MCPO Charles J Severance (USCG, retired)
PMB 293 Suiite A-113
1830 E. Parks Hwy
Wasilla, AK 99654
Tel: 907-360-4738

DATE

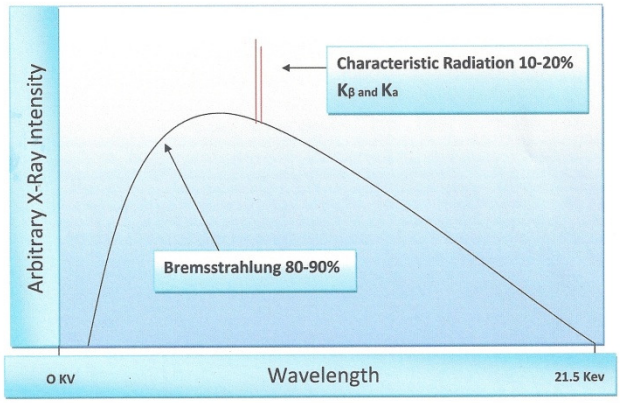
Dear

Subject: Your Spouse's Radiation Exposure

I am writing in response to concerns over your husband's death from cancer following over twenty-years of active duty service in the US military. Although your husband did not file for a VA disability rating, you should be entitled to Dependency and Indemnity Compensation (DIC) through the Department of Veterans Affairs (VA). This is based primarily on your husband's exposure to ionizing radiation in the form of x-rays while serving on US Coast Guard LORAN transmitting stations. Once the VA receives your VA form 21-534, they will determine if your husband's cancer was related to active duty service. In most cases veterans apply for a disability rating shortly after leaving active duty, but in your husband's case he was never aware that he was chronically exposed to harmful x-rays. Although LORAN's ionizing radiation was confirmed by the USCG in 1993, and protective shields were installed in 1994, the occupational hazard was never publically revealed, even to most active duty, veteran, reserve, and retired service members.

The ionizing radiation your husband was exposed to is bremsstrahlung. These harmful x-rays are normal by-product of high powered vacuum tubes typically used in LORAN transmitters operating with anode potentials greater than 10kv. Safety equipment and protocols would normally have been utilized when operating equipment that emits x-rays. Unfortunately for your husband, this was not the case since the radiation was not confirmed until 1993 at LORSTA George, Washington. While all LORAN transmitter types emit x-rays, you husband worked on the largest and highest transmitters in the USCG inventory, the AN/FPN-44/45.

Illustration of X-Ray Spectrum of Power Amplifier Vacuum Tube



These transmitters not only operate with a higher anode potential of 21.5 KV, but they also exceed 1 million watts peak power. Although potentials are known to be the most significant factor in developing bremsstrahlung, these voltages are highly regulated by transmitter power supplies. Therefore, individual vacuum tube cathode currents signify the greatest variation in the generation of x-rays for a given LORAN Transmitter type. Your husband not only worked on high powered transmitters throughout FESEC, but he also worked on dual rated transmitters (i.e. Lorsta Hokkaido). These types of transmitters operate with substantially higher cathode currents and therefore produce greater x-ray exposures. Although there are additional factors that contribute to your husband's exposure, you can see he was clearly exposed to some of the highest radiation doses in the LORAN system.

Several radiological surveys were conducted by the USCG following the discovery of radiation at LORSTA George. Unfortunately, none of these surveys considered the complex geometrics and radiation beam widths generated by the LORAN vacuum tubes. None-the-less, the radiation doses were high enough for the USCG to establish safety protocols, and install acrylic-shielding to protect personnel. On November 14, 1994, CWO Jones of MLCPAC (message ID: MLCPt-204823), completed a final radiological survey of an AN/FPN-45 Transmitter to confirm the effectiveness of the lead-acrylic shields. The tests confirmed the shields worked as planned. Prior to testing for the shield's effectiveness, CWO Jones surveyed the area while orientating the survey meter's ion chamber window for the maximum x-ray indication in the passageway for each vacuum tube. He found that the survey readings increased by as much as a factor of four, up to 22 mR/hr for a

single vacuum tube. These results indicate the x-ray dose your husband would have typically been exposed to from a single vacuum tube while in the common area (outside the interlocked doors) between the transmitters before the shields were installed. Although these findings were very significant, the emerging information was lost due to the effectiveness of the lead-acrylic shielding. Basically, all future tests were dropped, all protective safety protocols were lifted, and veteran LORAN personnel and civilians were never warned that the x-ray exposures existed. Member's like your husband would never know they were exposed to chronic x-ray levels powerful enough to cause cellular defects that could eventually develop into cancer or other serious illnesses.

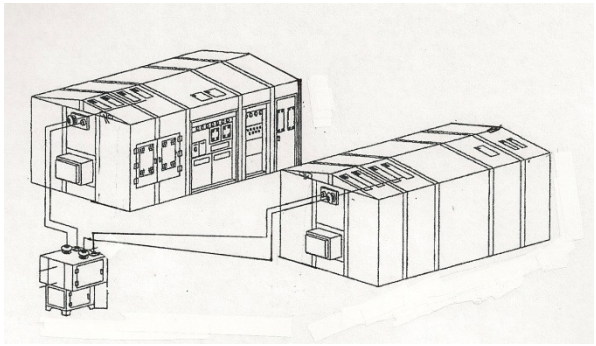
Although lead-acrylic shielding was accepted as a complete success, some USCG personnel called for continued area and personal monitoring. The photo to the right shows the position of the lead-acrylic shielding at the front of the power amplifier tube. The lack of information concerning the radiation shields caused many LORAN personnel to become concerned over radiation leakage. Many of the concerns were dismissed without consideration, but on September 21, 2003, contractor William Tell and Associates was hired by the Canadian government to conduct a radiological survey of the AN/FPN-44 Transmitters at LORAN Station Williams Lake. This survey revealed that leakage radiation did indeed exist with shields in place, and the levels exceeded safety standards, albeit no leakage radiation was detected in the passageway. However, the survey included dosimetry at the vacuum tube envelopes within the shielding, and inside the interlocked doors. These reading had never been taken before, and the survey team discovered that each vacuum tube amazingly emitted x-rays at more than 3 Rems/hr. This dose was limited to 3 Rems/hr because the exposures exceeded the survey device limits. This is very significant for your husband's case because he worked at a technical and

management level that required him to work within the interlocked spaces during corrective maintenance emergencies. It is important to note that the radiation dose for one year, according to present standards, is 3 Rems.

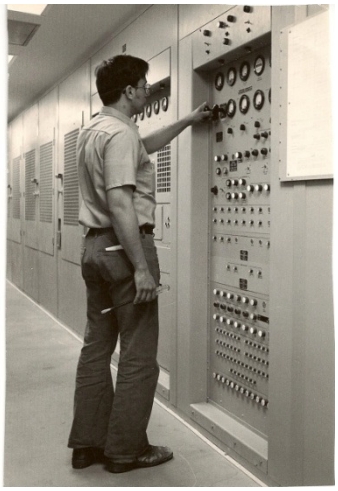
So it should be clear that your husband was exposed to hazardous chronic radiation doses from any single power amplifier tube of a fully energized transmitter. The radiation propagation from a single tube is very complex and difficult to understand because factors such as tube age, and internal arcing were never considered. Generally, physicists will agree that as vacuum tubes age the radiation will increase. In FESEC it was common practice to run the power amplifier tubes to failure, partly due to logistics, and partly due to the non-availability of replacement tubes. This is another factor that undoubtedly increased your husband's chronic radiation exposures. Experts would also agree that vacuum tube pitting, and internal tube arcing increases x-ray exposure energy to levels higher than the anode potential of the vacuum tubes, i.e. x-ray energy levels much greater than 21.5 KeV. This factor also undoubtedly contributed to your husband's chronic exposures.

It would be impossible for your husband to be exposed to radiation from only one power amplifier tube at any given time. This photograph shows a typical power amplifier section of four tubes. These tubes are operating in parallel and emitting radiation simultaneously. Clearly anyone standing or working in front of this section would be receiving x-rays from all four tubes. Unfortunately, for whatever reason, the radiological surveys conducted in the past did not consider this aspect of radiation exposure.

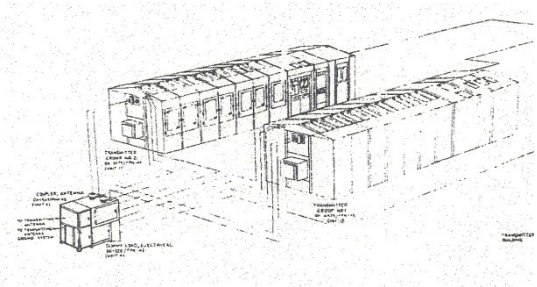
The LORAN AN/FPN-44 Transmitter has a single power amplifier section with four tubes as indicated in the photo above. A typical LORAN station is configured with two transmitters. One transmitter is always broadcasting on air while the other transmitter is in ready standby unless it is in maintenance. The transmitters face each other. Both transmitters are coupled to the antenna or the dummy load through an Antenna Coupler/Dummy Load. This unit is usually located in an adjacent room functioning as an air plenum for cooling the transmitters. This photo shows the passageway between two AN/FPN-44 transmitters. The red door at the end of the passageway leads to the air plenum room where the Antenna Coupler/Dummy Load is installed. The power amplifier section interlocked doors can clearly be seen at the end of the passageway on the transmitter to the right.

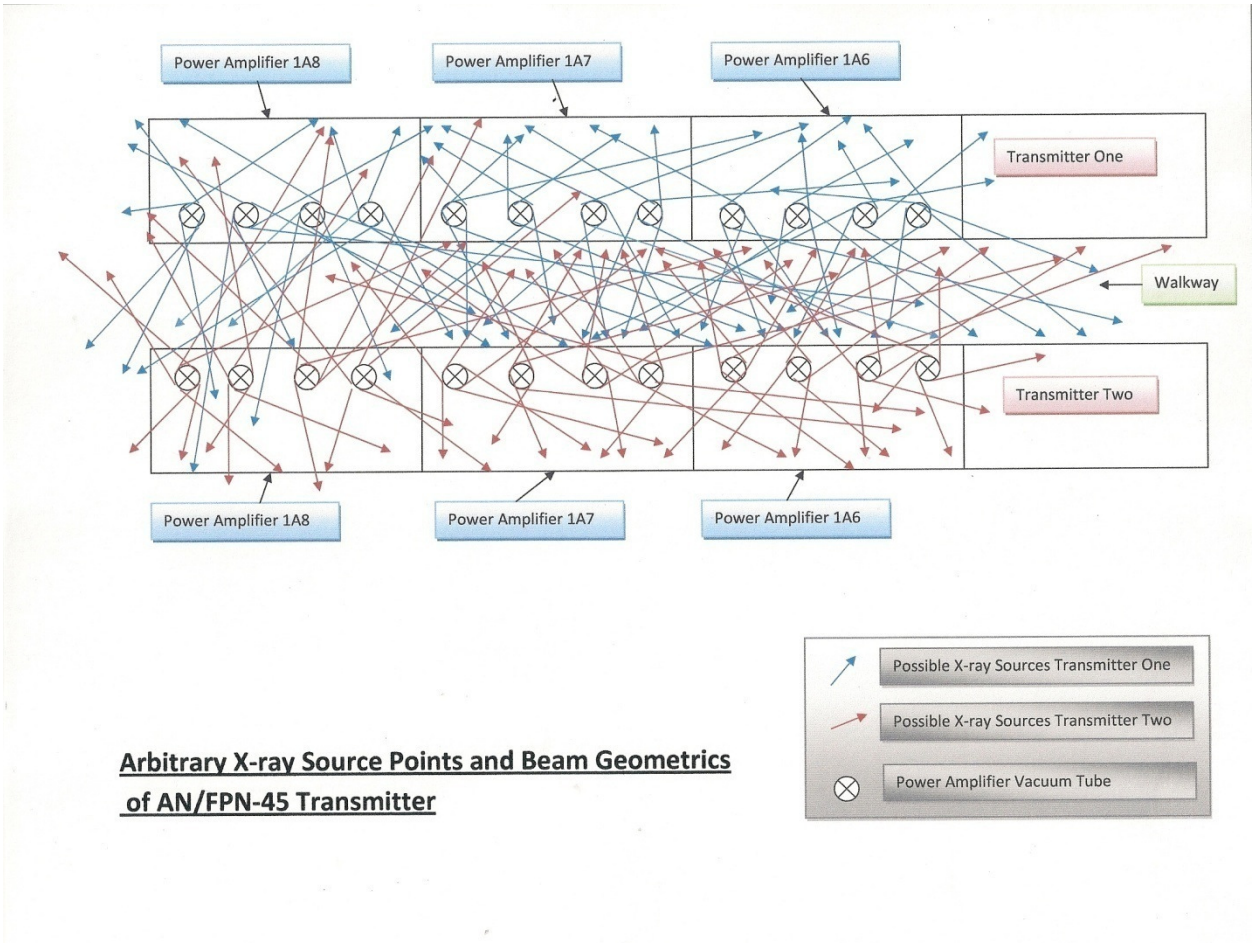


The high powered AN/FPN-45 transmitter your husband worked on in FESEC is a much larger transmitter than those of his previous assignments. The AN/FPN-45 contains two additional power amplifier racks. So, a single AN/FPN-45 transmitter has twelve power amplifier vacuum tubes simultaneously emitting radiation. The photo to the left shows ET3 Milohnick adjusting the control panel on an AN/FPN-45. This transmitter is the same type your husband worked on during his four years at FESEC. You can see that it has three power amplifier cabinets instead of one. These additional power amplifier cabinets had a significant impact on your husband's chronic radiation exposure.



The AN/FPN-45 Transmitters are configured the same as other LORAN stations, facing each other. Clearly a person working on a fully energized standby transmitter, in the vicinity of the power amplifier tubes would be exposed to the radiation from twenty-four power amplifier vacuum tubes. While it is unlikely that your husband would have been exposed to all of these tubes at the same time, he was undoubtedly exposed to many vacuum tubes (x-rays) simultaneously. The following illustration gives you a conceptual idea of the x-ray gauntlet of geometrics and multiple beams your husband worked in between transmitters.





Arbitrary X-ray Source Points and Beam Geometrics of AN/FPN-45 Transmitter

The Antenna Coupler/Dummy Load is a very critical component in the LORAN system since a failure would normally cause the station to go off air. A radiological survey was conducted on the AN/FPN-44 Transmitter spaces at LORAN Station Shoal Cove, Alaska in 1999 to check for radiation that might harm a pregnant USCG member stationed at the unit (Commanding Officer, ISC Ketchikan letter 5100 dated October 21, 1999). Although the survey indicated that leakage radiation did not exist in the transmitter passageway, a narrow beam source of X-ray radiation of 1.2 Rems/hr was found emitting from the Antenna Coupler. This photo shows the right side of an Antenna Coupler/Dummy Load. The female member was transferred but no safety protocols were ever implemented, and no veterans, reserves, or retirees were ever notified of this additional radiation exposure hazard.

Since the Antenna Coupler is essential to operation, corrective and preventive maintenance routines are assumed to be minimal. However, some stations have personnel working in the vicinity for considerable periods of time. More often than not, the exposure times in the vicinity of the Antenna Coupler are often grossly under rated. Preventive maintenance is performed on the Dummy Load portion of the Antenna Coupler while the operate transmitter is on air. Maintenance and modifications are also performed on the antenna and counterpoise feed lines from the standby transmitter. This is especially true at units like Iwo Jima were corrosion was a constant problem from the high levels of airborne sulfur. Your husband was involved in several maintenance evolutions at FESEC that included work in the Antenna Coupler/Dummy Load area exposing him to this still unidentified source of radiation. The Air Plenum where the Antenna Coupler/Dummy Load is installed also includes the water cooling system and pumps for the AN/FPN-44 transmitters. Work on these units increased the risk of being radiated by the Antenna Coupler. Cooling rack maintenance is a recurring, and often an unscheduled event.

This photo shows the cooling rack for a single transmitter. It is located outside the transmitter adjacent to the Antenna Coupler/Dummy Load.

I have firsthand knowledge of your husband's exposures and work routine because I was his replacement at Far East Section (FESEC), Yokota AFB, Japan. The electrical engineering office that we worked in at FESEC was responsible for the maintenance and engineering of all Loran stations in the Northwest Pacific. Since your husband was the regional technical expert, he worked extensively at LORAN stations Gesashi, Hokkaido, Iwo Jima, Marcus, and Yap. These transmitter stations not only operated the highest powered transmitters resulting in higher radiation exposures levels, but they were arguably some of the most maintenance intensive in the USCG resulting in prolonged exposures. The maintenance and equipment reliability had an extremely high priority in FESEC due to operational requirements and demands placed on LORAN's key role in national defense systems such as the US Navy Fleet Ballistic Missile System. As the technical expert in FESEC your husband was ultimately called upon to troubleshoot or assist with the most difficult corrective maintenance problems conceivable. These routines often resulted in very long maintenance evolutions undoubtedly contributing to his radiation exposures.
I personally know of several transmitter maintenance episodes led by your husband that exceeded 100 hours per week within the direct proximity of the power amplifier tubes. One case involved excessive phase modulation within the transmitters that required repeated sensitive signal measurements with a high voltage current probe within the interlocked spaces exposing him to greater than 3 Rems/hr per tube while at full power. It is important to remember there are twelve power amplifiers tubes per transmitter simultaneously emitting this radiation. The high voltage current probes your husband used had to be operated with the power amplifier interlocked doors open which unknowingly exposed him to high radiation doses.

Unfortunately, regulatory safety protocols intended to limit and monitor exposures were never implemented during your husband's career. This is due in part to the fact that the USCG was not convinced that radiation existed prior to 1993. Had the radiation been confirmed, USCG and other federal regulations would have dictated specific safety protocols. Loran transmitter spaces would have been classified as a controlled "Radiation Area". Additionally, the area inside the interlocked spaces would have been controlled and classified as a "High Radiation Area." Personnel working in these areas would have been placed on a personal monitoring program, very much like medical x-ray technicians. All other personnel would have been restricted from access, especially civilians, women, women with fetuses, and personnel under the age of 18. Current directives such as CFR 29 § 1910.1096 establish these protocols and limit exposures. Generally, radiation exposures should not exceed 2.5 mR/hr, 1.25 Rems per calendar quarter, or 3 Rems per year. Unfortunately, your husband was not protected by these protocols and his chronic or stochastic x-ray exposure was undoubtedly excessive.

The biological effects of x-rays on human cells are well documented and understood by the medical community, see the following web site: http://www.epa.gov/rpdweb00/understand/health_effects.html
While no one can be sure if a cancer is caused by x-rays, it is generally accepted that x-rays can permanently damage cell DNA, affecting a cells ability to properly repair itself. One factor that determines if a cause and effect relationship exists between radiation exposure and cancer is the latency period of the cancer. The latency period is the minimal amount of time required for cells damaged by x-rays to achieve a state that is medically detectable as cancer (carcinogenesis). It is very common for cancer to take 20 or even 30 years or more to become diagnosable in the organs of the human body. The latency period for leukemia can be much less, perhaps seven years or more. Cancer that is detected before the prescribed latency period will not usually be attributed to radiation exposure. Your husband's colon cancer diagnosis is well within the range of an acceptable latency period for that type of cancer. Furthermore, the x-ray geometrics from the vacuum tubes make the vital organs a likely target for exposure.

Your husband is not the first LORAN victim to be considered by the VA for exposure to ionizing radiation. ETCS John F. Milohnick III (USCG, retired SSN: 147-444-3897) died on November 11, 2006 from complications arising from acute myeloid leukemia which the VA associated with Loran exposures based on the same information I am providing you today. Other victims that have been exposed to chronic LORAN x-rays, and exhibit the proper latency period, have reported auto immune disease, lung cancer (non-smokers), liver cancer, pancreatic cancer, prostate cancer, testicle cancer, and others. Many of these potential victims have also reported complicated symptoms and missed diagnosis prior to the end stage disease. Unfortunately, missed diagnoses are common in these types of occupational exposures. Victims are usually not aware that they were exposed to hazardous conditions, and the affects of the carcinogenesis process is therefore not considered by medical personnel. I mention this point because you may recall other illnesses or complications that your husband may have suffered prior to developing end stage colon cancer, and they may be relative to the VA's decision.

I have met with the USCG headquarters personnel concerning these radiation exposures. They are attempting to gather enough information to determine if a full epidemiological survey should be conducted. I continue to hope for a public announcement of the radiation exposures independent of the study so that others can benefit from early detection. Ironically, it was Commandant (G-WKS-3) who was concerned about LORAN radiation exposures on April 15, 2002 , "…to tell someone they have cancer 20 years after the fact is not any significant benefit."

While I have focused on the x-ray radiation, I must also point out that your husband was also repeatedly exposed to toxic carcinogens. The co-agent effect from these exposures are difficult if not impossible to estimate, but can only contribute to the development of cancer and other illnesses. Your husband was exposed to significant quantities of polychlorinated biphenyls (PCB) from bursting transformers and capacitors. Occasionally, the PCB oil would catch on fire exposing the workers to toxic vapors. Ironically, the toxic PCBs were cleaned up

using a toxic solvent, carbon tetrachloride. These cleaning solvents were also used very liberally in general preventive maintenance. Finally, it is important to point out that many of the vacuum tubes in the LORAN transmitters were constructed with toxic or radioactive elements such a beryllium oxide and thoriated tungsten. Unfortunately, there were no warnings posted for most of these tubes, and personnel unknowingly became exposed to this additional radiation when they disassembled the tubes to make lamps, ash trays, etc, or to sell the copper anodes for scrap metal. Clearly, the co-agent effect from all of these carcinogens exasperated your husband's medical condition.

Finally, I must advise you that your husband was exposed to hazardous levels of non-ionized radiation in the vicinity of the LORAN transmitters, antenna transmission lines, antenna coupler, and antennas. These hazards were verified by USCG Electromagnetic Radiation Surveys. Unfortunately, these tests were conducted after your husband served at the LORAN transmitting stations. However, the USCG has never notified veteran personnel of the hazards, and never implemented most of the safety protocols dictated by federal and USCG regulations. These hazardous levels of EMF undoubtedly contributed to your husband's condition as another significant carcinogenic co-agent.

I am so sorry that your husband never had the benefit of knowing that he was exposed to such harmful radiation and carcinogens. I will keep you in my prayers, and I wish you the very best. If I can be of any further assistance please let me know. With my deepest sympathy for you, and great admiration for your husband I wish you the very best.

Sincerely,

MCPO Charles J. Severance (USCG, Retired)