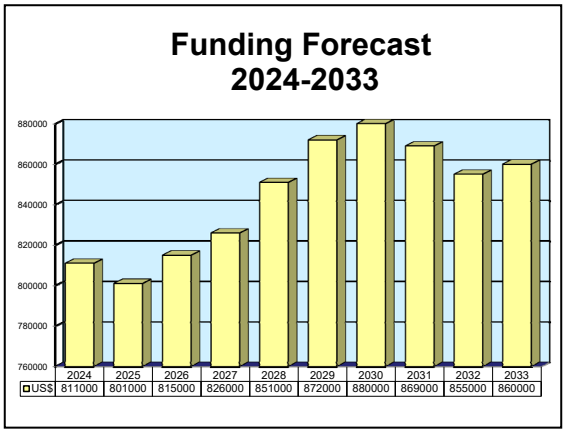
Radiological Control

Outlook

- Commercial dosimeters being tested for military use to cover gaps during product development
- Air particle detector and various systems under development for all U.S. Navy, Coast Guard and Military Sealift Command vessels, and at every Navy shore installation



Orientation

Description. This is a U.S. Navy effort to develop nuclear radiation detection devices in direct support of the Navy's Nuclear Propulsion program, as well as related concerns of the U.S. Department of Defense (DoD) and U.S. Department of Homeland Security (DHS).

Sponsor

U.S. Navy
U.S. Naval Surface Warfare Center
Carderock Division
9500 MacArthur Blvd
West Bethesda, MD 20817-5700
USA

Status. Ongoing research and development.

Total Produced. Wide variety of prototypes and measurement devices, with use of commercial off-the-shelf technology and material.

Application. Development of various equipment to measure nuclear radiation.

Price Range. One of the program's objectives is to develop equipment with a low life-cycle cost.

A commercial PDX-1 RADIAC unit is estimated to cost between $56,000 and $86,800.

Contractors

Prime

Science Applications International Corp (SAIC)	http://www.saic.com, 4015 Hancock St, San Diego, CA 92110 United States, Tel: + 1 (858) 826-6000, Fax: + 1 (858) 826-6634, Prime
Environmental Alternatives Inc, EAI	http://www.eai-inc.com, 33 Whittemore Farm Rd, Swanzey, NH 03446 United States, Tel: + 1 (603) 352-3888, Fax: + 1 (603) 352-3899, Packager (Radiological Control)
Orbis Inc	http://www.orbisinc.net, 268 W Coleman Blvd, Charleston, SC 29464 United States, Tel: + 1 (843) 971-9390, Fax: + 1 (843) 971-0636, Second Prime

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Sensor Technology Engineering Inc	http://ste-sb.com, 5553 Hollister Ave #1, Santa Barbara, CA 93117 United States, Tel: + 1 (805) 964-9507, Fax: + 1 (805) 964-2772, Consortium Member
Tetra Tech	http://www.tetratech.com, 3475 E Foothill Blvd, Pasadena, CA 91107-6024 United States, Tel: + 1 (626) 351-4663, Fax: + 1 (626) 351-5291, Consortium Member

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 75 Glen Road, Suite 302, Sandy Hook, CT 06482, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. The U.S. Navy's PE#0603542N Radiological Control program originally consisted of two projects: Project S1825 Radiological Controls, which was completed in 1995, and Project S1830 Radiation, Detection, Indication and Computation (RADIAC) Development, which is ongoing.

Project S1825 Radiological Controls. This project supported two U.S. Navy-wide radiation protection efforts and was completed in 1995. The first effort involved development of a PC-based computer modeling program for estimating potential radiation exposure in and around nuclear weapons and other radiation sources. The program, Mathematical Radiation Environment Model for Ships (MREMS), utilized all known radiation parameters particular to a weapons system, as well as taking into account the composition and arrangement of intervening structures.

Although initially intended for use as a shipboard radiation-exposure prediction system, MREMS has a significantly more critical role today as a valid means of estimating potential radiation exposure from weapons systems. MREMS also has applicability to other sources of ionizing radiation and could be utilized by other military services.

Additionally, through scientific laboratory and field testing, this project sought to refine the neutron measurements obtained from other sources. This effort demonstrated that the relative risk from neutron exposure is still a question of concern within the scientific community.

Project S1830 RADIAC Development. Coordinated within this project are all U.S. Navy efforts for the development of nuclear radiation detection devices in direct support of the Navy Nuclear Propulsion program and other users. This project serves to provide accurate, reliable health physics instrumentation at a low cost. Reliable radiation-monitoring instruments are needed to ensure the safety of personnel. These include handheld RADIAC meters, measurement devices, and area monitors used to measure radiation fields.

Among new developments, the laser-heated thermoluminescent dosimetry (LHTLD) system will be able to meet new Nuclear Regulatory Commission regulations and will provide sensitive measurements down to the levels required to meet all new and imminent health and safety requirements. Meanwhile, multifunction RADIAC systems will cut calibration costs by up to 75 percent and reduce the requirements for spare parts by 85 percent by replacing 16 families (over 60 different individual models) of obsolete equipment.

This project is considered crucial to joint-service radiation safety initiatives, and has been coordinated with Army, Air Force, and Defense Nuclear Agency personnel to achieve the maximum cross-service applicability.

Variants/Upgrades

Ongoing activities involve the prototyping and enhancement of various equipment.

PDX-1 RADIAC. The PDX-1 RADIAC Set was fielded in response to a Joint Urgent Operational Needs Statement to meet this requirement. It contains several instruments that serve different purposes, including the search detector, isotope identifier, and personal dosimeter. Current technology dictates that the sensitivity of the detector be directly proportional to the size of the detector element; i.e., the larger the detector, the more sensitive and capable it is. However, in Visit, Board, Search and Seizure (VBSS) operations, there must be a trade-off between size/weight and capability, since it is difficult and hazardous for boarding parties to carry a backpack-size detector, along with their weapons and other gear, up a rope ladder to board a vessel on the high seas. There will be a continuing and growing effort to find smaller, lighter instruments with enhanced sensitivity, reach-back capability, and other enhancements to provide the Navy with the best and most cost-effective equipment possible for this critical mission.

PDX-2 RADIAC. A RADIAC Set developed for the U.S. Marine Corps.

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Nuclear Radiation Radiological Control Area Warning

Source: U.S. National Renewable Energy Laboratory (NREL)

RADIAC CP-95A/PD DT-60 Reader

Source: Oak Ridge Associated Universities

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U.S. Radiological Control Monitoring

Source: U.S. Navy

Program Review

Over the years, program efforts have been focused on developing better and more cost-effective radiation measurement and detection equipment. Several test models were constructed in FY94. About 113 field test models of the basic Multifunction RADIAC (MFR) systems were built. Through FY95, work progressed on the development of the LHTLD system as it reached Phase III of engineering and manufacturing development (EMD). New efforts included the development of the copper-doped lithium dosimeter; the development of interfaces for the plastic scintillation probe, the alpha probe, the beta probe, and the universal (alpha, beta, gamma) probe; and the development of a small gamma probe for MFR systems. Development of the causality dosimeter was begun, and the potential for development of a commercial gamma camera was evaluated.

Phase III of the LHTLD system was completed during FY96. In other activity, the development of a proton recoil neutron dosimeter and beta dosimeter was initiated. By FY97, enhancements were already being made to the LHTLD system. In addition, development of the plastic scintillation probe and beta probe was completed.

During FY98 and FY99, further enhancements were made to the LHTLD system, and efforts to develop LHTLD dosimeters continued. In addition, development of the MFR universal probe and the tritium monitor was completed.

The agenda for FY00-FY05 called for completing development of the Navy's new dosimetry systems as well as developing the MFR system compact neutron probe. In other efforts, development of the radiography probe was begun, and further enhancements were made to the MFR system control unit. At the same time, the Navy began to develop the dosimetry system and completed the extendible probe and "frisker" station.

In other efforts, commercial off-the-shelf (COTS) technology was explored for its potential to minimize ownership costs. Additionally, the scope of development for the naval dosimetry system was expanded to include evaluation of a secondary system for shipboard use.

Next-Generation Air Particle Detector

A new version of the IM-239/WDQ air particle detector (APD) is under development: a 400-pound piece of equipment to be installed on nuclear-powered ships to monitor emissions from the ships' nuclear power plants. There are eight detectors on each Nimitz-class aircraft carrier and six on each submarine of all classes. The current version is approximately 30 years old, and, despite component upgrades, has reached the end of its useful life due to parts and technological obsolescence. Naval reactors require a new version for the nuclear fleet.

The RADIAC program is working with the U.S. Department of Energy's Remote Sensing Laboratory at Nellis AFB, Nevada, to develop the new version.

During FY09, various IM-239/WDQ APD technical issues were resolved, final specifications were developed, and production of the first three prototypes was begun. By the end of FY10, the three prototypes had been completed and delivered for testing and evaluation, which was completed by the end of FY12. Based on test results, the winning prototype would be selected and prepared for final specifications prior to production.

From FY12 through FY14, plans called for testing and evaluating commercial prototypes suitable for use by the Navy.

Work from FY15 onward has been focused on testing previously commercially produced units, with additional units being purchased for comparison testing and evaluation. In another effort, the existing IM-265 survey meter was to be modernized to bridge the gap until a new RDS meter could be found. To the maximum extent possible, new contracts involved fixed-price efforts aimed at controlling development costs.

The U.S. Navy considered adding capabilities to the fielded electronic pocket dosimeter (EPD). Besides recording dose exposure, this instrument can remotely monitor and report the radiation exposure of on-scene emergency responders. This feature had not been utilized by the Navy, but the U.S. Air Force made extensive use of an EPD equipped with extra hardware and software to keep track of the radiation exposure of emergency responders.

EPDs can also be equipped with a telemetry capability. Here, EPDs would be posted in high-radiation areas. These EPDs would preclude personnel entering the area from requiring a RADIAC meter to measure the radiation level. As an example, an EPD would monitor the radiation level of the pipe through which primary plant resin is being discharged from a ship.

The U.S. Navy is desperate to replace its PDR-73 tritium monitor, which is used at nuclear weapons storage facilities and research laboratories to sample the air for the presence of tritium. The current instrument is 30 years old and cannot be repaired due to its obsolete components. At the current loss rate due to normal wear and tear, there will be insufficient assets to meet operational requirements, so a replacement must be found.

In finding a replacement, efforts have been focused on gathering end-user feedback from field testing, comparing the performance and specifications of the three units, evaluating the pump design in each unit and determining life expectancy as compared to the PDR-73, working with the U.S. Air Force to leverage development efforts toward possible joint procurement, and working with NAVSEA engineering staff to develop procurement specifications.

Developing the PDX-1 RADIAC Set

Efforts during FY17-FY18 were centered on testing the PDX-1 RADIAC Set, which comprises three instruments that serve different purposes. The first instrument is a Handheld Radiation Monitor (HRM) that searches for radiological materials. The second is a Radioisotope Identifier (RID) that identifies the type of radiological material located. The third instrument is a Personal Radiation Detector (PRD) that displays the radiological dose that the VBSS team members may be receiving to ensure that they are not being exposed to dangerous levels of radioactivity. Three PDX-1 RADIAC Sets were procured in FY19.

From FY19-FY20, requirements for a new dosimetry system were to be submitted. Meanwhile, test and evaluation of possible new technologies continued.

In FY21, several new dosimeter technology prototypes began testing.

According to the program schedule, numerous tests and evaluations remain ongoing through FY25 at which time a final report will be submitted to the Navy and the contractor.

FBI and Savannah River National Laboratory Put Science to Work

In June 2010, the U.S. Federal Bureau of Investigation and the Department of Energy's Savannah River National Laboratory (SRNL) announced the opening of a major expansion of the FBI's facilities for the forensic examination of radiological material and associated evidence. The FBI's expanded Radiological Evidence Examination Facility (REEF), located at the SRNL near Aiken, South Carolina, enhances the FBI's ability to protect the U.S. from crimes involving radiological material and bring to justice those who would use these materials to harm the nation's citizens.

The first phase of the REEF opened at SRNL in 2006, providing facilities and equipment where trained FBI personnel can safely perform forensic examination on radiologically contaminated evidence. The new facility expands that initial suite to about six times its original size and provides the capability for many more types of forensic examination. The radiological forensic laboratory takes advantage of the long-standing security, safety, and radiological protection capabilities already in place at SRNL while allowing the FBI to

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focus on forensic examination in consultation with SRNL experts.

The expanded facility provides the FBI with the ability to conduct the full spectrum of traditional forensic analysis on contaminated evidence. Working together, FBI and SRNL personnel have developed new microscope slide holders, as well as digital photography and X-ray capabilities. Digital fingerprint comparisons can now be made using secure computer terminals linked to the FBI's national fingerprint database. The REEF includes a fully functional FBI satellite office where forensic examiners can securely share information via voice, data, or video with any other FBI office. The facility also has a dedicated evidence storage room where radiological evidence can be safely and securely stored to maintain its integrity for judicial proceedings.

At the FBI Laboratory in Quantico, Virginia, traditional forensic examinations of nonhazardous evidence are conducted in support of law enforcement investigations. In addition, SRNL provides radiological crime scene training to FBI agents from around the country, and has developed special evidence packaging to allow investigators to collect radiological evidence and deliver it to the laboratory.

SRNL is the Department of Energy's applied research and development national laboratory at the Savannah River Site. The management and operating contractor for SRS and SRNL is Savannah River Nuclear Solutions LLC.

U.S. DoD Launches Radiation Monitoring Site Following Japan Tsunami

The U.S. Department of Defense launched the Operation Tomodachi Registry website on September 5, 2012. The website provides location-based radiation dose estimate reports for adults and children comprising the DoD-affiliated population that was on or near mainland Japan following the Great East Japan Earthquake and Tsunami of March 11, 2011. DoD-affiliated members who were in Japan during the nuclear reactor crisis, medical providers, and the public at large are able to download location-based radiation dose estimate reports from the website. These reports include medical interpretations and provide comparisons of the Operation Tomodachi radiation doses with more commonly experienced radiation doses.

The website also includes information on the event, the DoD's response to the crisis, and answers to frequently asked questions. Individuals in the registry may request a dose assessment that is individually tailored for them, based on more detailed location data that they can provide using the "Contact Us" function on the site.

After extensive environmental monitoring and analysis, it was determined that none of the nearly 70,000 members of the DoD-affiliated population (service members, DoD civilian employees and contractors, and family members of service members and civilian employees) who were on or near the mainland of Japan between March 12 and May 11, 2011, were likely exposed to radiation at levels associated with adverse medical conditions.

The Operation Tomodachi Registry omits personally identifiable information.

Maritime Deployment Demonstrates Capability to Detect Radiological Materials

The U.S. Department of Homeland Security's Domestic Nuclear Detection Office (DNDO) and U.S. Coast Guard Sector New York recently coordinated with law enforcement and other first responders from New York and New Jersey to deploy nuclear detection equipment and personnel on the local waterways in the New York City-Newark metropolitan area. The purpose of this deployment was to screen vessels for illicit radiological and nuclear materials, train detection boat crews, and test equipment and detection capabilities as part of DNDO's Securing the Cities (STC) program. This program is designed to enhance the nation's ability to detect and prevent a radiological or nuclear attack in cities facing the highest risk.

As part of the STC program, the New York City-Newark region conducts close to 50 such maritime deployments annually. These enable first responders to test and enhance their capabilities to detect and interdict radiological and nuclear material outside of regulatory control.

This operation provided an opportunity for the DNDO to observe and take away many best practices and lessons learned in order to further develop and strengthen the Global Nuclear Detection Architecture. State, local, and tribal law enforcement and first responders are partnering to strengthen the GNDA.

Smiths Detection Supplies Portable Detectors for Canadian Border Security

In March 2013, Smiths Detection won an order from the Canada Border Services Agency (CBSA) for the supply of its RadSeeker, Smiths' next-generation portable radiation detector and identifier. This handheld device is being used to enhance security and screening measures throughout Canada, including key entry points at Montreal, Vancouver, and Halifax.

With its advanced software, RadSeeker provides the capability to distinguish radiological and nuclear threats from naturally occurring radiation or other legitimate radiological materials.

RadSeeker is deployed by governments around the world, helping resolve nuclear threat alarms during screening of cargo containers at borders and points of entry. It was originally developed with support from the DNDO, a jointly staffed agency within the U.S. Department of Homeland Security.

Among recent activity, Smiths Detection received a $40.9 million contract from the DNDO for its RadSeeker system.

U.S. DHS Expands the STC Program to the National Capital Region

The U.S. Department of Homeland Security announced in September 2014 the expansion of the DNDO's Securing the Cities program to the National Capital Region. This is the third implementation of the program, which began in 2006 as a pilot project for the New York City region and was expanded to the Los Angeles/Long Beach region in 2012. The DHS plans to expand the program to additional cities in the coming years.

As part of the STC program, the District of Columbia's Homeland Security and Emergency Management Agency received a direct grant of up to $30 million over five years; the first $6 million was disbursed in 2014. The funding allows the district to work with partners in the National Capital Region to build a robust regional nuclear detection capability for law enforcement and first responders. Initial efforts have focused on analyzing the region's current capabilities and planning for post-program sustainment activities.

The DNDO also provides equipment for training and exercises to further its nuclear detection capabilities and coordinate with federal operations. At the conclusion of the program, the DNDO will continue to support the region via alarm adjudication activities and by providing training exercises and technical support.

Ushering in a New Generation of Low-Cost, Networked, Nuclear-Radiation Detectors

In mid-2016, the U.S. Defense Advanced Research Projects Agency (DARPA) successfully developed and demonstrated a network of smartphone-size mobile devices that can detect the tiniest traces of radioactive materials. Combined with larger detectors along major roadways, bridges, and other fixed infrastructure and in vehicles, the new networked devices promise enhanced awareness of radiation sources and greater advance warning of possible threats.

This network of devices was developed under DARPA's SIGMA program, launched in 2014 with the goal of creating a cost-effective, continuous radiation-monitoring network that is able to cover a large city or region. Although radiation detectors have been installed in a number of key locations in the United States and around the world in recent years, the SIGMA program has sought to increase capabilities while lowering their costs in order to network an "unprecedented" number of advanced detectors and provide a comprehensive and automated overview of the radiological environment.

The demonstration was conducted at one of the Port Authority of New York and New Jersey's major transportation hubs, where DARPA tested more than 100 networked SIGMA sensors. During the month-long test, the system provided more than a 100-fold increase in the ability to locate and identify sources of radiation as compared to currently installed systems. All sources of radiation that SIGMA sensors identified were nonthreatening, but the system proved how it could pinpoint the location and intensity of a source and specify, in each case, the type of radiation to which it was alerting authorities.

Fulfilling the SIGMA program's initial goals, the pocket-size radiation "pager" sensors developed by DARPA and used in the exercise can be easily worn on a person's belt, are 1/10th the cost of conventional sensors, and are up to 10 times faster in detecting gamma and neutron radiation. Moreover, the program achieved its price goal of 10,000 pocket-size detectors for $400 per unit.

The test with the Port Authority was the largest deployment of the sensors to that point in time, but SIGMA has been refining the algorithms in its devices in order to improving their radiation-sensing technology. A large-scale test deployment of more than 1,000 detectors was conducted in Washington, DC, in 2016.

Ultimately, SIGMA may be expected to provide foundational capabilities for a range of detection approaches, including two under development by the DNDO: the Radiation Awareness and Interdiction Network (RAIN), which has been designed to monitor highways and roadways for vehicle-borne threats, and the Mobile Urban Radiation Search (MURS) project, which aims to provide an advanced mobile detection capability that could adjudicate detection alarms encountered by SIGMA or RAIN.

In addition to the handheld devices, large SIGMA prototype detectors with increased capabilities and reduced costs that can be deployed at fixed sites or in vehicles are also coming on line. For example, large

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SIGMA neutron detectors have now shown twice the sensitivity of existing neutron-detection drive-through portals. Multiple vendors reached the price target of $5,000 per unit, which is approximately 1/10th the cost of today's comparable large neutron detectors, while achieving or exceeding the required performance. Hundreds of large SIGMA detectors are currently being networked for gamma and neutron radiation detection at a number of critical locations and on vehicles.

DARPA demonstrated SIGMA's full city- and regional-scale monitoring capability in 2017 (see details below), and planned to transition the operational system to local, state, and federal entities in 2018.

Mary Cullen Appointed VP of Nuclear Propulsion at Newport News Shipbuilding

Huntington Ingalls Industries (HII) announced in October 2016 that Mary Cullen had been appointed vice president of nuclear propulsion at the company's Newport News Shipbuilding division. She was to assume her new role on November 14.

Cullen is responsible for overhaul engineering, reactor services, test engineering, radiological controls, construction and process engineering, and refueling production and nuclear support.

Cullen's previous work included leading the inactivation of the USS *Enterprise* (CVN 65).

Radioactive Threat Detection System Tested in U.S. Capital

The SIGMA program concluded its biggest and longest test deployment of vehicle-mounted radiation detectors in Washington, DC, in February 2017. For approximately seven months starting in July 2016, the fleet of DC Fire and Emergency Medical Services ambulances was outfitted with DARPA-developed nuclear and radiological detectors, providing the first city-scale, dynamic, real-time map of background radiation levels throughout the capital as well as identifying any unusual spikes in radiation that could indicate a threat.

During the test deployment, up to 73 large detectors were installed on emergency vehicles, which together logged well over 100,000 hours of detector operation covering more than 150,000 miles and identified thousands of radiation sources in real time. Items as innocuous as natural granite used in construction, as well as radiation lingering after certain medical treatments, can trigger positive responses. SIGMA detectors can readily distinguish between these kinds of benign sources and truly threatening ones. Equally important, the SIGMA detectors provided detailed background radiation maps of the district against which future sources may be more easily detected. The deployment also provided an opportunity to test and refine the wireless data fusion aspects of the system, which constantly fed information about vehicle location and radiation readings to a central command post.

U.S. Modernization, Replacement Programs a Nuclear Deterrence Priority

Modernization and replacement programs for elements of the U.S. nuclear triad were the top priority of the U.S. Defense and Energy departments, the Air Force, and the Navy in FY18, officials and military officers told a House panel in May 2017. Testifying before the House Armed Services Subcommittee on Strategic Forces regarding the president's budget request for FY18 were Frank Klotz, administrator of the National Nuclear Security Administration, and Dr. Rob Soofer, deputy assistant secretary of defense for nuclear and missile defense policy. Joining them were Air Force Gen. Robin Rand, commander of the Air Force Global Strike Command, and Navy Vice Adm. Terry Benedict, director of Navy Strategic Systems Programs.

The NNSA, which Congress established in 2000, maintains the U.S. nuclear weapons stockpile, helps reduce the global danger from weapons of mass destruction, provides the U.S. Navy with nuclear propulsion, and responds internationally to nuclear and radiological emergencies.

Klotz said that the NNSA budget request, which was about half of the Energy Department budget, was $13.9 billion, nearly $1 billion over the fiscal 2017 omnibus level.

Klotz told the panel that the 2018 budget request was vital to ensuring that the U.S. nuclear force remains modern, robust, and tailored to 21st century threats, and to reassuring U.S. allies.

"Our [fiscal] 2018 budget request ... accounts for the significant tempo of operations at NNSA that in many ways has reached a level unseen since the Cold War," Klotz said.

The request included investments to repair and replace infrastructure at national laboratories and production plants, he added, and improve workspace for the scientific, engineering, and professional workforce.

In his remarks to the panel, Soofer said that for decades U.S. nuclear forces have provided the ultimate deterrent against nuclear attacks on the United States and its allies. Effective deterrence requires a deliberate strategy and forces that are structured and postured to support that strategy, he said, noting that "strategy, forces, and posture also must be flexible enough to

maintain stability while adjusting to gradual and rapid technological and geopolitical changes."

For example, Soofer noted, Russia has taken aggressive actions against its neighbors, has threatened the United States, and has been modernizing a diverse nonstrategic nuclear weapons force. Among the threats he cited are China's increased assertiveness, which suggests a desire to dominate the Asia-Pacific region, and the willingness of North Korea's leaders to accept economic countermeasures and international isolation to advance the country's nuclear capability.

Against this backdrop, Soofer said, the president directed the DoD to conduct a comprehensive Nuclear Posture Review.

The DoD expects nuclear recapitalization costs to total $230 billion to $290 billion over more than two decades, according to Soofer.

In his remarks to the subcommittee, Air Force Gen. Robin Rand, commander of Air Force Global Strike Command, highlighted the need for modernization efforts across Air Force Global Strike Command.

"Fiscal constraints, while posing planning challenges, do not alter the national security landscape or the intent of competitors and adversaries," Rand said. "Nor do they diminish the enduring value of long-range strategic forces to our nation."

Navy Vice Adm. Terry Benedict, director of Navy Strategic Systems Programs, addressed long-term sustainment of the triad's sea-based leg.

"While our current life-extension efforts will sustain the D-5 [Trident submarine-launched ballistic missile] system until the 2040s, the Navy is already beginning to evaluate options to maintain a credible and effective strategic weapon system to the end of the Columbia class service life in the 2080s," Benedict said.

"At SSP, we are looking long term and across the spectrum, from our workforce and infrastructure to our industry partners and geographic footprint," he added.

University of Surrey Awarded $1.1 Million Research Grant

The University of Surrey (U.K.) was awarded $1.1 million by the U.S. Defense Threat Reduction Agency (DTRA) on March 12, 2018, to research new types of nano-materials that produce high-efficiency radiation detectors for use in nuclear security.

Under this five-year project, the team from Surrey will be working to develop a new class of materials called nanocomposite organic scintillators. These materials have the potential to be used in next-generation radiation detectors thanks to their high light yields and sensitivity to nuclear radiation.

The Surrey team, led by Professor Paul Sellin and in collaboration with Professor Stephen Sweeney and Dr. Carol Crean, aims to develop a deeper understanding of these materials. The project is in collaboration with Kromek plc.

DARPA's SIGMA+ Will Detect WMD Threats

Advanced commercially available technologies such as additive manufacturing (3D printing), small-scale chemical reactors for pharmaceuticals, and CRISPR gene manipulation tools have opened wide access to scientific exploration and discovery. In the hands of terrorists and rogue nation states, however, these capabilities could be misused to concoct chemical, biological, radiological, nuclear, and explosive (CBRNE) weapons of mass destruction (WMD) in small quantities and in form factors that are hard to detect.

To meet this challenge, DARPA announced its SIGMA+ program in February 2018. SIGMA+ is an expansion of the existing SIGMA program that seeks to develop new sensors and networks that alert authorities to chemical, biological, and explosives threats.

The program calls for the development of highly sensitive detectors and advanced intelligence analytics to detect minute traces of various substances related to WMD threats. SIGMA+ will use a common network infrastructure and mobile sensing strategy, a concept that was proven effective in the SIGMA program. The SIGMA+ CBRNE detection network would be scalable to cover a major metropolitan city and its surrounding region.

To uncover chemical and explosives threats, SIGMA+ seeks to develop scalable, long-range chemical sensors that would help interdict improvised chemical and explosive threats or their constituent materials before an attack occurs.

To quickly alert officials of a biological terror attack, such as the release of anthrax, smallpox or plague viruses, SIGMA+ seeks sensors that can detect, in real time, traces of a wide range of pathogens. The program aims to provide immediate, continuous monitoring of pathogen background levels and spikes, which could indicate malicious release of a biological agent.

New sensing methods for detecting threats could provide system sensitivity 10 times greater than the state-of-the-art, which would enable detection of a wider range of biological attacks days earlier, maximizing the effectiveness of countermeasures and

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prophylaxis. For natural pandemics, SIGMA+ sensing methods could yield awareness of major outbreaks weeks sooner than is currently possible.

The program is structured around two phases, with two Broad Agency Announcement (BAA) solicitations planned. The first phase focuses on developing novel sensors for chemicals, explosives, and biological agents. The second phase will focus on network development, analytics, and integration.

R&D Contract Mod to Help Increase SIGMA+ Biological Weapon Detection

Battelle Memorial Institute was awarded a $7.4 million modification (P00003) to previously awarded contract HR0011-19-C-0019 in January 2020 to research and develop an advanced networked sensor to detect and identify biological WMD threats in support of the SIGMA+ program. The modification brought the cumulative face value of the contract to $9.9 million.

Work was to be performed in Columbus, Ohio (60 percent) and Cambridge, Massachusetts (40 percent), and be completed in June 2021.

Fiscal 2020 RDT&E funds in the amount of $1.4 million were obligated at time of award.

DARPA, Arlington, Virginia, is the contracting activity.

U.S. Navy Awards Contract to Dismantle Radiological-Controlled Facility

APTIM Federal Services LLC was awarded a $129.1 million firm-fixed-price contract in June 2020 from the U.S. Navy to dismantle and dispose of the Surface Ship Support Barge, a radiological-controlled Navy support facility.

The U.S. Naval Sea Systems Command, Washington, DC, is the contracting activity. The contract award number is N00024-20-C-4139.

Ball Aerospace to Apply Focal Plane Array Technology to Detect Radiation

In July 2020, the Air Force Research Laboratory awarded a $7.6 million, cost-plus-fixed-fee contract to Ball Aerospace & Technologies for the development of technologies focused on focal plan array detection. An FPA is essentially an array of light detectors that is placed in the focal plane of an imaging system (a simple lens or an objective, possibly a telescope). The Air Force, along with Ball, seeks to apply this type of detection to radiation and radiometric characterizations. This will be accomplished through Ball's operation of the Infrared Radiation Effects Laboratory (IRREL) operation and improvements program.

The effort involves developing techniques to advance the current understanding of the characterization of infrared and visible FPAs and associated devices. More specifically, the effort will involve the development of characterization and analytical techniques and the testing of hardware and operational and test procedures that advance the experimental capabilities of the IRREL. Work will be performed in Albuquerque, New Mexico, and is expected to be completed October 10, 2025.

Funding

U.S. FUNDING

	FY23 AMT	FY24 AMT	FY25 AMT	FY26 AMT	FY27 AMT	FY28 AMT	FY29 AMT
U.S. Navy RDT&E							
PE#0603542N							
Radiological Control	0.769	0.811	0.801	0.817	0.833	0.851	0.879

All $ are in millions.

Source: U.S. Department of the Navy FY25 RDT&E Budget Item Justification (R-2)

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Tetra Tech EC	11.5	Jun 2010 – Contract for Parcel C radiological remediation and support at Hunters Point Shipyard. The primary objective was time-critical removal to achieve free release of Buildings 203, 214, 241, 271, and 272 in the inner portion of Parcel C. Work was performed in San Francisco and completed on Dec 22, 2011 (N62473-10-D-0809). This contract was given another task order in July 2012, with an additional $9.8 million in funds awarded to Tetra Tech, with this task completed in January 2014.
Tetra Tech EC	8.4	Aug 2011 – Contract modification to increase the maximum dollar value of task order #0004 under previously awarded contract N62473-10-D-0809 from the U.S. Navy for base-wide radiological support at Hunters Point Shipyard. The work provided for base-wide radiological support under the contractor's U.S. Nuclear Regulatory Commission broad-scope radioactive material license. The contractor provided all labor, supervision, engineering, materials, equipment, tools, parts, supplies, and transportation required to perform all work described in the Request for Proposals.
Sensor Technology Engineering	10.8	Aug 2011 – Contract from the U.S. Navy to procure linear radiation monitors (LRMs) and handheld radiation monitors (HRMs). Work was performed in Santa Barbara and completed in Nov 2012. This contract was not competitively procured, because Sensor Technology Engineering was the only company that produced LRMs and HRMs. The U.S. Naval Surface Warfare Center, Indian Head Division, MD, was the contracting activity. (N00174-11-C-0038)
Environmental Alternatives	13.2	Mar 2017 – Contract for engineering and technical services for disassembly and radiological inspection and cleaning of LM2500 single-shank turbine gas generator assemblies. This requirement is for the teardown, inspection, light cleaning, evaluation, and packaging of Navy and radiological control gas turbine assets to be utilized aboard surface combatants following remediation. Work would be performed in Santee, CA, and was expected to be completed by Mar 2021. Fiscal 2017 Operations and Maintenance (Navy) funds in the amount of $1,650,000 were obligated at time of award. This contract was competitively procured, with two offers received via Federal Business Opportunities. The U.S. Naval Surface Warfare Center, Philadelphia Division, PA, was the contracting activity. (N64498-17-D-0001)
Radiation Safety & Control Services	11.6	Oct 2017 – A sole-source, firm-fixed-price, indefinite delivery/indefinite quantity contract to provide the Mirion Battlefield Dosimeter (MBD-2) and auxiliary equipment to the U.S. Naval Surface Warfare Center Carderock Division in West Bethesda, MD. The MBD-2 is a real-time dosimeter for field use in military and homeland security applications. Work was performed in Turku, Finland (95 percent) and Atlanta, GA (5 percent), and completed by Sep 2020. Fiscal 2017 Operations and Maintenance (Navy) funding in the amount of $2,862,084 was to be obligated at time of award. The U.S. Naval Surface Warfare Center Carderock Division, West Bethesda, was the contracting activity. (N00167-17-C-0005)

Radiological Control

Contractor	Award ($ millions)	Date/Description
Gilbane Federal	8.6	Sep 2019 – A firm-fixed-price modification to increase the maximum value of task order N6247318F5305 under a multiple-award contract for radiological confirmation sampling and surveying within Parcel C at Hunters Point Naval Shipyard. The contractor provided all labor, supervision, engineering, materials, and transportation necessary to perform all work described in the Request for Proposals. After award of this modification, the cumulative task order value was $21,002,538. Work was performed in San Francisco, CA, and completed by Dec 2023. Fiscal 2019 Base Realignment & Closure and Environmental (Navy) funds in the amount of $8,644,506 were obligated on this award. The U.S. Naval Facilities Engineering Command, Southwest, San Diego, CA, was the contracting activity. The contract award number is N62473-17-D-0005.
Ball Aerospace & Technologies	7.7	Jul 2020 – A cost-plus-fixed-fee contract for the IRREL operation and improvements program. The objective of this effort is to provide radiometric and radiation characterizations of focal plane arrays and associated devices. The effort includes developing techniques to advance the state-of-the-art in the characterization of infrared and visible FPAs and associated devices. Work will be performed in Albuquerque, NM, and is expected to be completed Oct 10, 2025. The contract award number is FA9453-20-C-0015.

Worldwide Distribution/Inventories

Although this is a **U.S. Navy** program, it is considered critical to joint-service radiation safety initiatives within the **U.S. Department of Defense** and **U.S. Department of Homeland Security**. Additionally, it has been coordinated with **Army**, **Air Force**, and **Defense Nuclear Agency** personnel to achieve the maximum cross-service applicability. Some cooperative agreements may be reached with the **United Kingdom** and **France**, both of which are major users of nuclear propulsion. Thanks in part to the AUKUS agreement, Australia will likely be a participant in this program.

Forecast Rationale

Warships and submarines are precarious vehicles by mission and design; add nuclear-powered engines and weapons, and a whole new element of risk is introduced. All nuclear-powered ships and submarines require an instrument to detect and measure radiological activity in the event of a nuclear detonation in order to avoid the radiological danger and continue their mission.

The U.S. Navy's Radiation Detection, Indication and Computation (RADIAC), or Radiological Control 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.

This need for radiation detection can also be seen in efforts to exploit emerging technology in the development of new methods of detection. One such example is the application of a focal plane array that uses a light detector. Though still in development, there is hope that an FPA can be used to detect radiation through the use of light rather than air.

Funding is expected to remain relatively low (under $1 million per year) but will slightly increase over the forecast period as better and more cost-effective radiation measurement and detection equipment is sought by both the U.S. Department of Defense and U.S. Department of Homeland Security.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR RDT&E FUNDING (in US$)												
Designation or Program		High Confidence				Good Confidence			Speculative			
	Thru 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Total
Science Applications International Corp (SAIC) (Prime)												
RADIOLOGICAL CONTROL <> United States <> Navy												
	42,614,000	811000	801000	815000	826000	851000	872000	880000	869000	855000	860000	8,440,000
Total	42,614,000	811000	801000	815000	826000	851000	872000	880000	869000	855000	860000	8,440,000