USCG Summary of DTRA Report DTRA-TR-10-26

United States Coast Guard (USCG) veterans stationed at LORAN stations (LORSTA) from 1942-2010 have expressed concern that their duties may have caused them radiogenic disease due to their occupational exposure to x-rays emanating from high voltage vacuum tubes. Approximately 10,000 USCG service members operated these units during this period of time and may have been occupationally exposed to this x-ray source. In response to this concern, the USCG Commandant (CG-1133) commissioned a technical report to review the personnel radiation exposure associated with x-rays emanating from USCG LORAN high voltage vacuum tube transmitter units that operated between1942-2010. The Defense Threat Reduction Agency (DTRA) and the USCG jointly drafted this technical report (DTRA-TR-10-26). To assist USCG LORSTA veterans, their dependents, the Department of Veterans Affairs (VA), and the USCG, this report culminates in recommendations for the collection of veteran exposure scenario data and its subsequent use in radiation dose reconstructions in order to perform a probability of radiogenic disease causation calculation, which can lead to a VA radiogenic disease compensation decision.

Radiation measurements available for analysis included five distinct temporal collections: 1982, 1987-1988, 1993-1999, 2003, and 2008-2011. These measurements provide verification of a valid x-ray radiation exposure hazard that could potentially be a source of occupational disease. Radiation measurements in late 1993 resulted in the installation during 1995 of acrylic-lead radiation shields between the high power vacuum tubes and the outer electrical equipment cabinet doors. Subsequent radiation measurements demonstrated that the radiation shields were effective in eliminating occupational exposure from these radiation sources, if the shields were maintained between the USCG maintenance personnel and the energized power amplifier (vacuum tube).

The power amplifier tube used an applied voltage of 21,500 volts (21.5 kVp). From an x-ray protection viewpoint, a 21.5 kVp source is considered a “soft” x-ray source that is relatively easy to shield. For comparison purposes, clinical diagnostic imaging x-ray units are often operated at 100 kVp, and associated radiation shielding is typically lead sheets of approximately 1.5 mm in thickness. For USCG LORSTA tubes a lighter weight, plastic shield (commercial acrylic-lead) was sufficient. There were some other sources of potential x-ray exposure to the LORSTA workers outlined in the report. These include high voltage vacuum relays, vacuum tube switches, and arc suppressors. We have limited data associated with radiation exposures emanating from the LORSTA high voltage power amplifier tubes and even less exposure data associated with LORSTA vacuum tube switches, and other high voltage vacuum tube devices such as arc suppressors. These measurements varied over time and between individual tubes, and LORSTAs. As procedures changed, field changes were made, and radiation shielding was installed, radiation exposure scenarios evolved.

Results from the USCG’s limited LORSTA personnel radiation dosimetry monitoring program in 1988 and 1994 demonstrated minimal personnel radiation exposure for monitored personnel, well within federal occupational radiation exposure limits and presumably was the rationale for not establishing a USCG LORSTA personnel radiation dosimeter program. However, LORAN transmitter maintenance and engineering experts cite anecdotal reports of LORAN technicians performing exceptional operation/maintenance procedures that entailed significant radiation exposures. Unfortunately, the limited personnel monitoring program did not address these cases, and it is not possible to create a

standard scenario for universal application for these personnel. The exceptional scenario must be based on specific inputs from individuals.

Radiogenic disease resulting from active duty occupational radiation exposure is a recognized health impairment that can arise in veterans' post-active duty service, due to radiogenic disease latency periods. Disease arising from exposure to ionizing radiation (radiogenic disease) is typically described by one of two exposure scenarios:

Deterministic: characterized by relatively high, acute exposures of 200 rad or greater, and typically manifesting acute radiation syndrome (ARS) symptoms from whole body irradiations of nausea, vomiting, headache, erythema, fatigue, epilation, and conjunctival reddening. During the history of USCG LORSTA operation, there have been no known reports of ARS. This fact establishes an upper bound on USCG LORSTA personnel radiation doses.

Stochastic: characterized by non-acute exposures that may result in disease (e.g. cancer). Radiogenic disease latency periods (time between radiation exposure and diagnosis of disease) can vary between a few years for disease such as leukemia to decades for solid tumors.

Unfortunately, there are no unique biological markers that can distinguish between occupational radiation exposure and background radiation exposure (e.g. from natural sources or medical procedures). However, it is possible to calculate the risk or odds (probability) of developing stochastic radiogenic disease. The Health Physics Society provides a useful introductory table, reproduced in Table 8 of the report. It is often possible to estimate tissue-specific radiation doses with reasonable precision, and the relationship between dose and subsequent cancer risk is probably better quantified than for any other common environmental carcinogen. The VA recognizes 24 non-presumptive radiogenic diseases (see Appendix 3 of the report) . An unlisted disease may be considered if the claimant has cited competent scientific or medical evidence that the claimed condition is a radiogenic disease.

For the VA to connect the veteran's radiogenic disease to service related occupational radiation exposure, a number of inputs are required, including: clinical documentation of the disease, date of the disease diagnosis, veteran's gender, date of birth, radiation dose to the tissue of disease origin, and associated periods of exposure during service. These inputs are required for input into the National Institute for Occupational Safety and Health's (NIOSH) Interactive Radioepidemiological Program (IREP) software, which is used by VA to assist with developing a medical opinion, as to whether it is likely, unlikely, or as likely as not that the claimed disease is the result of exposure to ionizing radiation. Typically, VA requests the military service to provide the veterans' radiation dosimetry records. However, since few of the USCG LORSTA service members were monitored for radiation exposure, a radiation dose reconstruction must, instead, be submitted. This reconstruction will be an estimate of the veteran's radiation exposure, based on estimates of time, distance, and shielding of the veteran's proximity to operating LORSTA high voltage vacuum tubes.

In summary, this report documents two discrete scenarios of service member radiation exposure associated with x-rays emanating from U.S. Coast Guard LORAN high voltage vacuum tube transmitters:

(1) The majority of the LORAN service members who received minimal occupational ionizing radiation exposure, and
(2) A smaller group of LORAN personnel who performed "exceptional" maintenance activities (and were not monitored with personnel radiation dosimeters). This group potentially received significant ionizing radiation doses. There is also significant uncertainty associated with this scenario.

Detailed recommendations, guidance and documentation are provided in the attached and via web to assist USCG LORAN veterans and their dependents http://www.uscg.mil/hq/cg1/cg113/cg1133/dtra.asp.