Health Consultation

Aerojet Ordnance Tennessee

Jonesborough, Washington County, Tennessee

January 2008

TENNESSEE DEPARTMENT OF HEALTH

Prepared by

Tennessee Department of Health

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Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be action items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

Please write to: Environmental Epidemiology
Tennessee Department of Health
1st Floor Cordell Hull Building
425 5th Avenue North
Nashville TN 37243

Or call us at: (615) 741-7247 or toll-free during business hours: 1-800-404-3006

Introduction

Christian Peacemaker Teams asked Environmental Epidemiology (EEP) within the Tennessee Department of Health (TDH) to consider performing an epidemiological study in the population living near Aerojet Ordnance Tennessee (AOT) in Washington County. Both the Regional Environmental Epidemiologist, La'Shan Taylor, and the Director of EEP, Bonnie Bashor, explained the complexity of an environmental epidemiologic study designed to identify health problems and their probable causes. Ms. Bashor agreed to determine if area residents had completed exposure pathways to harmful levels of radionuclides associated with AOT. This exposure pathway investigation will be the focus of this health consultation.

Background

Site Description and History

Aerojet Ordnance Tennessee (AOT), located in Washington County near Jonesborough, has been a leading producer of depleted uranium (DU) and tungsten munitions for the U.S. Military. AOT integrates DU research, design, and production processes at one facility. Their experience in producing DU munitions has led to the growth and development of other activities, including reduction of depleted uranium tetrafluoride to uranium metal, rolling of cast DU into rod stock, and heat treating and advanced machining of DU products.

AOT is a licensee of the Tennessee Department of Environment and Conservation (TDEC), Division of Radiological Health (DRH). Tennessee is a Nuclear Regulatory Commission (NRC) Agreement State, with the authority designated to DRH. The license for AOT is based on Rules of the TDH and TDEC, Bureau of Environmental Health Services, DRH, Chapter 1200-2-5. The rules are based on a total effective dose equivalent to a maximally exposed member of the public of 100 millirem (mrem) [1] per year; this dose includes exposure to air, water, and ambient radiation and includes external and internal doses. These rules are the same as federal rules found in Title 10, Code of Federal Regulations, Part 20, Appendix B, Table 2. In addition, AOT cannot exceed a dose of 10 mrem per year from air exposure alone. The dose is calculated using an EPA model with activity measurements taken from AOT's stacks. The effective dose equivalent that is allowed from water is 50 mrem/year.

AOT has received a variance on the air concentration measurements for D, W, and Y classifications of uranium 238 (U-238) [2]. The variance is based on the actual mix of D, W, and Y U-238 that AOT uses, and maintains the basis of the allowable concentrations of an effective dose equivalent, from air, of 50 millirem (mrem) to a maximally exposed member of the public.

The U.S. Environmental Protection Agency (EPA) has established the maximum contaminant level (MCL) for drinking water at 15 pCi/liter (pCi/L) for gross alpha radiation and the screening

[1] rem stands for Roentgen Equivalent Man. It is a unit that relates the absorbed dose of radiation to the biological effect of that dose. To relate the absorbed dose of specific types of radiation to their biological effect, a "quality factor" must be multiplied by the dose in rad, which then shows the dose in rems.

[2] D, W, and Y classifications of uranium refer to specific uranium compounds and their individual solubilities in water. The classification is a scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

MCL at 50 pCi/L for gross beta radiation. AOT also has a National Pollutant Discharge Elimination Permit (NPDES) from the TDEC, Division of Water Pollution Control. The NPDES permit is for their discharge of industrial wastewater, cooling water discharge, and sewage treatment effluent from a small package plant to three outfalls on Little Limestone Creek; outfall 001 is the industrial outfall at mile 8.7. The effluent limit for total, natural uranium in the industrial discharge is 12.0 milligram per liter (mg/L).

DRH collects monthly air samples for gross alpha and gross beta radiation at the northeast corner of the AOT property. DRH also collects monthly water samples for gross alpha and gross beta in Little Limestone Creek, both upstream and downstream of AOT. In addition, DRH takes sediment samples upstream and downstream in the creek on an annual basis.

Discussion

Potentially Exposed Population

To determine whether persons have been, are, or are likely to be exposed to contaminants or radionuclides, EEP evaluates the environmental and human components that could lead to human exposure. An exposure pathway contains five elements:

1. a source of contamination,
2. contaminant transport through an environmental medium,
3. a point of exposure,
4. a route of human exposure, and
5. a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements have been, are, or will be present.

In the area near AOT, completed exposure routes are inhalation of ambient air and the possible ingestion of water or sediment from Little Limestone Creek. In this Health Consultation, EEP assumed that using Little Limestone Creek as a sole source of drinking water would be the worst case scenario. If risks from the worst case scenario do not present a health hazard, then risks from lesser exposures would also not present a health hazard.

Depleted Uranium

Uranium is a natural and commonly occurring radioactive element. It is found in very small amounts in nature in the form of minerals, but may be processed into a silver-colored metal. Rocks, soil, surface and underground water, air, plants, and animals all contain varying amounts of uranium.

Natural uranium is a mixture of three types (or isotopes) of uranium, written as U-234, U-235, and U-238. All three isotopes behave the same chemically so any combination of the three would have the same biological effect, but they are different radioactive materials with different radioactive properties. That is why we must look at the actual percentages of the three isotopes in a sample of uranium to determine how radioactive the uranium is (ATSDR 1999).

Natural uranium mined from the Earth's crust undergoes an enrichment process to increase the amount of U-235 for use in nuclear applications. When uranium is enriched, a large amount of U-238 is left over, along with a very small amount of U-234. The left over U-238 is called depleted uranium. Depleted uranium poses little risk from external radiation in the form of alpha particles. These particles can be stopped by a thin sheet of paper or by skin. For workers handling depleted uranium, exposure to beta particles can pose a hazard. Alpha particles that are inhaled can be a health hazard (ANL 2005).

Uranium is a chemical substance that is also radioactive. Scientists have never detected harmful radiation effects from low levels of natural uranium, although some may be possible. However, scientists have seen chemical effects. After intake of large amounts of uranium, a few people have developed signs of kidney disease. Animals have also developed kidney disease after they have been treated with large amounts of uranium (ATSDR 1999).

There is also a chance of getting cancer from any radioactive material like uranium. Natural and depleted uranium are only weakly radioactive and are not likely to cause you to get cancer from their radiation. Uranium can decay into other radionuclides, which can cause cancer if the exposure is long enough. Doctors that studied lung and other cancers in uranium miners did not think that uranium radiation caused these cancers. The miners smoked cigarettes and were exposed to other substances that we know cause cancer, and the observed lung cancers were attributed to large exposures to radon and its radioactive transformation products (ATSDR 1999).

Specific information is not available on whether children are more susceptible than adults to the effects of uranium. No reports were located describing toxicity in children as the result of uranium exposure. It is probable, however, that if exposure levels were high enough, signs of renal toxicity would be observed similar to those seen in adults exposed accidentally or intentionally. No reports are available of studies where toxic responses of young animals to uranium were directly compared to those of adults ATSDR 1999).

No studies are available on whether exposure to uranium affects development in humans. The information from animal studies is limited to the oral route in a single species (mice), and only one study examined structural malformations. Some developmental effects have been reported in mice with gavage doses greater than 6 mg uranium per kilogram per day (U/kg·day) in a soluble form as uranyl acetate. At doses of 14 mg U/kg·day embryolethality (increased total and late resorptions, decreased number of live fetuses) was observed on gestation day 13 in dams exposed from 14 days prior to mating through gestation. Gavage exposure over gestation days 6–15 resulted in an increased incidence of skeletal abnormalities (bipartite sternebrae, reduced and/or delayed ossification) at 14 and 28 mg U/kg/day and cleft palate at 6, 14, and 28 mg U/kg·day. Exposure of dams from late pregnancy (gestation day 13) continuing throughout lactation (21 days postpartum) resulted in reduced pup viability at 28 mg U/kg·day, but not at lower doses. Postpartum developmental events (pinna attachment, eye opening, incisor eruption) were unaffected at all doses. While developmental toxicity can be produced in animal models, the doses required are relatively high compared to known human exposures (ATSDR 1999).

Transfer of uranium across the placenta was investigated in an animal study, but no information is available for humans. In the animal study, only 0.01–0.03% of an intravenous dose of uranium to rat dams crossed the placenta; thus if an inhalation, oral, or dermal exposure was sufficient to raise the blood uranium level, a very limited amount of uranium might cross the placenta. No studies were located regarding uranium in breast milk. Based on the chemical properties of uranium, it seems unlikely that there would be preferential distribution from the blood to this high-fat compartment. It is not known if uranium has any effect on the active transport of calcium into breast milk. Most of the adult body burden of uranium is stored in bone. It is not known if maternal bone stores of uranium (like those of calcium and lead) are mobilized during pregnancy and lactation (ATSDR 1999).

Physiologically based pharmacokinetic (PBPK) modeling of uranium has been applied to children, after adjusting the model for the fraction of uranium absorbed and for transfer in and out of bone. The results of these modeling predict that a greater proportion of uranium would distribute to bone and a lesser proportion to soft tissues at ages under 25 years, compared to adults (ATSDR 1999).

The mechanism for the renal toxicity observed in cases of adult exposure to uranium is believed to be due to the retention of uranium in the kidney. Newborn humans have relatively inefficient tubular secretion and reabsorption compared to older children or adults, and whether this would increase or decrease the susceptibility of newborns to uranium toxicity is not known (ATSDR 1999).

The National Research Council Committee on the Biological Effects of Ionizing Radiation BEIR IV report stated that "exposure to natural uranium is unlikely to be a significant health risk in the population and may well have no measurable effect" (BEIR IV). This statement applies equally well to depleted uranium. BEIR IV reported that eating food or drinking water that has normal amounts of uranium will most likely not cause cancer or other health problems in most people.

Air

The DRH has records of monthly gross alpha and beta radiation measurements taken by DRH on the plant site since January 1994. This Health Consultation looked at air data taken January 25, 1994, through April 17, 2007. The data is summarized in Table 1 below.

Table 1. Gross alpha and beta radiation statistics in air at the onsite monitor. Aerojet Ordnance Tennessee, Jonesborough, Washington County, January 25, 1997 - April 17, 2007. All measurements in picocuries per cubic meter (pCi/m^3).

Radiation Type	***Average***	***Standard Deviation***	***Minimum***	***Maximum***
Alpha	0.003	0.0007	-0.001	0.085
Beta	0.023	0.018	0.001	0.18
Alpha + Beta	0.026	0.020	0.003	0.20

AOT has consistently met its license limits for air emissions of alpha and beta radiation. AOT demonstrates compliance by meeting the concentrations limits in the license and by calculating the doses to the public from its activity measurements taken in the stacks, insuring that the effective dose equivalent to a maximally exposed member of the public is less than 10 mrem per year from air and that the total effective dose equivalent for all pathways of exposure (water, air, and ambient radiation) is less than 100 mrem per year. The total effective dose equivalent is the sum of the deep-dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

In the years 1994, 1995, and 1996, the average concentrations released to unrestricted air for all stacks and fans combined and averaged over a period of one year did not exceed the effluent concentration limits for gross alpha and beta radiation. New release standards were implemented in 1994. As a result of the new standards, AOT exceeded the air limitations at several Heat Stress Fan release points in 1994 and 1995 until the fans were equipped with HEPA filters.

The Argonne National Laboratory (ANL), part of the U.S. Department of Energy, has developed National Emissions Standards for Hazardous Air Pollutants (NESHAPS) equivalents for U-238. The NESHAPS equivalent includes the contribution of the short-lived beta decay products. The NESHAPS for U-238 in air is 0.12 microcuries per cubic meter ($\mu Ci/m^3$). The sum of alpha plus beta radiation is well below the NESHAPS equivalent (ANL 2007).

ANL has, also, derived health-based risk coefficients for U-238 using EPA standard dose conversion factors and dose limits for drinking water and air referenced in Federal Guidance Report 11 (EPA 1988, ANL 2007). In addition, the EPA has derived slope factors (morbidity risk coefficients), based on Federal Guidance Report 13, for radionuclides that provide the lifetime excess total cancer risk per unit intake of exposure (EPA 1999); this risk coefficient is the same as ANL's risk coefficient for developing cancer. These risk coefficients can be used to estimate the additional risk of developing cancer or dying from cancer due to exposure to U-238. The additional risks were calculated using the following equation:

Additional risk = risk coefficient (risk/pCi) x average inhalation rate (m^3/day) x average life span (years) x 365 days/year x air concentration of alpha + beta

Values used for the variables are shown in Table 2.

Table 2. Values for variables used in calculating additional risk of developing or dying from cancer due to airborne exposure to U-238.

Risk coefficient, developing cancer	*Risk coefficient, dying from cancer*	*Average life time inhalation rate*	*Average life span*
9.3×10^{-9} risk/pCi	8.8×10^{-9} risk/pCi	17.8 m^3/day (combined for men and women)	75.2 years

The additional risk for developing cancer due to a lifetime inhalation of U-238 at the monitor is estimated to be 1.2 in 10,000. In the U.S., men have about a 1 in 2 lifetime risk of developing cancer; for women, the risk is about 1 in 3 (ACS 2007). The additional risk for dying of cancer due to a lifetime inhalation of U-238 at the monitor is estimated to be 1.2 in 10,000. In the U.S., about 1 in 4 people will die from cancer. These additional risks are not large enough to detect with an epidemiologic study. The amounts of alpha and beta radiation measured at the sampling point are consistent with background levels.

The EPA has a national program, RadNet, which measures ambient concentrations of select radionuclides in air, water, and milk (EPA RadNet). Ambient radionuclide data has been collected since 1960 and is still being collected. Gross beta radiation for Nashville and Knoxville are summarized in Table 3.

Table 3. Gross beta radiation summary statistics for air, Nashville and Knoxville, Tennessee. RadNet 1960 - March 30, 2007.

	Mean	*Minimum*	*Maximum*
Nashville			
Gross beta, pCi/m^3	0.0178	0.0081	0.519
Knoxville			
Gross beta, pCi/m^3	0.0222	0.0002	0.615

The concentrations of gross beta radiation at the northeast corner of AOT are comparable to the values found in 46.25 years of monitoring in Nashville and Knoxville. Breathing the air around the AOT facility for a lifetime should present no health hazard.

Water

The DRH has records of monthly gross alpha and beta radiation measurements taken upstream and downstream of the plant in Little Limestone Creek site on since January 1994. This report looked at water data taken January 25, 1994, through April 17, 2007. The data is summarized in Table 4 below.

Table 4. Gross alpha and beta radiation statistics in Little Limestone Creek. Aerojet Ordnance Tennessee, Jonesborough, Washington County, January 25, 1997 - April 17, 2007. All measurements in picocuries per liter (pCi/L).

Radiation Type	*Average*	*Standard Deviation*	*Maximum*	*2nd Largest*
W61: Little Limestone Creek upstream of AOT				
Alpha	1.49 (0.63 without max)	11.14 (1.58 without max)	141.8 (July 19, 2005)	8.0
Beta	4.63 (3.58 without max)	13.76 (1.46 without max)	178.20 (July 19, 2005)	7.0
W62: Little Limestone Creek downstream of AOT				
Alpha	1.14	1.62	8.9	5.1
Beta	3.60	1.63	8.8	7.6

AOT has consistently met its license limits for water emissions of alpha and beta radiation between 1997 and 2004, but did not meet its license limits in 1994, 1995, 1996, and 2005. In 1994, 1995, and 1996, AOT exceeded its effluent release limit. In 2005, AOT released wastewater with an average uranium effluent concentration of 4.82×10^{-7} pCi/L, greater than the 3×10^{-7} pCi/L allowed by DRH. The cause of this exceedance was found and corrected. AOT demonstrates compliance by meeting the concentration limits in the license and calculating the dose to a maximally exposed member of the public, insuring that the effective dose equivalent from water is less than 50 mrem per year and the total effective dose equivalent for all pathways (water, air, and ambient radiation) is less than 100 mrem per year.

Over the 14 years of data considered in this Health Consultation, all measurements for gross alpha and beta radiation at W62 (downstream of AOT) are below the EPA maximum contaminant level (MCL) and the screening MCL. Measurements of total natural uranium (not radioactivity measurements), taken for monitoring purposes for the NPDES permit, have consistently been below the daily maximum permit limit of 12 mg/L in the outfall before dilution in the creek (WPC).

Using the same methodology as for air, the additional risk of developing or dying from cancer were calculated for a lifetime use of Little Limestone Creek at sampling point W62 as a sole source of drinking water. The average concentrations of alpha and beta radiation were added to obtain the concentration values used in the equation. This is a very conservative way to look at the risk from Little Limestone Creek since it is not used as a drinking water source. The following equation was used. Values used for the variables are shown in Table 5.

Additional risk = risk coefficient (risk/pCi) x average ingestion rate for water (L/day) x average life span (years) x 365 days/year x water concentration of alpha + beta

Table 5. Values for variables used in calculating additional risk of developing or dying from cancer due to exposure to U-238 in drinking water.

Risk coefficient, developing cancer	*Risk coefficient, dying from cancer*	*Average life time inhalation rate*	*Average life span*
7.5×10^{-11} risk/pCi	1.2×10^{-10} risk/pCi	1.1 liter/day (combined for men and women)	75.2 years

The additional risk for developing cancer due to a lifetime of drinking water from Little Limestone Creek at sampling point W62 was estimated to be 1.1 in 100,000. The additional risk for dying from cancer due to a lifetime inhalation of U-238 at the sampling point is estimated to be 1.7 in 100,000.

These additional risks are not large enough to detect epidemiologically. DRH does not consider these levels of gross alpha and beta radiation significantly different from normal background.

EPA has monitored drinking water gross beta radiation in Knoxville and Chattanooga as part of its RadNet program (EPA RadNet). The gross beta radiation in Knoxville and Chattanooga drinking water is summarized in Table 6.

Table 6. Gross beta radiation summary statistics for drinking water, Knoxville and Chattanooga, Tennessee. RadNet 1960 - March 30, 2007.

	Minimum	*Maximum*	*Mean*
Knoxville			
Gross beta, pCi/L	0.84	3.78	1.88
Chattanooga			
Gross beta	0.9	3.95	1.84

The concentrations of beta radiation at sampling points W61 and W62 are higher than the average value found for drinking water in Knoxville and Chattanooga. Because the water tested in Knoxville and Chattanooga is finished drinking water rather than source water, the values are not strictly comparable. However, even without treatment the water at Little Limestone Creek would not present an unacceptable risk if used as a source of drinking water.

Sediment

DRH takes annual sediment samples, analyzed for gross alpha and beta radiation, from Little Limestone Creek and Telford Lake every year beginning in 1993. Sampling at the upstream location began in 1994. The upstream location is the same as the upstream water sampling location. Other samples are taken downstream of the Aerojet water discharges as far as the dam forming Telford Lake.

Concentrations of gross alpha radiation ranged from zero to a high of 5.2 pCi/g dry weight in 1994 at Little Limestone Creek 415 yards east of Telford Dam and in 1993 at the juncture of Little Limestone Creek and Telford Lake. All measurements of alpha radiation have been less than 3 pCi/g since 1997 and are indistinguishable from background measurements.

Concentrations of gross beta radiation ranged from 0.1 to a high of 26.3 pCi/g dry weight in 1998 at Telford Lake east of the embayment and in 2005 at the north bank of the backwater area of Telford Lake. All values measured since 1993 indicate only background levels of beta radiation.

A completed exposure pathway to sediment in the creek could occur if someone waded in the water and swallowed some of the sediment. This occurrence would be rare. Because of the rarity of the event and the very low background levels of radiation in the sediment, this would not present a public health hazard.

Unrestricted Area Ambient Radiation Levels

In addition to stack and waste water discharge monitoring, AOT has fence line thermoluminescent dosimetry badges posted around their facility to monitor the deep dose equivalent (measuring external whole body exposure) on a quarterly basis. They also perform stream sampling on Wednesday or Thursday after their weekly release of wastewater to Little Limestone Creek.

In 1994, a total effective dose equivalent was not calculated. However, the effective dose equivalent from air for 1994 was calculated to be less than 1 mrem. The total dose to the member of the public combining air, water, and fence line data was 0.62 mrem for 2004 and 0.7 mrem for 2005. The EPA model projected a dose to the nearest neighbor to be 0.6 mrem for both 2004 and 2005. This compares well to the total effective dose equivalent of 100 mrem that is allowed. The total effective dose equivalent for other years were comparable to those for 2004 and 2005.

Inspection Reports

The DRH inspection report dated September 9-12, 1996, detailed several non-compliance issues for the years 1994, 1995, and 1996. Some of the issues involve:

- demonstrating compliance with limits to provide protection to the public,
- confining the use and possession of licensed radioactive materials to those areas licensed,

- controlling radioactive materials not in storage,
- maintenance of negative pressure in process areas,
- performance of surveys to assess potential radiological hazards,
- decontamination procedures, and
- education of workers.

In spite of these areas of non-compliance, off-site exposures to radiation have been minimal.

The inspection report dated November 1, 2006, listed only one item of non-compliance that was successfully resolved. This issue involved leakage on a pipe inside the wastewater treatment plant. The inspector's observations were positive, indicating good house-keeping and protection of workers.

Health Outcome Data

For the years 1999 through 2003, the incidence rate for all cancers in Washington County is statistically no different from the rate for the State. The incidence rate for lung cancer is lower than the State rate, while the incidence rates for multiple myeloma, chronic lymphocytic and acute myeloid leukemias are statistically the same as the state rates. There were too few cases of acute lymphocytic, chronic myeloid, and other leukemias to obtain reliable statistics. Differences in rates were interpreted to be significantly significant if the Tennessee rate fell outside the 95% confidence interval for the county rate. See Table 7 for details (TCR 2007).

Table 7. Total cancer cases and age-adjusted[1] cancer incidence rates[2] by primary site, with 95% lower and upper confidence intervals (CI), Tennessee and Washington County, 1999-2003.

	Tennessee				*Washington County*			
Primary Site	*Number of cases*	*Age-Adj. Rate*	*Lower CI*	*Upper CI*	*Number of cases*	*Age-Adj. Rate*	*Lower CI*	*Upper CI*
All Cancer	116,443	399.8	397.5	402.1	2,433	410.7	394.3	427.0
Lung and Bronchus	20,946	71.7	70.7	72.7	392	65.7	59.2	72.8
Multiple Myeloma	594	2.1	1.9	2.2	17	2.8	1.5	4.2
Acute Lymphocytic	119	0.4	0.3	0.5	*			
Chronic Lymphocytic	297	1.0	0,9	1.2	12	2.0	0.9	3.2
Acute Myeloid	325	1.1	1.0	1.3	8	1.4	0.4	2.3
Chronic Myeloid	125	0.4	0.4	0.5	*			
Other Leukemias	173	0.6	0.5	0.7	*			

Source: Tennessee Cancer Registry.
[1] Rates are per 100,000 and are age adjusted using the 2000 U.S. population standard.
[2] Counts and rates are suppressed when fewer than 6 cases were reported.

The Tennessee Birth Defects Registry is a fairly new program. Its second widely distributed population-based statewide report was produced and published in 2007. The annual prevalences of both birth defects and of infants affected by birth defects from 1999 through 2003 have not shown any statistically significant changes over the five year period. Rates vary by maternal age, infant's sex, infant's race/ethnicity, and area of the state where the infant was born. As seen across the nation as well as in Tennessee, infants born to older aged mothers and male infants are associated with higher rates of birth defects. In Tennessee, the birth defects rates varied by perinatal region (the area of the state where the infant was born) with the Northeast having a higher rate of birth defects than the other regions; the rates generally declined as one moved through the East, Middle, and Western regions. Currently the Birth Defects Registry is attempting to evaluate factors that may affect the regional differences (TBDR 2007). All cases have been geocoded in an attempt to detect any clustering of cases. This has not yielded any insights into the causes of the higher prevalence rates in the Northeast (personal communication, David Law, Director, Tennessee Birth Defects Registry, November 27, 2007). The prevalence of orofacial and musculoskeletal birth defects in the northeast region are not higher than the prevalence rates in other perinatal regions of Tennessee (TBDR 2005). The overall increased prevalence of birth defects in the northeast region is not specific to Washington County; it occurs in the entire region.

Conclusions

1. There is no apparent health hazard from exposure to airborne emissions from Aerojet Ordnance Tennessee.
    a. Emissions are well under DRH licensee limits. The total effective dose equivalent to a maximally exposed member of the public is much less than the license requirement.
    b. Emissions are well below NESHAPS equivalents developed by the Argonne National Laboratory.
    c. Air concentrations of gross beta radiation at the northeast corner of the plant property are comparable to air concentrations of gross beta radiations monitored by EPA for over 46 years in Nashville and Knoxville.
2. There is no apparent health hazard from discharges of gross alpha or beta radiation in Little Limestone Creek from water or sediment.
3. An epidemiologic study at this time is neither indicated nor feasible. Exposures to gross alpha and beta radiation appear to be minimal at the plant and in Little Limestone Creek.

Recommendations

There are no recommendations at this time.

Public Health Action Plan

EEP will provide a copy of this Health Consultation to DRH and to AOT.

There is no other public health action planned at this time. EEP is ready to assist TDEC at anytime, if needed.

Authors, Technical Advisors

Author

Bonnie S. Bashor, Director
Environmental Epidemiology

Technical Advisors

Mark Hammon, Environmental Monitoring Manager
Division of Radiological Health

Jim Talley, Environmental Monitoring Manager
Division of Radiological Health

Mark Andrews, Knoxville Field Office Manager
Division of Radiological Health

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