**Acute Myelogenous Leukemia of Roy White**

**Due to**

**Radiation Exposure from Welding Employment**

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Report prepared for the

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***Roy White***

**Introduction**

Roy White was born July 24, 1944 in Haslam, Texas. He was exposed to gamma rays in the process of checking welds on tank cars he was welding for various manufacturers, primarily Trinity Industries, over a 34 year period. He developed acute myelogenous leukemia, a cancerous blood disorder, in 2008 and died in 2013

At Trinity Industries and other locations where he worked, there was no radiation protection program. When welds on tank cars were being inspected by a radiation source, Mr. White was protected by a rope placed approximately 20 feet from the tank car. No measurements were made at the time the work was performed, so the true radiation doses will never be known. From the deposition of Mr. White, and interviews with his wife Donna and workers at Trinity Industries, we know the duration of the radiation exposures. We know from the radiation license Trinity Industries held, the source strength employed by the company. Employing standard software Microshield, we can calculate the minimum and maximum radiation doses Mr. White received. Finally, we can determine the likelihood that Mr. White’s leukemia was caused by radiation employing the software developed by the Centers for Disease control, NIOSH-IREP. In Mr. White’s deposition, some attention has been paid to the fact that he occasionally crossed into the 20 foot area, within 10 feet while the radioactive source was unshielded. The difference between 10’ and 20’ is to increase the dose rate by a factor of 4; I have ignored this occasional increased dose rate in the calculations below.

To prepare this report I reviewed court petitions, deposition transcripts of Roy White, previous work in similar cases, and his medical records. The methodology and data I employed is standard for health physicists, and is, in my opinion, conservative. I take into account Mr. White’s work time, physical working condition, age when exposed, and date of diagnosis

Since 1992, I have worked on hundreds personal injury cases in the States of Mississippi, Louisiana, Texas, and Kentucky, primarily involving TENORM involving ITCO workers at the Harvey Yard. I am a graduate of the University of Michigan with a PhD in high energy theoretical physics and am presently the Senior Associate at Radioactive Waste Management Associate based in Bellows Falls, Vermont. My resume is attached as Appendix A. As more information becomes available, I reserve the right to supplement this report.

Before discussing the specifics of Mr. White’s radiation exposure, I wanted to point out one disturbing aspect of this case. Mr. White reported (tr 66-69) that in the 1970’s at Trinity Industries, for a year, he did the welding and the X-rays during the night shift. The radiation licenses for the gamma ray sources are assigned to specific persons who have taken specific course work. To my knowledge, Mr. White never completed this course, and his name was not listed on the license. It appears Trinity Industries violated the law, and Mr. White should not have been operating the gamma ray equipment.

## Radiation Risk Analysis for Acute Myelogenous Leukemia

We calculate the radiation risk with the following steps. We first determine the dose rate at 20 feet from a tank car when the radioactive source is outside the shielded container. We estimate the time period this occurs in a week and in a year. The number of tank cars produced per year can vary, from a slow to a fast production period. We therefore can have a spread of dose rates, from low to high, which are input to the NIOSH-IREP program to estimate the cancer risk.

### **Dose Rate**

Under the DHS, the gamma ray source for the weld inspection is a 100 Ci iridium-192. This source is usually stored within a shielded container except when film is exposed to check welds. We assume this source sits within an 8 foot tank car, with radius 4 feet, with iron metal thickness 5/8 inch. Depending on the purpose, tank cars, may have varying thickness, and the time of exposure may also vary. The dose point is taken as 20 feet from the surface of the tank car, or 24.053 feet from the Ir-192 source. The dose rate to red marrow is an average of rotational and isotropic, or 373 mrem per hour. This is the **dose rate**. The full Microshield print outs appear in Appendix B. We next have to estimate the actual time in a year that Mr. White was exposed.

### **Exposure Time and Radiation Dose**

From workers at Trinity Industries, we learned that two types of gamma weld checks were conducted spot checks and 360’s. 360’s were conducted every 25 tank cars inspected. Six or 12 spot checks were conducted on each tank car, depending on the number of steel shells. We take the average, nine per tank car. Workers stated that each spot check required 15 seconds of exposure. 360’s required one to two minutes of exposure, sometimes longer depending on the thickness of metal, according to Mr. White. We assume, one minute for a 5/8 inch thick tank car. In sum, we assume each tank car required 9 \* 15/60 = 2.25 minutes gamma exposure time for spot checks, and 1 minute exposure time for each 360.

At Trinity Industries, the number of tank cars manufactured per week varied from 10 to 50. This means the exposure time varied from 22.5 minutes/wk to 112.5 minutes/wk for spot checks, and 0.4 minutes/wk to 2 minutes/wk for 360’s. Assuming 50 weeks work/year (and we will adjust for partial years work), Mr. White was exposed to gamma radiation between 1145 minutes/year and 5725 minutes/year, or 19.08 hrs/yr and 95.42 hrs/yr. In Table 1, we list the minimum and maximum radiation exposures Mr. White received each year. These values are input into the NIOH-IREP software program to determine the likelihood radiation was responsibility for his AML.

### **Radiation Risk Analysis for Acute Myelogenous Leukemia**

For Mr. White, we use NIOSH's Interactive RadioEpidemiological Program (IREP), version 5.5.2[[1]](#footnote-1) to calculate the likelihood that AML was caused by radiation, rather than by something else. This program was developed by NIOSH to apply the National Cancer Institute's (NCI) risk models directly to data about exposure for a specific employee. IREP is based upon radioepidemiological tables developed by the National Institutes of Health (NIH) in 1985. These tables act as a reference tool to provide the probability of causation estimates for individuals with cancer that were exposed to ionizing radiation. The purpose of this program is to calculate the probability of causation that occupational radiation exposure received while working at a DOE facility or elsewhere within the nuclear weapons industry caused a specific type of cancer[[2]](#footnote-2).

IREP is primarily based upon risk coefficients for cancer incidence gathered from the Japanese atomic bomb survivor study. The risk coefficients have been adjusted to account for random and systemic errors in the atomic bomb survivor dosimetry as well as for the low dose and low dose-rate situations that are more common to American workers exposed while on the job. The probability of causation, or assigned share, for this risk is calculated as "the cancer risk attributable to radiation exposure divided by the sum of the baseline cancer risk (the risk to the general public) plus the cancer risk attributable to the radiation exposure". That is this is the fraction of cancers observed in a large heterogeneous group with similar exposure histories that would not have occurred in the absence of exposure. The assigned share is estimated with uncertainty in IREP and is expressed as a probability distribution of results. The statistical uncertainty of the risk model is accounted for with a Monte Carlo simulation where repeated samples (typically 2,000) are taken from probability distribution functions and the probability of causation is calculated for each set of samples. The upper 99-percent confidence level from the resulting probability distribution is compared to the probability causation of 50-percent to determine eligibility for compensation of Manhattan Project workers. If cancer is determined to be "at least as likely as not” caused by radiation doses received while working, i.e., with a probability of 50-percent or greater at the 99-percent confidence level, than the worker is deemed eligible for compensation. The upper 99-percent confidence level is used to minimize the possibility of denying compensation to employees with cancer likely caused by occupational radiation exposure. The following equation is utilized in IREP to determine the probability of causation or assigned share.[[3]](#footnote-3), [[4]](#footnote-4)



Where:

ERR Excess Relative Risk - Proportion of relative risk due solely to radiation exposure

PC Probability of Causation

RR Relative Risk - Ratio of the total risk from exposure divided by risk due to background alone

The IREP model calculated that, at the 99-percentconfidence level Mr. White's AML cancer has a probability causation of 98.16 percent that it is due to his occupational radiation exposure. That is, with near certainty, Mr. White’s cancer was caused by radiation. At the 50th percentile mark, the probability of causation was 95.8%. The full NIOSH-IREP printouts appear in Appendix C.

**able 1. Radiation Dose to Roy White**

|  |  |  |
| --- | --- | --- |
| **Year** | **Low (rem)** | **High (rem)** |
| 1967 | 5.43E+00 | 2.71E+01 |
| 1971 | 7.24E+00 | 3.62E+01 |
| 1972 | 1.81E+00 | 9.04E+00 |
| 1973 | 7.24E+00 | 3.62E+01 |
| 1974 | 7.24E+00 | 3.62E+01 |
| 1975 | 7.24E+00 | 3.62E+01 |
| 1976 | 7.24E+00 | 3.62E+01 |
| 1977 | 7.24E+00 | 3.62E+01 |
| 1978 | 3.62E+00 | 1.81E+01 |
| 1980 | 7.24E+00 | 3.62E+01 |
| 1981 | 7.24E+00 | 3.62E+01 |
| 1982 | 3.62E+00 | 1.81E+01 |
| 1985 | 7.24E+00 | 3.62E+01 |
| 1986 | 7.24E+00 | 3.62E+01 |
| 1987 | 7.24E+00 | 3.62E+01 |
| 1988 | 7.24E+00 | 3.62E+01 |
| 1989 | 7.24E+00 | 3.62E+01 |
| 1990 | 7.24E+00 | 3.62E+01 |
| 1991 | 7.24E+00 | 3.62E+01 |
| 1992 | 7.24E+00 | 3.62E+01 |
| 1993 | 7.24E+00 | 3.62E+01 |
| 1994 | 7.24E+00 | 3.62E+01 |
| 1995 | 7.24E+00 | 3.62E+01 |
| 1996 | 7.24E+00 | 3.62E+01 |
| 1997 | 7.24E+00 | 3.62E+01 |
| 1998 | 7.24E+00 | 3.62E+01 |
| 1999 | 7.24E+00 | 3.62E+01 |
| 2000 | 7.24E+00 | 3.62E+01 |
| 2001 | 7.24E+00 | 3.62E+01 |
| 2002 | 7.24E+00 | 3.62E+01 |
| 2003 | 7.24E+00 | 3.62E+01 |
| 2004 | 7.24E+00 | 3.62E+01 |
| 2005 | 7.24E+00 | 3.62E+01 |
| 2006 | 7.24E+00 | 3.62E+01 |
| 2007 | 7.24E+00 | 3.62E+01 |
| 2008 | 3.62E+00 | 1.81E+01 |

1. National Institute for Occupational Safety and Health (NIOSH), 2007 [↑](#footnote-ref-1)
2. SENES Oak Ridge, Prepared for NIOSH, 2007 [↑](#footnote-ref-2)
3. Ibid [↑](#footnote-ref-3)
4. Federal Register, 2002 [↑](#footnote-ref-4)