these systems. J.L. Shepherd and Associates would like to take this opportunity articulate their stories in the addendums to this letter. This information was taken from publically available websites and does not include classified or security related information.

J.L. Shepherd and Associates currently participates in projects to safeguard and protect radiological material from misuse. The US Nuclear Regulatory Commission (NRC) and the thirty-seven agreement states provide the regulatory oversight for the licensing and inspection of radiological materials and their safety. The NRC has enacted an all-embracing update of its regulations for radiation sources under Title 10 CFR Part 37, which addresses many of the issues identified in the Senate bill's provisions. This process includes extensive public review and comment. Section 402 would require NRC to abandon its established regulatory framework to implement mandatory security standards established by the National Nuclear Security Administration (NNSA) Global Threat Reduction Initiative (GTRI) for "High Risk Radiological Material." We are apprehensive that the Bill as written would set a detrimental precedent, wherein an independent regulatory agency (NRC) is forced to reject its own standards for those developed by a cabinet department (DOE/NNSA). We would advocate that the Subcommittee withdraw this language to ensure that NRC's authority is not in any way subordinated to NNSA or any other executive branch agency. We would like to add that commercial airplanes were used a weapons of mass destruction on September 11, 2001. The US did not ban the use of airplanes, we tightened security. The NRC with past security orders that have been codified with enactment of the new Title 10 CFR Part 37 security measures is following the same principal, with stakeholder involvement through a public comment period.

J.L. Shepherd and Associates also has concerns about Section 402(f), which as written, could mandate the NRC to ban licensing for widely used radioisotopes such as Cobalt-60, Cesium-137, Americium- 241, and Californium-252, without consideration of the cost, reliability, risks and overall effectiveness of potential substitute technologies. We believe that as a practical matter, many radioactive materials licensees are already exploring available alternatives on reliability and cost benefit basis. Since the events of September 11, 2001, Sandia National Laboratories has been partnering with private industry to develop alternative technologies and advances are progressing. However, it is uncertain that this alternative technology can be developed for all of the wide ranging applications of these radioactive materials. The X-ray replacement technology may not yet be suitable for all the areas of Cesium-137 research and development, especially regarding stem cell or cancer research. Over fifty years of cancer research using Cesium-137 sources has progressed to the point that tumors that are non-responsive to traditional therapy can now be DNA sequenced to provide individualized cancer treatment. We believe that mandating the NRC to stop licensing certain radioactive sources within fifteen years after enactment of the Bill could be detrimental to the health and safety of the public, if development of alternative technologies has not progressed to fully functional products for the specific applications needed. We would also like to note that the Department of Energy, also owns many of these high level radioactive sources for some of the applications we have noted in this letter (radioactive materials instrument calibration, personnel dosimetry qualification and radiation hardening for weapons and space projects), and these source would not be subject to the same potential restrictions that are being placed on NRC licensees.

J.L. Shepherd and Associates recognizes that radiological security in the US is an important part of our national security and that security review should be a continuous process. We would like to ask that you, with the committees of jurisdiction in the House and Senate, ensure that the issues raised by the language in this Bill are considered as part of the normal process of congressional oversight.

We thank you for your time and attention to this significant matter. If you have any additional questions, please feel free to contact Mary Shepherd, Vice President, Licensing and Special Projects at (818-898-2361) 438-0557 or sales@jlshepherd.com.

Sincerely yours,

Mary F. Shepherd
Vice President, Licensing and Special Projects

Addendum 1.
Infectious Disease Research - Biosafety Laboratories

High level Cobalt-60 sources in self-contained irradiators are an essential component of the research conducted inside a BioSafety Level (BSL) laboratory on dangerous biological agents. The scientists who work in BSL facilities follow a philosophy of "one world-one health." according to our contacts. "This philosophy has led to a network of colleagues around the world who collaborate with the belief that any infectious disease outbreak can quickly spread and become a public health crisis at any location. This global network has shown in its ability to quickly begin research at the start of the 2009 H1N1 influenza pandemic in the U.S. and Mexico, and again in September 2012 when a previously unknown corona virus emerged in Saudi Arabia (nine cases, five deaths as of December 2012). As with naturally occurring outbreaks, these scientists also would be called upon for immediate response to any intentional spread of biological disease", according to our contact at The NIH, NIAID, Rocky Mountain Laboratory, Hamilton, MT, and current projects include Ebola research.

If new sources and irradiators cannot be deployed the mandated viral inactivation cannot be achieved at a new BSL laboratory. For existing BSL laboratories, if new replacement sources for the existing irradiators cannot be deployed, specimen quality suffers because of the lengthy irradiation doses needed for mandated viral inactivation. The BSL Laboratories would have to discontinue certain projects and alter operating procedures, which would severely impact research missions and affect their public health mandate and role in national security. Some examples of BSL Laboratories follow.

USAMRIID—the birthplace of medical biodefense.
From the USAMRIID website:

> "Since its inception in 1969, USAMRIID has spearheaded research to develop medical solutions—vaccines, drugs, diagnostics, and information—to protect our military service members from biological threats. Our specialized capabilities include Biosafety Level 3 and Level 4 laboratories, world-class expertise in the generation of biological aerosols for testing candidate vaccines and therapeutics, and fully accredited animal research facilities.
>
> The outstanding national reputation of USAMRIID has been built over the years by numerous scientists and technical staff working to protect both military personnel and civilians from the threat of infectious diseases. We participate in support of emerging disease investigations, working alongside colleagues from the Centers for Disease Control and Prevention and the World Health Organization. As a reference laboratory for the Department of Defense, we set the standard for identification of biological agents. Our customers in the Army and the Department of Defense know us as a "tech base" organization that has produced some 20 candidate medical products over the past decade. Still others recognize the impressive scientific credentials of our workforce, which represents some of the top infectious disease and biological defense experts in the Nation—indeed, in the world.

Addendum 1.
Infectious Disease Research - Biosafety Laboratories, continued

USAMRIID—the birthplace of medical biodefense, continued.

As the United States continues a new era of civilian biodefense research, it is also clear that USAMRIID plays a critical role in the status of our country's preparedness for biological terrorism and biological warfare. While our primary mission is to protect the warfighter, our research benefits civilians as well.

USAMRIID is looking forward to continued collaborations with industry partners and with other federal agencies - including the Department of Health and Human Services and the Department of Homeland Security - to develop medical countermeasures that will protect all of our citizens, both military and civilian."

The National Institute of Allergy and Infectious Diseases (NIAID).
From the NIAID website:

"The National Institute of Allergy and Infectious Diseases (NIAID), a component of the National Institutes of Health (NIH), plays a key role in the nation's biomedical research program. NIAID conducts and supports research to understand, treat, and ultimately prevent the myriad infectious, immunologic, and allergic diseases that threaten hundreds of millions of people worldwide. NIAID's Division of Intramural Research is known as a state-of-the-art research enterprise carried out by world-class scientists on campuses in Bethesda and Rockville, MD, and in Hamilton, MT.

Because of NIAID's long-standing expertise in research on emerging infectious diseases, the President directed the Institute to play a leading role in the nation's fight against bioterrorism. NIAID is expanding its research programs to spearhead the development of new and improved diagnostics, treatments, and vaccines for diseases caused by naturally occurring infectious agents as well as microbes that may be intentionally released into a civilian population.

For that research to be carried out safely, NIH plans to construct a new Integrated Research Facility (IRF) for NIAID's biodefense program on the grounds of Fort Detrick in Frederick, MD. NIAID is committed to ensuring that its employees work in the safest possible laboratories, and that these laboratories also reduce to the maximal extent possible any potential risks to the surrounding community. The laboratories will employ the highest safety standards recommended for the research proposed to be conducted there, standards known as Biosafety Levels 3 and 4 (BSL-3 and BSL-4), to prevent scientists and the environment from being exposed to microorganisms. Researchers at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) facilities at Fort Detrick have studied similar agents for decades. The new facility will comply with stringent federal and state regulations for construction, use, security, inspection, and certification.

Addendum 1.
Infectious Disease Research - Biosafety Laboratories, continued

The National Institute of Allergy and Infectious Diseases (NIAID) continued.

Most facilities in the United States with infectious disease research programs have BSL-3 laboratories. In addition, many hospitals have areas that can be operated at this level; these areas are used for isolating patients with highly contagious diseases.

BSL-4 labs have the most stringent safety and security requirements. There are currently only four operational BSL-4 laboratory suites in the United States: at the Centers for Disease Control and Prevention in Atlanta, GA; at the United States Army Medical Research Institute for Infectious Diseases at Fort Detrick in Frederick, MD; at the Southwest Foundation for Biomedical Research in San Antonio; and at the University of Texas at Galveston."

U.S. Army, Aberdeen Proving Ground (APG)
From the APG website:

"•Workers at APG are responsible for numerous technical achievements in military intelligence, medical research, engineering and computer technology.

•A $1 billion research and development resource, and a key player in the nation's homeland defense and international counterterrorism efforts, APG is an economic and technology resource for the region.

•The installation also supports a wide variety of training, including mechanical maintenance, health promotion and preventive medicine, chemical and biological defense, and chemical casualty care, chemical demilitarization."

U.S. Army, Dugway Proving Ground (APG)
From the Dugway website:

"Team Dugway provides unique chemical, biological, radiological, nuclear, and explosives (CBRNE) and unmanned aerial system (UAS) testing and training and related support for our Nation's defenders. Skilled professionals execute these vital programs by using state-of-the-art equipment and efficient, quality-driven processes at our superior facilities."

Armed Forces Radiobiology Institute
From the AFRRI website:

"The unique resources of the Armed Forces Radiobiology Research Institute enable advancements in the protection of soldiers and citizens. The AFRRI mission is to preserve the health and performance of U.S. military personnel and to protect humankind through research that advances understanding of the effects of ionizing radiation.

Addendum 1.
Infectious Disease Research - Biosafety Laboratories, continued

Armed Forces Radiobiology Institute, continued

"The unique resources of the Armed Forces Radiobiology Research Institute enable advancements in the protection of soldiers and citizens. The AFRRI mission is to preserve the health and performance of U.S. military personnel and to protect humankind through research that advances understanding of the effects of ionizing radiation.

To these ends, the institute collaborates with other government facilities, academic institutions, and civilian laboratories in the United States and other countries to research the biological effects of ionizing radiation. In addition, it provides medical training and emergency response to manage incidents related to radiation exposure.

Research and development goals
•Pursue new drugs that will prevent the life-threatening and health-degrading effects of ionizing radiation and move those drugs from discovery through the Food and Drug

Administration approval process
•Develop methods of rapidly assessing radiation exposure to assure appropriate medical treatment
•Investigate the effects of radiation injury combined with other challenges such as trauma, disease, and chemical exposures
•Contribute to the knowledge base that is useful in understanding, for example, the effects of space radiation on astronauts

Resources
Three facilities are licensed by the Nuclear Regulatory Commission. They include the Cobalt-60 low-level irradiation facility: Delivers chronic radiation doses to biological samples to study early and late effects.

Addendum 2.
The Department of Defense, The Department of Homeland Security, First Responders, Healthcare Professionals, Laboratories, Educational Institutions, Industry, Manufacturing and Civilian Personnel Safety

High level Cesium-137 and Cobalt-60 sources are used by the US Army, Test, Measurement and Diagnostic Equipment Activity (USATA), Radiation Standards Laboratory at Redstone Arsenal and at USATA field laboratories worldwide and the US Navy RADIAC Calibration Standards Laboratories for the development and calibration of radiation detection instruments and personnel dosimetry. There is an equivalent commercial sector for providing these same services to first responders, medical personnel, laboratories, educational institutions, nuclear power, industrial users and civilians, or for providing response to a radiological attack. Additionally this type of equipment is required for non-proliferation tracking and certification projects. The National Institute of Standards and Technology currently uses these types of sources and has accreditation programs for calibration laboratories which encompasses the use of these sources.

U.S. Army, Redstone Arsenal, TMDE
From the Redstone Arsenal website:

"The APSL metrology and calibration program is the critical link which ensures measurement accuracy and traceability to national standards for every Army weapon system. The APSL is an element of the US Army Test, Measurement and Diagnostic Equipment Activity (USATA), a primary organizational element of the Army Aviation and Missile Command (AMCOM) located at Redstone Arsenal, AL.

The APSL consists of five major standards laboratories: Physical, Electrical, Applied Physics, Electromagnetic, and Radiation. In addition, the APSL includes the Army Dosimetry Center and the Customer Support Division.

Our mission is to provide the Army's highest level of metrology and calibration services as required, traceable to national standards or fundamental physical constants. We develop measurement and calibration technology, instrumentation, and TMDE systems required to support Army current and future weapon systems through USATA field laboratories worldwide. The APSL provides state-of-the-art metrology and calibration services, technical expertise, health physics services, and chemical/biological defense-related support to the Army. We provide engineering and scientific representation to the tri-service joint technical coordinating group for calibration and measurement technology and its subgroups responsible for managing and coordinating metrology R&D. Our subject matter experts serve on Army, DOD, and national technical committees, and provide liaison between the Army, NIST and other technology developers. We support the DA radiation safety community by providing program specific services. These services include health physics, nucleonics, ionizing radiation dosimetry, and maintenance and continuous update of the repository for Army personnel radiation exposure records."

Addendum 2.
The Department of Defense, The Department of Homeland Security, First Responders, Healthcare Professionals, Laboratories, Educational Institutions, Industry, Manufacturing and Civilian Personnel Safety, continued

U.S. Navy, Naval Sea Systems Command, NAVSEA Test, Measurement and Diagnostic Equipment (TMDE) and Calibration Programs
From www.dtic.mil/descriptivesum/Y2013/Navy

"Mission Description: The Radiation Detection, Indication and Computation (RADIAC) Program is responsible for providing radiation monitoring instruments that detect and measure ionizing radiation. These instruments are used on all Navy, Coast Guard and Military Sealift Command vessels, and at every Navy shore installation, in order to ensure the safety of personnel, continuity of operations in radiological contingencies, and protection of the environment.

Justification: Title 10 of the Code of Federal Regulations, Part 20 (10CFR20) requires RADIAC instruments be used to ensure the safety of personnel who work with or are exposed to radioactive materials in their work. Additionally, the Navy's mission requires personnel and ships to have the ability to operate in radiological environments and the ability to identify and interdict radiological Weapons of Mass Destruction (WMD). Navy programs that require RADIAC instruments for Occupational Safety & Health (OSH) reasons under the provisions of 10CFR20 include Naval Nuclear Propulsion, Nuclear Weapons, Medical, and Radiological Affairs

Support. Non-OSH programs include Radiological Defense, Consequence Management, Training, Technical (RADIAC calibration, shielding evaluation, research, etc.) and Radiological Search (maritime interdiction and radiological search missions to locate or intercept Weapons WMD).

Improvement in personnel dosimetry and neutron measurement is also a major emphasis."

National Institute of Standards and Technology (NIST)
From the NIST website:

"In addition to our mission to realize the Système International (SI) units for absorbed dose (the gray) and activity (the becquerel), we maintain an active research programs in terahertz spectroscopy, neutron physics, radiation dosimetry, and radionuclide metrology. We are also active in over-arching programmatic efforts in medical physics to support medical imaging and therapeutics, standards and test procedures for chemical/biological/ radiation/nuclear/explosives countermeasures in homeland security, measurement assurance and standards to support environmental stewardship and the nuclear energy and radiation industries, and methods in applications of ionizing radiation in advanced manufacturing. We promote the accurate and meaningful measurements of dosimetric quantities pertaining to ionizing radiation (x and gamma rays, electrons, and energetic, positively charged particles) and provide measurement services, standards, and

Addendum 2.
The Department of Defense, The Department of Homeland Security, First Responders, Healthcare Professionals, Laboratories, Educational Institutions, Industry, Manufacturing and Civilian Personnel Safety, continued

National Institute of Standards and Technology (NIST), continued

fundamental research to support neutron technology and neutron physics for industrial research and development through neutron dosimetry, calibration of neutron survey instruments, and development of neutron sources. We are also responsible for developing metrological techniques to standardize new radionuclides for research and for exploring radiation and nuclear applications, including through development and distribution of the Standard Reference Materials for radioactivity in the US."

Mirion Technologies
From the Mirion Technologies website:

"Nuclear Power

There are many operational challenges facing the Nuclear Power Industry, and Mirion Technologies has made a commitment to provide an array of options to meet them. Providing systems for personnel monitoring to reactor containment; or radiation sensitive cameras to radiation area monitoring and telemetry, Mirion Technologies is committed to engineering top notch solutions for the evolving needs of the Nuclear Industry.

Healthcare

Protecting physicians and their patients with world-class radiation safety solutions
In the modern medical environment, the radiation safety needs of both doctors and those they care for are constantly evolving. Mirion Technologies is committed to putting a high-quality array of tools in the hands of healthcare professionals, with options including badge dosimetry services, handheld survey meters, and installed area monitors. We tailor each radiation monitoring program to your requirements.

Military & Homeland Security

Precision engineered radiation detection equipment to protect those in uniform.
The threat of radioactive material on the battlefield whether on land or sea is a terrible reality, and the requirements for any equipment to be used to detect it or protect the people in the field are high. Mirion Technologies has a long history of providing highly reliable, hardened equipment designed to meet military standards, including personnel dosimetry, radiation survey meters, area and air monitoring as well as a range of specialized search & identification equipment.

Laboratories and Education

Equipment designed to meet the exacting needs of universities and research Institutions
The important work performed at national laboratories and universities often encompasses the risk for exposure to ionizing radiation. Scientists and research assistants working directly in these environments need to be aware of exposure levels

Addendum 2.

The Department of Defense, The Department of Homeland Security, First Responders, Healthcare Professionals, Laboratories, Educational Institutions, Industry, Manufacturing and Civilian Personnel Safety, continued

Mirion Technologies, continued

on a regular basis. Mirion Technologies strives to provide just that, with an array of options including radiation badge services and handheld measurement instruments with attachable probes.

Industry and Manufacturing

Hardened products to monitor and protect in the conditions of industrial applications Industrial and manufacturing processes are often filled with extreme conditions, and many increasingly use radiation for precision measurement or sterilization, which means that workers need to be protected. Mirion Technologies offers a specialized array of tools to protect workers and monitor the potentially volatile environments created, from radiation badges and electronic dosimetry and survey meters, to hardened cameras able to withstand extreme heat and radiation to closely monitor conditions."

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components

Electronic components used in satellites, space missions (examples; NASA deep space probes, planetary rovers, the International Space Station and the Hubble space telescope), airplanes (civilian and military) and weapons are tested and space radiation hardened on Earth before deployment. In space there are very large amounts of charged particles that are trapped in planetary magnetospheres, in cosmic wind or solar flares. When these particles strike computer or electronic components, they have a tendency to cause unexpected changes to stored data and program states and this event is identified as a single event upset or SEU. Continued exposure to radiation can cause permanent damage to electronics. The process known as radiation hardening is used to make electronics and computers operating reliably for long periods of time by resistance to damage by all types of radiation. Radiation hardness testing is performed to a set of military standards (MIL-STD) and high level Cobalt-60 and Cesium-137 sources are used in this process.

The Aerospace Corporation
From the Aerospace website:

"The Space and Missile Systems Center (SMC) at Los Angeles Air Force Base is a part of Air Force Space Command (AFSPC) of the United States Air Force. SMC's mission is to conduct research and development of U.S. military space and missile systems. They are also responsible for acquisition, on-orbit testing, and sustainment of several national space programs, including:

- Global Positioning System (GPS) III
- Space Based Infrared System (SBIRS)
- Wideband Global SATCOM System (WGS)
- Advanced Extremely High Frequency (AEHF) MILSATCOM System
- Defense Meteorological Satellite Program (DMSP)
- Evolved expendable launch vehicles (EELVs) Delta IV and Atlas V
- Defense Satellite Communications System (DSCS)
- Defense Support Program (DSP)

The National Reconnaissance Office (NRO) designs, builds, and operates the nation's reconnaissance satellites. NRO products, provided to customers like the Central Intelligence Agency and the Department of Defense, can warn of potential trouble spots around the world, help plan military operations, and monitor the environment. Aerospace supports the NRO by:

- Providing planning, development, test, and launch preparation support to classified NRO programs
- Supporting the NRO's exploration and development of international and commercial partnerships in new reconnaissance systems
- Assisting the NRO to develop new imaging and remote-sensing capabilities for national security

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

The Aerospace Corporation, continued

Civil and Commercial customers include civilian agencies (e.g., NASA, National Oceanic and Atmospheric Administration, U.S. Geological Survey) and commercial companies (e.g., Iridium, Boeing, Orbital Sciences Corporation).

Northrop Grumman Aerospace Systems
From the NGAS website:

"Northrop Grumman Aerospace Systems, one of four sectors within Northrop Grumman Corporation, is a premier developer, integrator, and producer of manned and unmanned aircraft, space systems and advanced technologies critical to our nation's security.

From sea, air, land or space, Aerospace Systems provides solutions that advance technology and discovery while meeting customer needs with high impact, best value aerospace products and systems.

Working closely with our customers and suppliers, these systems and technologies are used for a wide range of missions from intelligence, surveillance and reconnaissance; protected communications; battle management; strike operations; electronic warfare, and missile defense to Earth observation, space science and space exploration."

NASA Goddard Space Flight Center
From the NASA Goddard website

"Radiation Effects and Analysis (REA) Group and Space Radiation Physics Office (SRPO)

REA/SRPO Objectives
• The objectives of the REA/SRPO are two-fold:
– To provide NASA customers with critical support in the area of radiation hardness assurance (RHA), and,
– To support NASA spacecraft designers and technology developers in the radiation evaluation of new and emerging technologies as well as radiation models and tools

Flight Project RHA
- Providing lead radiation engineer support to flight missions;
- Definition of mission radiation environment, both external to and internal to the spacecraft;
- Development of project specifications and requirements;
- Evaluation of component list for radiation concerns including recommendations for testing and/or alternative device selection;

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry
MIL-STD total dose testing for electronic components, continued

NASA Goddard Space Flight Center, continued

- Radiation characterization of flight components;
- Calibration of flight instruments and detector technologies;
- Collaboration with spacecraft designers and system engineers on evaluating the system impact of radiation issues as well as mitigative options; and,
- Investigation of RHA issues that impact flight designs or are radiation-specific issues such as test methodology or dosimetry.

REA/SRPO Applied Research
- Provides characterization of new and commercial microelectronic and photonic technologies;
- Evaluates emerging leading edge microelectronic and photonic technologies;
- Develops models, characterization methods, and predictive tools for microelectronic and photonic technologies;
- Evaluates in-flight performance of microelectronic and photonic technologies;
- Develops radiation flight experiments and instrument monitors to evaluate radiation issues, to support technology developers, and to determine the radiation environment as it pertains to NASA designers and models;
- Supports flight opportunities for radiation flight experiments;
- Evaluates radiation environment models and determines applicability to NASA as we as development of new models; and,
- Supports technology developers in improving their products for radiation characteristics."

U.S. Air Force, Hill AFB, Little Mountain Facility
From the Hill AFB website:

"The Air Force Nuclear Weapons Center Intercontinental Ballistic Missile (ICBM) Systems Directorate is responsible for inception-to-retirement, integrated weapons system management of Minuteman weapon systems. The Directorate develops, acquires and supports silo-based ICBMs and provides program direction and logistics support as the single face to the customer. The Directorate is also responsible for acquisition, systems engineering, and depot repair. They manage equipment spares, provide storage and transportation, and accomplish modifications and equipment replacement to sustain silo-based ICBM systems.

The Directorate is comprised of the ICBM Ground Systems Division (NIA), ICBM Flight Systems Division (NIB), ICBM Future Systems Division (NIC) and other supporting offices.

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

U.S. Air Force, Hill AFB, Little Mountain Facility, continued

The Little Mountain Test Facility is a state-of-the-art test facility, Air Force Materiel Command laboratory dedicated to simulation testing of nuclear hardness, survivability, reliability and electromagnetic compatibility of defense systems. Center test laboratories simulate environments for nuclear radiation, air blast, shock and vibration, electromagnetic pulse, electromagnetic interference, and compatibility testing. The 1,000 + acre facility is located 15 miles west of Ogden on 12th Street, near the Great Salt Lake. It is owned by the Air Force and operated in conjunction with defense contractors.

The Strategic Missile Integration Complex is the ICBM System Directorate's test facility for performing system-level testing and integration. It is comprised of fully configured Minuteman launch facilities and launch control facilities with a host of unique test stations and instrumentation. Modifications to the weapon system are checked out at the complex prior to being fielded at operational units.

The ICBM Systems Directorate is a proud AFMC organization which reports directly to the Air Force Nuclear Weapons Center at Kirtland AFB, New Mexico."

U. S. Air Force, Kirtland AFB
From the Kirtland AFB website:

"The Air Force Research Laboratory (AFRL) has six, unique ionizing radiation sources maintained and, operated by the Space Electronics and Protection Branch (AFRL/VSSE) at Kirtland AFB, NM.

Two of the sources emit gamma rays, three provide X-rays, and one is an electron source.

Gamma Sources

1. Cobalt-60: The Cobalt-60 source can deliver a maximum total ionizing dose of 2 krad(Si)/min or a minimum of 1 rad(Si)/min. Slightly higher dose rates may be attained if researchers are willing to accept that the source will appear as a line source as opposed to a point source. This source produces two energy peaks at 1.17 and 1.33 MeV.

The facility area is 1,500 ft2 which provides the researcher the benefit of a large range of variable dose rates, and plenty of area to conduct experiments. Evaluation of subsystems is possible in this cell. The large area of the facility minimizes the possibility of dose enhancement due to scatter. The high energy photons give a uniform dose deposition throughout the sample of interest. The AFRL Co-60 facility provides the capability of performing in situ experiments in this source whereby measurements on components are

taken during gamma irradiation through the use of 120 ft. of cable running form the cell to the control building.

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

U. S. Air Force, Kirtland AFB, continued

2. Cesium-137 (Cs-137): The Cesium 137 low dose rate source will deliver a maximum of 40 rad(Si)/hr or a minimum of 0.3 rad(Si)/hr. This source produces gamma rays with a single energy peak at 662 keV. The Cs-137 source is capable of housing experiments which can fit in one cubic foot of volume. Due to the small exposure volume, a Pb/Al box is required for all experiments performed in this source. VSSE can provide one for experimenters which meets ASTM standards if users do not have one. This source is capable of providing in-situ experimentation.

These sources allow researchers to simulate the total ionizing dose and prompt dose effects occurring in a natural space environment and, during nuclear weapons events. The Space Electronics and Protection Branch primarily uses these sources to determine the effects of radiation on advanced microelectronics, sensors, and microelectromechanical systems (MEMS) needed for Air Force, Department of Defense, and government space and missile systems."

U.S. Navy, Naval Surface Warfare Center, Crane
From the NSWC Crane website

"The Crane Division (NSWC Crane), located in Crane, Indiana is a shore command of the U.S. Navy. NSWC Crane is under the Naval Sea Systems Command headquartered in Washington DC.

The mission of NSWC Crane is to provide acquisition engineering, in-service engineering and technical support for sensors, electronics, electronic warfare and special warfare weapons. NSWC Crane also works to apply component and system-level product and industrial engineering to surface sensors, strategic systems, special warfare devices and electronic warfare/information operations systems, as well as to execute other responsibilities as assigned by the Commander, Naval Surface Warfare Center.

The focus of NSWC Crane is harnessing the power of technology for the Warfighter. It specializes in total lifecycle support in three focus areas:

- Special Missions
- Strategic Missions
- Electronic Warfare"

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

U.S. Department of Energy, Sandia National Laboratories
From the Sandia website:

"Microsystems Science, Technology & Components (MSTC)

Sandia National Laboratories' MSTC pioneering work in microsystems began in the 1960s with the invention of the laminar flow cleanroom. Virtually every microdevice fabrication facility in the world uses this cleanroom technology. In the 1970's, Sandia established its leadership in radiation-hardened integrated circuits. The ability of the Galileo spacecraft to survive Jupiter's radiation belts was made possible by components designed and built by Sandia. In the 1980's Sandia began revolutionary work in Strained Layer Superlattices, providing the ability to make customized semiconductor materials. Building on this work, Sandia established a capability in optoelectronics that led to advances in Vertical Cavity Surface Emitting Lasers (VCSELs) and other devices. Sandia's VCSELs are now revolutionizing the worldwide optical communications network. In the 1990's, Sandia developed SUMMiT™, a groundbreaking capability in sacrificial surface micromachining as well as a broad range of capabilities to make novel microsensors. The 2000's has seen the maturation of a variety of chemical and biological detections systems, as well as significant advances in 3-D microsystems integration.

Today Sandia's Microsystems Center is uniquely positioned to develop, mature, and deliver custom microsystems through the ability to seamlessly integrate advanced simulation with agile manufacturing to provide a faster, better, cheaper process for providing qualified microsystems to support the enduring nuclear weapons stockpile and other critical nation security needs of the nation.

Who We Are

Sandia National Laboratory develops and delivers microsystems and their constituent components including electronic devices, MEMS, optoelectronic and photonic integrated circuits and discrete devices, sensors, and sensored systems. Sandia's silicon fab is optimized for radiation-hardened, analog, and mixed-signal microelectronics, custom digital ASICs, and discrete devices. Analog circuits, unlike digital circuits do not scale in geometry when it comes to optimum performance. A 0.35-micrometer silicon integrated-circuit technology offers better analog performance because of better device matching, high supply voltages, and extended signal dynamic range. Properly designed and fabricated, larger devices are more likely to continue to perform in extended operating environments including temperature, shock, and radiation. Sandia's fab has strong defense and space customer pull as one of the few remaining on-shore rad-hard microelectronic foundries and the only one producing chips hardened to survive the

nuclear battlefield. Sandia also operates a III-V compound-semiconductor device and circuit fab. Sandia focuses on performance optimization through design and integration.

Addendum 3.
Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

U.S. Department of Energy, Sandia National Laboratories, continued

The focus of Sandia's captive fabs is on rad-hard components, as well as a range of other critical components for a variety of national security applications that commercial industry chooses not to produce or that cannot be obtained from trusted on-shore foundries. Sandia provides the best performance at the lowest cost at an appropriate level of reliability.

In defense industries, and increasingly in commercial systems, the issue of trusted components is increasingly coming to the forefront. Theft of intellectual property, counterfeit parts, and concern for Trojan Horses increasingly require trusted suppliers. What the nation's defense contractors require, and what the commercial sector increasingly requires, is a coordinated plan to supply all the parts that are needed.

Sandia has received Category 1A Trusted Accreditation through the Department of Defense (DoD) Defense MicroElectronics Activity (DMEA) to provide "Trusted Design" services for both unclassified and classified ICs. Sandia's facility has developed and delivered digital and mixed-signal microelectronic products for national security programs for DOE nuclear weapons, nuclear nonproliferation, and other government agencies for over two decades. As an accredited Department of Defense Trusted Design Center, Sandia provides Trusted ASIC Design Services for both radiation-hardened and non-radiation-hardened foundries (350nm, 180nm, 130nm, 90nm), including in-house, IBM, National Semiconductor and other Trusted Foundries.

Rad-Hard Assurance and Assessments

Radiation Hardening or Rad-Hard is an essential service that Sandia National Laboratories can perform. Rad-Hard electronic components are a vital link for systems that operate in space, high altitude, defense systems or in close proximity to nuclear reactors. Due to the ionization effect that radiation produces, hardening provides that additional level of protection that is necessary in extreme environments. Sandia National Laboratories offers solution to tomorrow's challenges by providing rad-hard services such as:

- •Design and Layout
- •System Modeling
- •VHDL and Verilog
- •Rad-Hardened ASICS
- •Optical Technology
- •Nano Technology
- •Testing and Assurance

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Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

U.S. Department of Energy, Sandia National Laboratories, continued

Sandia Radiation Physics Total Ionizing Dose Testing
Gamma ray Radiation Sources
The Radiation Physics, Technology, and Assurance department at Sandia National Laboratories maintains 4 gamma ray radiation sources, including two 60Co sources and two 137Cs sources. These sources are located on-site in the department's laboratory space in New Mexico, and are routinely used for radiation qualification of Sandia and commercially fabricated ICs, as well as basic studies of the physical mechanisms responsible for radiation effects in semiconductor devices. Radiation testing in these cells requires that the parts to be tested are packaged and mounted on circuit boards."

Radiation-hardening at core of Labs' competence in microelectronics
By Ken Frazier

"Sandia's contributions to the Galileo mission's great success "remind us that radiation-hardening is the basis of our microelectronics work, past, present, and future," says Al Romig, VP for Science, Technology, and Components Div. 1000. "People should remember that at the very core the reason for our microelectronics work is radiation-hardening."

There is "a huge synergy and interplay" between these areas, he says.

Even with the forthcoming MESA project, he says, despite all the attention about microsystems, "one of the key things we will have to deliver is radiation-hardened circuits for our national security mission and the stockpile. As a matter of fact, the W76 rebuild will have radiation-hardened parts from Sandia's Microelectronics Development Laboratory/MESA," he notes.

"It's important for us to have outside customers like NASA for our radiation-hardened capabilities," Al says. "It allows us to continue to develop new technology and sharpen and maintain our competence inside the laboratory so we can use that for the benefit of national security, especially our nuclear weapons program. Without these things, it'd be difficult to maintain our competence as well as to move forward."

David Williams, Director of Microsystems Science, Technology, and Components Center 1700, notes that future space probes to Europa, a moon of Jupiter, as well as other space missions, will need radiation-hardened Pentium chips, which could include hardened Pentium chips made in the MDL by Sandia. In December 1998,

DOE, Sandia, Intel, NASA/JPL, NASA Goddard, the Air Force Research Laboratory, and the National Reconnaissance Office announced a landmark agreement in which Sandia will redesign Intel's Pentium processor into a radiation-hardened chip for

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MIL-STD total dose testing for electronic components, continued

U.S. Department of Energy, Sandia National Laboratories, continued

defense and space uses (Lab News, Dec. 18, 1998)."

Components of Deep Impact rocket checked at Sandia for radiation hardening
Spacecraft guidance system parts tested at Lab's Gamma Irradiation Facility
GIF Chamber The largest of GIF's three test cells, spacious enough to irradiate large objects such as tanks and satellites.

ALBUQUERQUE, N.M. — "Like the Creature from the Black Lagoon, the rods of radioactive cobalt-60 rose from their lair, an 18-ft.-deep pool in the Gamma Irradiation Facility of Sandia National Laboratories.

Raised by an electrically driven elevator into a dry, empty room with walls six feet thick, the radioactive material ionized some of the guidance system components of the Deep Impact spacecraft, expected to impact Comet Tempel 1 on July 4.

Then the rods descended back to the secure bottom of the shielding pool.

Afterwards, the parts were removed and tested to see how well their functionality survived the powerful irradiation.

The purpose of the exposure was to be sure the guidance system components were sufficiently radiation-hardened to survive their journey through space. The tests took place in spring 2003.

On Monday the rocket is expected to release a wine-cask-sized impactor and transmit data back to Earth on the results of the collision.

The reason for the space mission is twofold: to expose to human investigation the inner materials of the comet, believed to be in the same unaltered state as when the solar system originally formed; and to gain information to protect Earth by learning exactly what happens when a potentially deadly space voyager meets with a high-speed impact. Will it swerve? Crack? Pulverize? Ignore the impact?

"We provided the gamma radiation environment to test samples of the rocket's electronic parts before and after being hardened," says Sandia researcher Don Berry. The principal mission of the gamma irradiation facility is to ensure that nuclear weapons components can survive hostile environments."
(http://www.sandia.gov/media/NewsRel/NR2001/newgif.htm).

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Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

Excerpts from Radiation Hardened Information, Videos, Pictures and News http://www.rtbot.net/radiation_hardened [8/1/2012 11:03:06 AM]

"Radiation hardening is a method of designing and testing electronic components and systems to make them resistant to damage or malfunctions caused by ionizing radiation (particle radiation and high-energy electromagnetic radiation), such as would be encountered in outer space, high altitude flight, around nuclear reactors, particle accelerators, during nuclear accidents or nuclear warfare.

Most radiation-hardened chips are based on their commercial equivalents, with some manufacturing and design variations that reduce the susceptibility to radiation damage. Due to the extensive development and testing required to produce a radiation-tolerant design of a microelectronic chip, radiation-hardened chips tend to lag behind the cutting-edge of developments.

Environments with high levels of ionizing radiation create special design challenges. A single charged particle can knock thousands of electrons loose, causing electronic noise and signal spikes. In the case of digital circuits, this can cause results which are inaccurate or unintelligible.

This is a particularly serious problem in the design of artificial satellites, spacecraft, military aircraft, nuclear power stations, and nuclear weapons. In order to ensure the proper operation of such systems, manufacturers of integrated circuits and sensors intended for the military or aerospace markets employ various methods of radiation hardening. The resulting systems are said to be rad(iation)-hardened, rad-hard, or (within context) hardened.

Major radiation damage sources

Typical sources of exposure of electronics to ionizing radiation are the Van Allen radiation belts for satellites, nuclear reactors in power plants for sensors and control circuits, particle accelerators for control electronics particularly particle detector devices, residual radiation from isotopes in chip packaging materials, cosmic radiation for spacecraft and high-altitude aircraft, and nuclear explosions for potentially all military and civilian electronics.

Cosmic rays come from all directions and consist of approximately 85% protons, 14% alpha particles, and 1%, together with x-ray and gamma-ray radiation. Most effects are caused by particles with energies between 108 and 2*1010 eV. The atmosphere filters most of these, so they are primarily a concern for spacecraft and high-altitude aircraft.

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Civil, Commercial, NASA, Military and Reconnaissance Space Programs, Satellites, Space Missions, Airplanes and Weapons, – the Aerospace Industry MIL-STD total dose testing for electronic components, continued

Excerpts from Radiation Hardened Information, Videos, Pictures and News, continued

Solar particle events come from the direction of the sun and consist of a large flux of high energy (several GeV) protons and heavy ions, again accompanied by x-ray radiation. Van Allen radiation belts contain electrons (up to about 10 MeV) and protons (up to 100s MeV) trapped in the geomagnetic field. The particle flux in the regions farther from the Earth can vary wildly depending on the actual conditions of the sun and the magnetosphere. Due to their position they pose a concern for satellites.

Nuclear reactors produce gamma radiation and neutron radiation which can affect sensor and control circuits in nuclear power plants.

Particle accelerators produce high energy protons and electrons, and the secondary particles produced by their interactions product significant radiation damage on sensitive control and particle detector components, of the order of magnitude of 10 MRad[Si]/year for systems such as the Large Hadron Collider.

Nuclear explosions produce a short and extremely intense surge through a wide spectrum of electromagnetic radiation, an electromagnetic pulse (EMP), neutron radiation, and a flux of both primary and secondary charged particles. In case of a nuclear war they pose a potential concern for all civilian and military electronics."

Excerpts from Military & Aerospace Electronics Article, Space Technology
Aerospace and defense systems integrators continue their reliance on radiation-hardened electronics
June 5, 2012, Posted by Courtney Howard

"TECHNOLOGY FOCUS, 5 June 2012. Systems architects and integrators rely on radiation-hardened and radiation-tolerant innovations to ensure the extended, uninterrupted operation of electronics in space.

Space is an extremely hazardous vacuum filled with lethal radiation, storms of micrometeoroids, extreme variations of temperature, and all manner of man-made debris. Any one or a combination of these can damage or even destroy unshielded satellites and other spacecraft," explains a representative at the National Aeronautics and Space Administration (NASA) in Washington.

Space is wrought with radiation, which can alter the effectiveness of, interfere with, and even render useless myriad space-based systems. As a result, systems architects and

systems integrators are turning to aerospace technology firms for the latest radiation-hardened and radiation-tolerant electronics components and solutions."