THE ASSISTANT SECRETARY OF DEFENSE

1200 DEFENSE PENTAGON
WASHINGTON, DC 20301-1200

HEALTH AFFAIRS

The Honorable Richard J. Durbin
Chairman
Subcommittee on Defense
Committee on Appropriations
United States Senate
Washington, DC 20510

JUN 19 2014

Dear Mr. Chairman:

This letter provides a final report (enclosed), as requested in the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014, page 90, "Radiation Exposure," to the congressional defense committees on the number of sailors serving on the USS RONALD REAGAN during Operation Tomodachi who were potentially exposed to increased levels of radiation during the humanitarian mission. Our interim report, submitted on March 27, 2014, promised a final report by June 30, 2014.

Some sailors who developed cancer and other serious health conditions allege radiation exposures while serving on the USS RONALD REAGAN during Operation Tomodachi may be the cause. There is no objective evidence that the sailors on the USS RONALD REAGAN during Operation Tomodachi experienced radiation exposures that would result in an increase in the expected number of radiogenic diseases over time. The estimated radiation doses for all individuals in the Operation Tomodachi registry, including sailors on the USS RONALD REAGAN, were very small and well below levels associated with adverse medical conditions. A detailed explanation of the data collection, methodologies, analyses, and conclusions are included in the enclosed report.

Thank you for your interest in the health and well-being of our Service members, veterans, and their families. A similar letter is being sent to the other congressional defense committees.

Sincerely,

Jonathan Woodson, M.D.

Enclosure:
As stated

cc:
The Honorable Thad Cochran
Vice Chairman

THE ASSISTANT SECRETARY OF DEFENSE

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WASHINGTON, DC 20301-1200

HEALTH AFFAIRS

JUN 19 2014

The Honorable Rodney P. Frelinghuysen
Chairman
Subcommittee on Defense
Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515

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Enclosure:
As stated

cc:
The Honorable Peter J. Visclosky
Ranking Member

THE ASSISTANT SECRETARY OF DEFENSE

1200 DEFENSE PENTAGON
WASHINGTON, DC 20301-1200

HEALTH AFFAIRS

The Honorable Carl Levin
Chairman
Committee on Armed Services
United States Senate
Washington, DC 20510

JUN 19 2014

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As stated

cc:
The Honorable James M. Inhofe
Ranking Member

THE ASSISTANT SECRETARY OF DEFENSE

1200 DEFENSE PENTAGON
WASHINGTON, DC 20301-1200

HEALTH AFFAIRS

The Honorable Howard P. "Buck" McKeon
Chairman
Committee on Armed Services
U.S. House of Representatives
Washington, DC 20515

JUN 19 2014

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Sincerely,

Jonathan Woodson, M.D.

Enclosure:
As stated

cc:
The Honorable Adam Smith
Ranking Member

Final Report to the Congressional Defense Committees in Response to the Joint Explanatory Statement Accompanying the Department of Defense Appropriations Act, 2014, page 90, "Radiation Exposure"

Submitted by the Office of the Assistant Secretary of Defense for Health Affairs

June 2014

The estimated cost of report for the Department of Defense is approximately $98,000 for the 2014 Fiscal Year. This includes $49,000 in expenses and $49,000 in DoD labor.

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INTRODUCTION

Some sailors who developed cancer and other serious health conditions allege radiation exposures while serving on the United States Ship (USS) RONALD REAGAN (CVN 76) (hereafter referred to as "RONALD REAGAN") during Operation Tomodachi (OT) may be the cause. The Joint Explanatory Statement (page 90) that accompanied the Consolidated Appropriations Act, 2014, requested a report to be submitted to the congressional defense committees on the sailors serving on the RONALD REAGAN during Operation Tomodachi who were potentially exposed to increased levels of radiation during the humanitarian mission.

REPORT

Soon after the March 11, 2011, earthquake and tsunami on the Japanese mainland damaged the Fukushima Daiichi Nuclear Power Station (FDNPS) and resulted in release of radioactivity into the environment, the U.S. military took proactive steps to limit the radiation exposures of more than 75,000 members of the DoD-affiliated population (Service members, DoD civilian employees, family members, and DoD contractors) who were on or near the mainland of Japan. These steps included extensive environmental monitoring, including monitoring of meteorological conditions and movements of the radioactive plume from FDNPS; extensive coordination with the Japanese government, the U.S. Department of Energy and other federal agencies to share monitoring data; measures to protect the food and water sold and distributed on U.S military bases; frequent communications with the DoD population to ensure they were kept informed of the situation; and preparations in the event evacuation was needed. Additional steps were taken to limit the exposures of military personnel who were responding to the humanitarian disaster on shore, on the sea, and in the air, and to directly measure exposures for those who were at great risk of exposure. Following the humanitarian response and stabilization of radiation in the environment at levels slightly above the previous background, the Department of Defense (DoD) established a radiation exposure registry for the more than 75,000 individuals, with each individual assigned an estimated radiation dose based on location and age. Children tended to have higher doses due to a greater proportional uptake of radioactive iodine than adults have (see Appendix D for more information). The radiation dose estimates were developed using the best available radiological data. The National Council on Radiation Protection and Measurements (NCRP), a non-governmental panel of radiation health experts, reviewed and concurred with the scientific methods used to develop the dose estimates.

Based on DoD's calculation of OT-related radiation doses and the extensive peer-review of methods and results by the NCRP, we are confident the radiation exposures to the sailors serving aboard the RONALD REAGAN were very low—whole-body doses of 8 millirem or less, and thyroid doses of 110 millirem or less—for the entire 60-day surveillance period of OT. These doses were calculated using assumptions that individuals aboard the ship remained outside and on-deck for 24 hours every day and had a constantly high level of physical activity (and associated breathing rates) for the entire 60-day period, March 12–May 11, 2011. We took this approach to ensure it would be unlikely that any individual could have had higher doses than estimated, yet these doses are still well below Federal regulatory limits for exposure to ionizing radiation established by the Nuclear Regulatory Commission, the Environmental Protection Agency, and the Occupational Safety and Health Administration. These doses are also well below doses documented in the scientific literature that would plausibly result in detectable increases in the incidence of radiogenic diseases, such as certain types of cancer. Based on these dose estimates and the measures the U.S Navy took before, during, and after OT to protect sailors aboard the RONALD REAGAN (as well as other sailors on or in the waters near the mainland of Japan), we believe it is implausible that these low-level doses are the cause of the health effects reported by the RONALD REAGAN sailors.

We understand that for individuals exposed to radiation, the risk of cancer can be one of their greatest concerns, regardless of their exposure levels. With respect to nuclear power plant disasters, the release of radioactive iodine, which can be selectively absorbed by the thyroid gland (hereafter referred to as "thyroid"), represents a major concern. That is why we included the thyroid in our dose assessment efforts. According to the National Cancer Institute, approximately one person out of 100 in the U.S. will be diagnosed with thyroid cancer during their lifetime. This means that some of the RONALD REAGAN sailors, or other individuals included in the Operation Tomodachi Registry (OTR), may develop thyroid cancer during their lifetimes completely unrelated to radiation exposure received during OT. The NCRP concurs with the DoD's position that any additional cancer risks from OT-related radiation exposures are extremely small and would be undetectable from non-OT related normal incidence rates for the same diseases.

This report includes: (1) a complete inventory of any adverse medical conditions experienced since OT by sailors who were assigned to the RONALD REAGAN during OT, (2) a description of the actions taken by the U.S Navy before, during, and after the OT mission to ensure the safety of sailors from radiation associated with the FDNPS accident, and (3) a report on the number of sailors who participated in OT who are still in the Navy (including reserve component), as well as the number of sailors who have since separated from the Navy. A summary is included below, with the details included in Appendices A–C, respectively. An additional background section (Appendix D) is included to provide a comprehensive account of DoD's extensive efforts to accurately calculate the estimated radiation doses for the more than 75,000 DoD-affiliated individuals who were on or near the Japanese mainland from March 12 to May 11, 2011, and subsequently record those dose estimates in an enduring exposure registry for all DoD-affiliated individuals and in the electronic medical records of all Military Health System beneficiaries.

SUMMARY

1. Appendix A contains a detailed discussion of the complete inventory of adverse medical conditions experienced since OT by RONALD REAGAN sailors who participated in OT. Based on analysis of these data, the DoD offers the following observations:

    - A review of all medical encounters in the Service members' electronic medical records for RONALD REAGAN sailors participating in OT who were still in Service as of May 12, 2011 (the end of the OT period) did not indicate elevated incidence of health conditions plausibly related to their radiation exposures (Appendix A, Table 2).

- There were five broad categories of diseases and symptoms (Diseases of the Respiratory System; Diseases of the Digestive System; Diseases of the Genitourinary System; Complications of Pregnancy, Childbirth and the Puerperium; and Symptoms, Signs, and Ill-defined Conditions), as defined by the International Classification of Diseases, Ninth Revision, Clinical Modification, with slightly elevated incidence among the RONALD REAGAN sailors when compared to a control population of sailors deployed during the two years preceding OT. None of the diseases within these categories are radiogenic (i.e., caused by radiation), as defined in 38 CFR § 3.311, "Claims based on exposure to ionizing radiation."

- There was one disease subcategory, Infertility, male (606.X), that was slightly elevated in the RONALD REAGAN sailors when compared to the control population. However, male infertility has many causes, and there is no evidence in the scientific literature linking primary infertility to low-level ionizing radiation exposure, such as was encountered by sailors onboard the RONALD REAGAN.

- The adjusted incidence rate of malignant neoplasms (which can be radiogenic) in the RONALD REAGAN population was nearly 50 percent lower than the adjusted incidence rate of malignant neoplasms found in the control population.

- Only two adverse health conditions (three cases) were identified among the RONALD REAGAN sailors that are radiogenic. These include one case of non-chronic lymphocytic leukemia (non-CLL) and two cases of thyroid cancer. These numbers of cases are not unusual or unexpected among a population of nearly 5,000 individuals. With respect to these three cases, it's important to understand that all radiogenic diseases have what is called a "latency period" between the time of exposure and the appearance of health effects. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2013), the minimum latency period for radiation-induced leukemia is 2 years and 5 years for solid cancers (including thyroid cancer). Additionally, the World Health Organization, in a health risk assessment of the Fukushima Daiichi nuclear accident (WHO 2013), conservatively assumes the minimum latency period for radiation-induced leukemia is 2 years, 3 years for thyroid cancer, and 5 years for all other solid cancers. The dates of diagnosis for these three cases strongly suggest that these disease processes were initiated well before OT and therefore, are not causally related to low-level radiation exposures during OT. See Appendix A, Table 3, for the details of our latency analysis.

2. Appendix B contains a detailed accounting of the comprehensive actions taken by the U.S. Navy on board the RONALD REAGAN before, during, and after the mission to protect the sailors from the radioactivity released from the FDNPS. These actions constitute an extensive set of measures that were extremely effective in minimizing radiation exposures.

3. Appendix C includes an accounting of the personnel status (active duty, transferred to reserves, separated, retired, etc.) of all sailors who participated in OT as well as those aboard the RONALD REAGAN. Out of the 24,496 members of the U.S. Navy who participated in OT, 4,919 were on board the RONALD REAGAN.

CONCLUSION

There is no objective evidence that the RONALD REAGAN sailors experienced radiation exposures during OT that would result in an increase in the expected number of radiogenic diseases over time. The estimated radiation doses for all individuals in the OT registry (OTR), including RONALD REAGAN sailors, were very small and well below levels associated with the occurrence of adverse medical conditions. The NCRP peer-reviewed the dose estimates and supporting calculations and agreed the overall doses were very low. To further illustrate how small the OT radiation doses were, we have included the following table (Table 1) that puts the OT radiation dose estimates into context with other common radiation doses and exposure limits (the doses in the four columns are equivalent doses displayed in different units):

Table 1. Comparison of Various Radiation Doses

Whole-body doses:	**millirem**	**rem**	**Sv**	**milliSv**
▪ Occupational annual dose limit, adults[1]	5000	5	0.05	50
▪ Full body Computed Tomography (CT) scan, adult[4]	5000	5	0.05	50
▪ Occupational annual dose limit, minors (<18 years of age)[2]	500	0.5	0.005	5
▪ Average annual background radiation dose in U.S.[3]	310	0.31	0.0031	3.1
▪ **Adult, maximum estimated whole-body shore-based dose (OTR)**	**120**	**0.12**	**0.0012**	**1.2**
▪ X-ray of pelvis/hip[4]	60	0.06	0.0006	0.6
▪ Conventional chest x-ray[4]	10	0.01	0.0001	0.1
▪ **RONALD REAGAN estimated whole-body dose (OTR)**	**8**	**0.008**	**0.00008**	**0.08**
▪ Airplane flight from Los Angeles to Tokyo[4]	4.6	0.0046	0.000046	0.046

Thyroid doses:	**millirem**	**rem**	**Sv**	**milliSv**
▪ Occupational annual dose limit, adults[1]	50000	50	0.5	500
▪ CT of the cervical spine, child[4]	5200	5.2	0.052	52
▪ Occupational annual dose limit, minors (≤17 years of age)[2]	5000	5	0.05	50
▪ Food and Drug Administration recommendation for potassium iodide administration to sensitive populations (e.g., children, pregnant or lactating females)[5]	5000	5	0.05	50
▪ CT of the cervical spine, adult[4]	4400	4.4	0.044	44
▪ **Child, maximum estimated thyroid dose (OTR)**	**2700**	**2.7**	**0.027**	**27**
▪ Nuclear medicine thyroid scan[6]	2000	2	0.02	20
▪ **Adult, maximum estimated shore-based thyroid dose (OTR)**	**1200**	**1.2**	**0.012**	**12**
▪ **RONALD REAGAN estimated thyroid dose (OTR)**	**110**	**0.11**	**0.0011**	**1.1**

[1] Nuclear Regulatory Commission 10 CFR §20.1201 Occupational dose limits for adults
[2] Nuclear Regulatory Commission 10 CFR §20.1207 Occupational dose limits for minors
[3] Includes background radiation from space, terrestrial, internal, as well as radon and thoron sources (NCRP Report No. 160)
[4] NCRP Report No. 160
[5] Food and Drug Administration, http://www.fda.gov/cder/guidance/4825fnl.htm
[6] Society of Nuclear Medicine, Procedure Guidelines for Thyroid Uptake Measurement, Version 3.0, Sept 5, 2006.

The RONALD REAGAN Fleet-Based Radiation Dose Estimate Report is available on the OTR website at: https://registry.csd.disa.mil/registryWeb/docs/registry/optom/OPTOM_USS_RONALD_REAGAN.pdf.

Additional details on the fleet-based doses, including those for the RONALD REAGAN are available in the report "Radiation Dose Assessments for Fleet-Based Individuals in Operation Tomodachi" which is available through the OTR website at: https://registry.csd.disa.mil/registryWeb/Registry/OperationTomodachi/DisplayReferences.do.

APPENDIX A: Adverse medical conditions experienced by these sailors since OT

In Table A-1, the demographic characteristics are listed for 4,843 sailors serving on the RONALD REAGAN between March 12 and May 11, 2011, who were still in service as of the beginning of the medical follow-up period (May 12, 2011). A control population of 65,269 sailors was identified and used to compare disease/symptom incidence rates to those of the RONALD REAGAN sailors. Personnel records indicated that 76 RONALD REAGAN sailors had either separated or retired from service prior to the beginning of this follow up period, so these sailors are not included in this analysis. As a result, Table 2 accounts for 11,126 individual incident disease/symptom diagnoses recorded and grouped into 29 major disease/symptom categories and subcategories for the 4,843 RONALD REAGAN sailors from May 12, 2011, to December 31, 2013, as well as the crude disease/symptom category incidence rates for the RONALD REAGAN and control groups. The sailors in the control group had not deployed to OT, but deployed at some point during the two years before March 11, 2011, indicating they were healthy enough to do so. Ensuring individuals in the control group were healthy enough for deployment helps minimize biases in the control population that may predispose this group to increased incidence of disease relative to the sailors on the RONALD REAGAN. There was little overall difference in the demographic characteristics of the two populations, including age distribution, which is important when comparing disease incidence.

The Armed Forces Health Surveillance Center (AFHSC) developed Table A-2 using a validated roster of sailors to electronically search the Defense Medical Surveillance System and other surveillance systems for both inpatient and outpatient diagnoses, including those in the purchased care network. This table includes adjusted incidence rate ratios (IRRs). “Adjustment” is an epidemiological statistical tool used to control for any biases that could result from differences between the two populations (e.g., age, sex, socioeconomic status, etc.) that could affect health status or outcomes. The adjusted IRRs are used to determine whether there are significant differences between the incidence rates for the RONALD REAGAN sailors compared to the control population. A statistically significant difference, in these analyses, indicates there is less than a 5 percent probability that a difference in disease/symptom incidence rates between the two groups is due to chance. In Table 2, this statistical significance is most directly assessed by looking at the confidence interval (CI). If the 95 percent CI does not include the number “1”, we can conclude that the two incidence rates are significantly different.

Table A-2 shows five groups of disease/symptoms among the RONALD REAGAN sailors with small, but statistically significant, increased disease/symptom incidence rates when compared to the control population. These include: (1) Diseases of the Respiratory System); (2) Diseases of the Digestive System; (3) Diseases of the Genitourinary System; (4) Complications of Pregnancy, Childbirth, Puerperium (generally, the 6-week period following childbirth; and (5) Symptoms, Signs and Ill-defined Conditions (undiagnosed conditions). It is important to note that none of these conditions are known to be radiogenic in their origins and are therefore not causally related to ionizing radiation exposures. Additionally, one subcategory, Infertility, male (606.X) was slightly elevated in the RONALD REAGAN sailors when compared to the control population. However, male infertility has many causes, and there is no evidence in the scientific literature linking primary infertility to low-level ionizing radiation exposure, such as was encountered by the RONALD REAGAN sailors.

Table A-2 also shows five disease/symptom categories for which the incidence rates in the RONALD REAGAN sailors was LOWER than in the control population and statistically significant at the 95 percent confidence level. These include: (1) Malignant Neoplasms; (2) Other Neoplasms; (3) Nutritional Deficiencies; (4) Diseases of the Musculoskeletal System and Connective Tissue; and (5) Injury and Poisoning. Of particular importance is that the incidence rate for malignant neoplasms, many of which can be radiogenic in nature, was nearly 50 percent lower for the RONALD REAGAN sailors than for the sailors in the control population (approximately 45 cases of malignant neoplasms per 10,000 person-years for RONALD REAGAN sailors versus approximately 82 cases of malignant neoplasms per 10,000 person-years in the control population).

Through consultation with radiation subject matter experts and review of the current scientific literature on radiation health effects, we also identified two conditions experienced by the RONALD REAGAN sailors that are known to be radiogenic; they can be caused by ionizing radiation exposure but can also occur in the absence of such exposure. These include two cases of thyroid cancer and one case of non-chronic lymphocytic leukemia (non-CLL). This very small number of cases would not be unexpected among nearly 5,000 sailors. Furthermore, one of the cases of thyroid cancer occurred in an individual who was onboard the RONALD REAGAN for only a few days during OT. Therefore, this individual would have received a much smaller dose of radiation than others who were on the RONALD REAGAN for the entire OT period.

Analysis of incidence rates for thyroid cancer or non-CLL are not provided because incidence rates are considered unreliable and unstable—not scientifically valid—for such a small number of cases (Brillanger et al. 1986; Rothman, Greenland, and Lash, 2008) and could lead to false or spurious conclusions about differences in diseases incidence between the RONALD REAGAN and control groups. The same approach is used by the Centers for Disease Control (CDC) in its report on U.S. Cancer Statistics because the CDC will not compute or publish incidence rates when the number of cases is fewer than 16 (Division of Cancer Prevention and Control, National Center for Chronic Disease Prevention, CDC).

Instead we elected to perform a latency analysis, which can be found in Appendix A, Table A-3. All radiogenic diseases have what is termed a "latency period" between the time of exposure and the appearance of health effects and diagnosis of disease. According to the UNSCEAR (2013), the minimum latency period for radiation-induced leukemia is 2 years and 5 years for solid cancers (including thyroid cancer). In addition, the World Health Organization, in a health risk assessment of the FDNPS accident (WHO 2013), conservatively defined the minimum latency period for radiation-induced leukemia as 2 years, 3 years for thyroid cancer, and 5 years for solid cancers. Based on the dates of diagnosis for these three cases and the minimum latency period of these diseases, it is implausible that these cases are related to the low-level radiation exposures received during OT because all of these diseases were diagnosed much earlier than expected if they had been induced by Operation Tomodachi radiation exposures. More directly, the thyroid cases were diagnosed approximately 450 days earlier than expected and with less than 60 percent of the expected latency period elapsed if they had been induced by OT radiation exposures. Similarly, the non-CLL case was diagnosed more than 500 days earlier than expected and with only 30 percent of the latency period elapsed if it had been induced by OT.

Table A-1. Demographic and military characteristics

	USS RONALD REAGAN (CVN 76)				Control group*			
	Number in service on May 12, 2011	% of population	Number in service on December 31, 2013	% of population	Number in service on May 12, 2011	% of population	Number in service on December 31, 2013	% of population
Total	4,843	100	3,158	100	65,269	100	49,525	100
Gender								
Male	3,927	81	2,574	82	56,611	87	42,971	87
Female	916	19	584	18	8,658	13	6,554	13
Age group								
<20	109	2	0	0	949	1	0	0
20-24	2,009	41	588	19	22,055	34	6,669	13
25-29	1,228	25	1,005	32	16,211	25	15,034	30
30-34	672	14	707	22	10,868	17	11,363	23
35-39	458	9	458	14	8,194	13	8,178	17
40-44	246	5	263	8	4,491	7	5,152	10
45-49	98	2	103	3	1,849	3	2,176	4
50+	23	0	34	1	652	1	953	2
Race-ethnicity								
White non-Hispanic	2,097	43	1,365	43	33,663	52	25,712	52
Black non-Hispanic	703	15	456	14	10,668	16	8,205	17
Hispanic	1,031	21	653	21	10,779	17	7,948	16
Asian/Pacific Islander	364	8	272	9	3,105	5	2,529	5
American Indian/Alaskan Native	168	3	117	4	1,616	2	1,229	2
Other	480	10	295	9	5,438	8	3,902	8
Mil occupational group								
Aircrew/Pilots/Navigators	444	9	373	12	6,263	10	5,754	12
Comm/Intel	551	11	514	16	11,452	18	10,688	22
Aircraft/Equipment Repairers	1,668	34	858	27	10,002	15	5,802	12
Shipboard Propulsion/Ship Machinery	550	11	327	10	6,049	9	4,379	9
Other: all remaining occupations	1,630	34	1,086	34	31,503	48	22,902	46

*Sailors who were not deployed to OT, but who deployed sometime during the two years prior to March 11, 2011.

Table A-2. Incidence rates

	RONALD REAGAN Crude (unadjusted) incidence		CONTROL Crude (unadjusted) incidence				
	Number	Rate (per 10,000 p-yrs.)	Number	Rate (per 10,000 p-)	Adj. IRR* (by all var in table 1)	Lower 95 % CI	Upper 95 % CI
Infectious and parasitic diseases	654	1,292.68	9,645	1,283.30	1.01	0.91	1.07
Malignant Neoplasms[2]	**46**	**44.96**	**1,199**	**81.72**	**0.55**	**0.40**	**0.73**
Benign neoplasm	158	163.47	2,369	168.41	0.97	0.81	1.11
Other neoplasms	103	102.34	1,829	124.14	0.82	0.68	1.01
Disorders of thyroid gland	35	33.93	417	27.44	1.24	0.87	1.72
Diseases of other endocrine glands	38	36.93	681	45.04	0.82	0.58	1.12
Nutritional deficiencies[2]	**6**	**5.80**	**208**	**13.61**	**0.43**	**0.18**	**0.94**
Other metabolic and immunity disorders	193	211.28	2,893	216.44	0.98	0.82	1.10
Diseases of the blood and blood forming organs	35	35.34	568	38.79	0.91	0.63	1.26
Mental, behavioral and neurodevelopmental disorders	690	812.84	9,691	793.18	1.02	0.93	1.08
Diseases of the nervous system and sense organs	1	0.96	55	3.59	0.27	0.04	1.90
Diseases of the circulatory system	333	360.50	4,295	323.58	1.11	0.98	1.22
Diseases of the respiratory system[1]	**931**	**3,279.70**	**13,153**	**2,937.41**	**1.12**	**1.02**	**1.17**
Diseases of the digestive system[1]	**722**	**1,010.17**	**8,915**	**870.92**	**1.16**	**1.05**	**1.22**
Diseases of the genitourinary system[1]	**247**	**265.99**	**2,721**	**198.97**	**1.34**	**1.15**	**1.50**
Diseases of male genital organs	187	241.44	2,486	206.34	1.17	0.99	1.33
Subcategory: Infertility, male[1]	**38**	**45.67**	**402**	**30.80**	**1.48**	**1.04**	**2.02**
Disorders of Breast	59	327.54	725	401.67	0.82	0.61	1.04
Inflammatory diseases of female pelvic organs and other disorders	234	2,323.38	2,388	2,333.16	1.00	0.85	1.12
GU subcategory: Infertility female	23	120.99	193	97.92	1.24	0.78	1.85

Complications of Pregnancy, child birth and the puerperium[1]	**191**	**1,218.39**	**1,531**	**1,012.06**	**1.20**	**1.02**	**1.38**
Subcategory: spontaneous abortion	16	84.70	161	81.87	1.03	0.60	1.69
Infections of the skin and subcutaneous tissue	243	274.18	3,614	279.58	0.98	0.84	1.09
Other inflammatory conditions of the skin and subcutaneous tissue	270	318.37	3,724	294.79	1.08	0.94	1.20
Other diseases of the skin and subcutaneous tissue	463	610.40	6,637	601.55	1.01	0.90	1.09
Diseases of the musculoskeletal system and connective tissue[2]	**1,762**	**3,468.36**	**25,464**	**3,679.26**	**0.94**	**0.90**	**0.99**
Congenital anomalies (NOTE; of Service members NOT dependents)	68	67.28	944	64.11	1.05	0.81	1.32
Certain condition originating in the perinatal period	14	13.48	149	9.75	1.38	0.78	2.34
Symptoms, signs, and ill-defined conditions[1]	**1,752**	**3,911.96**	**22,211**	**3,335.30**	**1.17**	**1.12**	**1.23**
Injury and Poisoning[2]	**1,610**	**3,988.57**	**22,858**	**4,246.99**	**0.94**	**0.87**	**0.97**

* Adjusted for gender, age, race-ethnicity, and occupation

[1] Disease/symptom groups where RONALD REAGAN sailors had a statistically significant **increase** in incidence compared to the Control population

[2] Disease/symptom groups where RONALD REAGAN sailors had a statistically significant **decrease** in incidence compared to the Control population

Table A-3. Latency Analysis of RONALD REAGAN Cancer Cases Potentially Associated with Ionizing Radiation Exposure

Case	Date Operation Tomodachi Radiation Exposure Began	Minimum Latency Period	Estimated Date of Diagnosis if Radiogenic Cancer due to Operation Tomodachi	Actual Date of Diagnosis	Percentage of Post-Operation Tomodachi Minimum Latency Period Elapsed before Diagnosis	Number of Days (years) Diagnosed Before Estimated Date if Radiogenic Cancer due to Operation Tomodachi
Thyroid Cancer Case 1	3/12/2011	3 years	03/12/2014	11/29/2012	57%	-468 days (-1.3 years)
Thyroid Cancer Case 2	3/12/2011	3 years	03/12/2014	12/19/2012	59%	-448 days (-1.2 years)
non-Chronic Lymphocytic Leukemia (non-CLL) Case 1	3/12/2011	2 years	03/12/2013	10/19/2011	30%	-509 days (-1.4 years)

APPENDIX B. A description of the actions taken on board the RONALD REAGAN before, during, and after the mission to protect the sailors from nuclear radiation

The starting point for actions taken to protect the RONALD REAGAN (CVN 76) sailors from nuclear radiation and other hazards was the pre-deployment, basic phase training cycle. During basic phase training, the crew completes a series of chemical, biological and radiological (CBR) defense training events. The basic phase training provided the RONALD REAGAN sailors with adequate CBR skills such as radiation detection, control of ship's environment, maintaining ship's material condition, using personnel protective equipment, and survey and decontamination methods. CBR training is mandatory for sailors on all ships in preparation for overseas deployment. The basic phase training cycle confirmed the ship possessed the necessary materials and equipment for radiation detection and minimizing radiation exposure to the crew in a CBR environment. Additionally, the officers and crew were trained to use the ship's speed and maneuver to avoid areas of radioactive fallout, such as from a nuclear weapon detonation. Experts from the Fleet's Afloat Training Group validated the readiness of the ship to function in a CBR environment.

As a nuclear-powered warship, the RONALD REAGAN possesses a complement of officers and enlisted personnel who are trained and qualified to operate the ship's nuclear propulsion plant. Navy nuclear propulsion plant operator qualification includes training in the stringent radiological controls required for propulsion plant operations, including tracking and maintaining radiation exposure as low as reasonably achievable, controlling radioactive contamination to prevent spread, and controlling radioactively contaminated materials. In addition, nuclear-trained sailors are trained in the use of radiation detection instruments, personnel and equipment decontamination, and how to work on radioactively contaminated equipment. The RONALD REAGAN is equipped with sensitive radiation detection equipment for use in the propulsion plant, including continuous air particulate detectors (APDs), portable air samplers (PAS), and a number of beta-gamma contamination and radiation detectors.

From the start of OT, the Navy was aware of media reports indicating that several of the Japanese Fukushima Daiichi nuclear power plants were at risk of damage and potential release of radioactive material. On March 12, 2011, Commander, Seventh Fleet established a 100 nautical miles (nm) exclusion zone around the Fukushima Daiichi facility for U.S. naval vessels, including the RONALD REAGAN. At 1300 (local time) on March 13, 2011, airborne radioactivity from the Fukushima Daiichi power plants was detected on the RONALD REAGAN flight deck using a PAS and by propulsion plant APDs while the ship was operating approximately 110 nm from Fukushima Daiichi. Following the detection of airborne radioactivity, the RONALD REAGAN moved north of 40 degrees latitude (over 120 nm north of Fukushima Daiichi) to avoid further contact with radioactivity from Fukushima.

Radiation Protection Measures During OT

Once it became apparent that radioactive contamination from Fukushima Daiichi had been released to the environment, the Navy activated Emergency Control Centers (ECCs) throughout the Pacific region and in Washington, D.C., to facilitate data collection, communications, and decision-making. Technical experts operating from the ECCs provided support and technical direction to the RONALD REAGAN for minimizing contamination of personnel, ships, and aircraft operating in support of OT. Radiological controls experts from the U.S. Naval Shipyards flew to the RONALD REAGAN to provide the ship with additional expertise and manpower. The following provides a summary of actions taken during OT to minimize radiation exposure to personnel aboard the RONALD REAGAN.

1. Coordination and communication: By March 18, 2011, the RONALD REAGAN leadership and experts from U.S. Naval Shipyards established a dedicated command center onboard the ship to consolidate and organize radiological and environmental data coming to the ship from off-ship sources as well as from shipboard survey and decontamination teams (i.e., radiological survey data, environmental data, meteorological data, guidance from higher authorities, etc.). The command center provided ship and strike group leadership with the best available information and recommendations for safe operation of the ship and ship's aircraft. The command center was accessible to all personnel and provided regular briefings to ship's leadership. The ship's Commanding Officer kept his crew fully aware of the situation, radiological status of the ship, and the radiological controls in place by providing announcements to the ship's crew via the ship's general announcing system, Plans of the Day (a daily publication of information pertinent to the crew; all crew members are required to read it daily), General Military Training, and other standard means of intra-ship communication. Additionally, the ship's crew had full access to regular news media outlets such as CNN, FOX, etc., via the ship's television network and internet.

2. Ship positioning: Between March 13 and 16, 2011, the position of ships supporting OT was tracked to keep ships out of the downwind direction (prevailing winds were out to sea for most of the event) and at least 200 nm from the Fukushima Daiichi plants. Between March 16 and 19, 2011, ships supporting OT were directed to remain at least 100 nm from Fukushima Daiichi and greater than 150 nm from Fukushima Daiichi along a 90 degree arc, or wedge, centered on the direction of wind from Fukushima Daiichi. The standoff distance from Fukushima Daiichi was temporarily increased to 200 nm on March 16, 2011, as a precaution following detection of abnormally high radiation levels above the Fukushima Daiichi Unit 3 containment building by the Japanese military. On March 19, 2011, the wedge was reduced to 125 nm and the width of the wedge was reduced to 80 degrees to better support humanitarian assistance operations without compromising radiation safety.

3. Efforts to minimize and remove radioactive contamination: On March 13, 2011, Naval Sea Systems Command (NAVSEA) 08, with Commander Pacific Fleet concurrence, provided initial technical guidance to ships for contamination and radiation monitoring of ships, aircraft, and personnel; limiting the spread of contamination shipboard; and decontamination of ships and aircraft. Subsequent technical guidance for control of contamination was provided by NAVSEA 04 and U.S. Pacific Command and was updated throughout OT as more information became available. Eighteen Navy Radiation Health Officers, 125 trained Navy radiological controls technicians (RCTs), and a number of health physicists were deployed to responding U.S. ships and shore facilities to provide radiological controls and radiation health expertise. On the RONALD REAGAN, all personnel entering the ship from the flight deck were surveyed to prevent contamination from being carried inside the ship. Personnel who were required for Flight Deck duties used Personal Protective Equipment (PPE) to minimize their exposure to radioactive contamination. In addition, aircraft and aircrews returning from relief missions were

surveyed for contamination and decontaminated if necessary. Ship's spaces, including messing and berthing areas, were surveyed periodically with sensitive equipment and decontaminated as necessary. The ship used countermeasure wash down systems (a shipboard system specifically designed to rinse the exterior surfaces of the ship in a CBR atmosphere) in accordance with trained procedures to keep exterior decks as free from contamination as possible. The RONALD REAGAN flight deck was surveyed multiple times, loose surface contamination was removed, and fixed surface contamination was covered to prevent the fixed contamination from being disturbed until decontamination was completed. Anyone with detectable contamination on their clothing or skin was promptly decontaminated; contamination was generally easily removed from the skin by washing with soap and water and contaminated clothing was removed and controlled. There is no indication that any of these situations would have resulted in radiation exposures of a sufficient magnitude to result in adverse health conditions that could be attributed to the exposures.

4. Potable water analysis and control: Following the detection of airborne radioactivity released from Fukushima Daiichi, the RONALD REAGAN began daily sampling of shipboard potable water. On March 15, 2011, initial analysis with sensitive radiation detection equipment by the RONALD REAGAN of three potable water samples (two from drinking fountains and one from a potable water tank) indicated the presence of low levels of radioactivity. The RONALD REAGAN temporarily secured potable water systems while the problem was investigated. The sample from the potable water tank initially reported as containing low levels of radioactivity was reanalyzed with the same sensitive radiation detection equipment and found not to contain detectable radioactivity. Additional samples of potable water tanks online at the time the drinking fountain samples were taken, as well as samples of the effluent from the distilling units that generate potable water from seawater, did not identify detectable radioactivity. The RONALD REAGAN potable water samples collected during OT after March 15, 2011, also did not identify detectable radioactivity. The RONALD REAGAN concluded that the initial three samples on March 15, 2011, were erroneously reported as containing detectable radioactivity due to fluctuations in background radiation that affected the sample counts.

In February 2014, NAVSEA 08 requested the Knolls Atomic Power Laboratory (KAPL) perform an independent technical review of the potable water sample analyses performed by the RONALD REAGAN crew on March 15, 2011. A team of highly-qualified KAPL engineers and scientists, including two Certified Health Physicists (experts in radiation measurement and radiation dose assessment), a PhD in statistics, a PhD in radiochemistry, and two experts in radiation health and radiological engineering reviewed the RONALD REAGAN potable water data. The KAPL experts concluded the potable water sample results initially reported as containing detectable radioactivity were not indicative of a radiologically contaminated potable water system. KAPL's conclusion is based on the variability of both the background and sample count results, samples from all in-service potable water tanks showing the tanks did not contain detectable radioactivity, the design of the ship's distillation units which would remove a significant fraction of particulate radioactivity from seawater (between 99 and 99.9 percent), samples of the distillation units' effluents showing no detectable radioactivity, and the large distance of the RONALD REAGAN from Fukushima Daiichi at the time the samples were taken (over 100 nm). The preponderance of data shows the RONALD REAGAN's potable water systems were not contaminated.

However, for perspective, even if the erroneous potable water radioactivity measurements discussed above were correct, the radiation exposure to personnel aboard the RONALD REAGAN would be extremely small. A hypothetical dose estimate was developed by KAPL for sailors drinking and bathing in potable water on the RONALD REAGAN between the March 11, 2011, earthquake and tsunami and when the RONALD REAGAN's potable water supplies were verified to not contain detectable contamination on March 15, 2011. Using conservative assumptions, the total dose to a sailor on the RONALD REAGAN from potable water contamination would be less than the U.S. Environmental Protection Agency's annual limit for radiation exposure for the U.S. general public from drinking water that would result in a dose of 4 millirem to the limiting organ (in this case, the thyroid). The low level of radiation dose estimated for drinking and bathing with water contaminated to the levels erroneously reported by the RONALD REAGAN is approximately equivalent to the radiation dose from natural background radiation sources received during a cross country airline flight.

5. Efforts to control and maintain radiation exposure as low as reasonably achievable: Personnel on the RONALD REAGAN were directed to minimize time outside the skin of the ship to minimize their exposures. Low exposure control levels of 300 millirem effective (whole body) dose (approximately equivalent to the annual average background radiation dose for a member of the U.S. public from naturally occurring radiation sources) were established by U.S. Pacific Command (USPACOM) for all personnel for the duration of the operation. USPACOM allowed field commanders to authorize up to 1,000 millirem effective dose to meet operational requirements with additional consideration for exposure mitigation (such as minimizing time in contaminated areas). USPACOM approval was required to authorize exposure control levels greater than 1,000 millirem with an upper limit set at the Federal annual occupational radiation exposure limit (5,000 millirem per year). While no records are immediately available as to how many individuals were assigned exposure control levels above 300 millirem effective dose during OT, no exposure control level increases above 1,000 millirem were required. Detailed, conservative dose assessments posted on the OTR website (https://registry.csd.disa.mil/registryWeb/Registry/OperationTomodachi/DisplayAbout.do) determined all responding personnel, whether on shore or shipboard, received less than half of the 300 millirem effective dose control level for the duration of OT. Radiation exposures within Federal limits are not expected to result in risks of adverse health effects greater than risks normally accepted in everyday life.

Some preventive maintenance items on aircraft and ship's systems were deferred until procedures to minimize radiation exposure during the work were developed. For aircraft maintenance that was required in order to complete the ship's mission, radiological controls experts teamed with the aircraft maintenance experts to minimize radiation exposure to maintenance personnel. The teaming included radiological controls experts monitoring the maintenance work using sensitive radiation detection equipment and decontaminating any radioactivity identified during the maintenance. Radioactively contaminated items were segregated from occupied areas or removed from the ship to minimize radiation levels in adjacent occupied spaces. For example, ventilation system filters which concentrated radioactivity were either decontaminated or replaced in accordance with technical direction while taking necessary radiological precautions.

Aircraft flight crews, personnel performing maintenance on possibly contaminated aircraft or ship's systems, and others with a potential for receiving relatively higher radiation exposures, such as from missions ashore closer to Fukushima Daiichi or maintenance on contaminated systems, were monitored for radiation exposure with sensitive thermoluminescent dosimeters (TLDs) and electronic personal dosimeters (EPDs), which provided real-time radiation exposure data. Additionally, operational commanders were provided with a variety of assessment tools for estimating radiation exposure while planning missions. Flight crews were provided with information updated daily on wind direction and ground contamination levels for each mission area that was used to predetermine expected radiation exposures. Aircrews were briefed on expected radiation exposure before each mission. Aircrew exposure planning was based on whole body radiation exposure, as read on an EPD, with aircrews briefed to return to the ship if an exposure control level was reached. Dose to the thyroid was effectively eliminated by the use of potassium iodide, as discussed below.

6. Distribution and use of potassium iodide (KI): During a reactor accident event with a release of radioactive iodine to the environment, dose to the thyroid is of concern because the thyroid naturally concentrates iodine. KI is used to saturate the thyroid with stable (i.e., nonradioactive) iodine, almost eliminating the uptake of radioactive iodine by the thyroid and greatly reducing radiation dose from radioiodine. KI is very effective at significantly reducing radiation dose from radioiodine if taken before, during, or soon after exposure. The RONALD REAGAN deployed with sufficient KI to provide at least one dose to each crewmember. Additional KI was provided to the RONALD REAGAN and the strike group after the strike group first encountered the radioactive plume from Fukushima Daiichi, making sufficient quantities of KI available, if required. In accordance with medical guidance provided by USPACOM for OT, KI tablets were issued and administered to air wing flight crews and other personnel providing disaster relief ashore within zones around the damaged reactor plants defined by United States Forces Japan. Early in OT, personnel entering within 100 nm of the Fukushima Daiichi site, such as aircrews supporting disaster relief ashore, were recommended to take KI. Later, some personnel were directed to take KI based on the potential for radioiodine exposure in the shore zones. In accordance with standing U.S. Navy Bureau of Medicine and Surgery (BUMED) requirements and the recommendations of the Food and Drug Administration (FDA), issuance or administration of KI to shipboard personnel was neither necessary nor directed by medical authorities.

7. Personnel internal monitoring: As a verification of the effectiveness of controls and to determine if crew members were internally contaminated with radioactive material, the RONALD REAGAN used sensitive radiation detection instruments and approved procedures to "internally monitor" or assess, the level of internally deposited radioactive material in personnel considered most likely to have inhaled or ingested radioactive particles. Aircrews that may have flown through radioactive plumes from Fukushima Daiichi, personnel performing maintenance on contaminated ships and aircraft, and a portion of Ship's Force were internally monitored in accordance with guidance provided by Joint Support Forces – Japan and, later, by USPACOM. In total, approximately 1,360 individuals were monitored aboard the RONALD REAGAN and

the highest measured whole body dose was less than 10 percent of the average annual radiation exposure to a member of the U.S. public from natural background radiation sources. The highest measured thyroid dose was less than one percent of the applicable Federal annual radiation exposure limit. The highest measured thyroid dose aboard the RONALD REAGAN is also less than one percent of the dose at which BUMED and the FDA recommend administration of KI to the most sensitive populations (i.e., children and pregnant or lactating women), which validates the decision not to issue KI to all RONALD REAGAN personnel. More than 96 percent of personnel internally monitored aboard the RONALD REAGAN were found not to have detectable internal contamination.

Radiation Protection Measures After OT

In the aftermath of OT, the Navy continues to identify and remove low-level, fallout contamination remaining in areas of the RONALD REAGAN and other participating ships not normally accessible during routine operations. Remaining contamination aboard ships will not result in a significant radiation exposure or health concern and is consistent with levels of contamination on land bases in Japan.

NAVSEA is the Navy's overall technical authority for Fukushima Daiichi radioactive contamination on board U.S. Navy ships and aircraft. NAVSEA establishes requirements, approves survey plans, and approves release of any affected vessel or aircraft from radiological controls associated with Fukushima radioactivity. For the RONALD REAGAN, Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS&IMF) provides engineering and technical support for radiological surveys and decontamination efforts. For non-nuclear ships, NAVSEA established the Dahlgren Radiological Controls Data Center at Naval Surface Warfare Center (NSWC) Dahlgren to collect and analyze all radiological survey information and develop decontamination plans to release remaining shipboard systems of concern. Commander, Naval Air Forces Pacific coordinates with the Fleet in execution of aircraft carrier ship survey and release plans.

Technical requirements for control of radioactive contamination from the Fukushima Daiichi accident were developed during OT and continue to be updated. In April 2011, PSNS&IMF issued the manual "Radiological Controls for Maintenance Involving Fallout," for affected nuclear-powered ships and, in May 2011, NAVSEA published the "Radiological Controls Manual for Fukushima Daiichi Fallout" for non-nuclear ships. These manuals provide requirements for radiation exposure and contamination control, training, and waste control for handling radioactive contamination from Fukushima fallout. The manuals are largely equivalent, with small differences to account for non-nuclear crews having less familiarity with radioactivity and associated radiation detection equipment. Requirements in the manuals are based on Federal regulations, applicable National Standards (published by the American National Standards Institute and the Health Physics Society), and health physics and radiation protection best practices. Additionally, NAVSEA approved a training program to qualify non-nuclear sailors on the RONALD REAGAN and other ships as Contamination Technicians to ensure appropriate radiological controls during maintenance.

Every ship supporting OT was radiologically surveyed to identify contaminated systems and spaces, which were conservatively assumed to contain radioactivity above limits. Each ship was required to submit radiological survey data to the Fleet and NAVSEA to track radiological status and to support eventual release of the radiological controls in place on board vessels once remediation is complete.

Consistent with the above discussion, all normally accessible RONALD REAGAN spaces and equipment were surveyed and, as contamination was identified, promptly decontaminated during and immediately following OT. Contamination that could not be easily removed was covered over to prevent it from being disturbed until decontamination was completed. The highest level of contamination due to fallout from Fukushima Daiichi found on the RONALD REAGAN was 55,000 corrected counts per minute (ccpm)/probe (ccpm is the net count rate after subtraction of the background count rate). Specifically, 55,000 ccpm/probe of fixed contamination was found in one isolated spot on the flight deck; smaller discrete spots of fixed contamination (between 3,200 and 19,800 ccpm/probe) were found on the flight deck nearby. For perspective, if the RONALD REAGAN flight deck had been uniformly contaminated at the highest level measured during OT, radiation levels on the flight deck would have been less than one-tenth of the radiation levels requiring control as a radiation area per the requirements of the Nuclear Regulatory Commission (10CFR20). Further, as the radioactive contamination on the RONALD REAGAN primarily consisted of short-lived radioactive isotopes of iodine (with half-lives measured in days), the majority of the contamination decayed away quickly in the weeks after the RONALD REAGAN encountered the radioactive plume from Fukushima Daiichi on March 13, 2011. The contamination on the RONALD REAGAN's flight deck was similar to levels of contamination at U.S. shore facilities in Japan, such as Combined Fleet Activities Yokosuka, that remained manned throughout OT and afterwards. Therefore, the low levels of contamination aboard the RONALD REAGAN due to participation in OT are not considered to be of health concern.

Although all normally accessible areas were remediated by May 2011, low levels of radioactive contamination from the Fukushima Daiichi reactor accident remain, primarily inside portions of shipboard ventilation systems and some air cooled electric motors. The remaining contamination is low level and is primarily fixed (i.e., is not easily removable). As such, the contamination does not present a radiation exposure concern because the fixed contamination cannot easily be spread, inhaled, or ingested and the contamination does not result in increased general area radiation levels. For maintenance that requires access to the internal components of these systems, radiological control requirements remain in effect in accordance with NAVSEA directives. Responsible Naval organizations are actively completing decontamination and release of ventilation systems and motors from radiological controls.

Contamination found in aircraft during OT was of equivalent magnitude to contamination found on RONALD REAGAN. The Navy identified 189 affected aircraft (not all assigned to RONALD REAGAN) and provided radiological controls guidance commensurate with the radiological environment and the mission. Initial higher levels of radioactive contamination on aircraft primarily consisted of short-lived radioactive isotopes of iodine, and all normally accessible identified contamination was promptly decontaminated during and immediately following OT. The majority of the initial contamination decayed away quickly in the weeks following exposure to the radioactive plume from Fukushima Daiichi on 13 March 2011. Sailors performing maintenance on contaminated aircraft received radiation exposures, as measured with sensitive TLDs, equivalent to less than one month's worth of the average annual background radiation exposure to individuals in the U.S. from natural sources of radioactivity.

Technical requirements and oversight for managing radioactive contamination from the Fukushima Daiichi site were subsequently further developed and codified in Naval instructions by cognizant technical authorities. Specific radiological controls procedures for each type of contaminated aircraft were developed by the Naval Air Systems Command and approved by NAVSEA based on the requirements of "Radiological Controls Manual for Fukushima Daiichi Fallout" and also apply to maintenance of aircraft contaminated during OT. The intent of the radiological controls procedures for aircraft is to detect and remove contamination so that normal operational and intermediate level maintenance operations can be performed without radiological controls. Depot level maintenance (higher level maintenance requiring access to normally inaccessible areas) is not performed until required radiation surveys of the aircraft have been completed and the aircraft is evaluated for release from radiological controls by NAVSEA. All repairable aircraft components are surveyed before being returned to the repair facility. If the component cannot be adequately surveyed due to inaccessible areas or if contamination is detected above the limits for release from radiological controls, the component is segregated and evaluated for further decontamination or proper disposal.

Potentially contaminated components and parts removed from ships and aircraft are specially tracked. All repairable ship and aircraft components and engine exteriors are surveyed by the ship or squadron, decontaminated, and then shipped to the Forward Repairable Inspection Activity at Naval Air Station (NAS) Atsugi or the Aviation Radiological Inspection Facility at NAS North Island for extensive surveys and further decontamination. Materials above contamination limits are controlled until an appropriate disposition is determined.

APPENDIX C. A breakdown of the number of sailors who participated in Operation Tomodachi who are still Navy Service members (including reserve component), as well as the number of sailors who have since separated (provided by Navy)

Tables C-1 and C-2 below show the personnel status of all U.S. Navy and all RONALD REAGAN participants in OT, as of February 20, 2014. These tables were developed using information contained in the Operation Tomodachi Registry (OTR), which was based on Navy accountability reporting during OT and subsequent RTC-related efforts to validate the Navy roster data in the OTR. Due to short-term TAD/TDY periods during OT, the unprecedented and chaotic nature of this operation, and clerical or administrative inconsistencies, it is reasonable to expect that the OTR may not include every sailor who was in or near the mainland of Japan during OT. However, based on the force health protection measures instituted during OT and the radiation monitoring performed using TLDs and internal monitoring for individuals at risk of elevated radiation exposures, we are confident the possible omission of a small number of sailors from our analyses will have no bearing on the overall conclusions.

Table C-1. Personnel Status of All U.S. Navy Personnel Participating in Operation Tomodachi as of February 20, 2014

Active Duty:	16,217
Transferred to Reserves:	3,588
Separated:	3,177
Retired:	1,479
Deceased:	26
Admin Drop:	7
Deserter:	2
Total:	**24,496**

Table C-2. Personnel Status of RONALD REAGAN Personnel Participating in Operation Tomodachi as of February 20, 2014

Active Duty:	3,025
Transferred to Reserves:	960
Separated:	690
Retired:	238
Deceased:	5
Admin Drop:	1
Total:	**4,919**

NOTE: The total of 4,843 sailors included in Appendix A, Table A-1 was derived by taking the total RONALD REAGAN population in this table and removing the 76 sailors who were no longer in service at the beginning of the follow-up period (May 12, 2011).

APPENDIX D. Background: Operation Tomodachi (OT)

On March 11, 2011, a 9.0 magnitude earthquake occurred northeast of Tokyo, Japan, off the coast of Honshu Island. Approximately 40 minutes after the earthquake, a large tsunami reached the coast of Japan. The earthquake and tsunami severely damaged the Fukushima Daiichi Nuclear Power Station (FDNPS) located 150 miles northeast of Tokyo and resulted in the release of radioactive material into the environment over an extended period. Shortly after initial news reports of the devastating earthquake and tsunami surfaced, the U.S. Department of Defense (DoD) began responding to the developing situation in Japan. A high priority was placed on minimizing radiation exposures and protecting the health of the members of the DoD-affiliated population on the mainland of Japan. These response activities were centered in Japan, Hawaii, and Washington, DC. Additionally, at the request of the Government of Japan, DoD launched a substantial humanitarian assistance and disaster relief mission named Operation Tomodachi (OT). The USS RONALD REAGAN (CVN 76), a nuclear-powered aircraft carrier, was one of 25 U.S. Naval ships deployed to the region in support of OT.

In Japan and Hawaii:

To evaluate the magnitude of the potential health risk from radioactivity released from the FDNPS, external radiation dose measurements were made with portable radiation detection equipment at U.S. installations in Japan, on Naval vessels, and in other locations where DoD Service members were deployed. Special DoD radiation health, environmental health, and emergency response teams from the continental United States and Okinawa were deployed to augment the DoD capabilities within the U.S. Forces Japan region. U.S. Department of Energy (DoE) accident response teams also deployed to the area and conducted extensive radiation monitoring. DoD installation water supply systems were radiologically monitored by DoD and DoE to ensure the safety of the drinking water. Non-potable water samples were collected from a variety of sources, including the ocean, surface water bodies, and rainwater. Soil was assessed for radiological contamination. Additional actions were taken by the DoD to prevent radioactive contaminated food and water from reaching the U.S. DoD-affiliated population through our commissaries and other food sales and serving facilities on our installations. This included suspending the procurement of some bottled water and all subsistence items grown in or produced from food sources in areas with high levels of radioactive contamination. Environmental and radiological monitoring data, to include internal radiation monitoring data and radiation dosimetry, were collected by all four DoD military services (Air Force, Army, Marine Corps, and Navy) and Japan's Ministry of Education, Culture, Sports, Science, and Technology. Thousands of data points were subsequently used to calculate radiation exposure to U.S. Service members and DoD civilian employees, as well as the family members of U.S. Service members and DoD civilian employees, and DoD contractors (members of the DoD-affiliated population) who were on or near the Japanese mainland from March 12, 2011, to May 11, 2011. This period was selected based on the observation that the total effective radiation doses calculated for the 365 days following each day at the selected sites of Yokota AB and Yokosuka AB did not change by more than one millirem (0.01 milliSv) after May 11, 2011. The difference of one millirem (0.01 milliSv) was used because the NCRP (1993) considers one millirem (0.01 milliSv) to be an effective dose that does not warrant further efforts to reduce radiation exposure to an individual.

Military commanders within the Pacific/Japan area, including U.S. Pacific Command (USPACOM), U.S. Forces Japan (USFJ), and the Commander, U.S. Pacific Fleet (COMPACFLT), took additional actions to protect the health of the DoD-affiliated population on mainland Japan. COMPACFLT set a 300 millirem dose control limit with a maximum of 1,000 millirem for the duration of operations, established strict criteria for entry into hot and warm zones around the FDNPS, and published guidance for distribution and administration of potassium iodide (KI) for protection against radioactive iodine inhalation/ingestion. Individuals who entered "warm or hot zones" located closer to FDNPS, where radiation levels were relatively higher, wore dosimeters to measure external radiation. In addition, internal radioactivity was measured via internal monitoring devices, which measured radiation emitted from inhaled or ingested radioactive material inside the body. The internal monitoring program was later expanded to provide voluntary testing of other members of the DoD-affiliated population in Japan to include some shipboard personnel, air crews, Service members who did not deploy into the warm or hot zones, family members, civilians, and contractors. More than 8,500 individuals had their levels of internalized radioactive material monitored with sensitive radiation detection equipment, and approximately 98 percent of the internal monitoring results were negative. Only 2 percent had very small, detectable quantities of radioactivity that resulted in doses equivalent to those received during two inter-continental airplane flights or less than 10 percent of what a person in the U.S. would naturally receive annually from background radiation sources.

In Washington, DC:

On March 15, 2011, the Honorable Senator Patty Murray (WA), Chairperson of the Senate Veterans' Affairs Committee, wrote the Secretary of Defense urging that he create a comprehensive database of all U.S. Service members supporting the Japanese relief effort along with their estimated doses. In response, the Under Secretary of Defense for Personnel and Readiness informed Senator Murray that the DoD had begun such an effort in coordination with the Department of Veterans Affairs to capture the measures taken to monitor individuals for radiation exposure and to create a comprehensive database. The secure and comprehensive database is called the Operation Tomodachi Registry (OTR).

The OTR was created at a cost of $3.5M. The Office of the Assistant Secretary of Defense for Health Affairs directed and oversaw its construction, while the Army Institute of Public Health served as the lead organization for creating the OTR and today manages the registry. The Director, Armed Forces Radiobiology Research Institute, established a Dose Assessment and Recording Working Group (DARWG) with technical and acquisition support provided by the Defense Threat Reduction Agency (DTRA). The DARWG includes subject matter experts in radiation health from the Military Departments (Army, Navy, and Air Force). Their primary task was to assess and record the estimated radiation doses for all members of the DoD-affiliated population who were on or near the mainland of Japan between March 12, 2011, and May 11, 2011. A senior scientist from DTRA now chairs the DARWG, and is engaged in completing and refining its comprehensive technical reports.

The OTR's purpose is to serve as the authoritative historical record of the estimated radiation doses to Service members, DoD civilian employees, family members of Service members and DoD civilian employees, and DoD contractors who were in Japan during OT. The OTR contains the names, locations, and estimated radiation doses (both whole body and thyroid) for more than 75,000 individuals. Over 58,000 individuals are associated with one of 13 general shore-based locations, which include DoD military installations and major cities where the majority of the DoD-affiliated population worked or lived. Nearly 17,000 individuals are associated with 25 U.S. Navy fleet-based ships and aircrews in the area during this period.

The DoD created the publicly accessible OTR website (which is completely separated from the OTR itself) for use by medical providers, members of the OTR, and other interested individuals. It contains information about the disaster and DoD's humanitarian response, provides answers to frequently asked questions, and using an interactive map provides ready access to radiation dose estimate reports for adults and children for all 13 general shore-based areas (which include 63 more-specific locations) as well as for all 25 U.S. Navy ships. The reference section of the OTR website contains a series of peer-reviewed DTRA technical reports pertaining to the shore- and fleet-based radiation dose calculations. The website URL is http://registry.csd.disa.mil/otr.

For the RONALD REAGAN, the whole-body and thyroid radiation dose estimates for the two-month period were 8 millirem and 110 millirem, respectively. In comparison, the highest estimated doses for any of the 25 U.S. Navy ships for the two-month period were 35 millirem whole-body dose and 340 millirem thyroid dose. These high-sided, conservative dose estimates were calculated in a manner to ensure that they would likely be higher than the true doses received, yet these doses are still well below ionizing radiation exposure limits or exposure levels associated with adverse medical conditions or radiogenic disease.

The RONALD REAGAN Fleet-Based Radiation Dose Estimate Report is available on the OTR website at:
https://registry.csd.disa.mil/registryWeb/docs/registry/optom/OPTOM_USS_RONALD_REAGAN.pdf.

Additional details on the fleet-based doses, including those for the RONALD REAGAN, are available in the DTRA report "Radiation Dose Assessments for Fleet-Based Individuals in Operation Tomodachi," which is available through the OTR website at https://registry.csd.disa.mil/registryWeb/Registry/OperationTomodachi/DisplayReferences.do.

Finally, the DoD initiative to ensure the OT estimated radiation doses were entered into the electronic medical records of all Military Health System beneficiaries was recently completed.