APPENDIX H

Detailed Analyses of Normal Operations and Accident Conditions for Radiological Support Facilities

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APPENDIX H

DETAILED ANALYSES OF NORMAL OPERATIONS AND ACCIDENT CONDITIONS FOR RADIOLOGICAL SUPPORT FACILITIES

1.0 INTRODUCTION

Normal operations and accidents have been evaluated for support facilities to estimate the potential for releases of radioactive material. The results of these analyses, predicted due to the release of radioactive materials into the environment, are presented in terms of the health effects on facility workers and the public. For perspective, an additional discussion on radiation exposure and risk is provided in Appendix G, and supports the position that these analyses are conservative. Effects on environmental factors are also presented, based on the amount of land that could be impacted due to postulated accidents.

Accidents were considered for inclusion in detailed analyses if they were expected to contribute substantially to risk (defined as the product of the probability of occurrence of the accident and the consequence of the accident). Accidents were categorized into three types: Abnormal Events, Design Basis Accidents, or Beyond Design Basis Accidents. These categories are characterized by their probability of occurrence as described further in Section 2.6 of this appendix. Two hypothetical accidents were analyzed using site-specific data. The first scenario is a fire in a radiological support facility that spreads to radioactive material resulting in an airborne release of radioactivity. The second scenario is a spill of radioactive liquid from a collection facility into surrounding waters. References for citations in this appendix are located in Chapter 10 and are listed under the references section for Chapter 5.

1.1 USE OF SCIENTIFIC NOTATION

Much of the data in this appendix is presented using scientific notation. Scientific notation is commonly used to represent very large or small numbers. It consists of a number multiplied by the appropriate power of 10. For example, 0.0000035 would be represented as 3.5×10^{-6} and 3,500,000 would be represented as 3.5×10^{6}.

1.2 RISK FROM NORMAL OPERATION

Table H-1 presents the annual risk of latent fatal cancer (LFC) to a member of the general population living within a 50-mile radius of Naval Station (NAVSTA) Mayport, Florida and for the maximally exposed off-site individual (MOI) due to radiological releases from normal radiological support facility operations. The population within a 50-mile radius of NAVSTA Mayport is estimated to be 1,393,489, based on 2000 census projections for 2006. The normal incidence of cancer for a typical population has been included for comparison. The results in this table were calculated using the methods described in Section 2.0 of this appendix. The results show that the annual individual risk of a latent fatal cancer occurring in the general population within 50 miles of NAVSTA Mayport is very low, less than one in 3.3 billion. See Section 3.1 of this appendix for more information on calculation of risks from normal operation.

Table H-1. Annual Risk of Latent Fatal Cancer From Normal Operations

Location	*Average Annual Risk of LFC to a Member of the General Population*	*Individual Annual Risk of LFC to the Maximally Exposed Off-Site Individual*	*An Individual's Annual Risk of Dying From All Cancers*
NAVSTA Mayport	1 in 3.3 billion (3.1×10^{-10})	1 in 29 million (3.5×10^{-8})	1 in 360 (2.8×10^{-3})

1.3 RISK FROM HYPOTHETICAL ACCIDENTS AT SUPPORT FACILITIES

Two hypothetical radiological support facility accidents were analyzed for NAVSTA Mayport using the methods described in Section 2.0 of this appendix. The analysis does not combine the risks associated with both accidents. The risks presented in this section result from extremely conservative analyses and more refined analyses would not be expected to result in increases in calculated risk.

The accident that results in the highest latent fatal cancer risk is a fire in the radiological support facility that involves radioactive materials. As was the case for the normal operations evaluation, the accident latent fatal cancer risk is very low.

Table H-2 presents a summary of the risk of fatal cancers for a hypothetical fire at a radiological support facility, the risk for a hypothetical release of liquid containing low-level radioactivity, and, for comparison, the risk of fatal cancer from all sources in a typical population. This summary table shows that the annual individual latent fatal cancer risk to a member of the general population due to accidents associated with support facilities for homeporting of a NIMITZ-class aircraft carrier at NAVSTA Mayport is very low, one in 1 billion. (See Section 3.2 of this appendix for more information on calculation of latent fatal cancer risks associated with hypothetical accidents at support facilities.)

Table H-2. Annual Risk of Latent Fatal Cancer From Radiological Support Facility Accidents

Location	*Average Annual Risk of LFC to a Member of the General Population From a Fire, Including Probability of Fire Occurring*	*Individual Average Annual Risk of LFC to a Maximally Exposed Off-Site Individual From a Fire, Including Probability of Fire Occurring*	*Average Annual Risk of LFC to a Member of the General Population From a Spill, Including Probability of Spill Occurring*	*Average Annual Risk of LFC to a Maximally Exposed Off-Site Individual From a Spill, Including Probability of Spill Occurring*	*An Individual's Annual Risk of Dying From All Cancers*
NAVSTA Mayport	1 in 1 billion (9.6×10^{-10})	1 in 1 million (9.7×10^{-7})	1 in 120 billion (8.6×10^{-12})	1 in 5.9 billion (1.7×10^{-10})	1 in 360 (2.8×10^{-3})

1.4 RADIOLOGICAL IMPACT ON ENVIRONS

The radiological impact of accidents on the environs of NAVSTA Mayport was determined by examining the area that could be contaminated following the accident. To determine the area that could be contaminated, calculations using average meteorological conditions provided input for the accident scenario (95-percent worst-case meteorology was used when calculating exposure and risk to workers and the general population). These calculations determined the extent of the contamination that causes only a small increase in background radiation from naturally occurring sources. For the fire accident analyzed, the contaminated area was confined to the boundaries of NAVSTA Mayport. The impact of this contamination would be temporary while the area was isolated and remediation efforts completed; however, the analysis of the accident presented elsewhere in this Environmental Impact Statement (EIS) makes the conservative assumption that no isolation or removal occurs.

A footprint was not calculated for the release of a radioactive liquid accident, due to the rapid dilution of the radioactive material that occurs in the water.

The conclusion that there are no significant radiological impacts associated with homeporting a carrier in NAVSTA Mayport is based on the Navy's historical record of safe operation of nuclear-powered warships and a comprehensive environmental monitoring program performed by the Navy and corroborated by independent monitoring that has been in place for decades. Chapter 5 of the EIS provides a detailed discussion of both the Navy's record and environmental monitoring program.

1.5 CALCULATION OF RISK AND CONSEQUENCE

This EIS provides several discussions on the topics of human health effects caused by radiation and the risks associated with normal operations or postulated accidents. It is important to understand these concepts and how they are used to understand the information presented in this document. It is also valuable to have some frame of reference or comparison for understanding how the risks compare to the risks of daily life.

The EIS radiological analyses used a methodology that is consistent with other federal agencies' guidance for preparing National Environmental Policy Act (NEPA) documentation involving radiological analyses. (See Section 6.2 of Volume 2, U.S. Department of Energy, Office of NEPA Policy and Compliance, Part 2-Guidance on NEPA Document Preparation, Section 2-10, Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, Second Edition, December 2004.) The incidence of fatal cancer was evaluated using International Commission on Radiological Protection (ICRP) methodology (ICRP 1991), which is also consistent with the methodology set forth in the National Academy of Sciences (NAS) Biological Effects of Ionizing Radiation Report (NAS 1990).

The method used to calculate the risk of any impact is fundamental to all of the evaluations presented and follows standard accepted practices. The first step is to determine the probability that a specific event will occur. For example, the probability that a routine task, such as operating a crane, will be performed sometime during a year of normal operations at a facility would be 1.0. That means that the action would certainly occur. The probability that an accident might occur is less than 1.0. This is true because accidents occur only occasionally and some of the more severe accidents, such as a catastrophic earthquake, might occur at any location only once in hundreds, thousands, or millions of years.

Once the probability of an event has been determined, the next step is to predict what the consequences of the event being considered might be. One important measure of consequences chosen for this EIS is the number of human fatalities from cancer induced by radiation. This was chosen because this document deals with radioactive materials. The number of cancer fatalities that might be caused by any routine operation or any postulated accident can be calculated using a standard technique based on the amount of radiation exposure that might occur from all conceivable pathways and the number of people who might be affected (refer to Section 2.2 of this appendix).

Two examples illustrate the calculation of risk. In the first, the lifetime risk of dying in a motor vehicle accident can be computed from the likelihood of an individual being in an automobile accident and the consequences or number of fatalities per accident. There were 6,181,000 motor vehicle accidents during 2004 in the United States resulting in 42,636 deaths (National Highway Traffic Safety Administration 2005). Thus, the probability of a person being in an automobile accident is 6,181,000 accidents divided by approximately 300,000,000 persons in the United States, or about 0.02 per year. The number of fatalities per accident, 0.007 (42,636 deaths divided by 6,181,000 accidents), is less than one since many accidents do not cause fatalities. Multiplying the probability of the accident (0.02 per year) by the consequences of the accident (0.007 deaths per accident) by the number of years the person is exposed to the risk (77.5 years is considered to be an average lifetime as of 2003 (National Vital Statistics Report 2006)) gives the risk for any individual being killed in an automobile accident. From this calculation, the overall risk of someone dying in a motor vehicle accident is about one in 92 over his or her lifetime.

As a further comparison, the naturally occurring radioactive materials in agricultural fertilizer contribute about l to 2 millirems per year to an average American's exposure to radiation (NCRPM 1987a, Publication 95). A calculation similar to the one in the preceding paragraph shows that the use of fertilizer to produce food crops in the United States results in a lifetime risk of death from cancer from this radiation between one in 25,800 and one in 12,900, respectively. Finally, the average American's risk of dying from cancer from all causes is one in five over his or her entire lifetime. These risks can be compared, for example, to the average individual risk of less than one in 2.8 million for a resident near the home port location of developing a fatal cancer over that person's entire lifetime due to normal operations and support of a NIMITZ-class aircraft carrier. These risks and others from everyday life can be used to gain a perspective on the risks associated with the actions associated with homeporting a NIMITZ-class nuclear-powered aircraft carrier at NAVSTA Mayport.

A frame of reference for the lifetime risks from accidents associated with NIMITZ-class aircraft carrier operations and support can be developed in the same way. For example, for an average resident within 50 miles of NAVSTA Mayport, the individual risk of death from cancer over a person’s entire lifetime caused by a radioactive material fire in the support facility would be approximately one in 14 million. This individual risk was determined by dividing the risk value to the population within 50 miles (1.3×10^{-3}) by the population total (1,393,489) and multiplying by an average life span of 77.5 years. This risk can be compared to the risks of death from other accidental causes to gain a perspective. For example, earlier calculations showed the lifetime risk of death in a motor vehicle accident to be about one in 92. Similarly, the lifetime risk of death for the average American from fires is approximately one in 1300 (National Center for Injury Prevention and Control (NCIPC) 2005 Statistics), and for death from accidental poisoning the risk is about one in 135 (NCIPC 2003 Statistics).

2.0 PATHWAYS ANALYSIS

Accidents were considered for inclusion in detailed analyses if they were expected to contribute substantially to risk. The pathways from radiological support facility operations, which may affect the public, are direct exposure to radiation, inhalation of radioactive materials, and ingestion of radioactive materials. Recognizing these fundamental processes and pathways, two hypothetical accidents were postulated, each resulting in a release of 1 Curie of cobalt-60 (^{60}Co) and the associated proportioned amounts of other radioactive elements expected.

The first scenario is a fire in a radiological support facility that spreads to radioactive material and results in an airborne release of radioactivity. The amount of radioactivity released during this accident scenario was conservatively established at 1 Curie of ^{60}Co and the associated proportioned amounts of other radioactive elements expected, which represents a conservative amount of radioactivity as compared to the typical amount that might accumulate within a support facility due to normal operations. Note that this amount of activity is more than 500 times the annual amount released to harbors within the 12-mile coastal waters by the entire nuclear navy. For the analysis, several conservative assumptions were used as follows:

- The meteorological conditions are considered to be 95-percent worst case (with no credit given that the likelihood of these conditions is only one in 20).
- No evacuation of the public is assumed.
- No cleanup of the contaminated area is assumed to occur.

These assumptions are conservative since radioactive material storage facilities are specifically constructed to inhibit the spread of fire and have installed automatic sprinkler systems. Moreover, emergency response measures include provisions for immediate response to any emergency, identification of the accident conditions, and communications with state and local authorities.

The second scenario is a spill into surrounding waters of radioactive liquid from a collection facility. The released radioactivity is evaluated for transfer from the location of release to the public through tidal movements and ingestion by fish and crustaceans. The amount of water release was assumed to contain 1 Curie of ^{60}Co and the associated proportioned amount of other radioactive elements expected. These assumptions are conservative since it would require a spill of over 26 million gallons of radioactive liquid (discharged primary coolant) at levels normally contained in collection facilities, which are tanks no larger than 10,000 gallons. Furthermore, the total capacity to store radioactive liquid at support facilities typically would be less than 100,000 gallons.

Examining the kinds of accidents that could result in release of radioactive material to the environment or an increase in radiation levels shows that they can only occur if an accident produces severe conditions. Some types of accidents, such as procedure violations, spills of small volumes of water containing radioactive particles, or most other types of common human error, may occur more frequently than the more severe accidents analyzed. However, they involve minute amounts of radioactive material and thus are insignificant relative to the accidents evaluated. Stated another way, the very low consequences associated with these events produce smaller risks than those for the accidents analyzed, even when combined with a higher probability of occurrence. Consequently, they have not been evaluated in greater detail in this EIS.

Events such as acts of terrorism or hurricane storm surge would result in consequences bounded by the results of accidents evaluated in this EIS, because the accidents analyzed include conservative estimates of the amounts of radioactive material at the radiological support facility.

The EIS analyses performed for NAVSTA Mayport CVN homeporting are such that the estimates provided are unlikely to be exceeded during normal operations, accident events, or acts of terrorism. Even using these conservative analytical methods, the risks are very small and support the conclusion that there are no significant radiological impacts associated with homeporting a CVN at NAVSTA Mayport.

2.1 CALCULATION OF RADIATION EXPOSURES

An evaluation of normal operations and hypothetical accidents at NAVSTA Mayport was performed to assess the possible radiation exposure to individuals due to the release of radioactive materials from a radiological support facility.

Radiation exposure to the following different individuals and the general population is calculated for normal operations and for accident conditions:

- Worker - An individual located 100 meters (330 feet) from the radioactive material release point.
- Maximally exposed off-site individual (MOI) - A theoretical individual living at the naval base boundary receiving the maximum exposure. The assumption is that no evacuation of this individual occurs.
- Nearest public access individual (NPA) - Military personnel, civilian employees, or their family members, including some who reside on the base, may be located outside the controlled industrial area boundary but inside the confines of the military base. Such people may be in their homes, buildings, or on the roadways of the base at the time of an accident or at any time throughout the year for the evaluation of normal operations. For analyses of normal operations, the base residents are the NPA individuals. In the event of an accident, evacuation of these NPA individuals would take place within 2 hours, under military control of the base. The accident calculations use 2 hours as the time of exposure.
- General U.S. population within a 50-mile radius of the facility - Consistent with the requirements of NEPA, the results presented in the following tables identify the potential radiological impacts to the people living within 50 miles of the facility. The sections that follow provide a brief discussion of the results of this analysis.

Exposure would result from direct radiation from the facility and exposure to radioactive contamination released to the air and water. Releases directly to the water pathway occur because support facilities are located directly on bodies of water, and contamination of the water results from fallout of airborne contamination. The releases to the air and water might result in exposure through several pathways, described as follows:

- External direct exposure from immersion in the airborne radioactive material (air immersion)
- External direct exposure from radioactive material deposited on the ground (ground surface)
- Internal exposure from inhalation of radioactive aerosols and suspended particles (inhalation)

- Internal exposure from ingestion of terrestrial food and animal products (ingestion)
- Exposure from and ingestion of contaminated water.

The computer programs, discussed in Section 2.5 of this appendix, calculate radiation in a manner recommended by the ICRP (1977, 1979). The programs use weighting factors for various body organs to calculate a committed effective dose equivalent (CEDE) from radiation inside the body due to inhalation or ingestion. The programs calculate committed dose equivalents (CDEs) for organs such as the lungs, stomach, small intestine, upper large intestine, lower large intestine, bone surface red bone marrow, testes, ovaries, muscle, thyroid, bladder, kidneys, and liver. The CEDE value is the summation of the CDEs to the specific organ weighted by the relative risk to that organ compared to an equivalent whole-body exposure. The programs calculate an effective dose equivalent (EDE) for the external exposure pathways (immersion in the radioactive material, exposure to ground contamination) and a 50-year CEDE for the internal exposure pathways. In addition, the programs calculate the sum of the EDE from external pathways and the CEDE from internal pathways, called the total effective dose equivalent (TEDE). The TEDE reported in the results section is the sum of the TEDEs from air, water, and direct radiation exposures.

The calculation of exposure from ingestion of terrestrial food, animal products, and drinking water is on a yearly basis. However, there would be a suspension of continued consumption of contaminated food products and water by the public after reaching a protective action guideline. In 1991, the Environmental Protection Agency (EPA) provided protective action guidelines in the range of 1 to 5 rem whole-body exposure. To ensure a consistent analysis basis, the analysis does not account for reduction of exposure due to a protective action guideline. This results in a conservative approach that may slightly overestimate health effects within an exposed population, but allows for consistent comparisons.

2.2 CALCULATION OF HEALTH EFFECTS

Health effects are calculated from the exposure results. Publication 60 of the ICRP (ICRP 1991) provides the risk factors used for calculations of health effects. Table H-3 lists the appropriate factors used in the analysis of both the normal operations and the hypothetical accident scenarios. Risk factors are higher for the general population because the general population includes children. Total health effects to the general population (deaths, non-fatal cancers, genetic effects, and other impacts on human health) result by multiplying latent cancer fatalities by the factor of 1.46, which is the ratio of the weighted total effects for the general population divided by the number of fatal cancers for the general population, (i.e., $7.3 \times 10^{-4}/5.0 \times 10^{-4}$).

Table H-3. Risk Estimators for Health Effects From Ionizing Radiation

Effect	*Nuclide*	RISK FACTOR (PROBABILITY PER REM)[1]	
		Worker	*General Population*
Fatal cancer (all organs)	All	4.0×10^{-4}	5.0×10^{-4}
Weighted non-fatal cancer[2]	All	8.0×10^{-5}	1.0×10^{-4}
Weighted genetic effects[2]	All	8.0×10^{-5}	1.3×10^{-4}
Weighted total effects[2]	All	5.6×10^{-4}	7.3×10^{-4}

Notes: 1 For high individual exposures (20 rem), the above risk factors are multiplied by a factor of two. There is no modification of general population exposures, because the large drop in exposure with increasing distances results in average exposure rates well below 20 rem.

2 In determining a means of assessing health effects from radiation exposure, the ICRP has developed a weighting method for non-fatal cancers and genetic effects to obtain a total weighted effect, or "health detriment."

Since all of the analyses in this appendix present the consequences in terms of radiation exposure (rem), the health effect of interest can be determined by multiplying the radiation exposure by the risk factor of interest from Table H-3. For example, the number of people in the general population expected to develop a non-fatal cancer as a result of a hypothetical support facility fire at NAVSTA Mayport can be calculated by obtaining the exposure from Table H-11 (540 rem) and multiplying it by the risk factor from Table H-3 (1.0×10^{-4}) to get 5.4×10^{-2} or 0.054. Similar calculations are possible for other accidents or health effects of interest.

2.3 POPULATION DISTRIBUTION

The evaluation used population distributions specific to NAVSTA Mayport obtained from the population data shown in Table H-4. The source of these population distributions was the 2000 United States Census data projected to 2006. The population information was obtained in 16 compass directions and five equal 10-mile-radial distances from within 10 to 50 miles.

Table H-4. Population Distribution Around NAVSTA Mayport

Direction	*Within 50 miles*	*Within 40 miles*	*Within 30 miles*	*Within 20 miles*	*Within 10 miles*
N	30,501	22,410	12,637	7,382	1,052
NNE	2	2	2	2	2
NE	0	0	0	0	0
ENE	0	0	0	0	0
E	0	0	0	0	0
ESE	0	0	0	0	0
SE	35	35	35	35	35
SSE	43,363	32,971	19,248	15,575	12,451
S	149,893	127,255	88,936	75,745	44,783
SSW	157,876	136,686	122,057	88,546	42,595
SW	305,508	286,640	252,580	144,926	40,485
WSW	372,350	354,973	325,488	187,011	42,802
W	184,776	176,440	168,208	147,861	26,056
WNW	51,492	49,488	42,206	28,192	2,458
NW	41,767	37,855	27,206	16,940	2,542
NNW	55,927	51,725	23,247	18,490	2,124
Total	**1,393,489**	**1,276,482**	**1,094,850**	**730,704**	**217,367**

2.4 METEOROLOGY

The National Climatic Data Center (NCDC) website provided the meteorological data used in the analyses. The weather station located at NAVSTA Mayport provided the data compiled by the NCDC. This data served as input for NAVSTA Mayport calculations. The meteorological data from the NCDC was in the original DS 3505 format and covered the time interval from July 31, 2002 to July 31, 2007. The NCDC raw data was reformatted into STability ARray (STAR) format, which is a joint frequency distribution of six wind speed intervals, 16 wind directions, and six stability categories; the format required by the GENII program. For evaluation of normal operations the STAR data was reformatted. This included maintaining the wind direction data in 10-degree increments instead of translating the 10-degree incremental raw data into 22.5-degree sectors. This avoided potential errors previously associated with the STAR format (Droppo).

The STAR data provides the input to calculate the 95-percent meteorological conditions for the accident analyses. 95-percent meteorology is that combination of wind speed and stability class that results in doses that are exceeded in severity no more than 5-percent of the time. The 95-percent conditions represent the meteorological conditions that could produce the highest calculated exposure.

2.5 COMPUTER PROGRAMS

The evaluation of the radiation exposures to the specified individuals and general population required use of two computer programs.

GENII

The code used for the environmental transport and exposure assessment calculations for normal operations and surface water transport and exposure for accident scenarios was GENII (Napier 1988). Battelle Memorial Institute at Pacific Northwest National Laboratory developed this code to incorporate the internal dosimetry models recommended by the ICRP in Publication 26 (ICRP 1977) and Publication 30 (ICRP 1979) into environmental pathway analysis models in use at Pacific Northwest National Laboratory.

GENII models both acute and chronic releases to the atmosphere and calculates exposure from various pathways including inhalation, ingestion, ground surface, and immersion (such as swimming). GENII uses meteorological capabilities including Gaussian plume dispersion for Pasquill-Gifford conditions.

RSAC-6

Westinghouse Idaho Nuclear Co. Inc. developed, for the DOE-ID Operations Office, the computer code RSAC-6. The code is in the public domain (Wenzel 1994). The code calculates the consequences of the release of radionuclides to the atmosphere. RSAC-6 calculates potential radiation exposures via inhalation, ingestion, exposure to radionuclides deposited on the ground surface, immersion in airborne radioactive material, and radiation from a cloud of radioactive material. RSAC-6 meteorological capabilities include Gaussian plume dispersion for Pasquill-Gifford conditions. Population exposures are the product of the calculated individual exposure and the number of people in the affected population.

2.6 ACCIDENT CATEGORIZATION AND PROBABILITY OF OCCURRENCE

Abnormal Events

Abnormal events are unplanned or improper events that result in little or no consequence. Abnormal events include industrial accidents and accidents during normal operation such as skin contamination with radioactive materials, spills of radioactive liquids, or exposure to direct radiation due to improper placement of shielding. In anticipation of the occurrence of these unplanned events, mitigative procedures are in place that promptly detect and eliminate the events and limit the effects of these events on individuals. As a result, there is little hazard to the general population from these events. Such events are considered to occur in the probability range of 1 to 10^{-3} per year. The probability referred to here is the total probability of occurrence and includes the probability the event occurs (e.g., fire) times other probabilities required for the consequences.

Design Basis Accident Range

Accidents that have a probability of occurrence in the range of 10^{-3} to 10^{-6} per year are included in the range called the Design Basis Accident Range. The terminology "design basis accident," which normally refers to facilities to be constructed, also includes the "evaluation basis accident," which applies to existing facilities. For accidents included in this range, results are presented for the 95-percent meteorological condition. Risk calculations for accidents in this range utilize the consequences associated with 95-percent meteorological conditions.

Beyond Design Basis Accidents

This range includes accidents that are less likely to occur than the design basis accidents but that may have very large or catastrophic consequences. Accidents included in this range typically have a total probability of occurrence in the range of 10^{-6} to 10^{-7} per year. There is no discussion of accidents that are typically less likely than 10^{-7} per year, since they do not contribute in any substantial way to the risk. (See Section 6.5 Volume 2, U.S. Department of Energy, Office of NEPA Policy and Compliance, Part 2-Guidance on NEPA Document Preparation, Section 2-10, Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, Second Edition, December 2004.)

2.7 DETERMINATION AND EVALUATION OF IMPACTED AREA

The impacted area surrounding a facility following an accident was determined for the fire accident scenario. The impacted area is that area in which the plume deposited radioactive material to such a degree that an individual standing on the boundary of the fallout area would receive approximately 0.01 mrem/hr of exposure. If this individual spends 24 hours a day at this location, that person would receive about 88 mrem per year from the ground surface shine. This is within the 100 mrem/year limit of 10 CFR 20 for NRC-licensed reactor facilities.

To best characterize the affected area, a 50-percent meteorology (Pasquill-Gifford Class F, wind speed 10.8 m/sec) was chosen (note that 95-percent worst-case meteorology was used when calculating exposure and risk to workers and the general population). The RSAC-6 results for ground surface dose were interpolated to determine the distance downwind where the centerline dose had dropped to approximately 88 mrem per year based on 24-hours-per-day exposure. For the wind class chosen, the plume remains within a single 22.5-degree sector. The area affected by the plume is determined as the entire sector contaminated to the calculated downwind distance. This area (footprint) was determined to be 0.25 mile in length and it covers an area of approximately 8 acres.

Although the plume would be contained within a single sector, the direction of the wind is unknown. Therefore, the analysis examined the site in all directions around NAVSTA Mayport, out to a distance equal to the footprint length. The contaminated footprint is contained within the NAVSTA Mayport boundary. Since the accidents occur over a short time, the acreage of the sector quoted is still an accurate indication of the total contaminated area. For the release of radioactive liquid accident, a footprint was not calculated due to the rapid dilution of the radioactive material that occurs in the water.

For NAVSTA Mayport, the evaluation also considered secondary impacts of radiological accidents. Access to some areas may be temporarily restricted until cleanup is completed. The water used for drinking and industrial purposes is monitored and its use may be suspended during cleanup operations. In addition, some recreational activities may be suspended; however, no enduring impacts are expected. During an accident, temporary contamination of naval vessels at NAVSTA Mayport may occur. Cleanup operations would restore these ships to full readiness. A small number of individuals may experience temporary job loss due to temporary restrictions on farming, fishing, and other support activities near the facility during cleanup operations. There would be costs associated with the actual cleanup operations. Plants and animals on and around the site would experience no long-term impacts. A support facility accident would not result in the extermination of any species nor would it affect the long-term potential for survival of any species. There would be no enduring impacts on treaty rights due to a radiological support facility accident.

2.8 RADIATION EXPOSURE TIME

For members of the public residing at the site boundary or beyond, no credit is taken for any preventive or mitigative actions that would limit their exposure. These individuals are modeled as being exposed to the entire contaminated plume as it travels downwind from the accident site (see Table H-5). Similarly, no action is taken to prevent these people from continuing their normal day-to-day routine, and ingestion of terrestrial food, animal products, and drinking water are modeled as continuing on a yearly basis. In addition, the public is modeled as spending approximately 30-percent of the day within their homes or other buildings; therefore, the exposure to ground surface radiation is reduced appropriately on a yearly basis.

Table H-5. Estimated Time an Individual Might be Exposed

	Worker (100 m)	*Nearest Public Access*	*Individual at Nearest Site Boundary (MOI)*
To Plume	5 min.	100-percent of release time up to 120 min.	100-percent of release time
To Fallout on Ground Surface	20 min.	120 min.	0.7 yr
To Food	None	None	1 yr

Individuals that reside or work on site would be evacuated from the affected area within 2 hours (see Table H-5). This is based on the availability of security personnel to oversee the removal of residents, workers, and visitors in a safe and efficient manner. Periodic training and evaluation of the security personnel is conducted to ensure that correct actions are taken during an actual casualty. Projected exposure of residents, workers, and visitors to the entire contaminated plume on site as it travels downwind would be for a period not to exceed 2 hours. Similarly, the radiation shine from the deposited radioactive materials would be limited to 2 hours. The calculations assume there is no ingestion of contamination for these individuals during the 2 hours.

Facility workers all undergo training to take quick, decisive action during a casualty. These individuals quickly evacuate the area and move to previously defined "relocation" areas on the facility site. Workers could receive 5 minutes of exposure to the radioactive plume as they move to the relocation centers. Once the immediate threat of the plume has moved off-site and downwind, the workers would be instructed to walk to vehicles waiting to evacuate them from the site. An additional 15 minutes would be required to evacuate the workers from the contaminated area; therefore, the calculations assume the workers receive a total of 20 minutes of ground shine. There is no ingestion of contamination included in calculations for these individuals during that time.

3.0 RESULTS FROM PATHWAYS ANALYSIS

3.1 NORMAL OPERATION

The purpose of this analysis is to determine the hypothetical health effects on workers and the public due to routine operations. Radioactive releases involved in routine support of NIMITZ-class aircraft carriers at NAVSTA Mayport would be small. The EPA or States regulate airborne emissions of Atomic Energy Act radionuclides, under the Clean Air Act pursuant to 40 CFR 61 Subpart I. The NNPP performed testing to establish more precisely the airborne releases of Atomic Energy Act radioactivity from selected NNPP activities, and submitted that information to EPA. Those evaluations, completed in December 1995, reaffirmed that the total emissions of radioactivity from NNPP activities meet the EPA standards by a factor of 10 to 100. The EPA accepted the NNPP evaluation by letter dated October 1, 1997. The results of the NNPP evaluation, which were the basis for establishing compliance with the standards in 40 CFR 61, are also the basis for the emission estimates listed in this section. The NAVSTA Mayport analysis used site-specific meteorological and population data. For normal operations, the radiation dose evaluation addresses workers, the maximally exposed off-site individual, the general population, and the nearest public access (NPA) individual. The NPA individual is one living on the base in military housing. Table H-1 presents health risks to the general population from normal operation in two ways. It lists the annual risk of a single latent cancer fatality occurring in the entire population within 50 miles of the facility. The table also provides the average individual risk, which is calculated by dividing the annual risk value by the number of people living within 50 miles of the facility.

The radioactive material release source term for the analysis was conservatively estimated for the NIMITZ-class aircraft carrier based on procedures approved by the EPA for compliance with 40 CFR 61. Site-specific input parameters include distances to members of the public and wind speed and direction. The basis for the carbon-14 (^{14}C) source term for NAVSTA Mayport is the release from one NIMITZ-class aircraft carrier added to the site by this EIS. ^{14}C is the dominant contributor to radiation dose and accounts for approximately 98-percent of the radiation dose to the public. The ^{60}Co value is based on the value of actual measurements of ^{60}Co emissions from the exhaust of Navy radiological support facilities.

Table H-6 provides a listing of the radioactive nuclides used for the evaluation. Modeling assumes the release occurs at ground level.

Table H-6. Radionuclide Releases Used for Environmental Pathways Analysis

Radionuclide	*Naval Station Mayport (Projected Curies/year)*
^{3}H	1.0
^{14}C	2.2
^{83M}Kr	1.1×10^{-2}
^{85}Kr	2.3×10^{-5}
^{85M}Kr	2.7×10^{-2}
^{87}Kr	3.5×10^{-2}
^{88}Kr	5.5×10^{-2}
^{131M}Xe	1.5×10^{-3}
^{133M}Xe	1.2×10^{-2}
^{133}Xe	3.0×10^{-1}
^{135}Xe	3.3×10^{-1}
^{41}Ar	3.3
^{60}Co	2.8×10^{-4}
^{131}I	5.0×10^{-6}
^{132}I	5.4×10^{-6}
^{133}I	1.4×10^{-5}
^{135}I	9.7×10^{-6}

Table H-7 summarizes the public health risk to the general population that might result from normal operation.

Table H-7. Radiological Health Effects From Normal Operation

Location	*Total Radiation Exposure to Affected Population*[1]	*Annual Risk of Single Latent Fatal Cancer in Entire Affected Population*[2]	*Population Estimate Within 50 Miles of NAVSTA Mayport*[3]	*Average Annual Risk of Latent Fatal Cancer to a Member of the General Population*[4]	*Individual Annual Risk of Latent Fatal Cancer to the Maximally Exposed Off-Site Individual*[5]	*An Individual's Annual Risk of Dying From All Cancers*[6]
NAVSTA Mayport	0.9 person-rem	1 in 2,326 (4.3×10^{-4})	1,393,489	1 in 3.3 billion (3.1×10^{-10})	1 in 29 million (3.5×10^{-8})	1 in 360 (2.8×10^{-3})

Notes: 1	This is total exposure to affected population within a 50-mile radius of the facility due to normal operation (person-rem).
2	Annual risk of a single latent cancer fatality in the entire population within a 50-mile radius of the facility from radiation exposure due to normal operation is calculated by multiplying the total radiation exposure to affected population (rem) by 0.0005 latent fatal cancers estimated to be caused by each rem (See Table H-3 in Appendix H).
3	This is the estimated number of people within a 50-mile radius of the facility from census data from Table H-4
4	Average annual risk of latent fatal cancer for an average individual within a 50-mile radius of the facility from radiation exposure due to normal operation is calculated by dividing the total population cancer risk by the number of people within a 50-mile radius of the homeport location. Risk of cancer is noted in parentheses.
5	The MOI is a theoretical individual living at the base receiving maximum exposure, calculated by multiplying the total radiation exposure to the MOI (rem, see Table H-11 of Appendix H) by 0.0005 latent fatal cancers estimated to be caused by each rem (see Table H-3 in Appendix H).
6	This is the annual risk of an individual dying from all sources of cancer. Risk of cancer is noted in parentheses.

Table H-8 contains the detailed analysis results from normal operations as discussed in Section 3.1 of this appendix. The radiation exposures to the individuals and to the general population living within 50 miles of NAVSTA Mayport would be so small that they would be indistinguishable from naturally occurring background radiation. The results show that the annual individual risk of a latent fatal cancer occurring from normal operations in the general population within 50 miles of NAVSTA Mayport is low, less than one in 3.3 billion.

Table H-8. Analysis Results for Normal Operation

Location	*Individual*	*Total EDE (rem)*	*Likelihood of Fatal Cancer*
NAVSTA Mayport	Worker	2.3×10^{-3}	9.4×10^{-7} (1 in 1.1 million)
	NPA[1]	7.1×10^{-4}	3.5×10^{-7} (1 in 2.8 million)
	MOI[2]	7.0×10^{-5}	3.5×10^{-8} (1 in 29 million)
	Total Radiation Exposure to Affected Population[3]	*Annual Risk of Single Latent Fatal Cancer in Entire Affected Population*[4]	*Average Annual Risk of Latent Fatal Cancer to a Member of the General Population*[5]
NAVSTA Mayport	0.9 person-rem	4.3×10^{-4} (1 in 2,300)	3.1×10^{-10} (1 in 3.3 billion)

Notes:
1 The NPA is the nearest public access individual.
2 The MOI is a theoretical individual living at the base receiving maximum exposure.
3 This is the total exposure to affected population within a 50-mile radius of the facility due to normal operation (person-rem).
4 This is the annual risk of a single latent cancer fatality in the entire population within a 50-mile radius of the facility from radiation exposure due to normal operation.
5 This is the average annual risk of latent fatal cancer for an average individual within a 50-mile radius of the facility from radiation exposure due to normal operation.

3.2 HYPOTHETICAL ACCIDENTS AT SUPPORT FACILITIES

RSAC-6 evaluates the analysis of airborne releases from hypothetical accidents. Unless stated otherwise, RSAC-6 uses the following conditions when performing calculations. In most cases, RSAC-6 takes these conditions directly as defaults from the code.

Meteorological Data

- RSAC-6 takes wind speed, direction, and Pasquill stability from 95-percent meteorology. See Section 2.4 of this appendix for a discussion of meteorological conditions.
- RSAC-6 calculates the release as occurring at ground level (0 m).
- Mixing layer height is 400 meters (1320 feet). Airborne materials freely diffuse in the atmosphere near ground level at the mixing depth. A stable layer exists above the mixing depth, which restricts vertical diffusion.

- Wet deposition is zero (no rain occurs to accelerate deposition and reduce the area affected).
- RSAC-6 models dry deposition of the cloud. During movement of the radioactive plume, a fraction of the plume deposits on the ground due to gravitational forces and becomes available for exposure by ground surface radiation and ingestion.
- The quantity of deposited radioactive material is proportional to the material size and speed. RSAC-6 uses the following dry deposition velocities (m/s): solids = 0.001; halogens = 0.01; noble gases = 0.0; cesium = 0.001; ruthenium = 0.001.
- If radioactive releases occur through a stack, RSAC-6 can account for additional plume dispersion by calculating a jet plume rise. In this analysis, RSAC-6 uses no jet plume rise.
- When released gases have a heat content, the plume can disperse more quickly. In this calculation, RSAC-6 uses no buoyant plume effects.

Inhalation Data

- Breathing rate is 3.33 x 10^{-4} cubic meters per second (m^3/s) for worker and NPA and 2.66 x 10^{-4} m^3/s for people at site boundary and beyond.
- Particle size of inhalant is 1.0 micron.
- The internal exposure period is 50 years for individual organs and tissues, which have radionuclides committed to giving them dose.
- Exposure of the public is to the entire plume. The worker and NPA exposures are as discussed in Section 2.1 of this appendix.
- RSAC-6 calculates inhalation doses using the ICRP 30 (1979) model with Federal Guidance Report No. 11 dose conversion factors.

Ground Surface Exposure

- Exposed to contaminated soil for one year for the public. See Section 2.8 of this appendix for additional details.
- Building shielding factor is 0.7, which exposes the individual to contaminated soil for 16 hours a day.

Ingestion Data

- Ingestion numbers will be reduced by a factor of 10 to account for only 10-percent of the food consumed being grown locally (such as in a person's garden). Milk consumption was reduced to 30%.

- Since the worker takes immediate action, it was modeled that the worker did not consume any aquatic products. For everyone else, the aquatic products intake was reduced to 20%.
- The analysis used the following changes from RSAC-6 defaults.
  - Annual Dietary Consumption Rates:
    - ❖ 177.0 kg/yr Stored Vegetables
    - ❖ 18.3 kg/yr Fresh Vegetables
    - ❖ 94.0 kg/yr Meat
    - ❖ 112.0 l/yr Milk

3.2.1 Fire Analysis

In this hypothetical accident scenario, the analysis postulates a fire in a radiological support facility. The fire spreads to radioactive material, which results in an airborne release of particulate.

Conditions used in developing the source term are as follows:

- The basis of the source term is 1.0 Curie of ^{60}Co and the associated proportioned amounts of other radioactive elements expected.
- The release to the environment occurs at a constant rate over 15 minutes.
- There is no increase in direct radiation due to this accident.
- The amounts of radionuclides released to the environment are shown in Table H-9. This listing includes nuclides that result in at least 99-percent of the possible exposure.

Table H-9. Radionuclides Released to the Environment

Radionuclides	*Release (Curies)*	*Radionuclides*	*Release (Curies)*
^{14}C	1.5×10^{-2}	^{90}Sr	5.0×10^{-3}
^{54}Mn	8.6×10^{-1}	^{94}Nb	2.0×10^{-4}
^{55}Fe	1.0	^{99}Tc	9.0×10^{-3}
^{58}Co	1.1×10^{-1}	^{110m}Ag	9.0×10^{-3}
^{60}Co	1.0	^{125}Sb	4.0×10^{-2}
^{59}Ni	8.0×10^{-4}	^{129}I	4.0×10^{-6}
^{63}Ni	8.0×10^{-2}	^{134}Cs	1.0×10^{-2}
^{65}Zn	4.0×10^{-2}	^{137}Cs	9.0×10^{-2}

Table H-10 summarizes the public health risk to the general population that might result from the hypothetical support facility fire accident. Table H-10 presents the results for the design basis accident with 95-percent meteorology. The estimated total probability of occurrence of an event leading to a fire in the support facility is in the range of 4 x 10^{-3} to 5 x 10^{-3} per year (Ganti and Krasner 1984). A value of 5 x 10^{-3} was used in the analysis to develop the risk results in Table H-9. The analyses showed that no latent cancer fatalities are expected in the public, even for this severe hypothetical radiological fire. The average annual individual risk of a latent fatal cancer to the general public living within a 50-mile radius of NAVSTA Mayport due to a fire is less than one in 1 billion.

Table H-10. Summary of Radiological Support Facility Fire Results

Location	*Total Radiation Exposure to Affected Population From a Fire, Assuming Fire Occurs*[1]	*Annual Risk of Single LFC in Entire Affected Population From a Fire, Including Probability of Fire Occurring*[2]	*Population Estimate Within 50 Miles of NAVSTA Mayport*[3]	*Average Annual Risk of a LFC to a Member of the General Population From a Fire, Including Probability Of a Fire Occurring*[4]	*Individual Annual Risk of a LFC for a Maximally Exposed Off-Site Individual From a Fire, Including Probability Of a Fire Occurring*[5]	*An Individual's Annual Risk of Dying From All Cancers*[6]
NAVSTA Mayport	540 person-rem	1 in 770 (1.3 x 10^{-3})	1,393,489	1 in 1 billion (9.6 x 10^{-10})	1 in 1 million (9.7 x 10^{-7})	1 in 360 (2.8 x 10^{-3})

Notes: 1 This is the total exposure to affected population within a 50-mile radius of the facility due to a fire (person-rem).

2 Annual risk of a single latent cancer fatality in the affected population within a 50 mile radius of the facility from radiation exposure due to a fire is calculated by multiplying the total radiation exposure to affected population (rem) by 0.0005 latent fatal cancers estimated to be caused by each rem by a 1 in 200 (0.005) probability of a fire. (See Table H-3 in Appendix H.)

3 This is the estimated number of people within a 50-mile radius of the facility from census data from Table H-4.

4 Average annual risk of latent fatal cancer for an average individual within a 50-mile radius of the facility from radiation exposure due to a fire is calculated by dividing the affected population cancer risk by the number of people within a 50-mile radius of the homeport location. Risk of cancer is noted in parentheses.

5 The MOI is a theoretical individual living at the base boundary receiving maximum exposure. Risk is calculated by multiplying the total radiation exposure to the MOI (rem, see Table H-11 of Appendix H)

	by 0.0005 latent fatal cancers estimated to be caused by each rem (see Table H-3 in Appendix H) by a 1 in 200 (0.005) probability of a fire.
6	This is the annual risk of an individual dying from all sources of cancer. Risk of cancer is noted in parentheses.

For the hypothetical support facility fire scenario, the radioactive plume might result in contamination of the ground to a downwind distance of 0.25 mile. This would yield a total area impacted by the accident of approximately 8 acres. The calculated downwind distance would be contained within the boundary of NAVSTA Mayport. Detailed results are contained in Table H-10. The probability of a fire occurring (5×10^{-3}) is not included in the calculations for Worker, NPA, and MOI in Table H-11.

Table H-11. Analysis Results for Radiological Support Facility Fire, Assuming Fire Occurs

Location	*Individual*	*Total EDE (rem)*	*Likelihood of Fatal Cancer*
NAVSTA Mayport	Worker	7.6×10^{-1}	3.1×10^{-4} (1 in 3,200)
	NPA	1.5	7.4×10^{-4} (1 in 1,400)
	MOI	3.9×10^{-1}	1.9×10^{-4} (1 in 5,263)
	Total Radiation Exposure to Affected Population From a Fire[1]	*Number of LFC in Affected Population*	*Annual Risk of Single LFC in Entire Affected Population From a Fire, Including Probability of Fire Occurring*[2]
NAVSTA Mayport	540 person-rem	2.7×10^{-1}	1.3×10^{-3} (1 in 770)

Notes: 1	This is the total exposure to affected population within a 50-mile radius of the facility due to a fire (person-rem).
2	This is the annual risk of a single latent cancer fatality in the affected population within a 50-mile radius of the facility from radiation exposure due to a fire.

3.2.2 Spill Analysis

In this hypothetical accident scenario, the entire contents of a storage tank are spilled into the water surrounding the radiological support facility due to severe rupture. The scenario is conservative since it would require a spill of over 26 million gallons of radioactive liquid at levels normally contained in collection facilities that have tanks no larger than 10,000 gallons. Furthermore, the total capacity to store radioactive liquid at facilities at all locations would be less than 100,000 gallons. This amount was used to conservatively bound the amount of activity released to 1.0 Curie of ^{60}Co and the associated proportioned amounts of other radioactive elements expected.

Conditions used in developing the source term are as follows:

- The basis for the source term is 1.0 Curie of ^{60}Co and the associated proportioned amounts of other radioactive elements expected.
- Table H-9 lists the amounts of radionuclides released to the environment. This listing includes nuclides that result in at least 99-percent of the possible exposure.

Table H-12 summarizes the public health risk to the general population that might result from the hypothetical release of radioactive liquid accident. Table H-12 presents the results for the design basis accident with 95-percent meteorology. The estimated total probability of occurrence of an event leading to a release of radioactive liquid is in the range of 10^{-4} to 10^{-8} per year. A value of 10^{-4} was used in the analysis to develop the risks in Table H-12. The analyses showed that no expectant latent cancer fatalities in the public, even for this severe hypothetical radioactive liquid release. The average annual individual risk of a latent fatal cancer to the public living within a 50-mile radius of NAVSTA Mayport is very low, less than one in 120 billion. Detailed results are contained in Table H-13. The probability of a spill occurring (10^{-4}) is not included in the calculations of Worker, NPA, and MOI in Table H-11.

Table H-12. Summary of Radiological Support Facility Release of Radioactive Liquid Results

Location	*Total Radiation Exposure to Affected Population From a Spill Assuming a Spill Occurs,*[1]	*Annual Risk of Single LFC in Entire Affected Population From a Spill, Including Probability of Spill Occurring*[2]	*Population Estimate Within 50 Miles of NAVSTA Mayport*[3]	*Average Annual Risk of a LFC to a Member of the General Population From a Spill, Including Probability of a Spill Occurring*[4]	*Individual Annual Risk of a LFC for a Maximally Exposed Off-Site Individual From a Spill, Including Probability Of a Spill Occurring*[5]	*An Individual's Annual Risk of Dying From All Cancers*[6]
NAVSTA Mayport	240 person-rem	1 in 84,000 (1.2×10^{-5})	1,393,489	1 in 120 billion (8.6×10^{-12})	1 in 6 billion (1.7×10^{-10})	1 in 360 (2.8×10^{-3})

Notes: 1 This is the total exposure to affected population within a 50-mile radius of the facility due to a spill (person-rem).

2 Annual risk of a single latent cancer fatality in the affected population within a 50-mile radius of the facility from radiation exposure due to a spill is calculated by multiplying the total radiation exposure to affected population (rem) by 0.0005 latent fatal cancers estimated to be caused by each rem by a 1 in 10,000 (0.0001) probability of a spill. (See Table H-3 in Appendix H.)

3 This is the estimated number of people within a 50-mile radius of the facility from census data from Table H-4.

4 Average annual risk of latent fatal cancer for an average individual within a 50-mile radius of the facility from radiation exposure due to a spill is calculated by dividing the total population cancer risk by the number of people within a 50-mile radius of the homeport location. Risk of cancer is noted in parentheses.

5 The MOI is a theoretical individual living at the base boundary receiving maximum exposure. Risk is calculated by multiplying the total radiation exposure to the MOI (rem, see Table H-11 of Appendix H) by 0.0005 latent fatal cancers estimated to be caused by each rem (see Table H-3 in Appendix H) by a 1 in 10,000 (0.0001) probability of a spill.

6 This is the annual risk of an individual dying from all sources of cancer. Risk of cancer is noted in parentheses.

Table H-13. Analysis Results for Release of Radiological Liquid From a Radiological Support Facility, Assuming Spill Occurs

Location	*Individual*	*Total EDE (rem)*	*Likelihood of Fatal Cancer*
NAVSTA Mayport	Worker	N/A	N/A
	NPA	$6.9x 10^{-5}$	3.4×10^{-8} (1 in 29 million)
	MOI	3.4×10^{-3}	1.7×10^{-6} (1 in 590,000)
	Total Radiation Exposure to Affected Population From a Facility Spill[1]	*Number of LFC in General Population*	*Annual Risk of Single LFC in Entire Affected Population From a Spill, Including Probability of Spill Occurring*[2]
NAVSTA Mayport	240 person-rem	1.2×10^{-1}	1.2×10^{-5} (1 in 84,000)

Notes: 1 This is the total exposure to affected population within a 50-mile radius of the facility due to a spill (person-rem).

2 This is the annual risk of a single latent cancer fatality in the affected population within a 50-mile radius of the facility from radiation exposure due to a spill.

3.3 CUMULATIVE IMPACTS

Nuclear-powered submarines are homeported in Kings Bay Naval Submarine Base, in southeastern Georgia, 35 to 40 miles north of Jacksonville. Since the CVN addressed in this EIS would establish the presence of a nuclear-powered aircraft carrier in the northern Florida area, Bettis analyzed the cumulative radiological impacts. These analyses show that the cumulative radiological impacts associated with homeporting a NIMITZ-class aircraft carrier at NAVSTA Mayport are very small.

The analyses conservatively assume that all the nuclear-powered ships in the Kings Bay area were ported at NAVSTA Mayport. The analyses results show that the maximally exposed member of the public would receive less than 1 millirem of radiation exposure each year due to the additional homeporting operation. This exposure is so small that it is indistinguishable from naturally occurring background radiation. The additional annual radiation exposure to the entire population within 50 miles of NAVSTA Mayport is 0.86 person-rem. Table H-14 shows the cumulative impact of this additional radiation exposure, which compares the average annual individual risk of a member of the public developing a latent cancer fatality due to all NNPP operations in the surrounding area, both with and without an additional CVN.

Table H-14. Average Annual Individual Risk of Latent Cancer Fatality

Location	*Average Risk From Normal Operations to a Member of the Gen. Population (Existing Condition Without Additional CVN)*	*Average Risk From Normal Operations to a Member of the Gen. Population (Condition With Additional CVN)*
NAVSTA Mayport	1 in 3.1 billion	1 in 1.6 billion

The risks in the first column were determined using the same analytical methods discussed in this appendix for radioactivity projected to be released into the air during calendar year 2006 from all Naval nuclear operations within 50 miles of NAVSTA Mayport (excluding Mayport). The risks in the second column represent the cumulative risks, including the impacts associated with homeporting a CVN at Mayport, and were determined by adding the risks from Table H-10 in this appendix to those in the first column. For example, within 50 miles of NAVSTA Mayport operations are also conducted at Kings Bay Naval Submarine Base. The average individual risk of developing a latent cancer fatality due to normal operations at Kings Bay locations is 3.3×10^{-10} or about one in 3.1 billion. From Table H-8, the risk associated with homeporting a NIMITZ-class aircraft carrier at Mayport is 3.1×10^{-10} or about one chance in 3.3 billion. To determine the cumulative impact, the risks are added together (for a total of 6.3×10^{-10}) or about one in 1.6 billion.

New References:

UNSCEAR 1972: United Nations Scientific Committee on the Effects of Atomic Radiation, “Ionizing Radiation: Levels and Effects,” 1972

NAS 1972: National Academy of Sciences-National Research Council, “The Effects on Populations of Exposure to Low Levels of Ionizing Radiation,” Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, 1972

UNSCEAR 2000: United Nations Scientific Committee on the Effects of Atomic Radiation, “Sources and Effects of Ionizing Radiation,” 2000

NAS 2006: National Academy of Sciences-National Research Council, “Health Risks From Exposure to Low Levels of Ionizing Radiation, BEIR VII-Phase 2,” Report of the Committee to Assess Health Risks From Exposure to Low Levels of Ionizing Radiation, 2006

J.G. Droppo, Directional Frequency Correction for the STAR Meteorological Joint Frequency Computer Program, Health Physics, vol. 93, no. 2, August 2007.