# DRAFT Environmental Assessment for a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

**November 2009**

**U.S. Customs and Border Protection**

**DEPARTMENT OF HOMELAND SECURITY**
**U.S. CUSTOMS AND BORDER PROTECTION**
**OFFICE OF INFORMATION AND TECHNOLOGY**
**LABORATORIES AND SCIENTIFIC SERVICES**
**INTERDICTION TECHNOLOGY BRANCH**

**DRAFT**

# Environmental Assessment for a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

## DEPARTMENT OF HOMELAND SECURITY
## U.S. CUSTOMS AND BORDER PROTECTION
## OFFICE OF INFORMATION AND TECHNOLOGY
## LABORATORIES AND SCIENTIFIC SERVICES
## INTERDICTION TECHNOLOGY BRANCH

**November 2009**

---


Lead Agency: U.S. Department of Homeland Security
U.S. Customs and Border Protection
Office of Information and Technology
Laboratories and Scientific Services
Interdiction Technology Branch
1300 Pennsylvania Ave., N.W.
Washington, DC 20229

Point of Contact: Sharon Sharp-Harrison
Office of Information and Technology
Laboratories and Scientific Services
Interdiction Technology Branch
1300 Pennsylvania Avenue NW, Suite 1575
Washington, DC 20229

U.S. Department of Homeland Security
Washington, DC 20229

U.S. Customs and
Border Protection

November 5, 2009

Subject: Notice of Availability of the Draft Environmental Assessment Establishing a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

Dear Reader,

The U.S. Customs and Border Protection (CBP), Office of Information and Technology (OIT), Laboratories and Scientific Services (LSS), Interdiction Technology Branch (ITB) has prepared a Draft Environmental Assessment (DEA) to address the potential effects of establishing a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico.

The purpose of the Proposed Action is to enable CBP to conduct non-intrusive inspections of high-density cargo containers for contraband such as illicit drugs, currency, guns, and weapons of mass destruction.

The DEA will be available for a 30-day review beginning November 20 and ending December 21, 2009. The DEA is available during the review period at the San Juan Community Library, Avenida Apolo & Calle Topacio, San Juan, PR, 00969. The DEA can be obtained from Organizational Strategies, Inc., 1436 S Legend Hills Dr, Ste 140, Clearfield, UT 84015, telephone (801) 773-6459, facsimile (801) 525-1175. The DEA can also be viewed and downloaded via the internet at the following address: http://aerc.swf.usace.army.mil/Pages/Publicreview.cfm.

Comments must be postmarked, e-mailed or faxed by December 21, 2009 to ensure that they receive full consideration. Please address all comments to the attention of Mr. Gary Armstrong of Organizational Strategies, Inc. at the above address or facsimile number.

# Executive Summary

## Introduction

This Environmental Assessment (EA) addresses the potential environmental effects, beneficial and adverse, of the fielding and operation of one High Energy Mobile X-Ray Inspection System (HEMXRIS) by the United States (U.S.) Customs and Border Protection (CBP) at the Port of San Juan, San Juan County, Puerto Rico. This EA satisfies the requirements specified in the National Environmental Policy Act of 1969 (NEPA) as amended, the Council on Environmental Quality regulations implementing NEPA (40 CFR 1500-1508), and Department of Homeland Security Procedures Relating to the Implementation of the National Environmental Policy Act (71 FR 16790-16820, April 4, 2006). NEPA requires CBP and other federal agencies to fully understand, and take into consideration during decision making, the environmental consequences of proposed federal actions.

HEMXRISs, which are part of a comprehensive mix of technologies designed to complement one another and present a layered defense to smuggling attempts, allow CBP officers to inspect for contraband without having to physically enter into or unload cargo containers. Congressionally funded and directed, the systems fulfill Non-Intrusive Inspection (NII) technology requirements found in:

(1) the Office of National Drug Control Policy (ONDCP) *National Drug Control Strategy*;
(2) the ONDCP *Ten Year Counterdrug Technology Plan and Development Roadmap*;
(3) the CBP *Container Security Initiative*;
(4) National Security Presidential Directive – 17/Homeland Security Presidential Directive; 4 *National Strategy to Combat Weapons of Mass Destruction*;
(5) National Security Presidential Directive – 43/Homeland Security Presidential Directive – 14 *Domestic Nuclear Detection*;
(6) *U.S. Customs and Border Protection 2005-2010 Strategic Plan;* and
(7) the *Security and Accountability For Every Port Act of 2006*.

## Purpose and Need

The purpose for the Proposed Action is to perform NIIs of high-density cargo containers for contraband such as illicit drugs, currency, guns, and weapons of mass destruction. Selection and deployment of NII equipment at ports is based on the following criteria: size of the port and of the equipment, budget, schedule, mission requirements and cost.

The need of the Proposed Action is to assist in fulfilling the requirement for the 100% scanning of containers entering the U.S. as directed in the Security and Accountability For Every (SAFE) Port Act of 2006 (H.R. 4954). Because of the sheer volume of sea container traffic and the opportunities it presents for terrorists, containerized shipping is uniquely vulnerable to terrorist attack. During 2007, the Port of San Juan was ranked as the 12th busiest container port in North America, having 712,747 containers pass the port during that year (AAPA 2008).

## Proposed Action and Alternatives Considered

Under NEPA, the proponent for an action is responsible for considering a reasonable range of alternatives that could accomplish the agency's objectives. If alternatives were eliminated from detailed study, reasons for their elimination must be briefly discussed.

Two alternatives were evaluated based upon their ability to provide the required operational capacities identified in the purpose and need statement. The two alternatives considered were:

1. Fielding and Operation of a HEMXRIS
2. The No-Action Alternative

Fielding and operation of the HEMXRIS was chosen as the preferred alternative and is presented as the Proposed Action.

## Proposed Action

The Proposed Action consists of the fielding and operation of one HEMXRIS at the Port of San Juan for the purpose of conducting NIIs of high-density cargo containers. The model chosen by CBP for deployment is the Heimann Cargo Vision Mobile (HCVM). This decision was based on the manufacturer's ability to satisfy specification requirements for the penetration of high density cargo, budget, and deadline schedules. The system will be moved to any developed area of the terminals suitable for conducting inspections as required. The system is discussed in section 1.5. There is no additional construction or infrastructure required for the operation or storage of the system.

## No Action Alternative

The No Action Alternative is to continue to inspect cargo containers entering the U.S. at the Port of San Juan with existing equipment and methods. This inspection process involves visual and manual inspections with a limited number of tools such as alternative NII technology. This approach is not as efficient and effective at detecting the range of materials that could be detected with HEMXRISs in addition to current inspection techniques. Furthermore, it would not reduce the need for CBP officers to enter potentially dangerous situations to carry out these inspections. The No Action Alternative does not meet the purpose and need, however it serves as a basis of comparison to the Proposed Action.

## Other Alternatives Considered

Three additional alternatives were initially evaluated to determine whether they could fulfill the purpose and need of the Proposed Action, which is to support CBP's mission by providing the capability to inspect high density cargoes and containers.

3. Mid-Energy X-Ray Inspections Systems
4. Gamma Imaging Inspection Systems
5. Conducting inspection of containers at a dedicated cargo inspection facility at another location other than the marine terminals.

Alternatives 3 and 4 were dismissed from further consideration because they failed to meet the required functional capability of penetrating high-density cargo and containers. Alternative 5 was not carried forward for analysis in this EA because it conflicted with legal requirements of the SAFE Port Act. A more detailed discussion of these alternatives and the reasons why they were not analyzed is presented in Chapter 2.

## Environmental Consequences of the Proposed Action and Alternatives

This EA documents that the Proposed Action will result in no significant environmental impacts, direct, indirect, cumulative or otherwise.

The Port of San Juan is located in the metropolitan area of San Juan, Puerto Rico. The port is composed of a total of sixteen piers, of which eight are used for passenger ships and eight for cargo ships. The port facilities are located along San Antonio Canal, a narrow navigable section of San Juan Bay lying south of Old San Juan and San Juan island.

**Climate** – The HEMXRIS engine and onboard generator, as well as cargo-moving equipment, will emit small amounts of air pollutants and greenhouse gases as a result of the Proposed Action. Analysis presented in this EA has established that these emissions will be *de minimis*, as defined by the Clean Air Act. Accordingly, effects on the climate are expected to be negligible.

**Geology and Soils** – No construction or excavation is required for the Proposed Action. Scattered X-radiation will not contaminate soils because it is energy that dissipates as soon as the source is turned off, just as a room becomes dark as soon as the light switch is turned off. The system is mobile and can be moved as needed. No direct impacts to geology and soils would occur from the implementation of the Proposed Action.

**Hydrology and Water Quality** – The Proposed Action will not affect hydrology, water resources or water quality.

**Floodplains** – The Proposed Action will not result in any floodplain loss, adverse impacts to human safety, health, and welfare, or adverse impacts to the natural and beneficial values served by floodplains. HEMXRIS are mobile units that can be moved away from floodplains in the event of flooding or other natural disasters.

**Wetlands** – The Proposed Action will occur on previously paved surfaces and will not impact any wetlands.

**Coastal Zone** – The port is located in the Puerto Rico Coastal Zone. The Proposed Action is consistent with current actions at the port. No coastal zone resources will be adversely affected by the Proposed Action. Correspondence related to this determination is included in Appendix A.

**Vegetation and Wildlife** – The Proposed Action will occur on previously paved surfaces and will be consistent with current actions at the port. No vegetation or wildlife will be impacted by the Proposed Action.

**Threatened and Endangered Species** – The Proposed Action will take place in paved, industrial areas where suitable wildlife habitat and species do not exist. Therefore the Proposed Action will have no effect on threatened or endangered species. Correspondence related to this determination is included in Appendix A.

**Air Quality** – All estimated emission levels from the activities associated with the Proposed Action are below the tons/year *de minimis* threshold values applicable to nonattainment and maintenance areas for all pollutants as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause an exceedance of any National Ambient Air Quality Standard (NAAQS) for criteria pollutants. The Proposed Action will not conflict with conformity requirements of section 176 of the Clean Air Act for federal actions or any approved State Implementation Plan (SIP). The Proposed Action will not have a significant impact on local or regional air quality within the context of the Clean Air Act, NEPA or applicable state, or local environmental laws and regulations (see section 3.2 and Appendix B).

**Noise** – The Proposed Action is consistent with current actions at the port and will not measurably change the existing noise environment or violate any noise ordinances. As a result, the Proposed Action will not have a significant noise impact.

**Land Use and Zoning** – The Proposed Action is consistent with current actions at the port and will not impact land use or zoning.

**Aesthetics and Visual Resources** – The Proposed Action would not obscure or result in abrupt changes to the complexity of the landscape and skyline when viewed from points readily accessible to the public. No long-term change to the character of the area would occur as a result of the Proposed Action.

**Infrastructure and Utilities** – The port has pre-existing water and electrical services. The Proposed Action will not impact the infrastructure and utility services of the port.

**Traffic and Transportation** – During the planning process for each NII system and prior to deployment, site surveys are conducted, and coordinations with the appropriate stakeholders are made to ensure that the placement and operation of systems are integrated with port traffic patterns and facilities to minimize delays to legitimate transportation.

**Waste Management** – Wastes associated with the Proposed Action are used oil and lubricants for the operation and maintenance of the HEMXRIS. These will be accumulated and stored in compliance with applicable regulations at or near the point of generation and recycled by a licensed used oil recycler. 40 CFR Part 279 exempts used oil and lubricants from regulation as a hazardous waste if they are recycled and not mixed with any other hazardous wastes. It is not anticipated that the operation and maintenance of the system will generate amounts of hazardous wastes that would have any affect on the port's current generator status. There is no radioactive source or byproduct material used in the system, therefore there is no risk of a release of radioactive materials.

If a system or system component is replaced or decommissioned, the handling, storage, use, transfer, and disposal of all materials will comply with all applicable federal, state, or local environmental laws and regulations. This will prevent human exposure and releases to the environment of any hazardous material that could potentially be within the systems.

**Historical and Archeological (Cultural) Resources** – The HEMXRIS will be operated in an industrial setting and will not have an impact on sites that are listed on, or potentially eligible for listing on, the National Register of Historic Places. There is no construction or excavation related to the Proposed Action. If, in the course of deploying and operating the system CBP discovers that historical or archeological resources could be impacted, then project operations will be suspended and the appropriate authorities will be consulted. Implementing the Proposed Action will not have a significant impact on cultural or historic resources. Correspondence related to this determination is included in Appendix A.

**Socioeconomics** – The Proposed Action will not affect employment, housing or demographics. Implementation of the Proposed Action may produce indirect socioeconomic effects by deterring the movement of illicit drugs, explosives, firearms, or other contraband into the U.S. Similar indirect effects could result if the Proposed Action led to the apprehension of criminals or terrorists attempting to enter the U.S. Such effects, however, are only theoretical and will not be further evaluated in this document.

**Environmental Justice** – Implementation of the Proposed Action is not expected to have any negative or disproportionate effects on minority and low income populations or children.

**Transboundary Impacts –** The port is not located adjacent to any international borders and potential environmental effects from the Proposed Action will not extend beyond the territory of the U.S.

**Irreversible and Irretrievable Commitment of Resources** – The irreversible and irretrievable commitment of resources associated with the Proposed Action will be the procurement of the HEMXRIS, materials, utilities, labor and time expended in the operation of the system. No sensitive environmental resources will be lost or permanently altered due to the Proposed Action.

**Radiological Health and Safety** – While the use of any NII screening system must be evaluated to ensure that there are no adverse impacts to the health and safety of the public, CBP officers, and port employees, HEMXRISs are designed and operated to avoid these impacts. As promulgated by the Nuclear Regulatory Commission (NRC) in 10 CFR Part 20, the maximum permissible level of radiation dose to the general public is 0.1 rem in a year. As discussed in section 3.3, CBP will use this protective limit for the public and CBP employees and other port workers.

The term "rem" is an abbreviation for "roentgen equivalent man" and is a special unit used for expressing dose equivalent[1]. Some types of radiation produce greater biological effects for the same amount of energy imparted than other types. The rem is a unit that relates the dose of absorbed radiation to the biological effect of that dose on human tissues and organs. (See section 3.3 and Appendices C & D for additional analysis and information on radiation exposure).

***HEMXRIS Occupants* –** HEMXRISs are designed so that the radiation dose levels within the driver's cab and at the inspector work-stations (systems operators) will be below 0.00005 rem in any one hour. With an annual work limit of 2,000 hours, this hourly dose limit will prevent annual cumulative exposures that exceed the limit of 0.1 rem in a year.

Detailed radiation surveys, performed by or under the supervision of the CBP Radiation Safety Office, have confirmed that these design and exposure criteria have been met. In all cases, exposures were measured using a "worst-case" scatter in the X-ray beam. Since such a worst-case scatter scenario is not likely to occur, these estimated exposure levels are conservative by a substantial amount. As an additional precaution, as the systems are delivered, exposure measurements will be made in the cabs and work-station areas to ensure that the systems are in compliance with exposure limits.

***CBP Officers and Port Employees*** – Due to the nature of their work, CBP officers and port employees who work around HEMXRISs have the potential to be "occupationally exposed"[2] to radiation. The NRC and the Occupational Safety and Health Administration (OSHA) allow a higher permissible exposure level ("occupational dose") for radiation workers in restricted areas (5 rem in a year).

CBP uses the general public protection standard of 0.1 rem in a year as the maximum permissible level of radiation dose for CBP officers and port employees. This standard is

[1] rem is often expressed as mrem (millirem, or thousandths of a rem) or µrem (microrem, or millionths). For the sake of consistency, this document will use the notation "rem."
[2] As defined by the International Commission on Radiological Protection (ICRP) (ICRP 2007)

50 times more stringent than occupational dose limits established by the NRC and OSHA for radiation workers. The radiation dose from HEMXRISs will be no more than 0.00005 rem in any one hour since personnel will stand behind a marker delineating a "controlled area."

An analysis of potential exposure was based on 2,000 work hours per year as the maximum exposure time. This assumes that an individual spends all of a forty-hour work week, every week of the year, standing at the boundary of a system's controlled area. Even under those circumstances, neither CBP officers, port employees nor the public will receive a cumulative dose greater than the NRC limit for protecting the general public.

***Controlled Areas –*** To meet the threshold radiation dose limit, CBP establishes controlled areas for HEMXRISs. No personnel are allowed in the controlled areas during scanning operations. The HCVM has two operational settings: 3.8 MeV and 4.2 MeV, with each operational setting having a specific controlled area which must be maintained during operation. System modes of operation are set based on the density of the walls of the containers scanned. In the event images are not acquired from an initial scan with the system set at 3.8 MeV, the HCVM can be operated at 4.2 MeV to obtain data from denser containers.

When operating at 3.8 MeV, the safe operating dimensions of the controlled area are 110 feet in length and 82 feet in width, as depicted in Figure 3. When operating at 4.2 MeV the safe operating dimensions for the controlled area are 135 feet in length and 133 feet in width, as depicted in Figure 4.

In the extreme, with respect to radiation exposure, a system operator (or a member of the general public) could be situated at the edge of the controlled area 8 hours a day, every workday of the year (that is to say, 2,000 hours per year) and not receive more exposure than the limits prescribed by the NRC. The controlled areas ensure that the systems conform to the radiation protection guidelines of reducing the radiation levels to As Low as is Reasonably Achievable (ALARA).

Controlled areas are calculated and verified for each NII system and are designed to provide adequate separation from other NII operating areas, adjacent structures, work areas and traffic flows to protect workers, the general public and occupants of adjacent buildings. Controlled area dimensions may be adjusted when needed by using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit of 0.00005 rem in any one hour limit and 0.1 rem per year.

***Effects of Irradiation on Food –*** The Food and Drug Administration (FDA) at 21 CFR 179.21 requires a label be affixed to each machine stating that no food shall be exposed to X-ray radiation sources to receive an absorbed dose in excess of 50 rem. The CBP Radiation Safety Office conducted tests to determine the worst-case scenario of radiation doses to food as a result of implementing the Proposed Action. The HEMXRIS absorbed dose is 37,037 times less than this limit. Based on these measurements and compliance with the provisions of 21 CFR 179.21 it is concluded that radiation from the Proposed Action will have no significant impact on food that may be located in scanned containers.

***Effects of Irradiation on Persons Hiding in Cargo Containers –*** It is possible that people will hide themselves in cargo containers in order to surreptitiously enter the U.S. A person concealed in a cargo container that is scanned by a HEMXRIS will be exposed to radiation as a direct consequence of the inspection process. The total absorbed dose to persons hiding in cargo containers subjected to scanning by a system operating at 4.2 MeV (worst case) is approximately 0.00135 rem per scan, on the same order of that received by food. This dose is 266 times less than the average annual background dose in the U.S. of 0.360 rem and 74 times below levels permissible to the general public.

Assuming 0.00135 rem per scan, to reach the maximum allowable "in a year" radiation dose, a person would have to be scanned 74 times in a year. Since the chance of this frequency of exposure is remote, it is concluded that radiation from HEMXRISs will not have a significant impact on persons located in scanned cargo containers.

Analysis and testing for this environmental assessment shows that exposures are expected to be well below the maximum levels of exposure set by the NRC, OSHA and the FDA to protect the general public (which includes system operators, truck drivers, port personnel and other CBP personnel); therefore, the health and safety impacts from radiological exposure for the Proposed Action were found to not be significant. See section 3.3 for further discussion of radiological health and safety.

## Summary of Best Management Practices and Mitigation Actions Planned

**Best Management Practices for Air –** The emission estimates prepared for this EA were based on the assumption that HEMXRIS vehicles and generators would be idling for 16 hours per day. In practice, to reduce emissions from the Proposed Action, cargo container handling equipment waiting for the inspection of containers by the systems will comply with all applicable federal, state, or local environmental laws and regulations regarding the control of idling times. The systems are vehicle mounted, where the X-radiation equipment is installed on 2006-2007 model vehicles which meet the Best Available Control Technology as defined by the U.S. Environmental Protection Agency (EPA).

**Best Management Practices for Wastes** – Petroleum, oils, and lubricants will be stored, handled, and disposed of in compliance with applicable laws and regulations. Procedures for the safe refueling of HEMXRISs and for the containment and clean-up of potential spills will be in accordance with existing port procedures for preventing and controlling releases. CBP personnel will be trained in spill prevention and countermeasures as required by the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §6901, *et seq*.) and the Oil Pollution Act of 1990 (OPA) (33 U.S.C §2701 *et seq.*)

HEMXRISs might contain materials that could be hazardous if the materials are handled improperly. An example of such a material would be lead metal, which is used for radiation shielding. As a system component, the lead will be innocuous and will provide a protective function from ionizing radiation.

As a CBP asset, all materials within the systems will be in use for their intended purpose, under the supervision of appropriately trained personnel. Under this scenario, there is no hazard to the human environment because the materials will be contained within the systems as functional components of the systems.

In the event of an accident, hazardous materials would not be expected to cause any significant harm to the human environment, because the amount of materials is small, and most materials will be in solid form which is readily contained and recovered. Accident response procedures are in place at the port to contain and remove fluids such as lubricants and fuel.

The most important action to ensure that hazardous materials have no significant effect on the human environment will be upon the replacement or decommissioning of a component or system. Appropriate disposition will depend upon type and quantity of materials involved and the applicable regulations. If a component is replaced or decommissioned, the handling, storage, use, transfer, and disposal of all materials will comply with all applicable federal, state, or local environmental laws and regulations. This will prevent human exposure and releases to the environment of any hazardous material.

**Best Management Practices and Mitigation Measures for Radiological Health and Safety –** Best management practices for radiological health and safety include but are not limited to:

- Incorporation of safety warnings and precautions into technical manuals and operator manuals.
- Training of operators and screening operations supervisors in the hazards associated with radiation producing equipment.
- Incorporation of emergency stop buttons on the equipment that allow the system, including X-ray production, to be quickly shut down if necessary.
- Training operators and screening operations supervisors in the location and use of emergency stop buttons.
- The establishment of radiation controlled areas during screening operations.

The combination of these precautions will ensure that the cumulative radiation dose to officers and the general public will not exceed 0.00005 rem in any one hour or 0.1 rem per year.

## Cumulative Impacts

Cumulative impact is defined by the Council on Environmental Quality in 40 CFR 1508.7 as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The following relevant issues were analyzed for potential cumulative effects.

**Air Quality**

Emissions estimates for proposed and existing NII operations are (tons per year): 8.27 nitrogen oxides, 1.09 volatile organic compounds, 5.85 carbon monoxide, 0.522 $PM_{10}$ and 0.480 $PM_{2.5}$. These cumulative emissions estimates are below the tons/year *de minimis* threshold values applicable to nonattainment and maintenance areas as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause significant, cumulative, air quality impacts (see section 3.2 and Appendix B).

**Radiological Health and Safety**

Aside from NII equipment operated or proposed by CBP, there is no other known NII equipment at the port that could combine with the proposed action and cause a significant cumulative effect. NII equipment has little potential to create cumulative health impacts under normal operating conditions when they are used for their intended purpose by qualified personnel under the supervision of a radiation safety officer in accordance with applicable heath and safety regulations.

Controlled areas are calculated and verified for each NII system and are designed to provide adequate separation from other NII operating areas, adjacent structures, work areas and traffic flows to protect workers, the general public and occupants of adjacent buildings. Limiting access to the controlled areas ensures that the public (which includes system operators and port personnel) are not exposed to radiation levels exceeding those prescribed by applicable regulations (see Appendix C and Appendix D). In the event that other NII technologies are present or planned for operation at the port, CBP will ensure that controlled areas for each technology are adequately designated and do not overlap with one another.

The HEMXRIS and associated controlled area will occupy a maximum of 17,955 square feet of space on the port during operations (this includes the deployed system and necessary controlled area). The placement of this system combines with placement of other proposed and existing NII systems to occupy a total maximum (if all NII systems operate simultaneously) of 20,555 square feet of port space. The port has adequate space to accommodate the proposed NII system and existing and planned systems.

## Findings and Conclusions

The evaluation of the Proposed Action, fielding and operation of one HEMXRIS at the Port of San Juan, demonstrates that there will be no significant, adverse effects on the human environment as long as identified best management practices and mitigation measures are followed. Therefore, no further environmental impact analysis is warranted.

# Table of Contents

## List of Figures



## List of Tables

# 1 Introduction

This Environmental Assessment (EA) addresses the potential environmental effects, beneficial and adverse, of the fielding and operation of one High Energy Mobile X-Ray Inspection System (HEMXRIS) by the United States (U.S.) Customs and Border Protection (CBP) at the Port of San Juan, San Juan County, Puerto Rico. This EA satisfies the requirements specified in the National Environmental Policy Act of 1969 (NEPA) as amended, the Council on Environmental Quality regulations implementing NEPA (40 CFR 1500-1508), and Department of Homeland Security Procedures Relating to the Implementation of the National Environmental Policy Act (71 FR 16790-16820, April 4, 2006). NEPA requires CBP and other federal agencies to fully understand, and take into consideration during decision making, the environmental consequences of proposed federal actions.

HEMXRISs, which are part of a comprehensive mix of technologies designed to complement one another and present a layered defense to smuggling attempts, allow CBP officers to inspect for contraband without having to physically enter into or unload cargo containers. Congressionally funded and directed, the systems fulfill Non-Intrusive Inspection (NII) technology requirements found in:

(1) the Office of National Drug Control Policy (ONDCP) *National Drug Control Strategy*;
(2) the ONDCP *Ten Year Counterdrug Technology Plan and Development Roadmap*;
(3) the CBP *Container Security Initiative*;
(4) National Security Presidential Directive – 17/Homeland Security Presidential Directive; 4 *National Strategy to Combat Weapons of Mass Destruction*;
(5) National Security Presidential Directive – 43/Homeland Security Presidential Directive – 14 *Domestic Nuclear Detection*;
(6) *U.S. Customs and Border Protection 2005-2010 Strategic Plan;* and
(7) the *Security and Accountability For Every Port Act of 2006*.

## 1.1 Background

DHS was established in the aftermath of the terrorist attacks of September 11, 2001. The following elements are central to the mission of the department:

AWARENESS – Identify and understand threats, assess vulnerabilities, determine potential impacts, and disseminate timely information to our homeland security partners and the American public.

PREVENTION – Detect, deter, and mitigate threats to our homeland.

PROTECTION – Safeguard our people and their freedoms, critical infrastructure, property, and the economy of our Nation from acts of terrorism, natural disasters, or other emergencies.

> RESPONSE – Lead, manage, and coordinate the national response to acts of terrorism, natural disasters, or other emergencies.
>
> RECOVERY – Lead national, state, local, and private sector efforts to restore services and rebuild communities after acts of terrorism, natural disasters, or other emergencies.
>
> SERVICE – Serve the public effectively by facilitating lawful trade, travel, and immigration.
>
> ORGANIZATIONAL EXCELLENCE – Value our most important resource, our people. Create a culture that promotes a common identity, innovation, mutual respect, accountability and teamwork to achieve efficiencies, effectiveness, and operational synergies.

On March 1, 2003, the Immigration and Naturalization Service (INS) ceased to exist, U.S. Customs was renamed CBP and various border functions from INS and the Department of Agriculture were transferred to CBP. As the single, unified border agency, CBP's mission is vital to the protection of America and the American people. CBP's priority mission is preventing terrorists and terrorist weapons from entering the U.S., while also facilitating the flow of legitimate trade and travel. In performing its mission, CBP intercepts large quantities of contraband at the seaports and ports of entry. In Fiscal Year 2007 alone, a total of 2,786,137 pounds of marijuana, 281,371 pounds of cocaine, 3,248 pounds of methamphetamine, and 2,167 pounds of heroin were seized nationally by CBP (CBP 2007).

To improve the inspection process, CBP continuously seeks technological solutions that are safe for both humans and the environment and are cost effective. One method of conducting inspections used by CBP involves the use of NII technology, which uses X-ray or gamma radiation sources to "see" into cargo containers to identify potential contraband as well as persons attempting to illegally enter the country by hiding within a cargo container. These NII technologies can perform effective, rapid inspections without having to physically enter into or unload cargo containers, thereby reducing the risks for CBP officers.

At ports of entry, CBP's Office of Field Operations (OFO) secures the flow of people and cargo into and out of the country, while facilitating legitimate travel and trade. OFO's Strategic Plan, *Securing America's Borders at Ports of Entry, Office of Field Operations Strategic Plan FY 2007–2011*, defines CBP's national strategy for securing America's borders specifically at ports of entry. OFO's strategic plan includes a mission statement that fully supports the CBP mission statement, but narrows the scope to ports of entry: *"Ports of entry are America's gateways. At ports of entry, CBP prevents entry of people and goods that are prohibited or threaten our citizens, infrastructure, resources, and food supply, while efficiently facilitating legitimate trade and travel."*

HEMXRISs directly support the four elements outlined below in the operational vision for secure borders at the ports of entry. The successful combination of these elements creates ports of entry where only lawful border crossers and legitimate goods are allowed to enter the U.S.:

**Deterrence** – Potential violators are unwilling to attempt to enter the country through the ports of entry.
**Interception** – Dangerous and inadmissible people and goods are detected and prevented from entry.
**Facilitation** – Known low-risk people and goods are separated from those of higher risk and moved quickly and securely through the port.
**Consistency** – Violators have an equal risk of detection and prevention regardless of mode of transportation or port of entry.

## 1.2 Purpose and Need

The purpose for the Proposed Action is to perform NIIs of high-density cargo containers for contraband such as illicit drugs, currency, guns, and weapons of mass destruction. Selection and deployment of NII equipment at ports is based on the following criteria: size of the port and of the equipment, budget, schedule, mission requirements and cost.

The need of the Proposed Action is to assist in fulfilling the requirement for the 100% scanning of containers entering the U.S. as directed in the Security and Accountability For Every (SAFE) Port Act of 2006 (H.R. 4954). Because of the sheer volume of sea container traffic and the opportunities it presents for terrorists, containerized shipping is uniquely vulnerable to terrorist attack. During 2007, the Port of San Juan was ranked as the 12$^{th}$ busiest container port in North America, having 712,747 containers pass the port during that year (AAPA 2008).

## 1.3 Public Involvement

In keeping with established policy regarding an open decision-making process, this EA and resulting decision document of either a Finding of No Significant Impact (FONSI) or a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) will be made available to agencies and the general public for review and comment. A Notification of Availability (NOA) will be published in applicable local newspapers and copies of the EA made available to the general public at local libraries and the following public review website: http://ecso.swf.usace.army.mil/Pages/Publicreview.cfm.

For further information on the Proposed Action or to request a copy of the EA, please contact Sharon Sharp-Harrison, Branch Director, Office of Information and Technology, Laboratories and Scientific Services, Interdiction Technology Branch, 1300 Pennsylvania Avenue, NW, Suite 1575, Washington, DC 20229.

## 1.4 Framework for Analysis

This EA was prepared in compliance with the National Environmental Policy Act (NEPA), (Public Law 91-190, 42 U.S.C. 4321-4347, as amended), the Council on Environmental Quality regulations for implementing the procedural provisions of NEPA

(40 CFR Parts 1500-1508) and DHS Management Directive 023-01 (formerly 5100.1), "Environmental Planning Program," (April 19, 2006). [See also, 71 Fed. Reg. 16,790 (April 4, 2006).] NEPA directs federal agencies to fully understand and take into consideration during decision-making, the environmental consequences of proposed federal actions. This EA is intended to be a concise public document that provides sufficient evidence and analysis for determining whether to prepare an EIS or a FONSI.

In addition to the evaluation for potential direct and indirect impacts, the Proposed Action was also evaluated for cumulative impacts on the environment as described later in section 4, "Cumulative Impacts," of this EA.

## 1.5 Description of the HEMXRIS

The model chosen by CBP for deployment is the Heimann Cargo Vision Mobile (HCVM). Selection and deployment of this NII equipment was dependent upon the size of the port and of the equipment itself, cost of the equipment, satisfaction of specification requirements, and whether the manufacturer could meet mission deadlines. Representative photographs of the system are shown in figures 1 and 2.

**Figure 1: HCVM (Stowed Configuration)**


Image Source: Smiths Heimann

**Figure 2: HCVM (Deployed Configuration)**

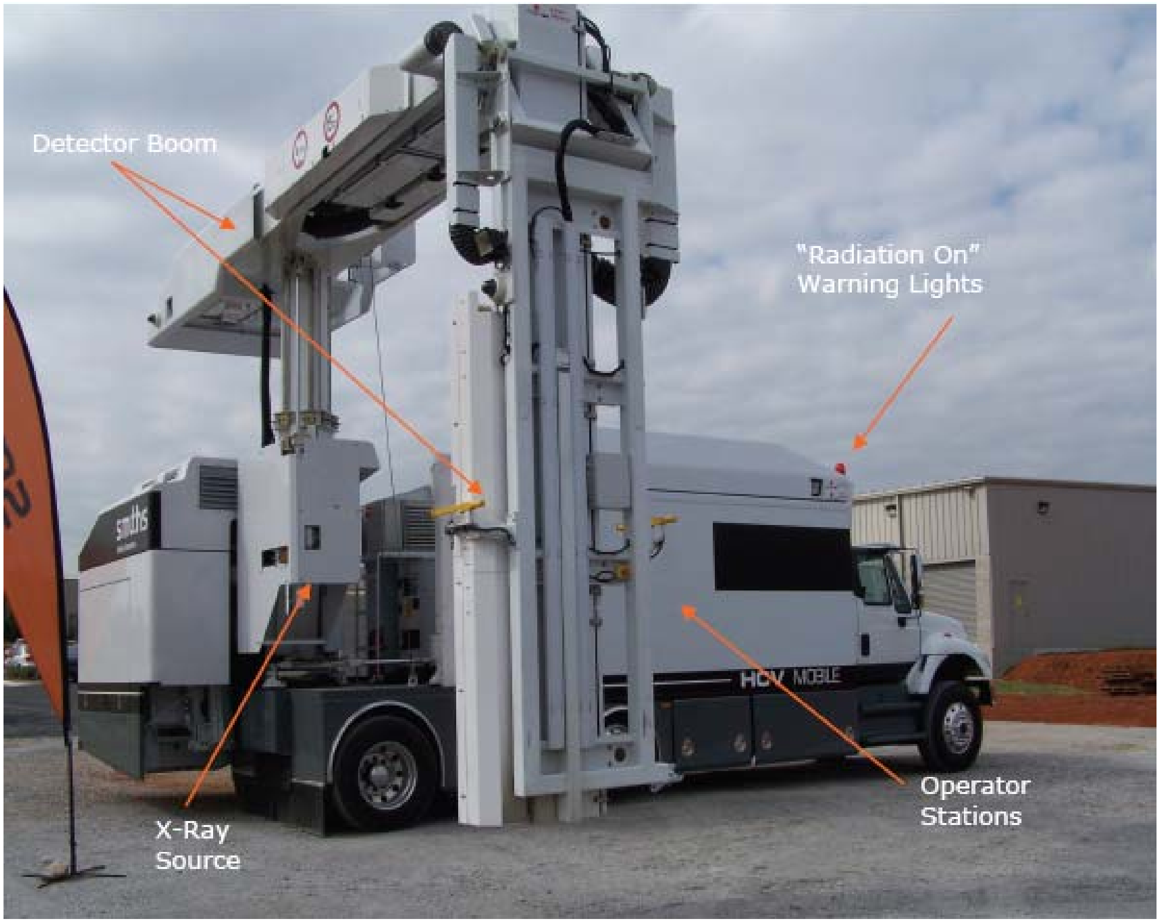



Image Source: CBP

HEMXRISs employ an X-ray source to produce images of tankers, commercial trucks, sea and air containers, and other cargo containers for contraband such as drugs, explosives, and weapons. The systems are able to scan cargo containers in one pass. The systems are mounted on a truck chassis and operated by a three-man crew. The systems operate by slowly driving past a cargo container with the boom extended over the target container. When deployed for scanning operations the HCVM is approximately 18.33 feet high, 29.0 feet wide, and 34.5 feet long. No radiation source material is used to produce images.

### 1.5.1 Detector and Source Boom Assembly

The detection boom is aligned with the X-ray emission subsystem, and when deployed, forms the complete detection subsystem. The detection boom is comprised of an L-shaped detection line made up of a series of detectors that convert the X-ray emissions produced by the accelerator, into an electronic signal. These detectors are placed along the length of a rigid metal structure, which is enclosed in a casing.

### 1.5.2 Imaging System

HEMXRISs utilize a linear accelerator to produce the X-ray emissions to the detector box assembly. An onboard generator provides the electric power supply during scanning operations. Emissions from the generator have been factored into the air quality analysis in section 3.2 and Appendix B

### 1.5.3 Radiation Safety Features

#### 1.5.3.1 Operator Controls and Displays

HEMXRISs are equipped with the operator controls and displays required for scanning targets and for reviewing images acquired from the scan. The X-ray linear accelerator is controlled through these interfaces when performing inspections. An emergency stop button can immediately stop all operations, including X-ray production when activated.

#### 1.5.3.2 Radiation Controlled Area

Controlled Area is defined by 10 CFR 20.1003 as *"an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason."* CBP uses the term "controlled area" rather than "restricted area" as the scanning systems are not in continuous scanning mode. Further, the traditional wording of restricted area has other uses on the port and does not accurately reflect the caution that CBP desires to show the public.

CBP establishes controlled areas around each HEMXRIS which help limit the potential doses to CBP personnel and the public to below 0.00005 rem in any one hour. The dimensions of the controlled areas are established through radiation surveys conducted by the CBP Radiation Safety Office.

The HCVM has two operational settings: 3.8 MeV and 4.2 MeV, with each operational setting having a specific controlled area which must be maintained during operation. System modes of operation are set based on the density of the walls of the containers scanned. In the event images are not acquired from an initial scan with the system set at 3.8 MeV, the HCVM can be operated at 4.2 MeV to obtain data from denser containers.

When operating at 3.8 MeV, the safe operating dimensions of the controlled area are 110 feet in length and 82 feet in width, as depicted in Figure 3. When operating at 4.2 MeV the safe operating dimensions for the controlled area are 135 feet in length and 133 feet in width, as depicted in Figure 4. At the edges of these controlled areas, the radiation dose will not exceed this limit. Based on a limit of 2,000 work hours per year, the 0.00005 rem limit ensures that the cumulative annual radiation dose to workers and the public will not exceed the Nuclear Regulatory Commission's (NRC) public dose limit of 0.1 rem in a year. No personnel will be allowed in the radiation controlled area during scanning operations.

Controlled areas are moving footprints of specified dimensions. During an inspection process, the controlled area will be coincident with the movement of the HEMXRIS. Controlled area dimensions may be adjusted when needed by using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit below 0.00005 rem in any one hour limit and 0.1 rem per year. In the event other NII technologies are present or planned for operation at the port, CBP will ensure that controlled areas for each technology are adequately designated and do not overlap with one another.

During scanning operations, signs in multiple languages are posted at the controlled area boundary indicating the radiation hazard. Ground guides, which are items such as jersey barriers, cones or other items or an individual who provides visual signals to the driver, are positioned at various locations around the controlled area to warn persons of the danger as well as provide visual references to the driver of the HEMXRIS. The system incorporates an infrared safety barrier that stops the forward movement of the inspection system as well as the production of X-rays should the beam barrier be broken.

**Figure 3: HCVM Controlled Area for Operation at 3.8 MeV**

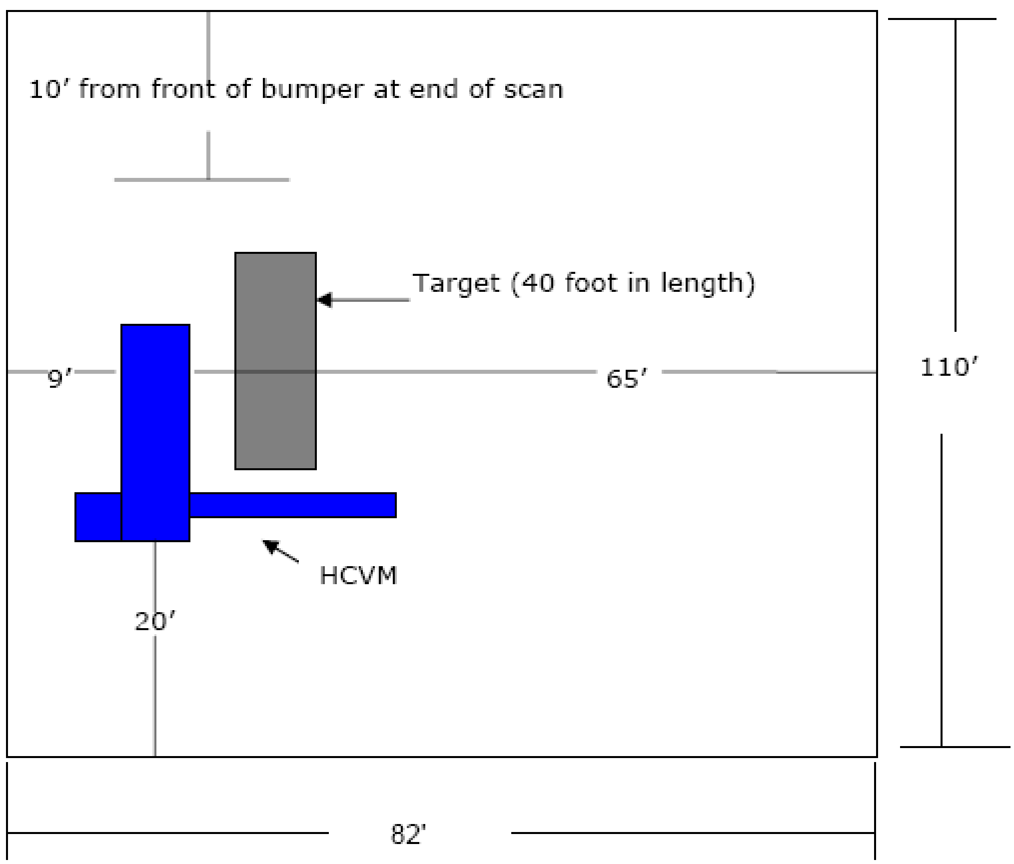
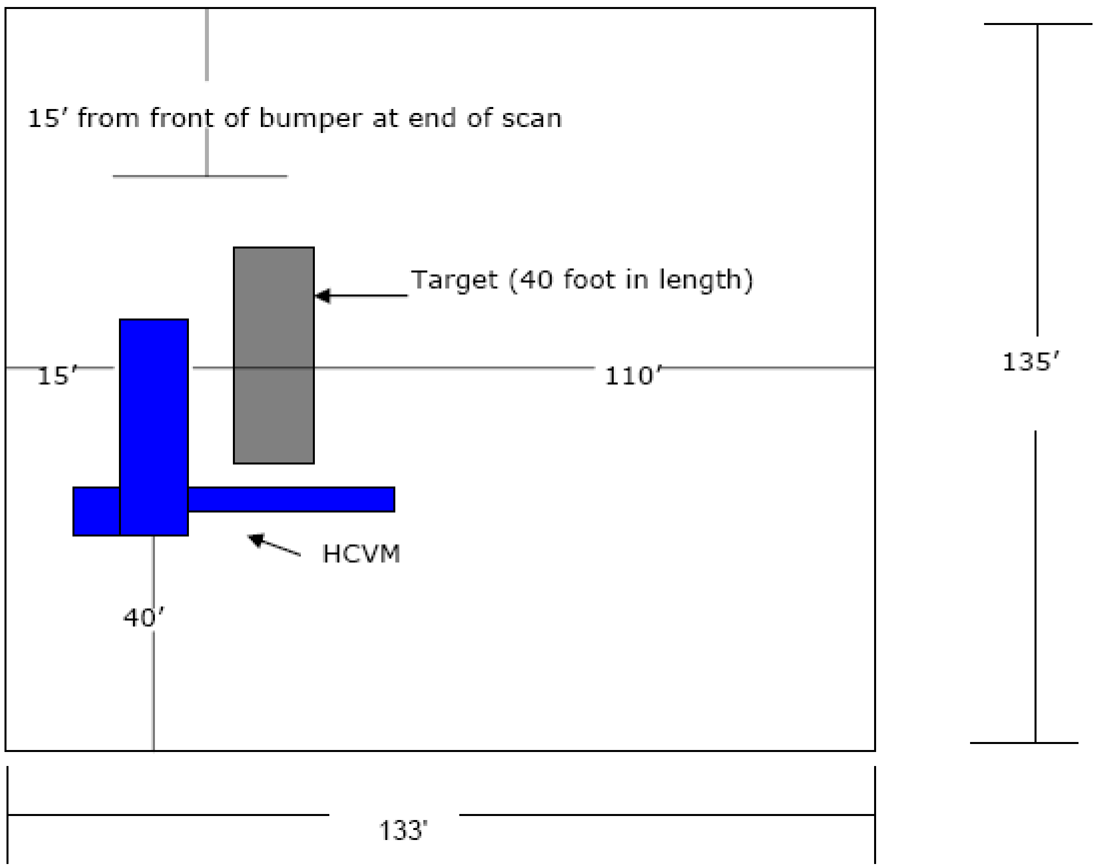


**Figure 4: HCVM Controlled Area for Operation at 4.2 MeV**



# 2 The Proposed Action and Alternatives

Under NEPA, the proponent for an action is responsible for considering a reasonable range of alternatives for achieving a goal or implementing a project or program. This section provides a description of the Proposed Action and alternatives considered in order to identify potentially affected environments and potential impacts to these environments. Two action scenarios were evaluated in the EA.

1. Fielding and Operation of the HEMXRIS
2. The No-Action Alternative

Fielding and Operation of the HEMXRIS was chosen as the preferred alternative and is presented as the Proposed Action, in this EA, along with the No Action Alternative.

## 2.1 Alternative 1 – Proposed Action

The Proposed Action consists of the fielding and operation of one HEMXRIS at the Port of San Juan for the purpose of conducting NIIs of high-density cargo containers. The model chosen by CBP for deployment is the Heimann Cargo Vision Mobile (HCVM). This decision was based on the manufacturer's ability to satisfy specification requirements for the penetration of high density cargo, budget, and deadline schedules. The system will be moved to any developed area of the terminals suitable for conducting inspections as required. The system is discussed in section 1.5. There is no additional construction or infrastructure required for the operation or storage of the system.

## 2.2 Alternative 2 – No Action Alternative

The No Action Alternative is to continue to inspect cargo containers entering the U.S. at the Port of San Juan with existing equipment and methods. This inspection process involves visual and manual inspections with a limited number of tools such as alternative NII technology. This approach is not as efficient and effective at detecting the range of materials that could be detected with HEMXRISs in addition to current inspection techniques. Furthermore, it would not reduce the need for CBP officers to enter potentially dangerous situations to carry out these inspections. The No Action Alternative does not meet the purpose and need, however it serves as a basis of comparison to the Proposed Action.

## 2.3 Other Alternatives Considered

Three additional alternatives were initially evaluated to determine whether they could fulfill the purpose and need of the Proposed Action, which is to support CBP's mission by providing the capability to inspect high density cargoes and containers.

3. Mid-Energy X-Ray Inspections Systems
4. Gamma Imaging Inspection Systems
5. Conducting inspection of containers at a dedicated cargo inspection facility at another location other than the marine terminals.

Alternative (3), Mid-Energy X-Ray Inspection Systems, was not evaluated further in this EA because it does not meet the mission requirement for penetration of high-density cargo. Mid-Energy X-ray systems operate between 0.25 and 2 million electron volts (MeV) of energy and are useful for many inspection needs, but are not capable of imaging high-density cargo and containers. Therefore, it was determined that these systems did not meet the purpose and need of this federal action, and further analysis of this alternative was not undertaken.

Alternative (4), Gamma Imaging Inspection Systems, was dismissed from further consideration for the same reasons as Alternative (3). Gamma imaging systems use ionizing gamma radiation from either radioactive cesium-137 ($^{137}Cs$) or cobalt-60 ($^{60}Co$) to create images of the contents of cargo and containers. These systems are already in use by CBP at a number of ports and ports of entry. However, as with mid-energy X-ray systems, the gamma imaging systems are not capable of penetrating high density cargoes and containers. Therefore, this alternative did not meet the purpose and need of the Proposed Action and was not evaluated further in this EA.

Alternative (5) was not carried forward for detailed analysis due to specific language in the SAFE Port Act requiring the use of non-intrusive imaging equipment in tandem with radiation detection equipment. Additionally, the SAFE Port Act requires that 100 percent of the containers that have been identified as high-risk are scanned before such containers leave a U.S. seaport facility.

# 3 The Affected Environment and Consequences

This section describes the current condition of environmental resources at the Port of San Juan and the possible impacts to these resources from the Proposed Action and No Action Alternative. The descriptions represent baseline conditions for the comparison of changes caused by implementation of the Proposed Action and No Action Alternative. Potential changes or impacts to the resources are described in each section as potential consequences. Cumulative impacts, or impacts attributable to the Proposed Action when combined with other past, present or reasonably foreseeable future impacts regardless of the source, are presented in section 4.

## 3.1 Preliminary Impact Scoping

Table 1 presents the results of the preliminary impact scoping and explains why certain resources were excluded from further discussion. In keeping with the Council on Environmental Quality guidelines (40 CFR 1500.4) on reducing paperwork and focusing the analysis on issues of concern to the public and policymakers, only those environmental resources that could potentially be affected (i.e. those resources that are retained in Table 1) will be discussed in detail.

**Table 1: Preliminary Impact Scoping**

| Resource | Potential for Impact | Retained (Y/N) |
|---|---|---|
| Climate | The HEMXRIS engine and onboard generator, as well as cargo-moving equipment, will emit small amounts of air pollutants and greenhouse gases as a result of the Proposed Action. Analysis presented in this EA has established that these emissions will be *de minimis*, as defined by the Clean Air Act. Accordingly, effects on the climate are expected to be negligible. | N |
| Geology and Soils | No construction or excavation is required for the Proposed Action. Scattered X-radiation will not contaminate soils because it is energy that dissipates as soon as the source is turned off, just as a room becomes dark as soon as the light switch is turned off. The system is mobile and can be moved as needed. No direct impacts to geology and soils would occur from the implementation of the Proposed Action. | N |
| Hydrology and Water Quality | The Proposed Action will not affect hydrology, water resources or water quality. | N |
| Floodplains | The Proposed Action will not result in any floodplain loss, adverse impacts to human safety, health, and welfare, or adverse impacts to the natural and beneficial values served by floodplains. HEMXRIS are mobile units that can be moved away from floodplains in the event of flooding or other natural disasters. | N |

| Resource | Potential for Impact | Retained (Y/N) |
|---|---|---|
| Wetlands | The Proposed Action will occur on previously paved surfaces and will not impact any wetlands. | N |
| Coastal Zone | The port is located in the Puerto Rico Coastal Zone. The Proposed Action is consistent with current actions at the port. No coastal zone resources will be adversely affected by the Proposed Action. Correspondence related to this determination is included in Appendix A. | N |
| Vegetation and Wildlife | The Proposed Action will occur on previously paved surfaces and will be consistent with current actions at the port. No vegetation or wildlife will be impacted by the Proposed Action. | N |
| Threatened and Endangered Species | The Proposed Action will take place in paved, industrial areas where suitable wildlife habitat and species do not exist. Therefore the Proposed Action will have no effect on threatened or endangered species. Correspondence related to this determination is included in Appendix A. | N |
| Air Quality | Air quality impacts associated with the Proposed Action would be limited to localized effects associated with emissions generated by the HEMXRIS and other idling vehicles during operations. Although emission levels are expected to be well below prescribed limits, further evaluation is warranted. See section 3.2 and Appendix B. | Y |
| Noise | The Proposed Action is consistent with current actions at the port and will not measurably change the existing noise environment or violate any noise ordinances. As a result, the Proposed Action will not have a significant noise impact. | N |
| Land Use and Zoning | The Proposed Action is consistent with current land use and zoning practices at the terminal. | N |
| Aesthetics and Visual Resources | The Proposed Action would not obscure or result in abrupt changes to the complexity of the landscape and skyline when viewed from points readily accessible to the public. No long-term change to the character of the area would occur as a result of the Proposed Action. | N |
| Infrastructure/Utilities | The port has pre-existing water and electrical services. The Proposed Action will not impact the infrastructure and utility services of the port. | N |
| Traffic / Transportation | During the planning process for each NII system and prior to deployment, site surveys are conducted, and coordinations with the appropriate stakeholders are made to ensure that the placement and operation of systems are integrated with port traffic patterns and facilities to minimize delays to legitimate transportation. | N |

| Resource | Potential for Impact | Retained (Y/N) |
|---|---|---|
| Waste Management | Wastes associated with the Proposed Action are used oil and lubricants for the operation and maintenance of the HEMXRIS. These will be accumulated and stored in compliance with applicable regulations at or near the point of generation and recycled by a licensed used oil recycler. 40 CFR Part 279 exempts used oil and lubricants from regulation as a hazardous waste if they are recycled and not mixed with any other hazardous wastes. It is not anticipated that the operation and maintenance of the system will generate amounts of hazardous wastes that would have any affect on the port's current generator status. There is no radioactive source or byproduct material used in the system, therefore there is no risk of a release of radioactive materials.<br><br>HEMXRIS might contain materials that could be hazardous if the materials are handled improperly. An example of such a material would be lead metal, which is used for radiation shielding. As a system component, the lead will be innocuous and will provide a protective function from ionizing radiation.<br><br>As a CBP asset, all materials within the systems will be in use for their intended purpose, under the supervision of appropriately trained personnel. Under this scenario, there is no hazard to the human environment because the materials will be contained within the systems as functional components of the systems.<br><br>In the event of an accident, hazardous materials would not be expected to cause any significant harm to the human environment, because the amount of materials is small, and most materials will be in solid form which is readily contained and recovered. Accident response procedures are in place at the port to contain and remove fluids such as lubricants and fuel.<br><br>The most important action to ensure that hazardous materials have no significant effect on the human environment will be upon the replacement or decommissioning of a component or system. Appropriate disposition will depend upon type and quantity of materials involved and the applicable regulations. If a component is replaced or decommissioned, the handling, | N |

| Resource | Potential for Impact | Retained (Y/N) |
|---|---|---|
| | storage, use, transfer, and disposal of all materials will comply with all applicable federal, state, or local environmental laws and regulations. This will prevent human exposure and releases to the environment of any hazardous material. | |
| Historic and Archeological (Cultural) Resources | Activities associated with the Proposed Action are related to operation of the HEMXRIS in an industrial setting and will not have an impact on sites that are listed on, or potentially eligible for listing on, the National Register of Historic Places. There are no known archeological resources within the port associated with the Proposed Action. There is no construction or excavation related to the Proposed Action. Implementing the Proposed Action will not have a significant impact on cultural or historic resources. | N |
| Socioeconomics | The Proposed Action will not affect employment, housing or demographics. Implementation of the Proposed Action may produce indirect socioeconomic effects by deterring the movement of illicit drugs, explosives, firearms, or other contraband into the U.S. Similar indirect effects could result if the Proposed Action led to the apprehension of criminals or terrorists attempting to enter the U.S. Such effects, however, are only theoretical and will not be further evaluated in this document. | N |
| Environmental Justice | Implementation of the Proposed Action will not have any negative effect on minority and low-income populations or children. | N |
| Transboundary Impacts | The port is not located adjacent to any international borders and potential environmental effects from the Proposed Action will not extend beyond the territory of the U.S. | N |
| Irreversible and Irretrievable Commitment of Resources | The irreversible and irretrievable commitment of resources associated with the Proposed Action will be the procurement of the HEMXRIS, materials, utilities, labor and time expended in the operation of the systems. No sensitive environmental resources will be lost or permanently altered due to the Proposed Action. | N |
| Radiological Health and Safety | X-radiation from the HEMXRIS has the potential to impact the health and safety of operators, officers, and the general public. Although exposures are expected to be well below the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) prescribed limits, further evaluation is warranted. | Y |

## 3.2 Air Quality

### 3.2.1 Criteria for Significance

The air quality analysis presented below responds to two separate federal statutes – NEPA, which is the basis of this EA, as well as the Clean Air Act. These two statutes vary considerably in terms of the analysis required as well as the mandated response to potential air quality impacts. Fulfillment of one requirement does not fulfill the other requirement, nor does the exemption of one automatically exempt the other. NEPA requires that agencies evaluate whether there will be significant air quality impacts resulting from their actions, with significance defined in terms of the "context" and "intensity" of impacts.

The Clean Air Act imposes certain duties on federal agencies. In November 1993, the EPA published the General Conformity Final Rule in the Federal Register (EPA 1993). The purpose of the rule is to ensure that all federal actions that take place in a nonattainment area or a maintenance area conform to any existing state implementation plan (SIP) or maintenance plan to protect air quality in the area where the Proposed Action occurs. Conformity to the purpose of the SIP means that the proposed federal action will not cause new air quality violations, worsen existing violations, or delay timely attainment of the relevant national ambient air quality standards (NAAQS or "standards").

Not all federal actions are required to make a formal conformity determination. If an initial review determines that annual emissions resulting from the Proposed Action will not reach certain threshold levels (40 CFR Part 93.153), then there is no obligation to proceed with a formal conformity determination. Additionally, conformity analysis is only required for those criteria pollutants for which the area is in non-attainment.

The applicable regulations for defining "conformity" are cited in 40 CFR Parts 6, 51, and 93. A "federal action" is defined in 40 CFR 93.152 as "any activity engaged in by a department, agency, or instrumentality of the federal government, or any activity that a department, agency or instrumentality of the federal government supports in any way, provides financial assistance for, licenses, permits, or approves, other than activities related to transportation plans, programs, and projects developed, funded, or approved under title 23 U.S.C. or the Federal Transit Act (49 U.S.C.1601 *et seq*.)." The General Conformity Rule is only applicable to non-attainment and maintenance areas.

Air quality impacts resulting from the Proposed Action would be considered significant, within the NEPA context, if the following were to occur:

- The Proposed Action or the No Action Alternative caused an exceedance of one or more of the NAAQS for criteria pollutants within the region of concern.
- The Proposed Action or the No Action Alternative is not in conformity with section 176 of the Clean Air Act for federal actions or an approved SIP.

### 3.2.2 Baseline Environment

San Juan County, Puerto Rico is in attainment area for all criteria pollutants (EPA 2008a).

### 3.2.3 Potential Consequences

#### 3.2.3.1 Proposed Action - Fielding and Operation of the HEMXRIS

Minimum emissions will be produced from the HEMXRIS, onboard generator and other idling vehicles during operations. Detailed air quality analysis and emissions estimates for the Proposed Action and cumulative emissions are provided in Appendix B. The estimates for the Proposed Action were based on the following assumptions:

- the HEMXRIS vehicle and generator will be idling for 16 hours per day;
- heavy duty diesel vehicles will be used to move cargo containers and will remain idling during the inspections; and
- the HEMXRIS will process an average of 20 vehicles per hour (i.e. processing time equals 3 minutes per vehicle/cargo container and the system processes 320 vehicles/cargo containers per day).

All estimated emission levels from the activities associated with the Proposed Action are below the tons/year *de minimis* threshold values applicable to nonattainment and maintenance areas for all pollutants as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause an exceedance of any NAAQS for criteria pollutants. The Proposed Action will not conflict with conformity requirements of section 176 of the Clean Air Act for federal actions or any approved SIP. The Proposed Action will not have a significant impact on local or regional air quality within the context of the Clean Air Act, NEPA or applicable state, or local environmental laws and regulations.

##### 3.2.3.1.1 Best Management Practices

To reduce emissions from the Proposed Action, cargo container handling equipment waiting for the inspection of containers by the HEMXRIS will comply with all applicable federal, state, or local environmental laws and regulations regarding the control of idling times. The system is vehicle mounted, where the X-radiation equipment is installed on a 2006-2007 model vehicle which meet the Best Available Control Technology as defined by the U.S. EPA.

#### 3.2.3.2 No Action Alternative

No change in existing ambient air quality would occur and no new pollution sources would be introduced. The No Action Alternative includes inspecting cargo containers visually and with other technologies currently in use at the port. No impact to air quality is anticipated under the No Action Alternative.

## 3.3 Radiological Health and Safety

### 3.3.1 Criteria for Significance

Evaluation of the potential effect of radiation exposure on public safety is based on both the potential for an accident and the consequences of any project-related effect associated with normal operations. Beneficial impacts may result from any direct or indirect safety improvements due to project implementation. An alternative could have a significant impact if it would increase or decrease the risk of exposure of personnel or the public to radiation hazards.

### 3.3.2 Baseline Environment

#### 3.3.2.1 Ionizing Radiation

Radiation is the most complex of all considerations pertaining to the operation of HEMXRISs. The focus of this section, Radiological Health and Safety, is ionizing radiation. See Appendix C for background information on ionizing radiation.

HEMXRISs employ advanced high energy digital X-ray imaging technology that has successfully been used in various industrial applications such as field inspection of structures like bridges and buildings. As radiation-producing devices, these systems are subject to review by radiation protection authorities. Regulations that cover radiation related to the operation of the HEMXRIS are discussed in detail in Appendix C.

During normal operating conditions, the affected environment includes the area surrounding the cargo containers being scanned by the HEMXRIS. System operators and maintenance personnel, as well as people in the area around the system are the key component of the affected environment. For purposes of discussion, people are classified into two categories:

1. Maintenance personnel
2. General public (including system operators, truck drivers, port personnel and other CBP personnel)

All maintenance personnel are employees of the equipment manufacturer. Due to the nature of their jobs, they have the potential to be exposed to a higher level of radiation than system operators and members of the general public.

For its officers, port employees and truck drivers, CBP has adopted the same effective radiation dose standard that the NRC prescribe for members of the general public, which is 0.1 rem in a year. These personnel do not pass through the beam during scanning operations.

## 3.3.3 Potential Consequences

### 3.3.3.1 Proposed Action - Fielding and Operation of the HEMXRIS

#### 3.3.3.1.1 Exposure Pathways

The radiation exposure pathway for the general public is created from exposure to scattered radiation from the X-ray source during container scanning operations. However, in all cases, the radiation dose received by the general public will not exceed 0.1 rem in a year.

#### 3.3.3.1.2 Normal Operations

##### 3.3.3.1.2.1 Human Exposure

All maintenance personnel who maintain the linear accelerator (linac) and X-ray source components are employees of the equipment manufacturer. By the nature of their jobs, they have the potential to be exposed to a higher level of radiation than the system operators and members of the general public. Maintenance of the linac and X-ray source components will have to comply with the EPA and OSHA's strict dose standards for radiation workers. For a more detailed discussion of dose standards, see Appendix C.

HEMXRISs are designed so that the radiation dose levels within the driver's cab and at the inspector work-stations (systems operators) will be below the CBP prescribed limits of 0.1 rem in a year. Detailed radiation surveys, performed by or under the supervision of the CBP Radiation Safety Office, have confirmed that these design criteria have been met. In all cases, exposures were measured using a "worst-case" scatter in the X-ray beam. A worst-case scatter scenario is not likely to occur; therefore the estimated exposure levels are conservative by a substantial amount. As an additional precaution, as the HEMXRISs are delivered, exposure measurements will be made in the cabs and work-station areas to ensure that the systems are in compliance with exposure limits.

CBP has adopted the same effective radiation dose standard that the NRC prescribes for members of the general public (i.e. 0.1 rem). CBP has adopted the NRC standard because the Occupational Safety and Health Act only addresses occupational dose exposure limits. As defined by the International Commission on Radiological Protection (ICRP) (ICRP 2007), CBP officers are "occupationally exposed," because their assigned duties involve exposure to radiation or to radioactive material. CBP has decided to limit the officers "occupational dose" to no more than that allowable for the general public.

This exposure limit applies to all CBP employees or contractors who work on or maintain HEMXRISs, but not the linac or X-ray source components. This means that, as far as radiation dose standards are concerned, system operators are the same as members of the general public. For a more detailed discussion of dose standards, see Appendix C. Occupational exposure, to the effective radiation dose standard CBP has adopted, is not expected to cause a significant increase in the risk of cancer. For a more detailed discussion of information concerning risks from occupational radiation exposure, see Appendix D.

To meet the threshold radiation dose limit, CBP establishes controlled areas for HEMXRISs. No personnel are allowed in the controlled areas during scanning operations. The HCVM has two operational settings: 3.8 MeV and 4.2 MeV, with each operational setting having a specific controlled area which must be maintained during operation. System modes of operation are set based on the density of the walls of the containers scanned. In the event images are not acquired from an initial scan with the system set at 3.8 MeV, the HCVM can be operated at 4.2 MeV to obtain data from denser containers.

When operating at 3.8 MeV, the safe operating dimensions of the controlled area are 110 feet in length and 82 feet in width, as depicted in Figure 3. When operating at 4.2 MeV the safe operating dimensions for the controlled area are 135 feet in length and 133 feet in width, as depicted in Figure 4.

Controlled areas are moving footprints of specified dimensions. During an inspection process, the controlled area will be coincident with the movement of the HEMXRIS. Controlled area dimensions may be adjusted when needed by using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit below 0.00005 rem in any one hour limit and 0.1 rem per year. In the event other NII technologies are present or planned for operation at the port, CBP will ensure that controlled areas for each technology are adequately designated and do not overlap with one another.

During scanning operations, signs in multiple languages are posted at the controlled area boundary indicating the radiation hazard. Ground guides, which are items such as jersey barriers, cones or other items or an individual who provides visual signals to the driver, are positioned at various locations around the controlled area to warn persons of the danger as well as provide visual references to the driver of the HEMXRIS. The system incorporates an infrared safety barrier that stops the forward movement of the inspection system as well as the production of X-rays should the beam barrier be broken.

In the extreme, with respect to radiation exposure, a system operator (or a member of the general public) could be situated at the edge of the controlled area 8 hours a day, every workday of the year (that is to say, 2,000 hours per year) and not receive more exposure than the limits prescribed by the NRC. The controlled areas ensure that the systems conform to the radiation protection guidelines of reducing the radiation levels to As Low as is Reasonably Achievable (ALARA).

ALARA is defined in 10 CFR 20.1003 as: *"…means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to* *utilization of nuclear energy and licensed materials in the public interest."* In addition, 10 CFR 20.1101(b) requires that: *"[t]he licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)."*

Controlled areas are calculated and verified for each NII system and are designed to provide adequate separation from other NII operating areas, adjacent structures, work areas and traffic flows to protect workers, the general public and occupants of adjacent buildings. Controlled area dimensions may be adjusted when needed by using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit of 0.00005 rem in any one hour limit and 0.1 rem per year.

Analysis and testing for this environmental assessment shows that exposures are expected to be well below the maximum levels of exposure set by the NRC, OSHA and Food and Drug Administration (FDA) to protect the general public (which includes system operators, truck drivers, port personnel and other CBP personnel); therefore, the health and safety impacts from radiological exposure for the Proposed Action were found to not be significant.

#### 3.3.3.1.2.2 Effects of Irradiation on Food

The CBP Radiation Safety Office has conducted tests to determine the worst-case scenario of radiation doses to food as a result of implementing the Proposed Action. The total absorbed dose deposited in food subjected to scanning by a HEMXRIS operating at 4.2 MeV (worst-case) is approximately 0.00135 rem per scan, on the same order as that received by a person hidden in a cargo container. This dose is 266 times less than the average annual background dose in the U.S. of 0.360 rem.

The Food and Drug Administration at 21 CFR 179.21 requires a label be affixed to each machine stating that no food shall be exposed to X-ray radiation sources to receive an absorbed dose in excess of 50 rem. The HEMXRIS's absorbed dose is 37,037 times less than this limit.

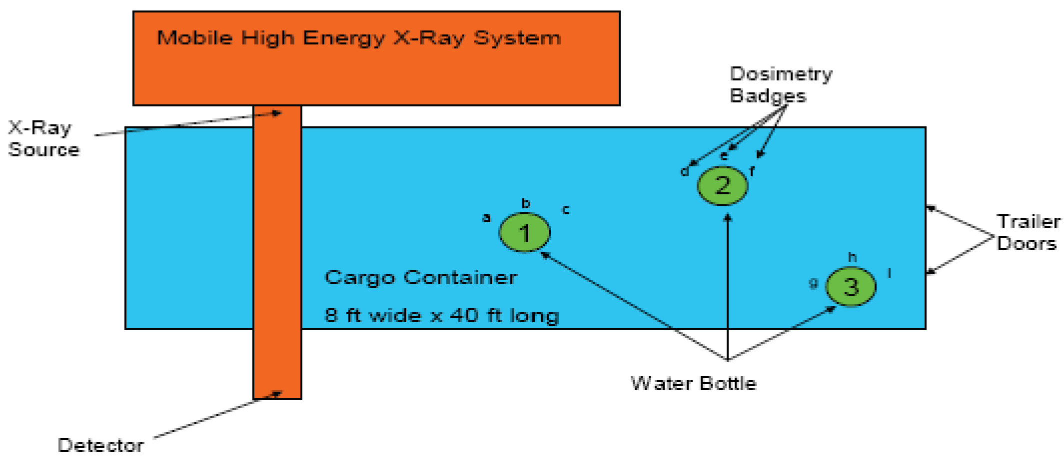
Table 2 lists the results of testing performed by the CBP Radiation Safety Officer. Three water bottles were positioned inside the cargo container as illustrated in Figure 5. Bottle 1 was positioned along the centerline of the cargo container approximately 19 feet forward of the rear entry doors. Bottle 2 was positioned next to the container wall (closest to the accelerator) approximately 14 feet forward of the rear entry doors. Bottle 3 was positioned next to the container wall (farthest from the accelerator) approximately 7 feet forward of the rear entry doors. Each bottle had 3 dosimetry badges attached (left, center, and right side) facing the accelerator.

Based on these measurements and in compliance with the provisions of 21 CFR 179.21 it is concluded that radiation from the Proposed Action will have no significant impact on food that may be located in scanned containers.

**Table 2: Dosimetry Results**

| Location | Position | Results (rem) | Number of Scans | Results (rem/scan) |
|---|---|---|---|---|
| **HCVM** | | | | |
| 1 | a | 0.022 | 23 | 0.00096 |
| 1 | b | 0.019 | 23 | 0.00083 |
| 1 | c | 0.024 | 23 | 0.00104 |
| 2 | d | 0.028 | 23 | 0.00122 |
| 2 | e | 0.026 | 23 | 0.00113 |
| 2 | f | 0.031 | 23 | 0.00135 |
| 3 | g | 0.007 | 23 | 0.00030 |
| 3 | h | 0.009 | 23 | 0.00039 |
| 3 | i | 0.007 | 23 | 0.00030 |

**Figure 5: Location of Water Bottles and Dosimetry Badges**




### 3.3.3.1.2.3 Maintenance

CBP personnel will not perform any maintenance of the linac or the X-ray source enclosure. CBP personnel will periodically perform maintenance of the detectors and test the system using procedures described in the operator's manual. Non-routine linac and X-ray source maintenance will be performed by the manufacturers.

### 3.3.3.1.2.4 Radiation Safety Engineering Controls

HEMXRISs incorporate redundant safety controls, such as emergency stop buttons at several locations on the systems that allow the system, including X-ray production, to be quickly shut down if necessary. In addition, the personnel assigned to operate the systems will be specifically trained for safe X-radiation system operations according to the CBP Office of Training and Development standards. Training for the system operators will consist of lectures, courses and a written examination in basic radiation physics, radiation safety, biological effects of radiation, instrumentation, radiation control and operating procedures during normal and emergency conditions.

## 3.3.3.1.3 Abnormal Events

### 3.3.3.1.3.1 Effects of Irradiation on Persons Hiding in Cargo Containers

As stated in section 3.3.3.1.2.1 (Human Exposure), the NRC has established the maximum allowable value of radiation dose that may be received by individuals (individual members of the general public) to be 0.1 rem in a year.

It is possible that people will hide themselves in cargo containers in order to surreptitiously enter the U.S. A person concealed in a cargo container that is scanned by a HEMXRIS will be exposed to radiation as a direct consequence of the inspection process.

The CBP Radiation Safety Officer conducted testing to determine the dose that a person hidden in a cargo container would experience during HEMXRIS scanning operations. The total absorbed dose to persons hiding in cargo containers subjected to scanning by a system operating at 4.2 MeV (worst-case) is approximately 0.00135 rem per scan, on the same order of that received by food. This dose is 266 times less than the average annual background dose in the U.S. of 0.360 rem and 74 times below levels permissible to the general public. Neither cargo container drivers nor any other personnel pass through the beam during scanning operations.

Assuming 0.00135 rem per scan, to reach the maximum allowable “in a year” radiation dose, a person would have to be scanned 74 times in a year. Since the chance of this frequency of exposure is remote, it is concluded that radiation from the HEMXRISs will not have a significant impact on persons located in scanned cargo containers.

## 3.3.3.1.4 Best Management Practices and Mitigation Measures for Radiological Health and Safety

Best management practices for radiological health and safety include but are not limited to:

- Incorporation of safety warnings and precautions into technical manuals and operator manuals.
- Training of operators and screening operations supervisors in the hazards associated with radiation producing equipment.
- Incorporation of emergency stop buttons on the equipment that allow the system, including X-ray production, to be quickly shut down if necessary.
- Training operators and screening operations supervisors in the location and use of emergency stop buttons.
- The establishment of radiation controlled areas during screening operations.

The combination of these precautions will ensure that the cumulative radiation dose to officers and the general public will not exceed 0.00005 rem in any one hour or 0.1 rem per year.

#### 3.3.3.2 No Action Alternative

Under the No Action Alternative, the inspection process at the port will continue to be conducted with current techniques and equipment, including visual and manual inspections to detect contraband. Persons entering the U.S. hidden in cargo containers would not be exposed to radiation levels above those that are naturally occurring if the No Action Alternative is implemented.

Alternatively, contraband that HEMXRISs are designed to detect could pass through the port unnoticed. As a consequence, there would be no health, public safety or environmental benefits to society that could theoretically result from intercepting a higher percentage of contraband at the U.S. border. Moreover, CBP officers would continue to engage in the same rate of potentially risky inspections of confined spaces to intercept contraband and prevent illegal entry into the U.S.

# 4 Cumulative Impacts

The Council on Environmental Quality regulations stipulate that the cumulative effects analysis in an EA should consider the potential environmental impacts resulting from "the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" 40 CFR 1508.7. Recent Council on Environmental Quality guidance (CEQ 1997) addressing cumulative effects affirms this requirement, stating that the first steps in assessing cumulative effects involves defining the scope of the other actions and their interrelationship with the Proposed Action. The scope must consider other projects that coincide with the location and timetable of the Proposed Action and other actions. Cumulative effects analysis must also evaluate the nature of interactions among these actions.

This EA identifies all known actions that are being considered and are in the planning phase at this time that could affect the area in the vicinity of the proposed HEMXRIS. To the extent that details regarding such actions exist and the actions have a potential to interact with the Proposed Action in this EA, these actions are included in this cumulative analysis. This approach enables decision-makers to have the most complete information available so that they can evaluate the environmental consequences of a Proposed Action in relation to other projects that may affect the same region of influence.

## 4.1 Past and Present Actions Relevant to the Proposed Action and Alternative

CBP operates presently, or plans to operate in the near future, other NII technologies suited to the various inspection needs at the port. Cumulative emission estimates for the other NII were made based on similar assumptions as the HEMXRIS, and the processing speeds of each system (see Appendix B and section 4.3.1 below).

## 4.2 Reasonably Foreseeable Actions that Could Interact with the Proposed Action and Alternative

Currently there are no known future actions that could combine with the resource areas analyzed within this EA to create a significant cumulative impact. It is likely that future projects at the port would be expected to improve the efficiency of the movement of traffic through the port and therefore reduce air quality impacts related to port operations. Alternatively, this could be counterbalanced by an increase in trade leading to increased cargo movements and increased emissions from NII trucks, onboard generators and cargo moving equipment. Other national factors, such as more stringent emissions controls on diesel engines or an increase in fuel costs, will also effect vehicle emissions and the number of vehicle miles driven.

## 4.3 Summary of Cumulative Effects

The potential for cumulative impacts resulting from the actions described above when combined with the Proposed Action in this EA are summarized here. The scope is limited to the resources analyzed in section 3 of this EA. Since the Proposed Action will have no impact on the resources that were determined to be unaffected by the Proposed Action, they would not contribute to cumulative impacts either.

### 4.3.1 Air Quality

Emissions estimates for proposed and existing NII operations are (tons per year): 8.27 nitrogen oxides, 1.09 volatile organic compounds, 5.85 carbon monoxide, 0.522 $PM_{10}$ and 0.480 $PM_{2.5}$. These cumulative emissions estimates are below the tons/year *de minimis* threshold values applicable to nonattainment and maintenance areas as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause significant, cumulative, air quality impacts (see tables 3 and 4, Appendix B).

### 4.3.2 Radiological Health and Safety

Aside from NII equipment operated or proposed by CBP, there is no other known NII equipment at the port that could combine with the proposed action and cause a significant cumulative effect. NII equipment has little potential to create cumulative health impacts under normal operating conditions when they are used for their intended purpose by qualified personnel under the supervision of a radiation safety officer in accordance with applicable heath and safety regulations.

Controlled areas are calculated and verified for each NII system and are designed to provide adequate separation from other NII operating areas, adjacent structures, work areas and traffic flows to protect workers, the general public and occupants of adjacent buildings. Limiting access to the controlled areas ensures that the public (which includes system operators and port personnel) are not exposed to radiation levels exceeding those prescribed by applicable regulations (see Appendix C and Appendix D). In the event other NII technologies are present or planned for operation at the port, CBP will ensure that controlled areas for each technology are adequately designated and do not overlap with one another to prevent any cumulative health impacts from radiation related to the operation of the HEMXRIS equipment.

The HEMXRIS and associated controlled area will occupy a maximum of 17,955 square feet of space on the port during operations (this includes the deployed system and necessary controlled area). The placement of this system combines with placement of other proposed and existing NII systems to occupy a total maximum (if all NII systems operate simultaneously) of 27,555 square feet of port space. The port has adequate space to accommodate the proposed NII system and existing and planned systems.

Controlled area dimensions may be adjusted when needed by aiming the beam of the system over a sea wall, using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit of 0.00005 rem in any one hour limit.

# 5 Findings and Conclusions

## 5.1 Environmental Consequences of the Proposed Action and Alternatives

The evaluation of the Proposed Action, fielding and operation of one HEMXRIS at the Port of San Juan, San Juan County, Puerto Rico, indicates that the human environment, as defined in NEPA, at the port will not be significantly affected. The predicted consequences on resource areas are briefly described below.

**Climate** – The HEMXRIS engine and onboard generator, as well as cargo-moving equipment, will emit small amounts of air pollutants and greenhouse gases as a result of the Proposed Action. Analysis presented in this EA has established that these emissions will be *de minimis*, as defined by the Clean Air Act. Accordingly, effects on the climate are expected to be negligible.

**Geology and Soils** – No construction or excavation is required for the Proposed Action. Scattered X-radiation will not contaminate soils because it is energy that dissipates as soon as the source is turned off, just as a room becomes dark as soon as the light switch is turned off. The system is mobile and can be moved as needed. No direct impacts to geology and soils would occur from the implementation of the Proposed Action.

**Hydrology and Water Quality** – The Proposed Action will not affect hydrology, water resources or water quality.

**Floodplains** – The Proposed Action will not result in any floodplain loss, adverse impacts to human safety, health, and welfare, or adverse impacts to the natural and beneficial values served by floodplains. HEMXRIS are mobile units that can be moved away from floodplains in the event of flooding or other natural disasters.

**Wetlands** – The Proposed Action will occur on previously paved surfaces and will not impact any wetlands.

**Coastal Zone** – The port is located in the Puerto Rico Coastal Zone. The Proposed Action is consistent with current actions at the port. No coastal zone resources will be adversely affected by the Proposed Action. Correspondence related to this determination is included in Appendix A.

**Vegetation and Wildlife** – The Proposed Action will occur on previously paved surfaces and will be consistent with current actions at the port. No vegetation or wildlife will be impacted by the Proposed Action.

**Threatened and Endangered Species** – The Proposed Action will take place in paved, industrial areas where suitable wildlife habitat and species do not exist. Therefore the Proposed Action will have no effect on threatened or endangered species. Correspondence related to this determination is included in Appendix A.

**Air Quality** – All estimated emission levels from the activities associated with the Proposed Action are below the tons/year *de minimis* threshold values applicable to nonattainment and maintenance areas for all pollutants as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause an exceedance of any NAAQS for criteria pollutants. The Proposed Action will not conflict with conformity requirements of section 176 of the Clean Air Act for federal actions or any approved SIP. The Proposed Action will not have a significant impact on local or regional air quality within the context of the Clean Air Act, NEPA or applicable state, or local environmental laws and regulations (see section 3.2 and Appendix B).

**Noise** – The Proposed Action is consistent with current actions at the port and will not measurably change the existing noise environment or violate any noise ordinances. As a result, the Proposed Action will not have a significant noise impact.

**Land Use and Zoning** – The Proposed Action is consistent with current actions at the port and will not impact land use or zoning.

**Aesthetics and Visual Resources** – The Proposed Action would not obscure or result in abrupt changes to the complexity of the landscape and skyline when viewed from points readily accessible to the public. No long-term change to the character of the area would occur as a result of the Proposed Action.

**Infrastructure and Utilities** – The port has pre-existing water and electrical services. The Proposed Action will not impact the infrastructure and utility services of the port.

**Traffic and Transportation** – During the planning process for each NII system and prior to deployment, site surveys are conducted, and coordinations with the appropriate stakeholders are made to ensure that the placement and operation of systems are integrated with port traffic patterns and facilities to minimize delays to legitimate transportation.

**Waste Management** – Wastes associated with the Proposed Action are used oil and lubricants for the operation and maintenance of the HEMXRIS. These will be accumulated and stored in compliance with applicable regulations at or near the point of generation and recycled by a licensed used oil recycler. 40 CFR Part 279 exempts used oil and lubricants from regulation as a hazardous waste if they are recycled and not mixed with any other hazardous wastes. It is not anticipated that the operation and maintenance of the system will generate amounts of hazardous wastes that would have any affect on the port's current generator status. There is no radioactive source or byproduct material used in the system, therefore there is no risk of a release of radioactive materials.

If a system or system component is replaced or decommissioned, the handling, storage, use, transfer, and disposal of all materials will comply with all applicable federal, state, or local environmental laws and regulations. This will prevent human exposure and releases to the environment of any hazardous material that could potentially be within the systems.

**Historical and Archeological (Cultural) Resources** – The HEMXRIS will be operated in an industrial setting and will not have an impact on sites that are listed on, or potentially eligible for listing on, the National Register of Historic Places. There is no construction or excavation related to the Proposed Action. If, in the course of deploying and operating the system CBP discovers that historical or archeological resources could be impacted, then project operations will be suspended and the appropriate authorities will be consulted. Implementing the Proposed Action will not have a significant impact on cultural or historic resources. Correspondence related to this determination is included in Appendix A.

**Socioeconomics** – The Proposed Action will not affect employment, housing or demographics. Implementation of the Proposed Action may produce indirect socioeconomic effects by deterring the movement of illicit drugs, explosives, firearms, or other contraband into the U.S. Similar indirect effects could result if the Proposed Action led to the apprehension of criminals or terrorists attempting to enter the U.S. Such effects, however, are only theoretical and will not be further evaluated in this document.

**Environmental Justice** – Implementation of the Proposed Action is not expected to have any negative or disproportionate effects on minority and low income populations or children.

**Transboundary Impacts –** The port is not located adjacent to any international borders and potential environmental effects from the Proposed Action will not extend beyond the territory of the U.S.

**Irreversible and Irretrievable Commitment of Resources** – The irreversible and irretrievable commitment of resources associated with the Proposed Action will be the procurement of the HEMXRIS, materials, utilities, labor and time expended in the operation of the system. No sensitive environmental resources will be lost or permanently altered due to the Proposed Action.

**Radiological Health and Safety** – While the use of any NII screening system must be evaluated to ensure that there are no adverse impacts to the health and safety of the public, CBP officers, and port employees, HEMXRISs are designed and operated to avoid these impacts. As promulgated by the NRC in 10 CFR Part 20, the maximum permissible level of radiation dose to the general public is 0.1 rem in a year. As discussed in section 3.3, CBP will use this protective limit for the public and CBP employees and other port workers.

The term "rem" is an abbreviation for "roentgen equivalent man" and is a special unit used for expressing dose equivalent[3]. Some types of radiation produce greater biological

---

[3] rem is often expressed as mrem (millirem, or thousandths of a rem) or µrem (microrem, or millionths). For the sake of consistency, this document will use the notation "rem."

effects for the same amount of energy imparted than other types. The rem is a unit that relates the dose of absorbed radiation to the biological effect of that dose on human tissues and organs. (See section 3.3 and Appendices C & D for additional analysis and information on radiation exposure).

***HEMXRIS Occupants –*** HEMXRISs are designed so that the radiation dose levels within the driver's cab and at the inspector work-stations (systems operators) will be below 0.00005 rem in any one hour. With an annual work limit of 2,000 hours, this hourly dose limit will prevent annual cumulative exposures that exceed the limit of 0.1 rem in a year.

Detailed radiation surveys, performed by or under the supervision of the CBP Radiation Safety Office, have confirmed that these design and exposure criteria have been met. In all cases, exposures were measured using a "worst-case" scatter in the X-ray beam. Since such a worst-case scatter scenario is not likely to occur, these estimated exposure levels are conservative by a substantial amount. As an additional precaution, as the systems are delivered, exposure measurements will be made in the cabs and work-station areas to ensure that the systems are in compliance with exposure limits.

***CBP Officers and Port Employees*** – Due to the nature of their work, CBP officers and port employees who work around HEMXRISs have the potential to be "occupationally exposed"[4] to radiation. The NRC and the Occupational Safety and Health Administration (OSHA) allow a higher permissible exposure level ("occupational dose") for radiation workers in restricted areas (5 rem in a year).

CBP uses the general public protection standard of 0.1 rem in a year as the maximum permissible level of radiation dose for CBP officers and port employees. This standard is 50 times more stringent than occupational dose limits established by the NRC and OSHA for radiation workers. The radiation dose from HEMXRISs will be no more than 0.00005 rem in any one hour since personnel will stand behind a marker delineating a "controlled area."

An analysis of potential exposure was based on 2,000 work hours per year as the maximum exposure time. This assumes that an individual spends all of a forty-hour work week, every week of the year, standing at the boundary of a system's controlled area. Even under those circumstances, neither CBP officers, port employees nor the public will receive a cumulative dose greater than the NRC limit for protecting the general public.

***Controlled Areas –*** To meet the threshold radiation dose limit, CBP establishes controlled areas for HEMXRISs. No personnel are allowed in the controlled areas during scanning operations. The HCVM has two operational settings: 3.8 MeV and 4.2 MeV, with each operational setting having a specific controlled area which must be maintained during operation. System modes of operation are set based on the density of the walls of the containers scanned. In the event images are not acquired from an initial scan with the

[4] As defined by the International Commission on Radiological Protection (ICRP) (ICRP 2007)

system set at 3.8 MeV, the HCVM can be operated at 4.2 MeV to obtain data from denser containers.

When operating at 3.8 MeV, the safe operating dimensions of the controlled area are 110 feet in length and 82 feet in width, as depicted in Figure 3. When operating at 4.2 MeV the safe operating dimensions for the controlled area are 135 feet in length and 133 feet in width, as depicted in Figure 4.

In the extreme, with respect to radiation exposure, a system operator (or a member of the general public) could be situated at the edge of the controlled area 8 hours a day, every workday of the year (that is to say, 2,000 hours per year) and not receive more exposure than the limits prescribed by the NRC. The controlled areas ensure that the systems conform to the radiation protection guidelines of reducing the radiation levels to As Low as is Reasonably Achievable (ALARA).

Controlled areas are calculated and verified for each NII system and are designed to provide adequate separation from other NII operating areas, adjacent structures, work areas and traffic flows to protect workers, the general public and occupants of adjacent buildings. Controlled area dimensions may be adjusted when needed by using cargo containers as a backstop, or by using masonry walls. When adjustments in the radiation controlled area are required or requested, the CBP Radiation Safety Officer will be on site in order to maintain the radiation exposure limit of 0.00005 rem in any one hour limit and 0.1 rem per year.

***Effects of Irradiation on Food –*** The FDA at 21 CFR 179.21 requires a label be affixed to each machine stating that no food shall be exposed to X-ray radiation sources to receive an absorbed dose in excess of 50 rem. The CBP Radiation Safety Office conducted tests to determine the worst-case scenario of radiation doses to food as a result of implementing the Proposed Action. The HEMXRIS absorbed dose is 37,037 times less than this limit. Based on these measurements and compliance with the provisions of 21 CFR 179.21 it is concluded that radiation from the Proposed Action will have no significant impact on food that may be located in scanned containers.

***Effects of Irradiation on Persons Hiding in Cargo Containers –*** It is possible that people will hide themselves in cargo containers in order to surreptitiously enter the U.S. A person concealed in a cargo container that is scanned by a HEMXRIS will be exposed to radiation as a direct consequence of the inspection process. The total absorbed dose to persons hiding in cargo containers subjected to scanning by a system operating at 4.2 MeV (worst case) is approximately 0.00135 rem per scan, on the same order of that received by food. This dose is 266 times less than the average annual background dose in the U.S. of 0.360 rem and 74 times below levels permissible to the general public.

Assuming 0.00135 rem per scan, to reach the maximum allowable "in a year" radiation dose, a person would have to be scanned 74 times in a year. Since the chance of this frequency of exposure is remote, it is concluded that radiation from HEMXRISs will not have a significant impact on persons located in scanned cargo containers.

Analysis and testing for this environmental assessment shows that exposures are expected to be well below the maximum levels of exposure set by the NRC, OSHA and the FDA to protect the general public (which includes system operators, truck drivers, port personnel and other CBP personnel); therefore, the health and safety impacts from radiological exposure for the Proposed Action were found to not be significant. See section 3.3 for further discussion of radiological health and safety.

## 5.2 Summary of Best Management Practices and Mitigation Actions Planned

**Best Management Practices for Air –** The emission estimates prepared for this EA were based on the assumption that HEMXRIS vehicles and generators would be idling for 16 hours per day. In practice, to reduce emissions from the Proposed Action, cargo container handling equipment waiting for the inspection of containers by the systems will comply with all applicable federal, state, or local environmental laws and regulations regarding the control of idling times. The systems are vehicle mounted, where the X-radiation equipment is installed on 2006-2007 model vehicles which meet the Best Available Control Technology as defined by the U.S. EPA.

**Best Management Practices for Wastes** – Petroleum, oils, and lubricants will be stored, handled, and disposed of in compliance with applicable laws and regulations. Procedures for the safe refueling of HEMXRISs and for the containment and clean-up of potential spills will be in accordance with existing port procedures for preventing and controlling releases. CBP personnel will be trained in spill prevention and countermeasures as required by the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §6901, *et seq*.) and the Oil Pollution Act of 1990 (OPA) (33 U.S.C §2701 *et seq.*)

HEMXRISs might contain materials that could be hazardous if the materials are handled improperly. An example of such a material would be lead metal, which is used for radiation shielding. As a system component, the lead will be innocuous and will provide a protective function from ionizing radiation.

As a CBP asset, all materials within the systems will be in use for their intended purpose, under the supervision of appropriately trained personnel. Under this scenario, there is no hazard to the human environment because the materials will be contained within the systems as functional components of the systems.

In the event of an accident, hazardous materials would not be expected to cause any significant harm to the human environment, because the amount of materials is small, and most materials will be in solid form which is readily contained and recovered. Accident response procedures are in place at the port to contain and remove fluids such as lubricants and fuel.

The most important action to ensure that hazardous materials have no significant effect on the human environment will be upon the replacement or decommissioning of a component or system. Appropriate disposition will depend upon type and quantity of materials involved and the applicable regulations. If a component is replaced or decommissioned, the handling, storage, use, transfer, and disposal of all materials will comply with all applicable federal, state, or local environmental laws and regulations. This will prevent human exposure and releases to the environment of any hazardous material.

**Best Management Practices and Mitigation Measures for Radiological Health and Safety –** Best management practices for radiological health and safety include but are not limited to:

- Incorporation of safety warnings and precautions into technical manuals and operator manuals.
- Training of operators and screening operations supervisors in the hazards associated with radiation producing equipment.
- Incorporation of emergency stop buttons on the equipment that allow the system, including X-ray production, to be quickly shut down if necessary.
- Training operators and screening operations supervisors in the location and use of emergency stop buttons.
- The establishment of radiation controlled areas during screening operations.

The combination of these precautions will ensure that the cumulative radiation dose to officers and the general public will not exceed 0.00005 rem in any one hour or 0.1 rem per year.

## 5.3 Findings and Conclusions

The evaluation of the Proposed Action, fielding and operation of one HEMXRIS at the Port of San Juan, demonstrates that there will be no significant, adverse effects on the human environment as long as identified best management practices and mitigation measures are followed. Therefore, no further environmental impact analysis is warranted.

# 6 References


AAPA. 2008. North American Port Container Traffic 2007. AAPA Advisory, May 2008.

Advisory Council on Historic Preservation. 2000. 36 CFR Part 800. Protection of Historical Properties. 65 FR 77725, Dec. 12, 2000.

CBP. Container Security Initiative. http://www.cbp.gov/xp/cgov/enforcement/international_activities/csi/. Accessed August 2007.

CBP. 2006. Securing America's Borders at Ports of Entry Office of Field Operations Strategic Plan FY 2007–2011. Office of Field Operations, September 2006.

CBP. 2007. Performance and Accountability Report Fiscal Year 2007, November 13, 2007, http://www.cbp.gov/xp/cgov/toolbox/publications/admin/ Accessed February 2008.

Coastal Zone Management Act. 1972. 16 U.S.C. 33 as amended

Council on Environmental Quality (CEQ). 1978. Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act. 40 CFR Parts 1500-1508. 43 FR 55994. November 29, 1978.

Council on Environmental Quality (CEQ). 1997. Considering Cumulative Effects Under the National Environmental Policy Act. January 1997.

Department of Homeland Security. 2006. Environmental Planning Program. Department of Homeland Security. Final Notice. Federal Register/Vol. 71, No.64/Tuesday, April 4, 2006/Notices. Pages 16790-16820.

Endangered Species Act of 1973. 16 USC 1531-1544 as amended.

Environmental Protection Agency (EPA). 1987. Radiation Guidance to Federal Agencies for Occupational Exposure. 52 FR 2822. January 27, 1987.

Environmental Protection Agency (EPA). 1998. Air and Radiation Office of Mobile Sources. 1998 EPA 420-F-014. Emission Facts, Idling Vehicle Emissions.

Environmental Protection Agency (EPA). 1993. 58 FR 63214, Determining Conformity of General Federal Actions to State and Federal Implementation Plans.

Environmental Protection Agency (EPA). 1995. Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources. January 1995.

Environmental Protection Agency (EPA). 2008a. EPA Greenbook. Website: http://www.epa.gov/oar/oaqps/greenbk. Accessed January 2008.

Environmental Protection Agency (EPA). 2008b. National Ambient Air Quality Standards http://epa.gov/air/criteria.html. Accessed January 2008.

Executive Office of the President. 1998. Office of the National Drug Control Policy. Ten-Year Counterdrug Technology Plan and Development Roadmap.

Executive Office of the President. 2003. Office of the National Drug Control Policy. Counterdrug Research and Development Blueprint Update 2003.

Executive Office of the President. 2008. Office of the National Drug Control Policy. National Drug Control Strategy 2008.

Executive Order of the President #11988. 1977. Floodplain Management

Executive Order of the President #11990. 1978. Protection of Wetlands

Executive Order of the President #12898. 1994. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.

Food and Drug Administration. 2002. Department of Health and Human Services. 21 CFR 179.21. Sources of Radiation Used for Inspection of Food, for Inspection of Packaged Food, and for Controlling Food Processing. 51 FR 13399, Apr. 18, 1986, as amended at 67 FR 9585, Mar. 4, 2002; 67 FR 35731, May 21,2002.

Health Physics Society. 2004. Radiation Risk in Perspective. Position Statement of the Health Physics Society. Health Physics News. August 2004.

International Commission on Radiological Protection (ICRP). 2007. Annals of the ICRP, Volume 37, Issues 2-4, April-June 2007, pages 81-123.

Khan, Siraj M., Paul E. Nicholas, and Michael S. Terpilak. 2004. Radiation Dose Equivalent to Stowaways in Vehicles. *Health Physics* **86** (5): 483-492.

National Environmental Policy Act. Public Law 91-190, 42 U.S.C. 4321-4347 as amended.

National Historic Preservation Act (NHPA). 1966. Public Law 89-665, 16 U.S.C. 470 as amended.

National Security Presidential Directive (NSPD), Number 43, and Homeland Security Presidential Directive (HSPD), Number 14, “Domestic Nuclear Detection” (April 15, 2002).

National Security Presidential Directive (NSPD), Number 17, and Homeland Security Presidential Directive (HSPD), Number 4, “National Strategy to Combat Weapons of Mass Destruction” (December 2002).

National Council on Radiation Protection and Measures (NCRP). 1997. Uncertainties in fatal cancer risk estimates used in radiation protection. Bethesda, MD: NCRP; NCRP Report No. 126.

Nuclear Regulatory Commission. Design-Basis Accident. http://www.nrc.gov/reading-rm/basic-ref/glossary/design-basis-accident.html. Accessed October 2007.

Nuclear Regulatory Commission. 1991. 10 CFR Part 20. Standards for Protection Against Radiation. 56 FR 23391, May 21, 1991.

Nuclear Regulatory Commission. 1996. Regulatory Guide 8.29. Instructions Concerning Risks From Occupational Radiation Exposure, Revision 1. February 1996.

Nuclear Regulatory Commission. 2001. Consolidated Guidance: 10 CFR Part 20

Standards for Protection Against Radiation (NUREG-1736). Division of Industrial and Medical Nuclear Safety, Office of Nuclear Material Safety and Safeguards. October

Occupational Health and Safety Administration. 1996a. 29 CFR 1910.95. Occupational Safety and Health Standards. 39 FR 23502, June 27, 1974, as amended at 46 FR 4161, Jan. 16, 1981; 46 FR 62845, Dec. 29, 1981; 48 FR 9776, Mar.8, 1983; 48 FR 29687, June 28, 1983; 54 FR 24333, June 7, 1989; 61 FR 9236, Mar. 7, 1996.

Occupational Health and Safety Administration. 1996b. 29 CFR 1910.1096. Ionizing Radiation. [39 FR 23502, June 27, 1974, as amended at 43 FR 49746, Oct. 24, 1978; 43 FR 51759, Nov. 7, 1978; 49 FR 18295, Apr. 30, 1984; 58 FR 35309, June 30, 1993. Redesignated at 61 FR 31430, June 20, 1996.

Office of National Drug Control Policy (ONDCP). 1998. Ten Year Counterdrug Technology Plan and Development Roadmap.

Office of National Drug Control Policy (ONDCP). 2000. National Drug Control Strategy, 2000 Annual Report, Counterdrug Research and Development Blueprint Update. Page 6.

Resource Conservation and Recovery Act. 1976. P.L.103-355. 42 U.S.C. 6901 *et seq*.

# 7 Persons and Organizations Contacted

Jennifer Hass
Environmental Program Office
U.S. Customs and Border Protection
1300 Pennsylvania Avenue, NW
Suite 1220
Washington, DC 20229

Luke McCormick
Radiation Safety Officer
U.S. Customs and Border Protection
6650 Telecom Drive
Suite 100
Indianapolis, IN 46278

Carolyn Whorton
NII Program Manager
U.S. Customs and Border Protection
Interdiction Technology Branch
1300 Pennsylvania Avenue NW
Suite 1575
Washington, DC 20229

José Luis Vega
Puerto Rico State Historic Preservation Office
P.O. Box 9066581
San Juan, PR 00906-6581

Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 491
Road 301 Km 5.1
Boquerón, Puerto Rico

Puerto Rico Department of Natural and Environmental Resources
Coastal Zone Program
PO Box 366147
San Juan, PR 00936

# 8 Acronyms and Abbreviations

| | |
|---|---|
| $^{137}Cs$ | Cesium 137 |
| $^{60}Co$ | Cobalt 60 |
| A | Ampere |
| AAPA | American Association of Port Authorities |
| AAQS | Ambient Air Quality Standards |
| ALARA | As Low As is Reasonably Achievable |
| BEIR | Biological Effects of Ionizing Radiation |
| BMP | Best Management Practices |
| CAA | Clean Air Act |
| CBP | Customs and Border Protection |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| CO | Carbon Monoxide |
| CSI | Container Security Initiative |
| dB | Decibel |
| dBA | Audio decibel |
| DHEC | Department of Health and Environmental Control |
| DHS | Department of Homeland Security |
| DOT | Department of Transportation |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| Erg | An erg is a small but measurable amount of energy |
| FDA | Food and Drug Administration |
| FEMA | Federal Emergency Management Agency |
| FONSI | Finding of No Significant Impact |
| FR | Federal Register |
| Gy | Gray |
| HDD | Heavy Duty Diesel |
| HDDV | Heavy Duty Diesel Vehicle |
| HDGV | Heavy Duty Gasoline Vehicle |
| HDV | Heavy-Duty Vehicles |
| HEMXRIS | High Energy Mobile X-Ray Inspection System |
| HP | HorsePower |
| Hr | Hour |
| $H_T$ | Dose equivalent |
| HVAC | Heating Ventilation and Air Conditioning |
| Hz | Hertz |
| ICRP | International Commission on Radiological Protection |
| lb | Pounds |
| Ldn | Day-Night average sound level |
| MeV | Million Electron Volts |
| mrad | millirad |
| mrem | millirem |

| | |
|---|---|
| NA | Not Applicable |
| NAA | Nonattainment Area |
| NAAQS | National Ambient Air Quality Standards |
| NCRP | National Council on Radiation Protection |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NII | Non-Intrusive Inspection |
| NOA | Notice of Availability |
| NOI | Notice of Intent |
| NOx | Nitrogen Oxides |
| NRC | Nuclear Regulatory Commission |
| NRCS | Natural Resources Conservation Service |
| $O_3$ | Ozone |
| OFO | Office of Field Operations |
| ONDCP | Office of National Drug Control Policy |
| OSHA | Occupational Safety and Health Administration |
| PEA | Programmatic Environmental Assessment |
| $PM_{2.5}$ | Particulate Matter 2.5 micrometers or smaller in diameter |
| $PM_{10}$ | Particulate Matter 10 micrometers or smaller in diameter |
| rad | Radiation Absorbed Dose |
| rem | Roentgen Equivalent Man |
| RPM | Revolutions Per Minute |
| RSO | Radiation Safety Officer |
| SAFE | Security and Accountability for Every (i.e. SAFE Port Act of 2006) |
| SHPO | State Historic Preservation Officer |
| SIP | State Implementation Plan |
| SOx | Sulfur Oxides |
| Sv | sievert |
| TEDE | Total Effective Dose Equivalent |
| TEU | Twenty Foot Equivalent Units |
| µrad | microrad |
| µrem | microrem |
| U.S.C. | United States Code |
| UNSCEAR | United Nations Scientific Committee on the Effects of Atomic Radiation |
| USDA | United States Department of Agriculture |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VAC | Volts, Alternating Current |
| VOC | Volatile Organic Compounds |

# 9 List of Preparers

| Name | Agency/ Organization | Discipline/ Expertise | Experience | Role in Preparing EA |
|---|---|---|---|---|
| Gary Armstrong | Organizational Strategies, Inc | Environmental Analyst. | 16 years in NEPA and related studies | Environmental Analysis & Impact Evaluation |
| Anneke Frederick | Organizational Strategies, Inc | Environmental Scientist | 15 years in environmental science and regulatory compliance | Technical review and editing |
| Kathryn Child | Organizational Strategies, Inc | Chemistry, Licensed Environmental Health Scientist | 15 years in environmental science and regulatory compliance | Environmental Analysis & Impact Evaluation |

# 10 Distribution List

Jennifer Hass
Environmental Program Office
U.S. Customs and Border Protection
1300 Pennsylvania Avenue, NW
Suite 1220
Washington, DC 20229

Luke McCormick
Radiation Safety Officer
U.S. Customs and Border Protection
6650 Telecom Drive
Suite 100
Indianapolis, IN 46278

Carolyn Whorton
NII Program Manager
U.S. Customs and Border Protection
Interdiction Technology Branch
1300 Pennsylvania Avenue NW
Suite 1575
Washington, DC 20229

José Luis Vega
Puerto Rico State Historic Preservation Office
P.O. Box 9066581
San Juan, PR 00906-6581

Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 491
Road 301 Km 5.1
Boquerón, Puerto Rico

Puerto Rico Department of Natural and Environmental Resources
Coastal Zone Program
PO Box 366147
San Juan, PR 00936

Chuck Carroll
National Maritime Safety Association
919 18th Street, NW
Suite 901
Washington, DC 20006

Director
San Juan Service Port
U.S. Customs and Border Protection
#1 La Puntilla Street
Room 214
San Juan, PR 00901

Librarian
San Juan Community Library
P O Box 3758
Guaynabo, PR 00970-3758

The Honorable Luis Fortuno
United States House of Representatives
126 Cannon House Office Building
Washington, DC 20515-0001

The Honorable Acevedo Vilá
Office of the Governor
P.O. Box 9020082
San Juan, PR 00902-0082

Román M. Velasco González
Puerto Rico Department of Labor and Human Resources
Prudencio Rivera Martinez Building, 21st Floor
505 Muñoz Rivera Avenue
Hato Rey, Puerto Rico 00918

# Appendix A: Correspondence

U.S. Department of Homeland Security
Washington, DC 20229

U.S. Customs and
Border Protection

August 7, 2009

Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 491
Road 301 Km 5.1
Boquerón, Puerto Rico

SUBJECT: Fielding and Operation of a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

Dear Supervisor:

The United States Customs and Border Protection (CBP) is notifying you of the proposed action noted above; which consists of fielding and operating one high energy mobile X-ray inspection system at the Port of San Juan, San Juan County, Puerto Rico. The purpose of the proposed action is to conduct non-intrusive inspections of high density cargo containers entering Puerto Rico. The system uses a linear accelerator to produce high energy X-rays to view the contents of cargo containers. No X-rays will be produced when the system is not being operated and no radiation source material is used in the operation of the system.

An aerial photograph, a topographic map and representative pictures of the system are enclosed for reference. There are a number of threatened and endangered species known to exist within the San Juan region (see enclosure). However, the proposed action will take place within the boundaries of the port's facilities where there is no habitat suitable for protected wildlife and no critical habitat that could be affected by the proposed action. The system is mobile and will only be operated on developed surfaces at the port. No construction is necessary for the proposed action. For these reasons we have determined that no threatened or endangered species will be affected by the proposed action. We request your concurrence with our determination.

Please provide your response and/or questions to Ms. Anneke Frederick at: 1331 Pennsylvania Ave, NW, Suite 1415, Washington, DC 20004; fax (202) 393-8442; telephone (202) 393-8441; or e-mail afrederick@orgstrategies.com. Thank you in advance for your assistance.

Sincerely,

Sharon Sharp-Harrison

Sharon Sharp-Harrison
Branch Director
Office of Information and Technology
Laboratories and Scientific Services
Interdiction Technology Branch

Enclosures

# United States Department of the Interior

**FISH & WILDLIFE SERVICE**
**Boqueron Field Office**
Carr. 301, KM 5.1, Bo. Corozo
P.O. Box 491
Boqueron, PR 00622

SEP 09 2009

Ms. Sharon Sharp-Harrison
Branch Director
Office of Information and Technology
Laboratories and Scientific Services
U.S. Customs and Border Protection
U.S. Department of Homeland Security
Washington, DC 20229

Re: Fielding and Operation of a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan PR

Dear Ms. Sharp-Harrison:

Thank you for your letter of August 7, 2009, received in our office on August 21, 2009, requesting concurrence with the determination of effects for the above-mentioned project. Our comments are provided under the Endangered Species Act (Act) (87 Stat. 884, as amended; 16 United States Code 1531 et seq.). Please refer to Project Identification Number **FWS-72127-472** in any further correspondence.

The proposed action consists of conducting non-intrusive inspections of high density cargo containers entering Puerto Rico. Based on the nature of the project and the characteristics of the site, we concur with your determination that the implementation of the above-mentioned project is not likely to adversely affect threatened and endangered species. Nevertheless, if the process is modified or if information on impacts to listed species becomes available this office should be contacted concerning the need for re-initiation of consultation under section 7 of the Act.

Sincerely yours,

Edwin E. Muñiz
Field Supervisor
Caribbean Field Office

MTR

## Enclosure: Species Known to Occur within the San Juan Region

A review of the USFWS Southwest Region Ecological Services website, http://www.fws.gov/caribbean/es/PDF/Map.pdf, indicated the following species may be found in the San Juan region:

### SAN JUAN

| SCIENTIFIC NAME | COMMON NAME | COMMON NAME SPANISH | GROUP | STATUS | DISTRIBUTION |
|---|---|---|---|---|---|
| Agelaius xanthomus | Yellow Shouldered Black Bird | Mariquita | Bird | E, CH | Coastal Forest |
| Banara vanderbilti | No Common Name | Palo de Ramon | Plant | E | Martin Peña |
| Chelonia mydas | Green Sea Turtle | Peje Blanco | Reptile | T, CH | Coastal Zones |
| Cornutia obovata | No Common Name | Palo de Nigua | Plant | E | Botanical Garden |
| Eretmochelys imbricata | Hawksbill Sea Turtle | Carey | Reptile | E, CH | Coastal Zones |
| Pelecanus occidentalis | Brown Pelican | Pelicano Pardo | Bird | E | Coastal Zones, No Nesting |
| Schoepfia arenaria | No Common Name | No Tiene Nombre Comun | Plant | T | San Jose Lagoon |
| Stahlia monosperma | No Common Name | Cobana Negra | Plant | T | Fundacion Luis Muñoz Marin |
| Trichechus manatus manatus | Antillean Manatee | Manati Antillano | Mammal | E | Coastal Zones |

U.S. Department of Homeland Security
Washington, DC 20229

U.S. Customs and
Border Protection

August 7, 2009

José Luis Vega
Puerto Rico State Historic Preservation Office
P.O. Box 9066581
San Juan, PR 00906-6581

SUBJECT: Fielding and Operation of a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

Dear Mr. Vega:

The United States Customs and Border Protection (CBP) is notifying you of the proposed action noted above; which consists of fielding and operating one high energy mobile X-ray inspection system at the Port of San Juan, San Juan County, Puerto Rico. The purpose of the proposed action is to conduct non-intrusive inspections of high density cargo containers entering Puerto Rico. The system uses a linear accelerator to produce high energy X-rays to view the contents of cargo containers. No X-rays will be produced when the system is not being operated and no radiation source material is used in the operation of the system.

An aerial photograph, topographic map and representative pictures of the system are enclosed for reference. The system is mobile and will be operated on developed surfaces at the port. No construction is necessary for the proposed action. For these reasons we have determined that no historic properties listed or eligible for listing within the National Register of Historic Places will be affected by the proposed undertaking. We request your concurrence with our determination.

Please provide your response and/or questions to Ms. Anneke Frederick at: 1331 Pennsylvania Ave, NW, Suite 1415, Washington, DC 20004; fax (202) 393-8442; telephone (202) 393-8441; or e-mail afrederick@orgstrategies.com. Thank you in advance for your assistance.

Sincerely,

Sharon Sharp-Harrison

Sharon Sharp-Harrison
Branch Director
Office of Information and Technology
Laboratories and Scientific Services
Interdiction Technology Branch

Enclosures

Oficina del Gobernador • Oficina Estatal de Conservación Histórica
oech
Office of the Governor • State Historic Preservation Office
shpo

August 26, 2009

Ms. Anneke Frederick
1331 Pennsylvania Ave. NW
Suite 1415
Washington, DC 20004

**SHPO: 08-20-09-01 FIELDING AND OPERATION OF A HIGH ENERGY MOBILE X-RAY INSPECTION SYSTEM AT THE PORT OF SAN JUAN, SAN JUAN COUNTY, PUERTO RICO**

Dear Ms. Frederick:

Our Office has received and reviewed the above referenced project in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended, and 36 CFR Part 800: *Protection of Historic Properties* from the Advisory Council on Historic Preservation. The State Historic Preservation Officer (SHPO) is to advise and assist federal agencies and other responsible entities when identifying historic properties, assessing effects upon them, and considering alternatives to avoid or reduce the project's effects.

Our records support your finding of **no historic properties affected** within the project's area of potential effects.

Please note that should the Agency discover other historic properties at any point during project implementation, you should notify the SHPO immediately. If you have any questions, please contact Miguel Bonini at (787) 721-3737 or mbonini@prshpo.gobierno.pr.

Sincerely,

For Carlos A. Rubio Cancela, Architect
State Historic Preservation Officer

CAR/BRS/MB/img

P.O. Box 9066581
San Juan, PR 00906-6581
Tel. (787) 721-3737
Fax. (787) 722-3622

U.S. Department of Homeland Security
Washington, DC 20229

U.S. Customs and
Border Protection

August 7, 2009

Puerto Rico Department of Natural and Environmental Resources
Coastal Zone Program
PO Box 366147
San Juan, PR 00936

SUBJECT: Fielding and Operation of a High Energy Mobile X-Ray Inspection System at the Port of San Juan, San Juan County, Puerto Rico

The United States Customs and Border Protection (CBP) is notifying you of the proposed action noted above, which consists of fielding and operating one high energy mobile X-ray inspection system at the Port of San Juan, San Juan County, Puerto Rico. The purpose of the proposed action is to conduct non-intrusive inspections of high density cargo containers entering Puerto Rico. The system uses a linear accelerator to produce high energy X-rays to view the contents of cargo containers. No X-rays will be produced when the system is not being operated and no radiation source material is used in the operation of the system.

An aerial photograph, topographic map and representative pictures of the system are enclosed for reference. The system is mobile and will be operated on developed surfaces at the port. No construction is necessary for the proposed action. For these reasons we have determined that Puerto Rico's coastal zone resources will not be adversely affected by the proposed action. We request your concurrence with this determination.

Please provide your response and/or questions to Ms. Anneke Frederick at: 1331 Pennsylvania Ave, NW, Suite 1415, Washington, DC 20004; fax (202) 393-8442; telephone (202) 393-8441 or e-mail afrederick@orgstrategies.com. Thank you in advance for your assistance.

Sincerely,

Sharon Sharp-Harrison
Branch Director
Office of Information and Technology
Laboratories and Scientific Services
Interdiction Technology Branch

Enclosures

# Appendix B: Air Quality Analysis

This analysis considers operational impacts to local and regional air quality that could result from implementation of the Proposed Action.

## Construction Emissions

The proposed HEMXRIS and existing NII systems discussed below will be operated on existing paved surfaces at the port. No construction is necessary for the Proposed Action.

## Idling Emissions

The Environmental Protection Agency has determined that for analysis not requiring detailed specific emission estimates tailored to local conditions, the summary of idle emission factors contained in EPA420-F-98-014 can be used to obtain first-order approximations of emissions under idling conditions (e.g., drive-thru lanes). This analysis includes emissions estimates for the proposed system and existing NII systems. Emissions estimates are summarized below in Table 3.

### HEMXRIS Operations

The engine type to be used on HCVM systems is the International DT570 medium duty diesel engine with an average horsepower (HP) rating of 285 HP at 2,200 revolutions per minute (RPM). Designated as a clean fuel fleet vehicle/low emissions vehicle, all engine types meet the EPA requirements for emissions. The onboard generator is a Martin Diesel 35.2 kilowatt, 61.2 HP at 1,800 RPM.

Emission estimates for HEMXRIS assumes the system and the diesel powered generator will be operated 16 hours per day, 365 days per year and the system will be continuously idling, or scanning cargo containers at a speed of less than 0.5 miles per hour. Emission estimates for vehicles that will be inspected assume that each mobile system processes an average of 20 vehicles per hour (i.e. processing time equals 3 minutes per vehicle and each system processes 320 vehicles per day).

### Existing and Planned NII Systems

CBP currently operates or plans to operate various NII systems at the port. The emissions estimates for the systems are based on the same assumptions and factors that are used for HEMXRISs, except the processing times for the systems vary.

**Table 3: Emissions Estimate from Proposed, Existing and Future Operations [1, 2 & 3]**

| Source | NOx (tons/yr) | VOC (tons/yr) | CO (tons/yr) | $PM_{10}$ (tons/yr) | $PM_{2.5}$ (tons/yr) |
|---|---|---|---|---|---|
| HEMXRIS Operations | 6.84 | 0.769 | 3.42 | 0.455 | 0.419 |
| Other NII System Operations | 1.44 | 0.323 | 2.43 | 0.0667 | 0.0614 |
| **Cumulative (tons/yr):** | **8.27** | **1.09** | **5.85** | **0.522** | **0.480** |

[1]Emission factor source for vehicles, "Idling Vehicle Emissions" (EPA 1998). Average of winter and summer factors for HDDV were used.
[2]Emission factor source for generators, AP 42, Fifth Edition, Volume I, chapter 3, Gasoline and Diesel Industrial Engines (EPA 1996).
[3]Final PM2.5 Calculation Methodology and PM2.5 Significance Thresholds, South Coast Air Quality Management District. October 2006.

Table 4 compares the data presented in above in Table 3 with the conformity criteria for non-attainment areas. This comparison shows that the estimated yearly emissions attributable to idling vehicles are well below the allowable limits set in 40 CFR Part 93.153, Determining Conformity of Federal Actions to State or Federal Implementation Plans (the rule). The rule applies to those federal actions that are located in areas of non-attainment of the NAAQS.

**Table 4: Conformity Criteria for Nonattainment Areas**

| Pollutant | Criterion (tons/yr) [a] | Idling Emissions Estimate (tons/yr) |
|---|---|---|
| Ozone (VOCs or NOx): | | 1.09 (VOC);<br>8.27 (NOx) |
| Serious NAAs | 50 | NA |
| Severe NAAs | 25 | NA |
| Extreme NAAs | 10 | NA |
| Other ozone NAAs outside an ozone transport region | 100 | NA |
| Other ozone NAAs inside an ozone transport region<br>VOC<br>NOx | <br><br>50<br>100 | NA |
| All maintenance areas (NOx, SO2 or NO2) | 100 | NA |
| Maintenance areas outside an ozone transport region (VOCs) | 100 | NA |
| Maintenance areas inside an ozone transport region (VOCs) | 50 | NA |
| CO: | | 5.85 |
| All NAAs | 100 | NA |
| All maintenance areas | 100 | NA |
| SO2 or NO2: | | |
| All NAAs | 100 | NA |
| $PM_{10}$: | | 0.522 |
| Moderate NAAs | 100 | NA |
| Serious NAAs | 70 | NA |
| All maintenance areas | 100 | NA |
| $PM_{2.5}$: | | 0.480 |
| Direct Emissions | 100 | NA |
| SO2 | 100 | NA |
| NOx | 100 | NA |
| VOC or ammonia | 100 | NA |
| Pb: | | |
| All NAAs | 25 | NA |

| **Pollutant** | **Criterion (tons/yr) [a]** | **Idling Emissions Estimate (tons/yr)** |
|---|---|---|
| Ozone (VOCs or NOx): | | 1.09 (VOC); 8.27 (NOx) |
| Serious NAAs | 50 | NA |
| Severe NAAs | 25 | NA |
| Extreme NAAs | 10 | NA |
| Other ozone NAAs outside an ozone transport region | 100 | NA |
| Other ozone NAAs inside an ozone transport region VOC NOx | 50 100 | NA |
| CO: | | 5.85 |
| All NAAs | 100 | NA |
| SO2 or NO2: | | |
| All NAAs | 100 | NA |
| $PM_{10}$: | | 0.522 |
| Moderate NAAs | 100 | NA |
| Serious NAAs | 70 | NA |
| $PM_{2.5}$: | | 0.480 |
| Direct Emissions | 100 | NA |
| SO2 | 100 | NA |
| NOx | 100 | NA |
| VOC or ammonia | 100 | NA |
| Pb: | | |
| All NAAs | 25 | NA |

[a] 40 CFR Part 93.153

Table 5 lists the NAAQS. Emissions attributed to the Proposed Action combined with those attributable to past and future actions are well within the limits of the regulations of emissions standards required by the federal government.

**Table 5: NAAQS and State Ambient Air Quality Standards**

| Pollutant | Averaging Time | Federal Standards [b] | |
|---|---|---|---|
| | | **Primary** | **Secondary** |
| **Ozone (03)** | 1 Hour | 0.12 ppm (235 µg/m3) | Same as Primary Standard |
| | 8 Hour | 0.08 ppm (157 µg/m3) | |
| **Respirable Particulate Matter** ($PM_{10}$) | 24 Hour | 150 µg/m3 | Same as Primary Standard |
| | Annual Arithmetic Mean | 50 µg/m3 | |
| **Fine Particulate Matter (PM2.5)** | 24 Hour | 35 µg/m3 | Same as Primary Standard |
| | Annual Arithmetic Mean | 15 µg/m3 | |
| **Carbon Monoxide (CO)** | 8 Hour | 9.0 ppm (10 mg/m3) | None |
| | 1 Hour | 35 ppm (40 mg/m3) | |
| **Nitrogen Dioxide (NO2)** | Annual Arithmetic Mean | 0.053 ppm (100 µg/m3) | Same as Primary Standard |
| **Sulfur Dioxide (SO2)** | Annual Arithmetic Mean | 0.03 ppm | 0.5 ppm (1300 g/m3) [3-hour] |
| | 24 Hour | 0.14 ppm (365 µg/m3) | None |
| | 3 Hour | None | 0.5 ppm (1300 µg/m3) |
| | 1 Hour | None | None |
| **Lead** | Calendar Quarter | 1.5 µg/m3 | Same as Primary Standard |

[a] 40 CFR Part 50

## Conclusion

All emission levels from the activities associated with the Proposed Action are below the tons/year *de minimis* threshold values that are applicable to nonattainment and maintenance areas for all pollutants as specified in 40 CFR 93.153(b)(1)(2). Therefore the Proposed Action is not anticipated to cause an exceedance of any NAAQS for criteria pollutants. The Proposed Action will not conflict with conformity requirements of section 176 of the Clean Air Act for federal actions or any approved SIP. The Proposed Action will not have a significant impact on local or regional air quality within the context of the Clean Air Act, NEPA or applicable state, or local environmental laws and regulations. This analysis considers both emissions specific to the Proposed Action and cumulative effects of HEMXRIS operations combined with emissions of existing and/or planned NII systems operations.

# Appendix C: Background Information on Ionizing Radiation

The background material contained in this appendix is excerpted from information found in National Council on Radiation Protection and Measures (NCRP) *Uncertainties in Fatal Cancer Risk Estimates Used in Radiation Protection, NCRP Report Number 126*, and is intended to provide the user with the best available background and regulatory information on ionizing radiation.

- ## Measurement of Radiation Dose

Radiation is measured using units that people seldom encounter. It is important to relate the amount of radiation received by the body to its physiological effects. Two terms used to relate the amount of radiation received by the body are "absorbed dose" and "dose equivalent."

Absorbed dose means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

The term "rad" (radiation absorbed dose) is the special unit of absorbed dose of 100 ergs per gram. Different materials that receive the same exposure may not absorb the same amount of energy. The rad is the basic unit of the absorbed dose of radiation (i.e., alpha, beta, gamma, and neutron) to the energy they impart in materials. The dose of one rad indicates the absorption of 100 ergs (an erg is a small but measurable amount of energy) per gram of absorbing material. To indicate the dose an individual receives in the unit rad, the word "rad" follows immediately after the magnitude, for example "50 rad." One thousandth of a rad (millirad) is abbreviated "mrad," and one millionth of a rad (microrad) is abbreviated "µrad."

Dose equivalent ($H_T$) means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv). At the present time, rem is used in the U.S. while sieverts are used internationally. Eventually, the U.S. will adopt these international terms.

The term "rem" (Roentgen equivalent man) is a special unit used for expressing dose equivalent. Some types of radiation produce greater biological effects for the same amount of energy imparted than other types. The rem is a unit that relates the dose of absorbed radiation to the biological effect of that dose. Therefore, to relate the absorbed dose of specific types of radiation, a "quality factor" must be multiplied by the dose in rad. To indicate the dose an individual receives in the unit rem, the word "rem" follows immediately after the magnitude, for example "50 rem." One thousandth of a rem (millirem) is abbreviated "mrem," and one millionth of a rem (microrem) is abbreviated "µrem." The quality factor allows for the effect of higher energy deposition along particle tracks produced by various radiation types such as neutrons or alpha particles. For the X- rays, such as those currently utilized in the HEMXRISs, the quality factor is 1, meaning that 1 rad of absorbed dose results in 1 rem of dose equivalent.

- **Regulations Covering Radiation Dose**

Regulations pertaining to radiation exposure are administered by many different federal and state agencies under a variety of legislative authorities.

- **Nuclear Regulatory Commission (NRC) (10 CFR Part 20)**

The Nuclear Regulatory Commission (NRC) promulgates regulations and establishes standards for protection against radiation arising out of activities conducted under licenses issued by the Commission. NRC regulations control the receipt, possession, use, transfer, and disposal of licensed material by any licensee. CBP currently holds an NRC Materials License for $^{137}Cs$/ $^{60}Co$ sealed sources.

- **Occupational Safety and Health Administration (OSHA) (29 CFR 1910.1096)**

OSHA regulations establish standards for protection against ionizing radiation that result in an occupational risk, but do not regulate the safety of licensed radioactive materials.

- **Food and Drug Administration (FDA) (21 CFR 1020) Performance Standards for Ionizing Radiation Emitting Products)**

The Food and Drug Administration (FDA) promulgates regulations and establishes standards for the protection against radiation by setting performance standards that manufacturers of ionizing radiation emitting products must meet.

- **Environmental Protection Agency (EPA) (Radiation Protection Guidance to Federal Agencies for Occupational Exposure FR 52 2822 January 27, 1987)**

Federal radiation exposure protection guidance for occupational exposure is defined in *Radiation Protection Guidance to Federal Agencies for Occupational Exposure.* Administered by the EPA, the guidance was developed cooperatively by the NRC, the Occupational Safety and Health Administration, the Mine Safety and Health Administration, the Department of Defense, the Department of Energy, the National Aeronautics and Space Administration, the Department of Commerce, the Department of Transportation, the Department of Health and Human Services, and the Environmental Protection Agency. The guidance provides general principles, and specifies the numerical primary guides for limiting worker exposure. It applies to all workers who are exposed to radiation in the course of their work, either as employees of institutions and companies subject to federal regulation or as federal employees. It is expected that individual federal agencies, on the basis of their knowledge of specific worker exposure situations, will use the guidance as the basis upon which to revise or develop detailed standards and regulations to the extent that they have regulatory or administrative jurisdiction.

- **State Regulations**

Many states have adopted regulations modeled on the *Suggested State Regulations for Control of Radiation*.

- **Commonwealth of Puerto Rico**

The Commonwealth of Puerto Rico does not have agreement state status with the NRC, which means that the commonwealth lacks authority to regulate NRC-licensed radioactive materials within its borders.

## Regulatory Jurisdiction

As it applies to the operation of HEMXRISs, the applicable regulations are FDA [21 CFR Part 1020] and OSHA [29 CFR 1910.1096].

- The NRC Guidance provided in 10 CFR Part 20 Standards for Protection Against Radiation apply to persons licensed by the Commission to receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material or to operate a production or utilization facility.
- The EPA guidance provided in FR 52 2822, *Radiation Protection Guidance to Federal Agencies for Occupational Exposure,* is to be used as the basis upon which individual federal agencies revise or develop detailed standards and regulations to the extent that they have regulatory or administrative jurisdiction.

## Dose Limits

Dose limits represent the upper bound limit below which risks from radiation exposure are deemed to be acceptable. In 10 CFR. Part 20 the NRC identifies two classifications of radiation dose to people.

The first classification, "occupational dose," is the *"dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under §35.75, from voluntary participation in medical research programs, or as member of the public."* 20 CFR. 20.1003. The individuals subject to the occupational dose classification must closely monitor their degree of radiation exposure using dosimeters. The annual occupational dose limit for adults shall not exceed whichever is the more limiting of : a total effective dose equivalent of 5 rem or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem. 10 CFR. 20.1201.

The second radiation dose classification, "public dose," is *"the dose received by a member of the public from exposure to radiation or to radioactive material released by a licensee, or to another source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered* *radioactive material and released under §35.75 or from voluntary participation in medical research programs."* 10 CFR. 20.1003 and FAC 64E-5.101. The total effective dose equivalent to individual members of the general public from the licensed operations shall not exceed 0.1 rem in a year. 10 CFR. 20.1301 and FAC 64E-5.312. A summary of pertinent dose limits is presented below in Table 6.

## Table 6: Summary of Regulatory Dose Limits

| Dose Limit by Agency and Regulation (rem in any year) | | | | |
|---|---|---|---|---|
| | **NRC** **10 CFR 20** | **EPA** **52 FR 2822** | **FAC 64E-5** | **OSHA** **29 CFR 1910.1096** |
| **"Occupational Dose" = "Radiation Workers" in "Restricted Areas"** | | | | |
| **Whole Body** | 5 | 5 | 5 | 5 (1.25 rem/calendar quarter) |
| **Lens of Eye** | 15 | 15 | 15 | 5 (1.25 rem/calendar quarter) |
| **Skin, Hands and Feet** | 50 | 50 | 50 | |
| **Skin of Whole Body** | | | | 30 (7.5 rem/calendar quarter) |
| **Hands and forearms; feet and ankles** | | | | 75 (18.75 rem/calendar quarter) |
| **Minors (10 CFR 20.1207)** | 10% of above limits | 10% of above limits | 10% of above limits | 10% of above limits |
| **Pregnant Women* (10 CFR 20.1208)** | 10% of above limits | 10% of above limits | 10% of above limits | Not Addressed |
| **"Non-Occupational Dose" = "Controlled Area"** | | | | |
| **Member of the General Public** | 0.1 rem in a year | Not Addressed | 0.1 rem in any one year; 0.002 rem in any one hour | Not Addressed |
| **Radiation Levels in Unrestricted (Uncontrolled) Areas** | | | | |
| **Member of the General Public** | 0.002 rem in any one hour | | 0.002 rem in any one hour or 0.100 rem in any one year | Not Addressed |

*Applicable period is nine months rather than 1 year.

Although OSHA subscribes to dose limits set in NRC regulations, EPA guidance, and various consensus standards, they have not incorporated these limits into 29 CFR 1910.1096. The NRC regulations incorporate the most recent guidance from the International Commission on Radiological Protection (ICRP) as well as the National Council on Radiation Protection and Measurements (NCRP).

### Radiation Protection Principles

In the United States and most other countries, three basic principles have governed radiation protection of workers and members of the general public:

1. Any activity involving occupational exposure should be useful enough to society to warrant the exposure of the worker. This same principle applies to virtually any human endeavor that involves some risk of injury.
2. For justified activities, exposure of the work force should be as low as reasonably achievable (ALARA).
3. To provide an upper limit on risk to individual workers, "limitation" of the maximum allowed dose is required. This is required above the protection provided by the first two principles because their primary objective is to minimize the total harm from occupational exposure to the entire work force; they do not limit the way that harm is distributed among individual workers.

### As Low as is Reasonably Achievable (ALARA)

"As Low as is Reasonably Achievable" (ALARA) means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest. This common sense approach means that radiation doses for both workers and the general public are typically kept lower than their regulatory limits.

The principle reduction of exposure to levels that are "as low as is reasonably achievable" is typically implemented in four different ways.

1. Shielding of the source holder.
2. Selection of as small of an amount of source material as is needed.
3. Designing facilities to reduce the anticipated exposure.
4. Designing work practices to reduce the anticipated exposure.

Effective implementation of the ALARA principle involves most facets of an effective radiation protection program including: education of workers concerning the health risks of exposure to radiation, training in regulatory requirements and procedures to control exposure, monitoring, assessment, and reporting of exposure levels and doses and management and supervision of radiation protection activities including the choice and implementation of radiation control measures.

A comprehensive radiation protection program will also include, as appropriate: properly trained and qualified radiation protection personnel; adequately designed, operated and maintained facilities and equipment; and quality assurance and audit procedures.

### Customs and Border Protection Dose Limits

In conformance with ALARA principles, CBP has adopted for its workers the same dose limit as the NRC prescribes for the general public – i.e. 0.1 rem in any year. As a result, CBP will establishes controlled areas around HEMXRISs as described in section 3.3.3.1.2.1 (Human Exposure) to equally protect the general public, truck drivers, port personnel and other CBP personnel from radiation emissions in accordance with the maximum dose permitted pursuant to NRC. CBP has taken care to model and explore potential exposure to employees working around these systems, and has even made measurements if someone were to be scanned by this or other NII systems. See "Radiation Dose Equivalent to Stowaways in Vehicles," Khan, et al, Health Physics Journal, Volume 86, No. 5, p. 483, May 2004.

### Health Risks

In their August 2004 revised position statement on radiation risk, the Health Physics Society recommended against the quantitative estimation of health risks below an individual dose of 5 rem in a one year or a lifetime dose of 10 rem above that received from natural sources. Doses from natural background radiation in the United States average about 0.360 rem per year. Estimation of health risks associated with radiation doses that are of similar magnitude as those received from natural sources should be strictly qualitative and encompass a range of hypothetical health outcomes, including the possibility of no adverse health effects at such low levels.

The Society further states "While there is substantial and convincing scientific evidence for health risks following high-dose exposures, below 5-10 rem (which includes occupational and environmental exposures), risks of health effects are either too small to be observed or nonexistent."

The Society has concluded that estimates of risk should be limited to individuals receiving a dose of 5 rem in any one year or a lifetime dose of 10 rem in addition to natural background. Below these doses, risk estimates should not be used. Expressions of risk should only be qualitative, that is, a range based on the uncertainties in estimating risk (NCRP 1997) emphasizing the inability to detect any increased health detriment (that is zero health effects is a probable outcome).

# Appendix D: Background Information Concerning Risks from Occupational Radiation Exposure

The background material contained in this appendix is excerpted of from the U.S. Nuclear Regulatory Commission Regulatory Guide 8.29, "Instruction Concerning Risks From Occupational Radiation Exposure," February 1996 and the Health Physics Society "Radiation Basics" http://www.hps.org/publicinformation/ate/faqs/radiation.html. This material is intended to provide the user with the best available information about the health risks from occupational exposure to ionizing radiation. Ionizing radiation consists of energy or small particles, such as gamma rays and beta and alpha particles, emitted from radioactive materials, which can cause chemical or physical damage when they deposit energy in living tissue. A question and answer format is used. Many of the questions or subjects were developed by the NRC staff in consultation with workers, union representatives and licensee representatives experienced in radiation protection training.

## How Is Radiation Measured?

In the United States, radiation dose or exposure is measured in units called rad, rem, or roentgen(R). For practical purposes with gamma and X-Rays, these are considered equal: 1 R = 1 rad = 1 rem.

Milli (m) means 1/1000. For example, 1,000 mrad = 1 rad. Micro (μ) means 1/1,000,000. So, 1,000,000 μrad = 1 rad, or 10 μR = 0.000010 R.

The International System of Units (SI system) for radiation measurement use "gray" and "sievert."
1 Gy = 100 rad
1 mGy = 100 mrad
1 Sv = 100 rem
1 mSv = 100 mrem

## Is It Safe To Be Around Sources Of Radiation?

A single high-level radiation exposure (i.e., greater than 10,000 mrem) delivered to the whole body over a very short period of time may have potential health risks. From follow-up of the atomic bomb survivors, we know acutely delivered very high radiation doses can increase the occurrence of certain kinds of disease (e.g., cancer) and possibly negative genetic effects. To protect the public and radiation workers (and environment) from the potential effects of chronic low-level exposure (i.e., less than 10,000 mrem), the current radiation safety practice is to prudently assume similar adverse effects are possible with low-level protracted exposure to radiation. Thus, the risks associated with low-level medical, occupational, and environmental radiation exposure are conservatively calculated to be proportional to those observed with high-level exposure. These calculated risks are compared to other known occupational and environmental hazards, and appropriate safety standards and policies have been established by international and national radiation protection organizations (e.g., International Commission on Radiological Protection and National Council on Radiation Protection and Measurements) to control and limit potential harmful radiation effects.

Both public and occupational regulatory dose limits are set by federal agencies (i.e., Environmental Protection Agency, Nuclear Regulatory Commission, and Department of Energy) and state agencies (e.g., agreement states) to limit cancer risk. Other radiation dose limits are applied to limit other potential biological effects with workers' skin and lens of the eye.

| **Annual Radiation Dose Limits** | **Agency** |
| --- | --- |
| Radiation Worker - 5,000 mrem | (NRC, "occupationally" exposed) |
| General Public - 100 mrem | (NRC, member of the public) |
| General Public - 25 mrem | (NRC, D&D all pathways) |
| General Public - 10 mrem | (EPA, air pathway) |
| General Public - 4 mrem | (EPA, drinking-water pathway) |

## What Is Meant By Health Risk?

A health risk is generally thought of as something that may endanger health. Scientists consider health risk to be the statistical probability or mathematical chance that personal injury, illness, or death may result from some action. Most people do not think about health risks in terms of mathematics. Instead, most of us consider the health risk of a particular action in terms of whether we believe that particular action will, or will not, cause us some harm. The intent of this appendix is to provide estimates of, and explain the basis for, the risk of injury, illness, or death from occupational radiation exposure. Risk can be quantified in terms of the probability of a health effect per unit of dose received.

When X-Rays, gamma rays, and ionizing particles interact with living materials such as our bodies, they may deposit enough energy to cause biological damage.

Radiation can cause several different types of events such as the very small physical displacement of molecules, changing a molecule to a different form, or ionization, which is the removal of electrons from atoms and molecules. When the quantity of radiation energy deposited in living tissue is high enough, biological damage can occur as a result of chemical bonds being broken and cells being damaged or killed. These effects can result in observable clinical symptoms.

The basic unit for measuring absorbed radiation is the rad. One rad (0.01 gray in the International System of units) equals the absorption of 100 ergs (a small but measurable amount of energy) in a gram of material such as tissue exposed to radiation. To reflect biological risk, rad must be converted to rem. The new international unit is the sievert (100 rem = 1 Sv). This conversion accounts for the differences in the effectiveness of different types of radiation in causing damage. The rem is used to estimate biological risk. For beta and gamma radiation, a rem is considered equal to a rad.

## What Are The Possible Health Effects Of Exposure To Radiation?

Health effects from exposure to radiation range from no effect at all to death, including diseases such as leukemia or bone, breast and lung cancer. Very high (100s of rad), short-term doses of radiation have been known to cause prompt (or early) effects, such as vomiting and diarrhea, skin burns, cataracts and even death. It is suspected that radiation exposure may be linked to the potential for genetic effects in the children of exposed parents. Also, children who were exposed to high doses (20 or more rad) of radiation prior to birth (as an embryo/fetus) have shown an increased risk of mental retardation and other congenital malformations. These effects (with the exception of genetic effects) have been observed in various studies of medical radiologists, uranium miners, radium workers, radiotherapy patients and the people exposed to radiation from atomic bombs dropped on Japan. In addition, radiation effects studies with laboratory animals, in which the animals were given relatively high doses, have provided extensive data on radiation-induced health effects, including genetic effects.

It is important to note that these kinds of health effects result from high doses, compared to occupational levels, delivered over a relatively short period of time.

Although studies have not shown a consistent cause-and-effect relationship between current levels of occupational radiation exposure and biological effects, it is prudent from a worker protection perspective to assume that some effects may occur.

## Who Developed Radiation Risk Estimates?

Radiation risk estimates were developed by several national and international scientific organizations over the last 40 years. These organizations include the National Academy of Sciences (which has issued several reports from the Committee on the Biological Effects of Ionizing Radiations, BEIR), the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Each of these organizations continues to review new research findings on radiation health risks.

Several reports from these organizations present new findings on radiation risks based upon revised estimates of radiation dose to survivors of the atomic bombing at Hiroshima and Nagasaki. For example, UNSCEAR published risk estimates in 1988 and 1993 (UNSCEAR 1988; UNSCEAR 1993). The NCRP also published a report in 1988, “New Dosimetry at Hiroshima and Nagasaki and Its Implications for Risk Estimates” (NCRP 1988). In January 1990, the National Academy of Sciences released the fifth report of the BEIR Committee, “Health Effects of Exposure to Low Levels of Ionizing Radiation,” National Research Council, 1990). Each of these publications also provides extensive bibliographies on other published studies concerning radiation health effects for those who may wish to read further on this subject.

## What Are The Estimates Of The Risk Of Fatal Cancer From Radiation Exposure?

We don't know exactly what the chances are of getting cancer from a low-level radiation dose, primarily because the few effects that may occur cannot be distinguished from normally occurring cancers. However, we can make estimates based on extrapolation from extensive knowledge from scientific research on high dose effects. The estimates of radiation effects at high doses are better known than are those of most chemical carcinogens (NCRP 1989).

From currently available data, the NRC has adopted a risk value for an occupational dose of 1 rem (0.01 Sv) Total Effective Dose Equivalent (TEDE) of 4 in 10,000 of developing a fatal cancer, or approximately 1 chance in 2,500 of fatal cancer per rem of TEDE received. The uncertainty associated with this risk estimate does not rule out the possibility of higher risk, or the possibility that the risk may even be zero at low occupational doses and dose rates.

The radiation risk incurred by a worker depends on the amount of dose received. A worker who receives 5 rem (0.05 Sv) in a year incurs 10 times as much risk as another worker who receives only 0.5 rem (0.005 Sv). Only a very few workers receive doses near 5 rem (0.05 Sv) per year (Raddatz and Hagemeyer 1995).

According to the BEIR V report (National Research Council 1990), approximately one in five adults normally will die from cancer from all possible causes such as smoking, food, alcohol, drugs, air pollutants, natural background radiation and inherited traits. Thus, in any group of 10,000 workers, we can estimate that about 2,000 (20%) will die from cancer without any occupational radiation exposure.

To explain the significance of these estimates, we will use as an example a group of 10,000 people, each exposed to 1 rem (0.01 Sv) of ionizing radiation. Using the risk factor of 4 effects per 10,000 rem of dose, we estimate that 4 of the 10,000 people might die from delayed cancer because of that 1 rem dose (although the actual number could be more or less than 4) in addition to the 2,000 normal cancer fatalities expected to occur in that group from all other causes. This means that a 1 rem (0.01 Sv) dose may increase an individual worker's chances of dying from cancer from 20 percent to 20.04 percent. If one's lifetime occupational dose is 10 rem, we could raise the estimate to 20.4 percent. A lifetime dose of 100 rem may increase chances of dying from cancer from 20 to 24 percent.[5] It is important to understand the probability factors here. A

[5] Given the CBP standard of 0.1 rem (0.001 Sv) exposure in any one year, the risk would equate to 4 effects per 100,000. This means that a 0.1 rem (0.001 Sv) dose may increase an individual workers chance of dying from cancer from 20 percent to 20.005 percent. The average measurable dose for radiation workers reported to the NRC was 0.31 rem (0.0031 Sv) for 1993 (Raddatz and Hagemeyer, 1995). Today, very few CBP employees ever accumulate 100 rem (1 Sv) in a working lifetime, and the average career dose of workers at NRC-licensed facilities

similar question would be, "If you select one card from a full deck of cards, will you get the ace of spades?" This question cannot be answered with a simple yes or no. The best answer is that your chance is 1 in 52. However, if 1000 people each select one card from full decks; we can predict that about 20 of them will get an ace of spades. Each person will have 1 chance in 52 of drawing the ace of spades, but there is no way we can predict which persons will get that card. The issue is further complicated by the fact that in a drawing by 1000 people, we might get only 15 successes, and in another, perhaps 25 correct cards in 1000 draws. We can say that if you receive a radiation dose, you will have increased your chances of eventually developing cancer. It is assumed that the more radiation exposure you get, the more you increase your chances of cancer.

The normal chance of dying from cancer is about one in five for persons who have not received any occupational radiation dose. The additional chance of developing fatal cancer from an occupational exposure of 1 rem (0.01 Sv) is about the same as the chance of drawing any ace from a full deck of cards three times in a row. The additional chance of dying from cancer from an occupational exposure of 10 rem (0.1 Sv) is about equal to your chance of drawing two aces successively on the first two draws from a full deck of cards.

It is important to realize that these risk numbers are only estimates based on data for people and research animals exposed to high levels of radiation in short periods of time. There is still uncertainty with regard to estimates of radiation risk from low levels of exposure. Many difficulties are involved in designing research studies that can accurately measure the projected small increases in cancer cases that might be caused by low exposures to radiation as compared to the normal rate of cancer.

These estimates are considered by the NRC staff to be the best available for the worker to use to make an informed decision concerning acceptance of the risks associated with exposure to radiation. A worker who decides to accept this risk should try to keep exposure to radiation as low as is reasonably achievable (ALARA) to avoid unnecessary risk.

## If I Receive A Radiation Dose That Is Within Occupational Limits, Will It Cause Me To Get Cancer?

Probably not. Based on the risk estimates previously discussed, the risk of cancer from doses below the occupational limits is believed to be small. Assessment of the cancer risks that may be associated with low doses of radiation are projected from data available at doses larger than 10 rem (0.1 Sv) (ICRP 1991). For radiation protection purposes, these estimates are made using the straight line portion of the linear quadratic model (Curve 2 in Figure 1). We have data on cancer probabilities only for high doses, as shown by the solid line in 8. Only in studies involving radiation doses above occupational limits are there dependable determinations of the risk of cancer, primarily because below the limits the effect is small compared to differences in

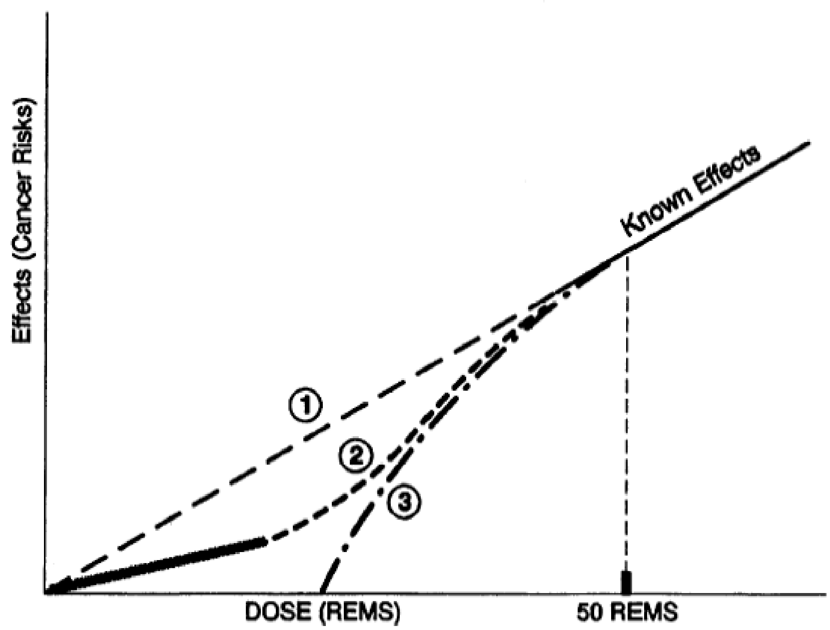
---

is 1.5 rem (0.015 Sv), which represents an estimated increase from 20 to about 20.06 percent in the risk of dying from cancer.

the normal cancer incidence from year to year and place to place. The ICRP, NCRP and other standards-setting organizations assume for radiation protection purposes that there is some risk, no matter how small the dose (Curves 1 and 2). Some scientists believe that the risk drops off to zero at some low dose (Curve 3), the threshold effect, The ICRP and NCRP endorse the linear quadratic model as a conservative means of assuring safety (Curve 2).

For regulatory purposes, the NRC uses the straight line portion of Curve 2, which shows the number of effects decreasing linearly as the dose decreases. Because the scientific evidence does not conclusively demonstrate whether there is or is not an effect at low doses, the NRC assumes for radiation protection purposes, that even small doses have some chance of causing cancer. Thus, a principle of radiation protection is to do more than merely meet the allowed regulatory limits; doses should be kept as low as is reasonably achievable (ALARA). This is as true for natural carcinogens such as sunlight and natural radiation as it is for those that are manmade, such as cigarette smoke, smog and X-Rays.

**Figure 1 Some Proposed Models for How the Effects of Radiation Vary with Doses at Low Levels**




## How Can We Compare The Risk Of Cancer From Radiation To Other Kinds Of Health Risks?

One way to make these comparisons is to compare the average number of days of life expectancy lost because of the effects associated with each particular health risk. Estimates are calculated by looking at a large number of persons, recording the age when death occurs from specific causes, and estimating the average number of days of life lost as a result of these early deaths. The total number of days of life lost is then averaged over the total observed group.

Several studies have compared the average days of life lost from exposure to radiation with the number of days lost as a result of being exposed to other health risks. The word “average” is important because an individual who gets cancer loses about 15 years of life expectancy, while his or her coworkers do not suffer any loss.

Some representative numbers are presented in Table 1. For categories of NRC-regulated industries with larger doses, the average measurable occupational dose in 1993 was 0.31 rem (0.0031 Sv). A simple calculation based on the article by Cohen and Lee (Cohen and Lee 1991) shows that 0.3 rem (0.003 Sv) per year from age 18 to 65 results in an average loss of 15 days. These estimates indicate that the health risks from occupational radiation exposure are smaller than the risks associated with many other events or activities we encounter and accept in normal day-to-day activities.

It is also useful to compare the estimated average number of days of life lost from occupational exposure to radiation with the number of days lost as a result of working in several types of industries. Table 2 shows average days of life expectancy lost as a result of fatal work-related accidents. Table 2 does not include non-accidental types of occupational risks such as occupational disease and stress because the data are not available.

These comparisons are not ideal because we are comparing the possible effects of chronic exposure to radiation to different kinds of risks such as accidental death, in which death is inevitable if the event occurs. This is the best we can do because good data are not available on chronic exposure to other workplace carcinogens. Also, the estimates of loss of life expectancy for workers from radiation-induced cancer do not take into consideration the competing effect on the life expectancy of the workers from industrial accidents.

**Table 1 Estimated Loss of Life Expectancy from Health Risks**

| Health Risks | Estimate of Life Expectancy Lost (Average) |
|---|---|
| Smoking 20 cigarette a day | 6 years |
| Overweight (by 15%) | 2 years |
| Alcohol consumption (U.S. average) | 1 year |
| All accidents combined | 1 year |
| Motor vehicle accidents | 207 days |
| Home accidents | 74 days |
| Drowning | 24 days |
| All natural hazards (earthquake, lightning, flood, etc.) | 7 days |
| Medical radiation | 6 days |
| **Occupational Exposure** | |
| 0.3 rem/y from age 18 to 65 | 15 days |
| 1 rem/y from age 18 to 65 | 51 days |

(Cohen and Lee 1991)

**Table 2 Estimated Loss of Life Expectancy from Industrial Accidents**

| Industry Type | Estimated Days of Life Expectancy Lost (Average) |
|---|---|
| All Industries | 60 |
| Agriculture | 320 |
| Construction | 227 |
| Mining and Quarrying | 167 |
| Transportation and Public Utilities | 160 |
| Government | 60 |
| Manufacturing | 40 |
| Trade | 27 |
| Services | 27 |

(Cohen and Lee 1991)

## What Are The Health Risks From Radiation Exposure To The Embryo/Fetus?

During certain stages of development, the embryo/fetus is believed to be more sensitive to radiation damage than adults. Studies of atomic bomb survivors exposed to acute radiation doses exceeding 20 rad (0.2 Gy) during pregnancy show that children born after receiving these doses have a higher risk of mental retardation. Other studies suggest that an association exists between exposure to diagnostic X-Rays before birth and carcinogenic effects in childhood and in adult life. Scientists are uncertain about the magnitude of the risk. Some studies show the embryo/fetus to be more sensitive to radiation-induced cancer than adults, but other studies do not. In recognition of the possibility of increased radiation sensitivity, and because dose to the embryo/fetus is involuntary on the part of the embryo/fetus, a more restrictive dose limit has been established for the embryo/fetus of a declared pregnant radiation worker. See Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure.”

If an occupationally exposed woman declares her pregnancy in writing, she is subject to the more restrictive dose limits for the embryo/fetus during the remainder of the pregnancy. The dose limit of 500 mrem (5 mSv) for the total gestation period applies to the embryo/fetus and is controlled by restricting the exposure to the declared pregnant woman. Restricting the woman’s occupational exposure, if she declares her pregnancy, raises questions about individual privacy rights, equal employment opportunities and the possible loss of income. Because of these concerns, the declaration of pregnancy by a female radiation worker is voluntary. Also, the declaration of pregnancy can be withdrawn for any reason, for example, if the woman believes that her benefits from receiving the occupational exposure would outweigh the risk to her embryo/fetus from the radiation exposure.

## Can A Worker Become Sterile Or Impotent From Normal Occupational Radiation Exposure?

No. Temporary or permanent sterility cannot be caused by radiation at the levels allowed under NRC’s occupational limits. There is a threshold below which these effects do not occur. Acute doses on the order of 10 rem (0.1 Sv) to the testes can result in a measurable but temporary reduction in sperm count. Temporary sterility (suppression of ovulation) has been observed in women who have received acute doses of 150 rad (1.5 Gy). The estimated threshold (acute) radiation dose for induction of permanent sterility is about 200 rad (2 Gy) for men and about 350 rad (3.5 Gy) for women (National Research Council 1990; Scott et al 1993). These doses are far greater than the NRC’s occupational dose limits for workers.

Although acute doses can affect fertility by reducing sperm count or suppressing ovulation, they do not have any direct effect on one’s ability to function sexually. No evidence exists to suggest that exposures within the NRC’s occupational limits have any effect on the ability to function sexually.

## What Are Background Radiation Exposures?

The average person is constantly exposed to ionizing radiation from several sources. Our environment and even the human body contain naturally occurring radioactive materials (e.g., potassium-40) that contribute to the radiation dose that we receive. The largest source of natural background radiation exposure is terrestrial radon, a colorless, odorless, chemically inert gas, which causes about 55 percent of our average, non-occupational exposure. Cosmic radiation originating in space contributes additional exposure. The use of X-Rays and radioactive materials in medicine and dentistry adds to our population exposure. As shown below in Table 3, the average person receives an annual radiation dose of about 0.36 rem (3.6 mSv). By age 20, the average person will accumulate over 7 rem (70 mSv) of dose. By age 50, the total dose is up to 18 rem (180 mSv). After 70 years of exposure this dose is up to 25 rem (250 mSv).

**Table 3 Average Annual Effective Dose Equivalent to Individuals in the U.S.**

| Source | | Effective Dose Equivalent (mrem) | |
|---|---|---|---|
| Natural | | | |
| | Radon | 200 | |
| | Other than Radon | 100 | |
| | Total Natural | | 300 |
| Nuclear Fuel Cycle | | | 0.05 |
| Consumer Products[b] | | | 9 |
| Medical | | | |
| | Diagnostic X-Rays | 39 | |
| | Nuclear Medicine | 14 | |
| | Total Medical | | 53 |
| Total | | | About 360 mrem/year |

(NCRP 1987).

## References

B.L. Cohen and I.S. Lee, “Catalog of Risks Extended and Updated,” Health Physics, Vol. 61, September 1991.

B.R. Scott et al., “Health Effects Model for Nuclear Power Plant Accident Consequence Analysis,” Part I: Introduction, Integration, and Summary, U.S. Nuclear Regulatory Commission, NUREG/CR-4214, Revision 2, Part I, October 1993.

C.T. Raddatz and D. Hagemeyer, “Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, 1993,” U.S. Nuclear Regulatory Commission, NUREG-0713, Volume 15, January 1995.

International Commission on Radiological Protection (ICRP), Annals of the ICRP, Risks Associated with Ionizing Radiation, Volume 22, No.1, Pergamon Press, Oxford, UK, 1991.

National Council on Radiation Protection and Measurements (NCRP), New Dosimetry at Hiroshima and Nagasaki and Its Implications for Risk Estimates, Proceedings of the Twenty-third Annual Meeting of the National Council on Radiation Protection and Measurements Held on April 8-9, 1987 (1988).

National Council on Radiation Protection and Measurements (NCRP), Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 93, September 1987.

National Council on Radiation Protection and Measurements (NCRP), Comparative Carcinogenicity of Ionizing Radiation and Chemicals, NCRP Report No. 96, March 1989.

National Research Council, Health Effects of Exposure to Low Levels of Ionizing Radiation, Report of the Committee on the Biological Effects of Ionizing Radiation (BEIR V), National Academy Press, Washington, DC, 1990.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR); Sources, Effects and Risks of Ionizing Radiation, Report E.88.IX.7, United Nations, New York, 1988.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), Sources, Effects and Risks of Ionizing Radiation, United Nations, New York, 1993.

U.S. Nuclear Regulatory Commission Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure. February 1996.