

THE NUCLEAR AND RADIOLOGICAL SECURITY MARKET

CIVITAS GROUP llc

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About the Civitas Group

Civitas Group llc is a strategic advisory and investment firm serving the homeland and national security markets. Civitas Group clients include Fortune 100 firms, leading security services providers, leading defense and information technology companies, early stage companies with promising technologies, and private investment firms. In a rapidly evolving homeland and national security industry, Civitas helps its clients build and implement successful strategies and grow their businesses.

Civitas Group's investment operation provides capital directly in early and mid-stage companies with promising security-related technologies or services. Civitas concentrates its efforts on companies in which the firm can apply its significant market and business expertise to accelerate growth and build value.

About the Authors

This report has been developed by the Civitas Group. The lead author for the report is Salina Diiorio, Associate. Civitas Group has unique expertise and an extensive practice in the nuclear threat detection market. This practice is headed by Dr. Penrose ("Parney") Albright, who oversaw the production of this report. For more information about our team, please visit our website at www.civitasgroup.com.

Purpose and Scope of the Report

This report provides the reader with Civitas Group’s view of the U.S. nuclear and radiological security market¹. The scope of our analysis covers both domestic security (in the public and private sectors) and international assistance programs sponsored by the federal government. We have broadly defined the nuclear and radiological security market to include products and services that are directly related to 1) the prevention of nuclear and radiological materials from being used in an attack, 2) the protection of nuclear and radiological materials and facilities, and 3) the elements of an effective response to a radiological or nuclear incident (e.g. radiation sensors, physical security at nuclear facilities, decontamination services and technologies, and related activities). We have not included the development, stockpiling, or component manufacture of nuclear weapons related to the U.S. nuclear defense posture, although we have included the physical protection of nuclear weapons facilities.

Section I of this report provides an overview of the threat of nuclear terrorism, including the potential sources of nuclear and radiological weapons and materials, potential targets, and the consequences of an attack.

Section II describes the current U.S. nuclear and radiological security policy framework.

Section III assesses the potential size of the U.S. segment of the nuclear and radiological security market based on an assessment of the threat, current policy directions, and major programs and initiatives.

Section IV identifies several major investment opportunities within the nuclear and radiological security market that focus primarily on key gaps in current technological capabilities and the emerging solutions needed to fill those gaps.

Section V presents Civitas’ concluding analysis regarding the nuclear and radiological security market as it relates to several key characteristics observed within the larger homeland security market.

¹ The analysis in this report differs from Civitas’ November 2006 *Homeland Security Market: Essential Trends and Dynamics* report in two important ways: 1) we have defined the nuclear security market much more broadly for this analysis, and 2) we have segmented the market differently (e.g. physical security measures related to nuclear facilities were included in the November report’s section on *Physical Infrastructure Protection*, rather than the *Nuclear and Radiological Prevention, Detection and Recovery* section).

Summary of Conclusions

Nuclear and radiological terrorism, which includes attacks utilizing nuclear or radiological devices or direct attacks upon nuclear facilities, is a real and growing threat. As a result, nuclear and radiological security remains a top priority for the United States, and substantially influences the government’s planning and funding decisions. It is a market, therefore, that is heavily driven by federal policy.

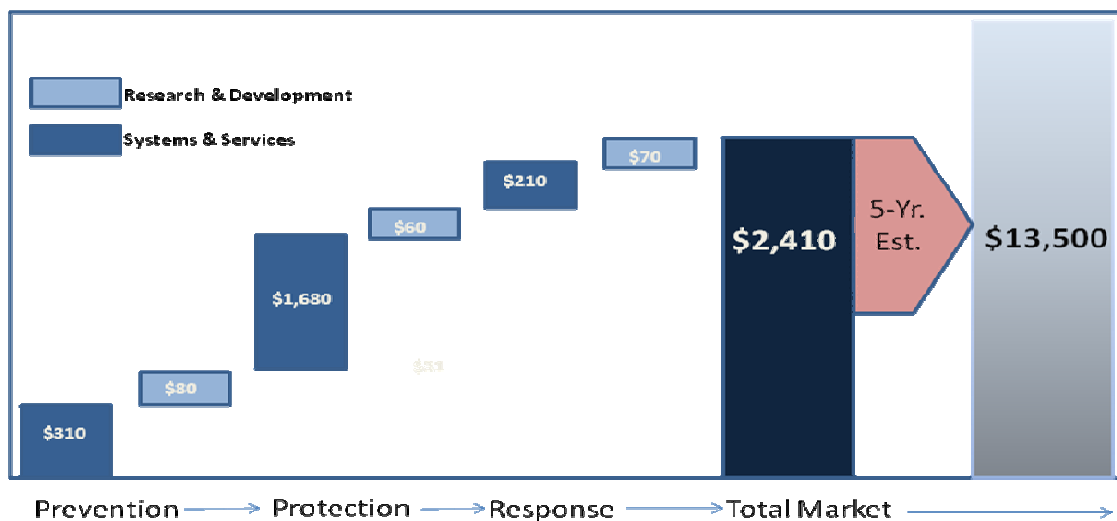
Civitas estimates that the total addressable² U.S. nuclear and radiological security market for FY 2007 is approximately \$2.4 billion. This includes procurement of systems and services (\$2.2 billion), as well as research and development initiatives (\$210 million). We estimate that the total addressable U.S. market over the next five years will be close to \$13.5 billion.

Key sectors in the market include:

- Radiation sensors;
- Accounting, tracking, and auditing systems for nuclear and radiological materials;
- Nuclear material disposition, reprocessing, and secure transport;
- On-site security systems and personnel for nuclear facilities;
- Attribution systems;
- Decontamination services and technologies;
- Medical countermeasures;
- Nuclear and radiological incident response planning, exercises, and training; and
- Personal protective equipment.

Key private sector opportunities will exist in the areas of next generation radiation sensors, integrated sensor systems, and the development of new and effective medical countermeasures to mitigate the health effects of nuclear and radiological attacks.

Fig. 1: U.S. Nuclear and Radiological Security Market



² By “addressable market” we mean that part of the market that is available for commercial procurements; it does not include such internal government spending as personnel and operations. That is, it is spending that could ultimately result in revenue for contractors and industry serving the market.

I. The Threat of Nuclear and Radiological Terrorism

From the end of World War II through the Cold War, the nuclear threat to the United States was perceived to come primarily from state actors with nuclear weapons capabilities. Today, the threat is far more complex, and involves both state and non-state actors such as al Qaeda and other terrorist organizations. The fall of the Soviet Union has resulted in degraded security around weapons and nuclear and radiological materials. Additionally, past and perhaps continuing proliferation from states such as North Korea and Pakistan increases the risk of weapons and materials being sold, transferred, or stolen and falling into the hands of terrorist organizations. The attacks on the World Trade Center and Pentagon on September 11, 2001 demonstrated the immense destructive capability of radical terrorist groups using conventional means to attack civilian targets, and their desire to inflict casualties on as large a scale as possible. This desire, coupled with their professed willingness to acquire and use weapons of mass destruction and the potential availability of nuclear and radiological materials and weapons components has caused the U.S. to give top priority to addressing the nuclear and radiological threat posed by both hostile states and terrorists.

Nuclear and radiological security as treated in this analysis³ consists of those measures taken to address the threats posed by nuclear terrorism, which include:

- Attacks using nuclear weapons⁴ or improvised nuclear devices⁵;
- Attacks using radiological dispersal devices (commonly referred to as RDDs or “dirty bombs”); and,
- Attacks on nuclear facilities, including nuclear power plants, weapons facilities, and research reactors.

The prospect of terrorist groups detonating a nuclear weapon or improvised nuclear device (IND) is one of the highest priority risks being addressed by the U.S. government. Although attacks using RDDs would result in far lower potential consequence, their relative ease of manufacture and deployment (as compared to acquiring a nuclear weapon or sufficient quantities of fissile materials for an IND) causes them to be considered a significant and more likely risk to domestic security.

An attack on a city, seat of government, or major port with a nuclear weapon or IND would result in catastrophic loss of life and cause long-term political, economic, and social consequences. Depending on the output of the weapon and the location of the attack, casualties resulting from the initial blast and subsequent thermal and fallout injuries could

³ Defense activities to counter hostile state use of nuclear weapons have not been included, although post-attack response functions would basically be the same (e.g. use of medical countermeasures, area decontamination, etc.).

⁴ "Nuclear weapons" refer to state owned strategic and tactical nuclear weapons, generally delivered via bombers, ballistic missiles, artillery shells, etc. (National Research Council, 2002. *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*).

⁵ "Improvised nuclear devices" refer to weapons fabricated by terrorists using stolen or diverted plutonium or highly enriched uranium (Ibid).

exceed a million dead⁶. Critical infrastructure including buildings, transportation systems, and power grids would be destroyed. The ability of the federal government to respond effectively and to provide health care and basic needs to the survivors would be severely impaired. In short, its effect would be epochal in nature.

Radiological dispersion devices (RDDs)⁷ present more of an opportunity for attackers than either nuclear weapons or INDs, since they can utilize a much larger range of radioactive materials that are far more common – examples include radiological sources commonly used in medicine and industry, radioactive waste from nuclear power plants, and material from portable generators. Of particular concern is Cesium¹³⁷ due to its chemical properties, its high radioactivity, and the mode in which it is typically available.

An RDD attack would likely result in relatively few casualties due to the initial blast and dispersed radiation. Casualties would be somewhat higher if the RDD were designed to disperse material in a highly respirable form, although the technical expertise needed to do this effectively is fairly sophisticated. The major damage from an RDD attack would most likely be economic. If much of the radioactive material is localized (i.e. it mostly deploys in large particles that settle in the immediate area of the blast) then cleanup is relatively straightforward. On the other hand, an attack that results in significant amounts of radioactive material being dispersed by the wind over wide areas and then chemically binding to structures and roads could lead to an expensive and time consuming remediation campaign.

Nuclear facilities, such as power plants, research reactors, and spent fuel storage sites, are also potential targets – either for a direct attack intended to cause radiation release, or from theft or diversion of materials. An attack on a nuclear power plant could have severe consequences if large enough to result in the release of radiation (e.g. compromising the containment dome), although this would be extremely difficult to accomplish. Fuel storage systems and research reactors are less attractive targets for direct attack since such an attack would not generally result in significant radiation exposure. They are, however, potentially vulnerable to diversion or theft of highly enriched uranium (HEU). For example, many research reactors in Russia are not highly secured. Many more reactors have been shut down but have not been properly decommissioned by removing the HEU fuel, thus providing a potential source of nuclear and radiological materials for black market trade.

⁶ Based on affected population model from 20kt surface detonation – Source: Bell, W.C. and Dallas, C. E. (2007, February 28). Vulnerability of population and the urban health care system to nuclear weapon attack – examples from four American cities. *International Journal of Health Geographics* 2007, 6:5.

⁷ "Radiological dispersion devices" use radioactive materials, sometimes combined with conventional explosives, to contaminate an area (National Research Council, 2002).

II. Current U.S. Policy Framework

The U.S. has employed a variety of policy tools to address nuclear and radiological security in the post-September 11 era. They focus on reducing or eliminating nuclear weapons and materials, keeping those weapons and materials out of the hands of terrorist organizations and rogue regimes, protecting key assets identified as potential targets, detecting nuclear material, and preparing to respond effectively to mitigate the effects should an attack occur. The overarching strategy for dealing with nuclear and radiological threats is found in the *National Security Strategy*⁸ and the *National Strategy to Combat Weapons of Mass Destruction*⁹, which describe a three-pronged approach that includes counter-proliferation strategies (e.g. interdiction of weapons, counterterrorism and defense options), nonproliferation initiatives (e.g. export controls, threat reduction cooperation, and security assistance to provide nuclear material controls), and consequence management. In addition, the *National Strategy for Homeland Security*¹⁰ establishes six critical homeland security mission areas, all of which are relevant to nuclear security.¹¹

Taken together, these U.S. policy strategies form a complementary, multi-layered, defense-in-depth approach to nuclear security. This approach focuses on 1) **Prevention** of the loss and illicit use of materials and weapons through a large and layered deployment of detection systems (both domestically and abroad), as well as interdiction measures, and effective intelligence capabilities to support them, 2) **Protection** of critical infrastructure, including nuclear power plants and other facilities and physical control and accountability of nuclear, fissile and radiological materials, 3) **Response** by federal, state, and local government agencies in the immediate aftermath of a nuclear or radiological incident, and 4) **Recovery** over the longer term, including physical, economic, and environmental mitigation and reconstruction.

The U.S.'s nuclear and radiological security policy is fairly mature, and has significant impact on the development of the market. For example, a key component of the U.S. strategy has been a large and layered deployment of detection systems to screen cargo both within the domestic U.S. and abroad. As noted earlier, the threat of greatest concern comes from a nuclear weapon or IND, due to the potentially catastrophic consequences of such an attack. While the highest leverage investment that can be made to mitigate this threat is to assure the safety and security of nuclear weapons and material at their source, in addition to that there must be ways to detect the movement of weapons or materials should they be diverted or stolen. Any architecture designed to prevent the detonation of a terrorist weapon on U.S. soil must consist of multiple layers of detection technology to prevent its transport into the United States. A detection architecture has therefore been developed that includes deployment of sensor systems around the borders of source nations, at major overseas and

⁸ *National Security Strategy*, available at <http://www.whitehouse.gov/nsc/nss.html>

⁹ *National Strategy to Combat Weapons of Mass Destruction*, available at <http://www.fas.org/irp/offdocs/nspd/nspd-17.html>

¹⁰ *National Strategy for Homeland Security*, available at <http://www.whitehouse.gov/homeland/book/>

¹¹ Intelligence & Warning, Border and Transportation Security, Domestic Counterterrorism, Protecting Critical Infrastructure & Key Assets, Defending Against Catastrophic Threats, and Emergency Preparedness & Response.

domestic ports and transportation hubs, at U.S. land borders, and at choke points within the internal domestic transportation networks that are feasible for detection.

Historically, responsibility for managing these detection system deployment programs has been spread across DHS, DOD, DOE, and the State Department. This decentralized approach has had a variety of difficulties involving execution, including imperfect coordination and planning among these programs leading to duplication of effort and inconsistent quality of the equipment being deployed. Over the past several years, the U.S. government has made several policy changes to address these issues. First, procurement activities that had been dispersed across DHS have been brought into a new Domestic Nuclear Detection Office (DNDO), which also has a mandate for coordinating efforts across cabinet agencies. Additionally, the technology development efforts originally initiated within DHS's Science and Technology Directorate were moved to DNDO. These changes have resulted in greater coordination around the deployment of nuclear detection systems, consolidated procurement vehicles for major detection technologies, and more robust and focused research and development efforts for next generation technologies.

There remain several areas of policy debate with regard to radiological threats that could potentially influence the market in the future. For example, there has been some discussion of controlling commercial radiation sources (e.g. medical sources) to a greater degree through better tracking and control measures (such as RFID tagging and real-time tracking), or requirements for embedding the radioactive material in a material that makes weaponization difficult. Also, there is currently no single federal standard for environmental restoration after a radiological incident – the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC) each have their own, which differ in the level of their requirements. The adoption of new material control regulations or more stringent restoration standards could translate to increased private sector opportunities in these areas.

III. Market Definition & Sizing

Civitas has defined the nuclear and radiological security market according to the major functions suggested by the U.S. government’s policy approach: *Prevention, Protection, Response,* and *Recovery*.

Prevention – Prevention measures include the successful detection and interdiction of illicit nuclear weapons, special nuclear material (SNM), and radiological materials once they have been removed from their points of origin and before they can be used in an attack. Detection relies primarily on the use of various types of radiation sensors at strategic locations, such as material points of origin, ports of entry and debarkation, and main transportation corridors.

Protection – Various measures are in place to protect nuclear weapons, SNM, and radiological materials from loss, including on-site security systems; accounting, tracking, and auditing systems; and secure material disposition, reprocessing, and transportation services.

Response – Response measures include personal protective equipment for first responders, environmental and human decontamination, radioprotectants and other medical countermeasures, incident response planning and training efforts, and a forensic attribution system to identify those responsible for an attack.

Recovery – Recovery activities in the aftermath of a nuclear or radiological incident would include debris and environmental hazard removal, critical infrastructure and service restoration, and long-term economic and community recovery efforts.

Figure 2: Segments of the Nuclear and Radiological Security Market

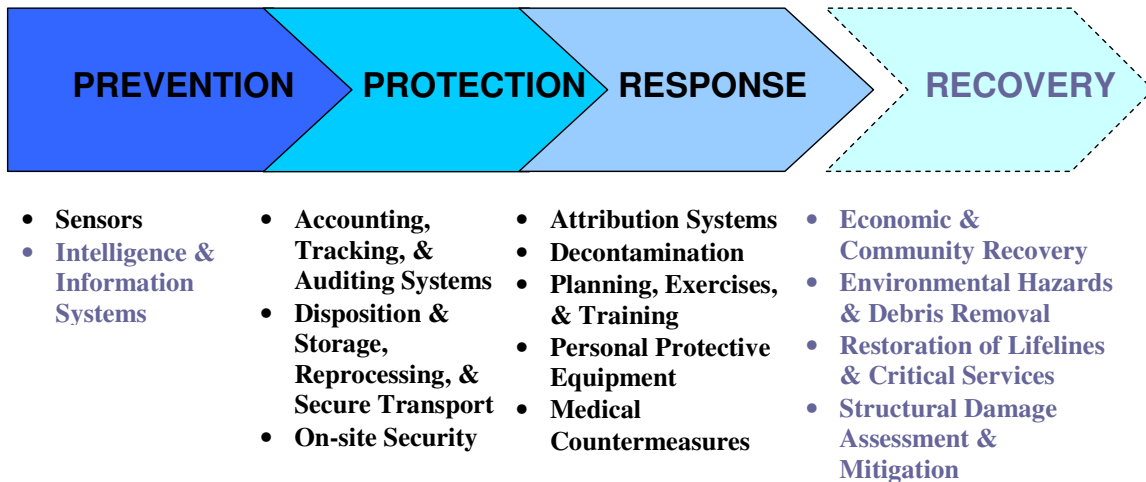


Figure 2 above shows the segmentation of the nuclear and radiological security market as defined by Civitas, and highlights the portions of the market that this report will include. While *Prevention, Protection,* and *Response* measures represent markets that are active even in the absence of a nuclear or radiological incident, *Recovery* activities only occur in the case of a successful attack. Any sizing of the *Recovery* portion of the market would be purely

speculative and highly variable depending on the nature and extent of the attack. Civitas has therefore chosen not to include a sizing of the *Recovery* portion of the market in this report

It should also be noted that several federal agencies (e.g. the Federal Bureau of Investigation (FBI), Customs and Border Protection (CBP), the Coast Guard (USCG), and the Department of Energy (DOE)) have intelligence and information system capabilities that inform nuclear and radiological interdiction and non-proliferation efforts. However, the classified nature of these programs restricts the information needed to accurately size them; thus a sizing of the intelligence segment of the market has also been excluded from this report.

Market Sizing

Civitas estimates the size of the addressable nuclear and radiological security market to be approximately **\$13.5 billion** over the next five years.

Table 1: Total Nuclear and Radiological Security Market¹²

	Market Segment	Annual - 2007 (in \$ millions)	Weighted Five-Year Value (in \$ millions)
Systems & Services	Prevention	310	2,600
	Protection	1,680	8,790
	Response	210	940
	TOTAL	2,200	12,330
Research & Development	Prevention	80	500
	Protection	60	280
	Response	70	370
	TOTAL	210	1,150
TOTAL NUCLEAR MARKET		2,410	13,480

Protection is the largest dollar value market, primarily due to on-site security of critical infrastructure. However, the component segments of that market are relatively mature (e.g. on-site security of nuclear reactors and weapons sites) and favor entrenched providers. Potential for growth and technological innovation is seen more in the *Prevention* and *Response* markets, particularly with regard to integrated and emerging radiation detection technologies and medical countermeasures that can mitigate the adverse effects of radiation exposure.

¹² Methodology: We have based the Annual – 2007 values on a number of inputs, including 1) budget analysis on the programmatic level, discounting for line items such as salaries and benefits, pensions, and routine operating and administrative expenses, which are not generally able to be captured by the private sector, 2) agency acquisition plans when available, 3) stakeholder interviews, and 4) Congressional testimony and hearings, and other open source documentation. Five-year numbers were based on estimated spending growth in the absence of a major nuclear or other security event occurring within that time-frame.

Segment Components

The following sections contain further detail on the *Prevention*, *Protection*, and *Response* market segments.

Prevention

Civitas estimates the addressable portion of the *Prevention* segment of the nuclear and radiological security market to be approximately \$3 billion over the next five years. It includes current and emerging sensor technologies that detect nuclear and radiological materials.

Table 2: Nuclear and Radiological Security Market: Prevention

	Annual - 2007 (in \$ millions)	Weighted Five-Year Value (in \$ millions)
Systems & Services	310	2,600
Research & Development	80	500
TOTAL PREVENTION SEGMENT	390	3,100

Radiation Sensors – The radiation sensor market includes the deployment of the global nuclear detection architecture, DOE and Environmental Protection Agency (EPA) radiation monitoring capabilities, Department of Defense (DOD) installation protection, and research and development on new detection technologies. It is primarily driven by DNDO's Advanced Nuclear Detection System program. This is a large research, development, and procurement initiative that includes three main programs: the Advanced Spectroscopic Portal Monitor (ASP) program, the Cargo Advanced Automated Radiography System (CAARS) program, and the Human Portable Radiation Detection System (HPRDS) program. Contracts were awarded for each of these programs in 2006.

Civitas estimates the radiation sensor market to be approximately \$3.1 billion over the next five years¹³, with \$2.6 billion for systems and services, and \$500 million for research and development. However, the majority of the systems and services portion of the market will likely only be accessible to the awardees of the ASP, CAARS, and HPRDS programs. DNDO may spend as much as \$1.3 billion on CAARS over the next seven years; however, since this is a spiral development program, DNDO may opt not to go to full scale production and deployment if the new technology does not perform to standard. Also, sodium iodide production capacities¹⁴ could potentially limit the planned production and deployment of the ASP monitors that will be based on that technology.

¹³ Includes equipment installation but not operations and maintenance or service contracts.

¹⁴ A significant portion of the ASP program involves procurement of portals that utilize sodium iodide crystals for gamma radiation detection.

Protection

Civitas estimates the addressable portion of the *Protection* segment of the nuclear and radiological security market to be approximately \$9 billion over the next five years. This segment includes accounting, tracking, and auditing of nuclear and radiological materials; material disposition, reprocessing, and transportation services; and on-site security systems for critical infrastructure such as nuclear power plants and national laboratories.

Table 3: Nuclear and Radiological Security Market: Protection

	Annual - 2007 (in \$ millions)	Weighted Five-Year Value (in \$ millions)
Systems & Services	1,680	8,790
Research & Development	60	280
TOTAL PROTECTION SEGMENT	1,740	9,070

Accounting, Tracking and Auditing Systems – Accounting, tracking and auditing systems primarily include those systems implemented by the DOE as part of its Material Control and Accountability programs – both for domestic DOE facilities and for overseas assistance. This segment will be approximately \$70 million over the next five years.

The Nuclear Regulatory Commission (NRC) has begun development and implementation of a radiological source tracking system to track licensed sources on a transactional basis. However, there is currently no system for real-time tagging and tracking of radiological sources from the time they depart the point of origin to the time they are received. The EPA, in collaboration with Oak Ridge National Laboratory, has been conducting research and evaluation of RFID technologies for this purpose. If implemented, the potential market for a national tracking system of this type could be an additional \$10 million over five years.

Material Disposition, Reprocessing, and Secure Transport – This segment includes the following components: 1) the disposition of spent nuclear fuels and fissile materials through overseas U.S. assistance programs, 2) the reprocessing, or “blending down” of weapons grade HEU to low enriched uranium, which can no longer be readily used for nuclear weapons, and 3) secure transportation services for nuclear weapons, weapons components, and SNM. Various DOE domestic programs, as well as the Global Threat Reduction Initiative administered through the National Nuclear Security Administration (NNSA), drive spending in this segment.

Current DOE disposition assistance programs represent approximately \$120 million in addressable funding over five years. The market for reprocessing and conversion of HEU (both domestic and overseas assistance programs) will total approximately \$1.8 billion. Secure transportation (domestic and overseas assistance) spending will be approximately \$80 million. We estimate that research and development of new fuel treatment technologies that will reduce the quantity and toxicity of waste requiring disposition will be approximately \$200 million.

On-Site Security Systems – On-site physical security for nuclear facilities can include access control, perimeter security, camera surveillance, intrusion detection, and contract guard services. Included in this sizing is spending related to DOE national labs and nuclear facilities; domestic nuclear power plants, research reactors, and weapons facilities; and overseas assistance programs for securing similar sites.

The On-site Security Systems segment will be approximately \$6.7 billion over the next five years – almost 60% of which is attributable to DOE national labs and domestic nuclear power plants. Although there was an initial surge in spending at these sites post 9/11, that spending has since leveled off. New opportunities exist in security system upgrades, operations and maintenance contracts, and contract expiration and re-competition, rather than new facility builds. We estimate research and development on new physical security technologies to secure nuclear stockpiles will be approximately \$80 million over five years.

Response

Civitas estimates the *Response* segment of the nuclear and radiological security market to be approximately \$1.3 billion over the next five years. While there are many functions of all-hazards catastrophic incident response that are relevant to a nuclear or radiological terrorism incident (e.g. command and control systems, medical surge capacity, interoperable communications, and emergency shelter), the scope of this report is limited to only those functions that are directly attributable to nuclear security. In this segment, we have included forensic attribution systems, environmental and human decontamination, radioprotectants and other medical countermeasures, incident response planning and training efforts, and personal protective equipment for first responders.

Table 4: Nuclear and Radiological Security Market: Response

	Annual - 2007 (in \$ millions)	Weighted Five-Year Value (in \$ millions)
Systems & Services	210	940
Research & Development	70	370
TOTAL RESPONSE SEGMENT	280	1,310

Attribution Systems – The threat of retaliation can be a deterrent against a state-sponsored nuclear or radiological attack, although less so for most terrorist organizations. To be effective, the capacity must exist to accurately attribute an attack to specific states or terrorist groups. Such an attribution system would use laboratory-based forensics techniques combined with intelligence and database information to determine the characteristics of the weapon and its country of origin. Research and development in this area is focused on developing improved technologies for rapid and effective debris collection, improved analytical instrumentation, and new technologies to analyze the forensic signature of debris and weapons; as well as enhancing knowledge databases and the tools to access them.

Attribution system development is primarily driven by two research and development programs: the Domestic Nuclear Event Attribution program (within DTRA) and the Radiological and Nuclear Attribution and Forensics Initiative (within DNDO). Based on current spending for these programs, we estimate the nuclear attribution system market to be approximately \$130 million over the next five years. However, this development work is primarily being done in collaboration with DOE and the national labs. Opportunities for the private sector may be limited.

Decontamination (People and Environment) – In the aftermath of a radiological or nuclear event, rapid decontamination of people would be critical to mitigating the health effects of exposure to radiation. Decontamination of the environment would likewise be crucial for decreasing long-term exposure to radiation and enabling reconstruction and recovery within the affected area.

The annual market for decontamination equipment and services will be approximately \$200 million over the next five years. It is driven primarily by the EPA's response capability, and, to a much lesser extent, DOD Project Guardian procurements and state spending through homeland security grants.

Medical Countermeasures – Due to the potential exposure of large numbers of people to high levels of radiation, there is a need for medical countermeasures to mitigate the effects after an attack. Radioprotectants can help protect against acute and long-term radiation exposure. Currently available treatments included in the Strategic National Stockpile (SNS) are Prussian blue to help block internal absorption of cesium-137, calcium- and zinc-diethylenetriaminepentaacetate (Ca-DTPA and Zn-DTPA) to treat internal contamination from radioactive elements, and potassium iodide (KI), which blocks thyroid radioiodine uptake. However, there are no effective “whole body” radioprotectants that can treat acute radiation sickness, guard against DNA mutations, and mitigate other health consequences of acute radiation exposure. The Department of Health and Human Services (HHS) is currently pursuing the development and procurement of new radioprotectants and other medical countermeasures, to be included in the Strategic National Stockpile in the future.

Civitas estimates the medical countermeasures market to be approximately \$290 million over the next five years – \$240 million for research and development and \$50 million for procurements. This is based on current research and development spending for the development of new drugs, as well as current and projected spending on procurements of Ca-DTPA, Zn-DTPA, and KI for the Strategic National Stockpile. However, based upon the average cost to bring a new drug to market, research and development of radioprotectants alone could potentially reach as much as \$65 - \$80 million annually. Research and development is driven by the level of grant and research contract funding through the National Institutes of Health (NIH).

Nuclear and Radiological Incident Response Planning, Exercises, & Training – Emergency responders need to be trained and prepared to conduct appropriate response measures to protect, evacuate, and assist affected populations in the event of a nuclear or radiological incident. Such activities can include: nuclear emergency response plan development and assessment, course-based training, simulations, tabletop scenarios, and field exercises.

A total of approximately \$370 million will be spent over the next five years on planning, exercises, and training services, which includes \$55 million across all federal agencies for

spending on tabletop and field exercises, particularly within DOD. Approximately \$80 million will go to federally-funded state and local programs, including the Radiological Emergency Preparedness Program (REPP) and the National Exercise Program. Another \$240 million will go to nuclear- and radiological-related first responder and other team training courses through the REPP, the Federal Law Enforcement Training Center (FLETC), and the Emergency Management Institute.

Personal Protective Equipment – Potentially thousands to tens of thousands of emergency responders and other workers would need personal protective equipment (PPE) in the immediate aftermath and long-term recovery period following a nuclear or radiological event. There is also demand for PPE within DOD for force protection. PPE includes protective suits, masks, gloves, boots, respirators, and personal dosimeters, as well as specialized masks and outer-garments utilized by the military.

Spending on PPE for first responders is bounded by state spending on equipment through various DHS preparedness grants. It is difficult to gauge how state grant funds are being spent as many states refuse to release the information publicly. However, we estimate that approximately \$220 million¹⁵ of federal homeland security grants to states may be spent on PPE over the next five years.

Force protection PPE spending is driven by procurements for the DOD's Guardian program, which will be approximately \$100 million over the next five years.

Market Drivers

Below are a few of the primary drivers that will influence the nuclear and radiological security market over the next three to five years.

Events

The terrorist attacks on the World Trade Center and Pentagon on September 11, 2001 demonstrated the immense destructive power of radical terrorist groups using conventional means to hit domestic targets. In its 2004 final report, the 9/11 Commission Report warned that "the greatest danger of another catastrophic attack in the United States will materialize if the world's most dangerous terrorists acquire the world's most dangerous weapons."¹⁶ The U.S. now regards the prospect of a radiological or nuclear terrorist attack to be one of the most serious challenges to its security. This is a broadly held and bi-partisan sentiment, and will therefore continue to drive homeland security policy direction and focus for the foreseeable future.

More recently, a natural disaster and not a terrorist event brought issues related to catastrophic incidents to the forefront. Hurricane Katrina exposed many of the difficulties faced by federal, state, and local authorities in responding to a catastrophic incident that affected and displaced a large population. In the aftermath of Katrina, the DHS homeland security grant program was criticized for being too focused on terrorism preparedness at the expense of natural disaster preparedness. With calls for a more balanced, all-hazards

¹⁵ Generally, PPE is multi-functional and is procured for response to various hazards, including nuclear, chemical, and biological agents. This reflects an estimate of PPE spending that can be attributable to nuclear response needs. Thus, actual spending by states and federal agencies will likely be higher.

¹⁶ *The 9/11 Commission Report*, available at: <http://www.9-11commission.gov/report/index.htm>

approach to preparedness and response, a new risk-based grant funding formula, and the recent reorganization of FEMA to include the Office of Grants and Training, there may be more focus in the future on all hazards planning in addition to counterterrorism efforts.

Major Program Initiatives

Below are the key federal nuclear security programs that will continue to drive the market in the near to mid-term. They include next generation radiation sensor development and deployment, military force protection, threat reduction programs focused on international assistance for the protection and/or elimination of weapons and fissile materials, major research efforts focused on improved radiation sensor capabilities, and the development of new and effective medical countermeasures to mitigate the health consequences of a nuclear or radiological attack.

Radiation Sensor Development and Deployment

The largest and most ambitious nuclear security initiative that has been adopted by the federal government since 2001 is the development of the **global nuclear detection architecture**. A key component of this strategy is a large and layered deployment of advanced nuclear detection systems (both within the domestic U.S. and abroad) to screen cargo at ports of entry and debarkation, including international mail centers, land border crossings, seaports, and international airports.

Programs that deploy radiation detection equipment to combat nuclear smuggling have historically been decentralized across several federal agencies, with little coordination among them. The Departments of Defense, Energy, and State provide assistance and equipment to foreign countries on an ad hoc basis to protect weapons installations, land borders, and seaports, and U.S. Customs and Border Protection (CBP) deploys equipment to domestic ports of entry.

To improve coordination and planning among these programs, the DNDO was created within DHS in 2005. DNDO has become the centralized, accountable office for developing the global nuclear detection architecture, as well as supporting the deployment of the domestic component of the architecture.

Advanced Nuclear Detection System Program – The **Advanced Nuclear Detection System** (ANDS) program is DNDO's initiative to deploy next generation technologies to U.S. ports of entry. The ANDS consists of three major programs that include the research and development, procurement, and deployment of advanced radiation detection technologies: the Advanced Spectroscopic Portal Program, the Cargo Advanced Automated Radiography System Program, and the Human Portable Radiation Detection Systems Program (see below for more detailed discussion of the status of these programs). DNDO is working jointly with CBP on the phased procurement and deployment of these systems as they are developed. These new sensor technologies will also be made available through DNDO's procurement contract vehicles to other federal departments that have responsibility for deploying detection systems internationally.

Second Line of Defense Programs – The NNSA Second Line of Defense programs were established to help prevent illicit trafficking in nuclear and radiological materials. The program has two components: the Second Line of Defense (SLD) Core Program, and the Megaports Initiative. The **SLD Core Program** has provided detection equipment and

training at about sixty-six borders and crossing points, primarily in Russia and Greece. Additionally, the program has taken over responsibility for repair and maintenance of equipment previously supplied to countries through the Department of State and other programs. Through its **Megaports Initiative**, the NNSA installs radiation detectors and provides training for operators at key ports worldwide. The Megaports Initiative is currently operational in six partner countries¹⁷, and is at various stages of implementation in thirteen others.¹⁸ The NNSA is also engaged in negotiations with approximately twenty other countries throughout Europe, Asia, the Middle East, and South America to further expand the initiative.

Other Detection Programs – DOD and the State Department also run several smaller programs that contribute to the deployment of radiation detection equipment outside of the United States. DOD's **International Counterproliferation Program** is a collaborative effort within DOD that engages the FBI and Customs and Border Protection to provide nuclear detection equipment and training to former Soviet states and countries within the Baltic region and Central and Eastern Europe. The **WMD Proliferation Prevention Initiative** was created in 2003 to help former Soviet states other than Russia build the capacity to prevent illicit trafficking in CBRN weapons and related materials and respond effectively to trafficking incidents at their borders. The focus of this DOD program is to help partner countries secure discrete ports of entry and the stretches of land (or sea) in between.

The State Department's **Export Control & Related Border Security Program** works with Customs and Border Protection to provide nuclear detection equipment, including hand held "radiation pagers" and isotope identifiers, and training to partner countries. Through its **Nonproliferation & Disarmament Fund (NDF)**, State provides the means for a rapid response to unanticipated or unusually difficult proliferation problems. Currently, the NDF is helping to fund the Dangerous Materials Initiative, which will help other countries establish accounting and control mechanisms to secure radioactive materials, as well as pathogens, and chemical precursors.

Military Force Protection

Joint Project Manager Guardian Installation Protection Program is a force protection program that provides DOD installations with CBRN protection and response capability, including handheld and portal monitor radiation detectors. In addition to sensor capabilities, the program also procures, deploys, and supports CBRN analytical communications, protection, response, and survey capabilities in support of civil support teams, as well as reserve reconnaissance and decontamination platoons in support of homeland security requirements. DOD is currently in the process of re-competing the Guardian contract¹⁹ to institute a new tiered approach to capability deployments. Overall, DOD is seeking a major integrator that can support program execution, including site visits; equipment selection and

¹⁷ Greece, Bahamas, Sri Lanka, Spain, Singapore and the Netherlands

¹⁸ Belgium, China, Dubai, Honduras, Israel, Oman, the Philippines, Thailand, Egypt, Honduras, Jamaica, the Dominican Republic and Taiwan

¹⁹ Nuclear security is only a portion of the Guardian focus. The contract will also involve deploying chemical and biological detection, identification, and response equipment.

planning, design, procurement, integration, and programming; system development testing and operational testing; personnel training; and integrated logistics support. The RFP is currently being bid, and the contract will be an ID/IQ²⁰ single award, totaling between \$180-245 million for a period of performance up to five years. The contract will provide capabilities for 50 – 100 bases (both domestic and overseas).²¹

Nuclear and Radiological Threat Reduction

NNSA administers the **Global Threat Reduction Program**, which identifies, secures, removes and/or facilitates the disposition of high risk vulnerable nuclear and radiological materials around the world. Earlier this year, NNSA awarded contracts totaling up to \$100 million that would cover security vulnerability assessments, material removal planning, facility security upgrades, and material removal and disposition. Three small business - Global Threat Reduction Solutions, LLC, Professional Project Services (Pro2Serve), and GEM Technology International Corporation – were selected to compete for task orders under the five-year contracts.

The **Nunn-Lugar Cooperative Threat Reduction** program within DOD’s Defense Threat Reduction Agency provides funding for the decommissioning of nuclear, chemical, and biological weapons and materials in Russia, the former Soviet states, and elsewhere. Projects include security upgrades to weapons and material sites, as well as HEU blend-down programs.

Research and Development

The DNDO is engaging in a **Transformational Research Program** to provide long-term funding for exploratory research and advanced technology development that will develop innovative, effective, and affordable next generation nuclear sensor technologies. The program also contains an academic research component, which is intended to foster and support interest within the academic community in nuclear detection technology by creating incubator research programs at universities.

In FY 2006, DNDO’s transformational research program received \$56.6 million in funding. Congressional appropriations for FY 2007 increased to \$65 million, although the President’s budget request for the program was \$100 million. It is anticipated that some funding will be directed toward the discovery and development of new detector materials, with award amounts around \$10 million. It is unclear how the remaining funds will be spent, with Congress unenthusiastic over funding a DNDO proposal for a new university “center of excellence.” Thus, these funds represent an attractive opportunity for research and development firms with plausible ideas from both the technical and operational perspectives.

In 2005, the NIH established its research program on **Medical Countermeasures against Radiological and Nuclear Threats**. Through this program, the National Institute of Allergy and Infectious Diseases (NIAID) provides funding to help support the various phases of developing new medical countermeasures, including basic research, accelerated

²⁰ ID/IQ = indefinite delivery/indefinite quantity contracts specify the allotted funds available for purchases to be made with specific vendor(s) for specific goods and/or services within a certain period of time. Dates and quantities of purchases are determined through individual task orders.

²¹ See RFP W9113M-07-R-0003 and Industry Day documents:
<http://www.smhc.army.mil/Contracts/Contracts.html> (IPP link)

product development, and licensure. In 2005, twelve grants, four contracts and two interagency agreements totaling \$47 million were awarded. More recently, the Department of Health and Human Services released its **Public Health Emergency Medical Countermeasures Enterprise (PHEMCE) Implementation Plan** in April 2007. The plan identifies fourteen primary nuclear, biological, and chemical threats, and prioritizes countermeasure research and procurement for each. NIH will be aligning its research and development efforts with this plan.

Trend towards Integrated Systems Solutions

End-user demand for integrated solutions has been a dominant characteristic of the homeland security market as a whole for at least the past three years. This trend is also seen in the nuclear security segment of the market, particularly with regard to the sensor systems being deployed as part of the global nuclear detection architecture. The ultimate aim of the nuclear detection architecture is to provide a system that is so daunting that potential attackers will either choose to deploy whatever capability they have achieved elsewhere, or they will be forced to engage in complex and manpower intensive schemes for penetrating the system that dramatically increase the chances of being discovered through intelligence and law enforcement means. Thus, the system should provide multiple opportunities for detecting the illicit transport of relevant materials – overseas, across the borders, and within the domestic transportation infrastructure. However, it must accomplish these security goals without impeding the flow of legitimate commerce.

Thus, the nuclear detection architecture will need to integrate with the larger efforts that allow risk assessment of commerce, as well as with the associated operations offshore and at the ports of entry. The information from a spectroscopic portal monitor deployed at a border port of entry that detects a commercial source of radiation must be cross-correlated with advanced cargo manifest data to assure that what is seen by the detector is what is expected (and declared by the shipper). Efficient secondary inspection of a suspicious commercial load requires passing sensor data collected at primary to the secondary inspector. And all the radiation detection information collected from multiple sources should be integrated together with risk analyses and intelligence information for analysis and detection of suspicious trends, and for improving system capabilities.

The integration of disparate detection systems at a port of entry, and bringing that data together with manifest records and risk assessment information for the resolution of local events, or the linking of global systems with intelligence data, presents significant opportunities for firms with the relevant capabilities. It is difficult to quantify the potential market, but the concept of a “port of entry of the future” that brings together all the available information sources efficiently to the agent on the ground, rendering the border both more secure and more efficient, would resonate both with DHS and with international governments.

IV. Private Sector Implications

Below is an overview of several major technology investment opportunities that will be developing over the next three to five years: **Next Generation Sensors**, **Integrated Sensor Systems**, and **Medical Countermeasures**. These opportunities focus primarily on current gaps in technological capabilities, and the emerging solutions needed to fill those gaps.

Next Generation Sensors

There remain technical and systems architecture challenges facing the development and deployment of an effective global nuclear detection architecture. Specifically, DNDO has identified the need for:

- Better detection and verification of shielded SNM at domestic ports of entry;
- Radiation monitoring along unattended air, land, and sea borders;
- In-transit monitoring of cargo and conveyances;
- Mobile or re-locatable radiation detection and monitoring; and
- Unattended or ubiquitous radiation detection sensing systems.

DNDO has established three spiral development programs to develop and procure new sensor technologies over the near- to mid-term, as well as a robust transformational research and development program to address these challenges in the long-term.

Next Generation Passive Detection Systems

DNDO's **Advanced Spectroscopic Portal (ASP) Monitor Program** is focused on developing and procuring next-generation passive detection portal monitors for deployment at domestic ports of entry. The goals of the program are to develop superior detection technologies that will increase the probability of detection (particularly of SNM) without increasing false alarm rates, and that will also be able to identify the materials causing the alarms to better discriminate between naturally occurring radiation sources and actual threats. DHS is also planning to establish a Sodium Iodide Crystal Manufacturing Program (SIMP) to promote the industrial capacity necessary to manufacture sufficient quantities of NaI detectors to meet full rate production requirements for the ASP Program. Contract awards (except for the SIMP) were made for the ASP program in 2006.

The ASP program represents the culmination of an effort begun in 2004 to develop and deploy a portal monitor to border ports of entry and similar environments that would be able to discriminate between illicit radioactive threats and benign sources (such as kitty litter and jet engine turbine blades) that will cause the current portals to alarm. The research and development activities were initiated in a 2004 solicitation from the Homeland Security Advanced Research Projects Agency (HSARPA). That effort included a test and evaluation phase conducted at the Nevada Test Site where actual nuclear materials were used (in conjunction with other threatening and benign sources of interest) to evaluate the various contenders. Firms that either did not participate in the HSARPA effort or did not perform well in it were unlikely to succeed in winning the engineering, manufacturing, and production effort embodied in the ASP program.

The ASP program is divided into two efforts, with the first focused on so-called “medium resolution” portals utilizing sodium iodide detectors for gamma radiation, and the second directed at “high resolution” portals utilizing high purity germanium detectors of gamma radiation. It is expected that the vast bulk of sensors purchased under the ASP program will be for the medium resolution systems; Raytheon Corporation (teamed with Bubble Technologies, who designed the sensor) and Thermo Electron won this portion of the ASP competition. The high resolution systems are expected to be used in those circumstances where their additional discrimination performance justifies the additional cost; Canberra won the competition for this portion of the ASP program. Interestingly, the ASP program, while clearly focused on border portals, required performers on the medium resolution systems to bid several variants that included vehicle mounted detectors (that could be used, for example, on a golf cart to inspect stacked containers at a port), backpack systems, and systems designed for rail car inspection. Of additional interest is that one of the variants is for a portal that utilizes (the currently deployed) plastic scintillator technology (and hence does not possess the spectral discrimination capability associated with sodium iodide). Since it is expected that many border ports of entry, due to their low volume, may continue to use the older and less costly technology without impacting detection performance, there is some speculation that the government will take advantage of the ASP contract vehicle to procure those portals as well.

It is expected that the ASP program will dominate federal spending in non-handheld radiation detection for the foreseeable future. In addition to the DHS/CBP deployments, the Department of Energy has indicated its intent to purchase systems through the ASP contracts for its overseas efforts. It will be highly challenging for non-ASP vendors to penetrate the federal, state, local, commercial, and even international markets because of 1) the economies of scale inherent in the large production lots required for satisfying DHS and other federal needs, 2) the advantaged position the ASP vendors will have with the very limited global production sources for sodium iodide crystals, and 3) the simple fact that the ASP vendors will have the cachet associated with being the U.S. government supplier (i.e. large fielded operational base with demonstrated performance against the spectrum of threats of interest).

Next Generation Active Detection Systems

The **Cargo Advanced Automated Radiography System (CAARS) Program** will develop next generation active-imaging radiography systems for cargo inspection at ports of entry. The CAARS program seeks to 1) significantly improve imaging systems designed to identify concealed nuclear materials, particularly shielded SNM threats, 2) eliminate the need for operator interpretation of radiographic images through automated image processing, and 3) reduce overall inspection time from five minutes to approximately thirty seconds.

The CAARS program is designed to address a key issue with the ASP systems, which is their inability to detect fissile material in a shielded environment. CAARS is expected to provide active imaging of containers and trucks in much the same way that the Science Applications International Corporation (SAIC) VACIS system currently works, but with the additional feature that either shielding material or perhaps even the fissile material itself can be identified in the image. This would allow more accurate identification of potentially dangerous cargo that could then be sent to secondary inspection for further inspection. This capability will be realized by utilizing multiple energies in the imaging beam (current systems effectively scan the container with a mono-energetic beam). A further desire for CAARS is

to allow significantly faster throughput compared to current imaging systems, although at some point the limiting factor is not the characteristics of the technology but rather the ability of the operator to interpret the image quickly. Again, the winners of this effort (SAIC, American Science and Engineering, and L3) will hold an advantaged position in this market due to the cost advantages that accrue from the economies of scale, and their position with the U.S. government.

Portable Detection Systems

The purpose of DNDO's **Human Portable Radiation Detection Systems (HPRDS) Program** is to design, develop, enhance, and produce the next generation of handheld, backpack, and other portable radiation detection units. The contracts call for medium- and enhanced-medium-energy resolution scintillation material detectors, as well as high-energy resolution semiconductor material detectors.

The objectives of the program are to produce new, lightweight sensors that will:

- Operate according to threat-based performance specifications;
- Achieve higher-energy resolution through improved detection materials;
- Utilize standardized and user-friendly display and controls;
- Employ improved algorithms for better detection and isotope identification; and
- Utilize improved & standardized connection to computer systems.

The HPRDS program contracts were awarded in late 2006 to Ametec AMT, SAIC, Sanmina-SCI, Target Instruments, Inc., and Smiths Detection Inc. DNDO will be looking first to deploy sensors using NaI and germanium as detection materials; and then to develop technologies that will employ new materials, such as lanthanum bromide (LaBr₃), to further improve the probability of detection. These hand-held units will primarily be utilized by CBP officers during secondary inspection of cargo at ports of entry. They may also be deployed by the Coast Guard for on-board vessel inspections.

Transformational Research Program

The *Exploratory Research* component of DNDO's Transformational Research Program will specifically focus on the development of:

- **Innovative detection materials** and associated electronics that lead to significant improvements in key detection system properties such as spectral energy resolution, intrinsic efficiency, operating temperature, and unit cost.
- **Innovative detection techniques** that will extend detection range, improve directionality, and/or enhance isotope identification and discrimination for SNM and radiological materials.
- **Advanced SNM interrogation and verification** that can detect and verify SNM at multiple application venues, including: cargo at maritime ports, air cargo at foreign airports, items in vehicles or on persons crossing land borders at or between ports of entry, and items found on boats and small ships near the U.S. coastline.

- **Operational algorithms** for various stages of development and evaluation of new detection technologies, from exploratory research, through prototype development, to the final implementation into an operational system.

In March 2007, DNDO announced ten Exploratory Research contract awards to nine companies, for a total of \$8.8 million. Contracted companies include Alliant Techsystems Inc., Canberra, EIC Laboratories Inc., GE Global Research Center (two awards), Physical Optics Corporation, Radiation Monitoring Devices Inc., Rapiscan Systems Corporation, SAIC; and Westinghouse Electric Company.

The *Advanced Technology Demonstration* component is currently focusing on the development of the following technologies:

- **Standoff interrogation capabilities** (both covert and overt) for vehicles, vessels, and aircraft that extend nuclear detection ranges beyond 100 meters – \$25 million in grant awards is currently pending.
- **A portable, intelligent personal radiation detector** that can determine the direction, flux and energy of incoming radiation, as well as its own location and orientation, and integrate with other detectors to locate radiation sources.
- **Long-dwell detection** in transit systems that can exploit cargo transit time to detect materials.
- **Active SNM verification systems** that will have the capacity for direct detection of highly shielded SNM.

Solicitations for long-dwell detection in transit systems and active SNM verification systems are anticipated for 2007.

DNDO is also pursuing a Small Business Innovation Research (SBIR) Program, and is currently soliciting proposals for 1) surveillance and monitoring of radiological sources that are in use (e.g. in hospitals, research centers, and food irradiation), 2) improved solid-state neutron detection devices, and 3) high reliability occupancy sensors to replace the current “break beam” sensors used in Advanced Spectroscopic Portals.²²

Integrated Sensor Systems

In addition to the need for new sensor technologies, there is also a need to integrate different sensor capabilities and other security, communication, and information systems in order to augment the effectiveness of cargo screening operations. The Integrated Container Inspection System (ICIS) program currently being piloted in the Hong Kong port is an example of a private-sector driven integrated solution. All cargo containers entering the port’s participating terminals via truck or barge are screened using radiographic imaging, radiation sensor, and optical character recognition technologies. The goal of the program is to develop the capacity of port facilities to screen cargo containers as part of their normal operations without impeding the flow of traffic, and to provide integrated data for more efficient evaluation and resolution of radiation alarms.

²² Occupancy sensors determine the relative position between the sensor and the cargo, and are critical to accurately pinpointing the location of alarms.

DHS and DOE have expressed interest in the potential of the ICIS program, both in terms of integrating passive and active detection systems and encouraging public-private partnerships in nuclear security initiatives. However, the departments do not view the program as an operational system as deployed due to the significant limitations of the technologies utilized. DHS will look to build on the basic concept of ICIS, favoring an integrated systems approach that will allow for all cargo containers leaving international seaports to be both passively and actively screened. Ideally, this data could then be provided to DHS prior to cargo transit, and integrated with cargo manifest information and CBP's Automated Targeting System to more effectively and efficiently identify high-risk cargo shipments for additional inspections. If agreements can be reached with private terminal operators and host governments on data sharing and alarm evaluation and response, DOE will also work to support the incorporation of integrated systems into its Megaports initiative. The SAFE Port Act of 2006 contained a provision requiring DHS to designate three foreign seaports by January 2007 to serve as pilot sites for just such an integrated sensor system. Port Qasim, Pakistan; Puerto Cortes, Honduras; and Southampton, UK have been selected to participate. The pilot programs are required to be implemented no later than October 2007.

DHS in partnership with DOE has also begun the Secure Freight Initiative, which is designed to better assess the risk of inbound containers and enhance nuclear and radiological screening capabilities at overseas ports. During the initial phase of the program, current screening technologies will be deployed to six foreign ports,²³ and U.S.-bound containers will be screened and assessed for risk prior to their departure. In the area of systems integration, DNDO is also planning to launch multiple integration programs to develop deployable "systems of systems" for specific operational venues, such as metropolitan, port of entry, maritime, and aviation protection. Each program will determine the necessary suites of detectors, as well as the necessary component interfaces, to design customized solutions that will provide the greatest degree of prevention for each venue.

Medical Countermeasures

The medical countermeasures currently available to help combat the effects of radiation exposure (Prussian Blue, KI, Ca-DTPA, and Zn-DTPA) offer only limited protection against some of the long-term biological effects of exposure to certain types of radiation. There remains a need for the development of a variety of medical countermeasures. The HHS PHEMCE Implementation Plan had identified the following as near- and mid-term research and development priorities:

- Effective treatments for Acute Radiation Syndrome (ARS) and Delayed Effects of Radiation Exposure (DEARE);
- Bio-dosimetry and radionuclide bio-assay capabilities to aid in on-scene triage, as well as a system of bio-dosimetry and radionuclide bioassay laboratories;

²³ The foreign ports selected were: Port Qasim, Pakistan; Puerto Cortes, Honduras; Southampton, UK; Port Salalah, Oman; the Port of Singapore; and Port Busan, Korea.

- Radionuclide-specific countermeasures that could eliminate radioactive particles from the body in cases of RDD attacks and nuclear power plant events, including improved formulations of DTPA

In 2006, HHS issued an RFP for the procurement of 100,000 doses of radioprotectants for the treatment of Acute Radiation Syndrome, pending the successful development and clinical trial testing of the drugs. The RFP was withdrawn in March 2007 when it was determined that none of the products put forward by responding vendors could meet the requirements for a BioShield acquisition. The Department will continue to pursue the development of ARS countermeasures, and expects to leverage new authorities granted under the Pandemic and All-Hazards Preparedness Act when it issues a new RFP this year. Funding for this as well as the bio-dosimetry, radionuclide bioassay, and radionuclide-specific countermeasures research and development projects will come from the BioShield Special Reserve Fund and the Strategic National Stockpile (SNS) budget.

V. Conclusions

The nuclear and radiological security market exhibits several of the dynamics that we have observed in the larger homeland security market (see Civitas Group's *Homeland Security Market: Essential Dynamics and Trends*, November 2006). Namely:

- Centrality of government policy – Federal policy is a major factor across all segments of the market, driving major government procurement programs, funding for research and development projects, and private sector spending as a result of regulations.
- Innovation – DNDO's Advanced Nuclear Detection Architecture programs are an example of the government's demand for improved capabilities driving innovative and dynamic research and development. If successful, these massive spiral development programs will spur the private sector to develop detection technologies that are far beyond current capabilities, and that begin to meet the real needs of both the government (to accurately detect threats) and the private sector (to minimize the impact on the flow of commerce).
- System integration – In order to achieve a truly layered and robust nuclear detection capability, radiation sensors must be integrated with other operational processes and systems, particularly those which assess risk (e.g. CBP's Automated Targeting System, which assesses the risk of cargo based on a number of factors). The integrated system pilot programs mandated by the FY 2007 Appropriations Act indicates continued government interest in and movement towards integrated systems.
- Customer fragmentation – while there are pockets of centralization developing within the federal government in order to manage specific capabilities (e.g. DNDO), responsibility for various aspects of nuclear and radiological security is very diffuse.

Overall, this is a large and attractive market with a potential for significant growth. While many segments are fairly mature, most notably the protection of critical infrastructure such as nuclear power plants, the continued federal policy focus on preventing the real and growing threat of nuclear and radiological terrorism will translate to significant opportunities for the private sector. The federal government will continue to engage the private sector to develop new and innovative technologies and integrated systems to close current capability gaps, as well as to address emerging threats as they arise.

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