DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR ENVIRONMENT, SAFETY
AND OCCUPATIONAL HEALTH RISK ANALYSIS (AFMC)
BROOKS AIR FORCE BASE, TEXAS

30 Dec 2001

MEMORANDUM FOR 341 MDOS/SGOAB/SGOAM

FROM: AFIERA/RSHI
2513 Kennedy Circle Bldg 180
Brooks AFB, TX 78235-5123

SUBJECT: Consultative Letter, IERA-RS-BR-CL-2001-0120, Exposure Assessment of Missile Crew Members in 564th Missile Squadron, Malmstrom AFB, MT.

1. **INTRODUCTION:**

a. **Purpose:** At the request of the 341 MDOS Bioenvironmental Engineering Flight, AFIERA/RSHI conducted an assessment of workplace exposures on all of the 564th Missile Squadron Missile Alert Facilities (MAFs) from 2 to 5 July 2001. 341 MDOS Bioenvironmental Engineering had requested our support in response to heightened crew member concerns over potential sources of chemical and biological exposures within the MAFs.

b. **Survey Personnel:**

[redacted]

c. **Personnel Contacted:**

[redacted]

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d. **Survey Equipment:**

(1) SKC High/Low Flow Pumps- used to collect air samples
(2) BIOS Dry Cal calibrator- used to calibrate SKC high/low flow pumps
(3) Kurz 444 Ventilation Meters – used to measure ventilation system performance
(4) TSI Q-Trak Indoor Air Quality Meter- used to measure relative humidity, temperature, and carbon dioxide concentrations (CO2)

2. **BACKGROUND:**

a. Personnel in the 564[th] Missile Squadron have concerns over the health and safety of working conditions within the Launch Control Centers (LCCs) of the Missile Alert Facilities (MAFs). The concern was initially expressed based on the occurrence of lymphomas (lymph node cancers) among three missile crew members who had worked in the 564[th] Missile Squadron over a 3-year period between 1994 and 1997.

b. Operational and Facility Description:

(1) The 564[th] Missile Squadron is comprised of five MAFs. The locations of all the MAFs are scattered throughout a region northwest of Malmstrom AFB, with the majority located near and surrounded by actively farmed agricultural areas.

(2) Each of the five LCCs evaluated were of similar construction. The MAFs capsule is situated completely underground with access provided by an elevator shaft system. The capsule is divided into three main areas: the launch control equipment building (LCEB), the clean room, and launch control center (LCC).

(3) LCCs are separated from LCEBs by air-tight blast doors. Ambient air is mechanically driven with a fan into the LCEB through a duct that runs to the surface, and is similarly exhausted through a separate duct. Air brought into the LCEB is pulled into the LCC with a 5.25-inch make-up air fan positioned within the LCEB, and exhausted with a 3-inch fan located in the LCC.

(4) The egg-shaped LCC has an inherent volume of 21,000 cubic feet; the acoustical enclosure, which is open to the full LCC, has a volume of 5,300 cubic feet. When assessing air exchange rates, the larger LCC volume is the most appropriate volume to apply. Note that the volumes are the design volumes, prior to installation of equipment; therefore, the actual volume is smaller.

(5) The LCCs are manned 24-hours a day, 7 days a week, 365 days a year. A 2-person crew stays in the LCC for a period of 24 hours at a time until a new crew arrives.

c. Potential exposures: Based on information provided by the 564th Missile Squadron and the 341st Medical Squadron, and a visual inspection of the MAFs and LCCs, the AFIERA team evaluated potential exposures to personnel from the following sources:

(1) Ambient airborne substances originating within capsule: naphthas and other volatile organic compounds, from diesel fuel used in a generator housed within the LCEB; polychlorinated biphenyls (PCBs), known to be contained in some electrical components in the LCC; intermittent exposure to emission from the periodic burning of crypto tape; infrequent corrosion control activities; and biological exposures from stagnant water at A/C discharge point within the LCC.

(2) Ambient airborne substances originating outside capsule: pesticides, herbicides, and chlorophenols, all potentially used in agricultural applications to crop fields located near the MAFs.

(3) Drinking water: Water is brought into an 750 gallon holding tank in the LCC from the surface through black iron pipe. Consequently, there could be possible exposures to metals contained in the pipe; pesticides and herbicides potentially present in the source water; or bacteriological growth.

(4) General Indoor Air Quality: Inadequate air flow could lead to potential comfort problems for missile crews. Environmental conditions of temperature, relative humidity, and carbon dioxide are factors that can indicate the adequacy of environmental controls within a facility.

(a) Carbon dioxide: According to ASHRAE® Standard 62-1999, "Ventilation for Acceptable Indoor Air Quality," fresh air is required to "dilute odors from human bioeffluents to levels that will satisfy a substantial majority" of persons. Carbon dioxide (CO_2), which is released at a rate of 0.31 Liters per minute (L/min) by sedentary persons, is considered to be a good marker of bioeffluents. When levels of CO_2 are maintained below 700 parts per million (ppm) above the background (or outdoor) levels of between 300 and 500 ppm, a substantial majority of people will be satisfied. This implies that concentrations of CO_2 should be held to less than 1200 ppm to provide for worker comfort. Both the Occupational Safety and Health Act (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH®) have established an 8-hour Time-Weighted Average (TWA) exposure limit of 5000 ppm for CO_2. The basis for the exposure limits is primarily driven by its simple asphyxiant properties, although it can also be a "potent stimulus to respiration, and both a depressant and an excitant of the central nervous system."

(b) Temperature and relative humidity: Both play a role in comfort and in controlling growth of biological matter, such as fungi. Most complaints in non-industrial settings occur when relative humidity is less than 30 percent or greater than 60 percent, or temperatures fluctuate greatly due to an imbalanced or poorly designed ventilation system (reference ASHRAE Standard 62-1999). Recommended temperature ranges for indoor work range from 68-75°F during the winter, and 73-79°F in the summertime (reference ASHRAE Standard 55-1992, "Thermal Environmental Conditions for Human Occupancy"). Please note that these temperature ranges are only recommendations, and local conditions, such as clothing requirements and workload, dictate the appropriate ambient temperatures.

(c) The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Std 62-1999, Table 2, "Outdoor Air Requirements for Ventilation – Chapter 2.1, Commercial Facilities," recommends 20 cubic feet per minute/person (cfm/person).

(5) Contact with PCBs: There have been reports of leaking electrical components in the past that are believed to contain PCBs. Contact with PCB-containing fluids could lead to mild to moderate skin irriation and chloracne, as well as toxic liver effects when PCBs are absorbed into the body through the skin.

3. **SURVEY PROCEDURES:**

a. Air Sampling: During this survey, area air samples were collected within LCCs for all five MAFs: Papa, Quebec, Romeo, Sierra, and Tango. Sampling addressed possible substances originating within and outside of the LCC (see Attachment 1). Air sampling positions within each capsule were selected specifically to identify hazardous materials that could potentially be present in the LCC, or had been identified as potential substances used in the immediate vicinity of the MAF over the previous several years. Locations were selected to be different positions from each other, in order to represent the range of locations in which personnel could work or rest (see Attachment 2). Samples were collected for a total period in each LCC of approximately between 5 and 8 hours (see Attachment 3 for specific sample times and associated parameters).

b. Air quality was monitored for carbon dioxide (CO_2), temperature, and relative humidity in three of the five LCCs (Papa, Sierra, and Tango). An Indoor Air Quality (IAQ) meter capable of measuring all three parameters was used. The meter logged the data each minute, allowing a comprehensive assessment of the entire monitoring period. Air was monitored for a duration approximately equivalent to the air sampling times cited above. Locations were selected as shown in Attachment 2.

c. Ventilation measurements were taken to determine the amount of fresh air entering the LCC. Measurements were taken for all LCCs except Sierra, whose ventilation system was not operational at the time. Air flow rates were estimated by measuring face velocities and fan size at the LCC make-up air fan within the LCEB. Similarly, LCC exhaust air flow rate was determined by measuring face velocities and opening size for the exhaust duct located above the latrine in the LCC capsule.

d. Water samples were collected from the bathroom sink cold-water tap in all five LCCs. We removed the faucet screens and flushed the lines before collecting the samples. Water originates topside but is carried through a black iron pipe into a 750-gallon holding tank below the capsule. It is pressurized to provide adequate flow into the bathroom sink within the LCC. To detect potential infiltration of pesticides and herbicides from reservoir and wells, testing included a screening for pesticides and herbicides per EPA method 525.2 (183 chemicals in the parameter list) and 515.3 (17 chemicals), respectively. The samples were also analyzed for 15 metals (some of which are typically used during the manufacturing of black iron pipes) via EPA method 200.8. The 341 MDOS/Bioenvironmental Engineering shop tested the water for chlorine levels during our visit.

e. Composite and grab samples of topside surface soil were collected near the ventilation intake in areas where dirt/dust could potentially be suspended and pulled into the ventilation system. These samples were analyzed for pesticides and herbicides to determine the amount of residual that may have accumulated over the years as a result of agricultural application of these substances to adjacent crop fields. Samples were also collected outside of the restricted fenced area to establish background concentrations.

f. Although no structured interviews were done, informal interactions with each of the missile crews provided a great opportunity for the team to gather insight into the conditions of the working environment and to better understand the concerns of personnel in the squadron.

4. **RESULTS/DISCUSSIONS**

a. Air Sampling Results: Air sampling for all chemical substances in each of the five LCCs indicated exposures to be less than the laboratory limits of detection, except for a trace quantity of naphthas (volatile organic substances) detected in the Quebec LCC. However, one of the blank samples also showed a trace amount. Blanks, which were never exposed to the work environment, are used to assess potential contamination of media during the manufacturing and handling processes. Results for actual sampling media are usually adjusted for any amounts of substance found on a blank. Therefore, after correction the one trace sample is deemed less than the detection limit as well.

b. Indoor Air Quality: Carbon dioxide, relative humidity, and temperature measurements for each of the three LCCs tested (Papa, Sierra, and Tango) are shown in Attachment 4.

(1) Carbon dioxide: All carbon dioxide levels were considerably less than the recommended worker comfort maximum of 1200 ppm in every facility except Sierra. This indicates that carbon dioxide levels within two of the three LCCs tested meets ASHRAE criteria. In Sierra LCC, whose make-up air fan was inoperable at the time of the survey, carbon dioxide levels averaged 1363 ppm. While this concentration does not exceed the occupational exposure limit, it does slightly exceed the ASHRAE-recommended standard for worker comfort.

(2) Relative humidity: Average relative humidity levels ranged from 28 percent (in Tango LCC) to 34 percent (in Sierra LCC). These are near the low end of the ASHRAE-recommended values for indoor air; however, they are representative of the outdoor humidity levels to which personnel are accustomed in the Great Falls area.

(3) Temperature: The average temperature within all three LCCs tested was 73 degrees F. This falls within the ASHRAE recommended temperature guidelines for winter and summer.

c. Ventilation: Estimates of ventilation flow rates in four of the five LCCs (Attachment 5) show that fresh air levels brought into each facility exceed the minimum recommended flow rate of 20 cfm/person. (As stated previously, we did not measure ventilation exchange rates in Sierra LCC due to a broken make-up air fan.)

d. Water Sampling: Concentrations of chemicals in the water are low, meeting all primary drinking water standard regulatory limits, which indicates that the water is safe to drink with respect to harmful chemicals. However, note that 341 MDOS/Bioenvironmental Engineering tested the water for chlorine at the time of our sample collection and determined that there was no residual chlorine available at any of the five sites; residual chlorine is recommended for ensuring no biological growth occurs in the water. Attachment 6 lists concentrations of metals detected in the water. Specific sampling results for metals, pesticides, and herbicides at each site are discussed below:

(1) Papa: Concentrations of all pesticides and herbicides were below the laboratory limits of detection except for dalapon, an herbicide, which had a concentration of 2.0 ug/L, 1/100 of its Maximum Concentration Limit (MCL). Seven out of 15 metals were detected in trace amounts, below their respective MCLs.

(2) Quebec: Concentrations of all pesticides and herbicides were below the laboratory limits of detection. EPA method 200.8, metals screening, detected trace amounts of six analytes out of 15. The remaining nine chemicals were all below detectable limits.

(3) Romeo: Concentrations of all pesticides and herbicides were below the laboratory limits of detection except for fluorine, a pesticide, which was found at a concentration level of 0.1 ug/L. No MCL currently exists for this chemical; however, relative to other fluorinated compounds, this is a very low concentration. Trace amounts of eight out of 15 metals were detected.

(4) Sierra: Concentrations of all pesticides and herbicides were below the laboratory limits of detection. Trace amounts of eight out of 15 metals were detected.

(5) Tango: Concentrations of all pesticides and herbicides were below the laboratory limits of detection. Trace amounts of nine out of 15 metals were detected.

e. Soil Sampling:

(1) The majority of analytes tested were below the laboratory limits of detection. Trace amounts of some compounds commonly used in pesticides and herbicides were detected in some of the samples. However, all concentrations are considerably lower than the Environmental Protection Agency's "1 in a million" risk of cancer that is commonly used for exposures to the public in industrial work areas. Soil sampling results are summarized in Attachments 7 through 9.

(2) Air brought into the ventilation system is cleaned by an Chemical, Biological, and Radiological (CBR) filter in the LCEB prior to it being taken into the LCC. The design standards for this filter require it to be greater than 99.97 percent efficient at removing particulate matter. Therefore, potential exposure to personnel in the LCC from any residual pesticides or herbicides contained in the soil is extremely low.

f. Other observations:

(1) There was some evidence of organic growth of a black, slimy appearance at the base of some LCC capsules where stagnant HVAC condenser water has accumulated. This evidence was most pronounced in Quebec LCC. It appears that the sump pump used to remove water accumulation is not functioning adequately to remove any discharge. While not identified, it is currently in a wet form, which inhibits release of substances into the air. Furthermore, it is in an area where little air flow is present, thereby posing minimal exposure risk to missile crews, even in a dry state.

(2) Ventilation filters: Air within the LCC is recirculated through a bank of cleaning filters to control dust levels. Air filters in Papa and Romeo contained the most debris, but appeared to be otherwise in good shape. The remaining air filters were clean.

(3) Polychlorinated biphenyls (PCBs): Air sampling for PCBs was not accomplished during this survey. The vapor pressures of PCBs are extremely low, such that a potential inhalation hazard to personnel is very unlikely. Furthermore, a meticulous survey of the five LCC capsules showed no signs of past or present leakage that would warrant sampling. PCBs primarily represent a possible hazard to personnel under two conditions: when heated or burned, or when personnel come into direct physical contact with these compounds.

(4) Hazardous materials usage by the 2-person crew was very minimal. Occasional use of office-type cleaning supplies does not pose a risk to personnel.

(5) At the end of each work shift, personnel dispose of crypto tape via combustion in a small coffee can. The tape is lit with a match and is at times burned using a paper towel as a starter fuel. At the end of each month, a larger quantity of tape is disposed through combustion.

(a) Two types of crypto tape have been used in the recent past. From 1994 to 1997, a blue-colored tape composed of Mylar® and paper was used. From 1997 to the present, a white-colored tape was used. In the near future, missile crews will switch to using an off-white crypto tape that, according to the National Security Agency (NSA), is nearly identical in composition to the bluish tape. Part numbers and manufacturer information was not readily available for these products. However, the NSA was able to provide samples of the blue and white tapes for combustion product analysis.

(b) The blue-colored and white-colored tapes were burned under controlled laboratory conditions and analyzed via infrared (IR) spectrometry to identify the composition of gases released during combustion. Products from the bluish sample were relatively "clean" – releasing carbon dioxide, carbon monoxide, and water vapor. The white crypto tape released carbon dioxide, carbon monoxide, water vapor; and double-bonded hydrocarbons consisting of acetylene, ethylene, and propylene.

(c) It is not possible to effectively estimate the concentrations of these gases in the capsule without collecting air samples within the LCC itself during burning operations. However, with the exception of carbon monoxide, each of the gases released are classified as simple asphyxiants and will not pose a health hazard to missile crews. With the small amount of material burned, carbon monoxide levels would be expected to be well below the Occupational Exposure Limit (OEL) of 50 ppm. Air sampling is not necessary to assess this exposure.

(6) Corrosion control activities are occasionally conducted to apply rust-resistant coatings to the interior of the LCC. To the best of our knowledge, coatings are rolled (not sprayed) onto the interior surface. We do not have enough information to assess possible exposures to personnel in the LCC during coating applications. 341 MDOS/Bioenvironmental Engineering has conducted limited air sampling in the past, which indicated levels of organic solvents to be below their respective exposure limits. We recommend additional sampling and assessment when the opportunity arises.

5. **RECOMMENDATIONS:**

a. 341 MDOS/Bioenvironmental Engineering should further assess corrosion control activities to evaluate potential exposures both to missile crews and to maintenance personnel. Some exposure data is available from previous years, and should be considered as part of the evaluation.

b. 564 MS and 341 CES should ensure the make-up air fans are functioning properly, especially in Sierra MAF. These are critical components of the air handling systems. Since there is a history of make-up air fan failure, maintenance personnel should have spare fan assemblies available to install when the need arises.

c. Drinking water: While our survey indicated metal levels to be within standards, there was no residual chlorine available in the tanks. This is likely a result of stagnation. Based on the 750-gallon tank storage volume in each LCC, it would take a 2-person crew approximately 1 month to consume the water in the tank (2 people @ 15 gallons per day for toilet, hand washing, etc. over each 24-hour period). Stagnant water with no residual chlorine could lead to bacteriological growth. For this reason, we recommended further assessment to ensure the potability of the water, to include routine bacteriological monitoring.

d. 564 MS and 341 CES should inspect the sump pumps at the base of the capsule to ensure they are functioning properly and adequately removing water accumulating at the base of the LCC from outside sources or from the air conditioning condenser drainage tube.

6. **CONCLUSIONS:**

a. Extensive air, water, and soil sampling indicates that the workplace is free of health hazards. We consider the work area to be a safe and healthy environment for your personnel.

b. We presented the results of our survey to 564 MS personnel on 14 and 15 November. It is important to ensure all missile crews are made aware of the results of this assessment, as it should alleviate many of the worries expressed prior to our study. We recommend providing a copy of this report, with attachments, and a copy of our briefing, to all squadron personnel. Possible avenues of distribution include posting on the 564 MS web site, providing copies in a read file, and sending via electronic mail to interested parties.

c. We would like to thank the 341st Medical Squadron and the 564th Missile Squadron personnel for outstanding support to our team during the visit. It was a true pleasure to work with such a highly professional group of people throughout the survey. The support they provided us was absolutely exceptional.

d. If you have any questions regarding this survey, or need any additional support regarding this issue, please contact the undersigned at [redacted].

[redacted]

Attachments:

1. Hazardous materials monitored during survey
2. LCC Diagram: Air Sampling Pump and IAQ Meter Location
3. Air sampling log
4. Carbon dioxide, temperature, and relative humidity measurements
5. Ventilation air flow rates
6. Water sampling results
7. Organophosphorous pesticide soil sample results
8. Herbicide soil sample results
9. Organochlorine pesticide soil sample results
10. Fact Sheet: Lymphoma
11. Fact Sheet: MAF Survey

cc: HQ AFSPC/SGPB

Attachment 1. Hazardous materials monitored during survey.

Compound(s)	Potential source	Sampling method
Naphthas - Benzene - Diesel - Ethylbenzene - Petroleum naptha - Toluene - Xylene (total)	Diesel fuel	NIOSH 1550/OSHA 7 (charcoal tubes)
Volatile Organic Compounds (VOCs)	Diesel fuel; off-gassing from paints, sealants, etc.	NIOSH 1550/OSHA 7 (charcoal tubes)
Organophosphate pesticides - Azinphos Methyl - Chloropyrifos - Diazinon - Dicrotophos - Disulfoton - Ethion - Ethoprop - Fenamiphos - Fonofos - Malathion - Methamidophos - Methyl Parathion - Mevinphos - Monocrotophos - Parathion - Phorate - Ronnel - Sulprophos - Terbufos	Neighboring farmland; ventilation uptake of contaminated soil; water runoff into facility	NIOSH 5600 (13 mm quartz filter + XAD-2)
Organonitrate pesticides	Neighboring farmland; ventilation uptake of contaminated soil; water runoff into facility	NIOSH 5601 (13 mm quartz filter + XAD-2)
Chlorinated and organonitrogen herbicides	Neighboring farmland; ventilation uptake of contaminated soil; water runoff into facility	NIOSH 5602 (13 mm quartz filter + XAD-2)
p-Chlorophenol	Neighboring farmland; ventilation uptake of contaminated soil; water runoff into facility	NIOSH 2014 (silica gel sorbent tube)

Attachment 2. LCC Diagram: Air Sampling Pump and IAQ Meter Location

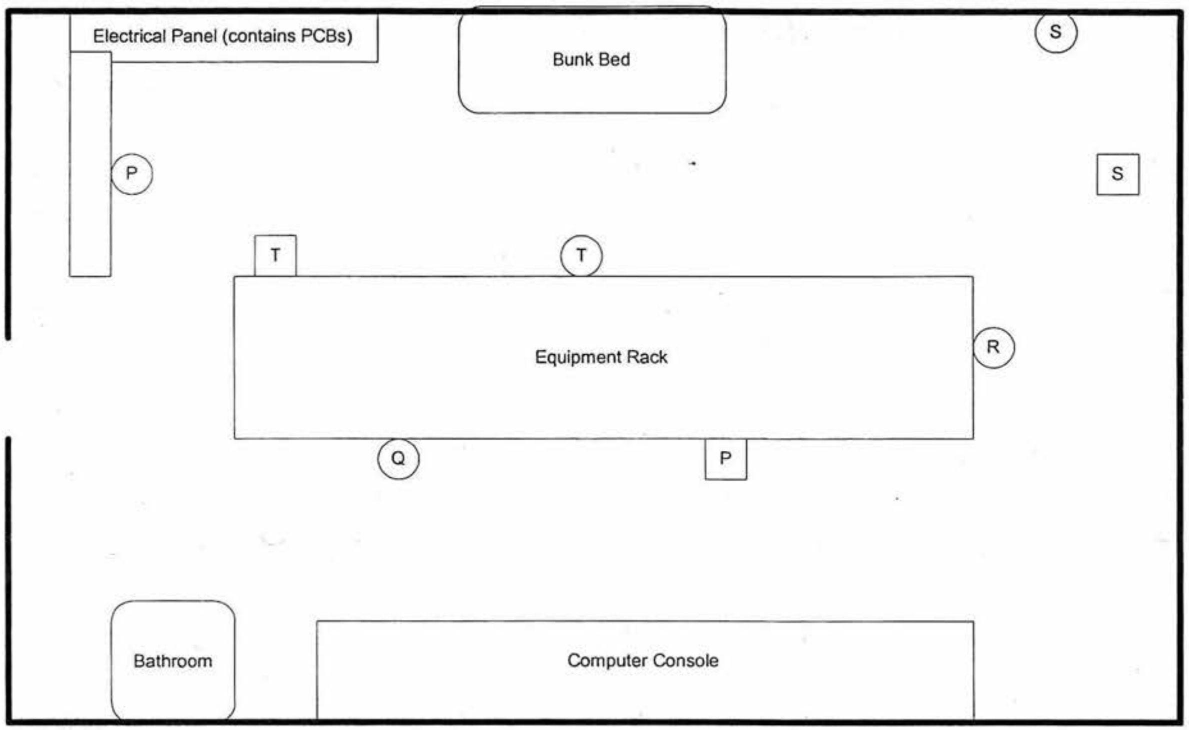
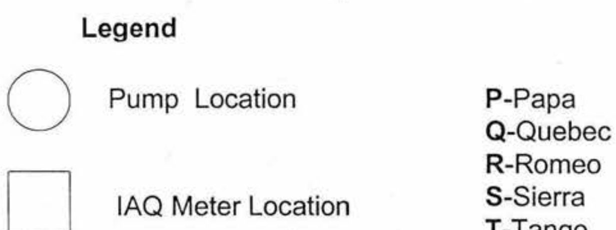


Diagram Not to Scale



Attachment 3. Air Sampling Log

Date	Site	Pump	Analyte	Pre-cal (ml)	Post-cal (ml)	Start	End	Elapsed (min)	Sample Number
7/4/2001	P	8394	Chlorophenol	84	84	8:35:00 AM	3:36:00 PM	421	EX010906
7/4/2001	P	8418	Naphthas	41.5	41.4	8:35:00 AM	3:36:00 PM	421	EX010907
7/4/2001	P	8629	VOCs (screening)	22.1	21	8:35:00 AM	3:36:00 PM	421	EX010908
7/4/2001	P	625141	Pesticides: Cl/Nitro	1006	940	8:35:00 AM	3:36:00 PM	421	EX010909
7/4/2001	P	625163	Herbicides: Nitrate	955	899	8:35:00 AM	3:36:00 PM	421	EX010910
7/4/2001	P	625171	Pesticides: Phosphate	960	895	8:35:00 AM	3:36:00 PM	421	EX010911
7/4/2001	Q	8370	Chlorophenol	84.8	83	9:32:00 AM	4:59:00 PM	447	EX010912
7/4/2001	Q	8504	Naphthas	41.8	41.1	9:32:00 AM	4:59:00 PM	447	EX010913
7/4/2001	Q	8650	VOCs (screening)	22.4	22.2	9:32:00 AM	4:59:00 PM	447	EX010914
7/4/2001	Q	538443	Pesticides: Cl/Nitro	1000	910	9:32:00 AM	4:59:00 PM	447	EX010915
7/4/2001	Q	625170	Herbicides: Nitrate	1002	899	9:32:00 AM	4:59:00 PM	447	EX010916
7/4/2001	Q	625188	Pesticides: Phosphate	985	918	9:32:00 AM	4:59:00 PM	447	EX010917
7/3/2001	R	8370	Chlorophenol	81.27	84.7	11:50:00 AM	5:25:00 PM	335	EX010918
7/3/2001	R	8380	Pesticides: Cl/Nitro	228	242	11:50:00 AM	5:25:00 PM	335	EX010919
7/3/2001	R	8462	Herbicides: Nitrate	231	244	11:50:00 AM	5:25:00 PM	335	EX010920
7/3/2001	R	8463	Pesticides: Phosphate	231	245	11:50:00 AM	5:25:00 PM	335	EX010921
7/3/2001	R	8504	Naphthas	46	41.7	11:50:00 AM	5:25:00 PM	335	EX010922
7/3/2001	R	8650	VOCs (screening)	21.9	22.4	11:50:00 AM	5:25:00 PM	335	EX010923
7/3/2001	S	8394	Chlorophenol	81.03	84	8:20:23 AM	4:22:00 PM	409	EX010924
7/3/2001	S	8418	Naphthas	40.7	41.5	8:20:47 AM	4:21:00 PM	409	EX010925
7/3/2001	S	8461	Pesticides: Phosphate	234	241	8:52:16 AM	4:22:00 PM	377	EX010926
7/3/2001	S	8627	Pesticides: Cl/Nitro	233	244	8:52:16 AM	4:22:00 PM	377	EX010927
7/3/2001	S	8629	VOCs (screening)	27.6	22.1	8:20:35 AM	4:21:00 PM	409	EX010928
7/3/2001	S	8656	Herbicides: Nitrate	237	245	8:52:16 AM	4:22:00 PM	377	EX010929
7/5/2001	T	8394	Chlorophenol	84	80.1	9:25:00 AM	3:40:00 PM	375	EX010930
7/5/2001	T	8418	Naphthas	41.4	39.6	9:25:00 AM	3:40:00 PM	375	EX010931
7/5/2001	T	8629	VOCs (screening)	21	20.5	9:25:00 AM	3:40:00 PM	375	EX010932
7/5/2001	T	625141	Pesticides: Cl/Nitro	940	927	9:25:00 AM	3:40:00 PM	375	EX010933
7/5/2001	T	625163	Herbicides: Nitrate	899	875	9:25:00 AM	3:40:00 PM	375	EX010934
7/5/2001	T	625171	Pesticides: Phosphate	895	900	9:25:00 AM	3:40:00 PM	375	EX010935

Attachment 4. Carbon Dioxide, Temperature, and Relative Humidity Measurements.

Papa LCC:

Channel:	CO_2	Temp	RH
Units:	PPM	DEG F	%
Average:	644	73.3	32.3
Minimum:	588	71.8	31.1
Time of Minimum:	13:31:33	8:46:33	9:01:33
Date of Minimum:	7/4/2001	7/4/2001	7/4/2001
Maximum:	703	73.9	33.9
Time of Maximum:	14:36:33	15:51:33	10:51:33
Date of Maximum:	7/4/2001	7/4/2001	7/4/2001

Sierra LCC:

Channel:	CO_2	Temp	RH
Units:	PPM	DEG F	%
Average:	1363	73.3	34.3
Minimum:	1333	72.4	31.2
Time of Minimum:	16:01:44	11:26:44	12:11:44
Date of Minimum:	7/3/2001	7/3/2001	7/3/2001
Maximum:	1509	74.1	36.1
Time of Maximum:	11:26:44	11:46:44	15:26:44
Date of Maximum:	7/3/2001	7/3/2001	7/3/2001

Tango LCC:

Channel:	CO_2	Temp	RH
Units:	PPM	DEG F	%
Average:	653	72.6	28
Minimum:	609	72.1	27.2
Time of Minimum:	9:48:09	10:03:09	15:28:09
Date of Minimum:	7/5/2001	7/5/2001	7/5/2001
Maximum:	692	73.4	28.6
Time of Maximum:	10:23:09	9:43:09	11:58:09
Date of Maximum:	7/5/2001	7/5/2001	7/5/2001

Attachment 5. Ventilation air flow rates

MAF	Supply air flow rate into LCC (measured in LCEB), in cfm	Supply air flow rate per person (cfm/person)	Exhausted air flow rate (measured in LCC), in cfm	Exhausted air flow rate per person (cfm/person)
Papa	43	21	156	78
Quebec	47	24	84	42
Romeo	48	24	160	80
Sierra	Not measured	Not measured	Not measured	Not measured
Tango	53	27	206	103

Attachment 6. Water Sampling Results for Metals, per EPA Method 200.8

Chemical	Papa (GM000036) ug/L	Quebec (GM000048) ug/L	Romeo (GM000012) ug/L	Sierra (GM000024) ug/L	Tango (GM000051) ug/L	Maximum Concentration Level (MCL), ug/L
Antimony	ND	ND	ND	ND	0.4	6
Arsenic	ND	ND	ND	ND	1.5	50
Barium	78	56	59	57	49	2000
Beryllium	ND	ND	ND	ND	ND	4
Cadmium	ND	ND	ND	ND	ND	5
Chromium	9	8.2	7.4	6.9	7.7	100
Copper	20	9.6	16	37	67	1000
Lead	1.2	ND	0.9	2.8	0.5	15
Manganese	2.8	29	27	21	29	50
Mercury	ND	ND	ND	ND	ND	2
Nickel	4	5	4.9	5.4	3.9	100
Selenium	ND	ND	ND	ND	ND	50
Silver	ND	ND	0.8	0.4	ND	100
Thallium	ND	ND	ND	ND	ND	2
Zinc	36	46	33	93	67	5000

ND = None detected; concentration was below laboratory limits of detection

Attachment 7. Organophosphorus Pesticides Soil Sampling EPA Method 8141A

Chemicals	P-Outside West (GM000031)	P-Vent (GM000040)	Q-Vent (GM000037)	Q-Outside West (GM000043)	R-Vent East (GM000001)	R-Vent West (GM000004)	R-Outside West (GM000007)
Azinphosmethyl	ND	ND	ND	ND	ND	ND	ND
Bolstar	ND	ND	ND	ND	ND	ND	ND
Chloropyrifos	ND	ND	ND	ND	ND	ND	ND
Coumaphos	ND	ND	ND	ND	ND	ND	ND
Demeton, Total	ND	ND	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND	ND	ND
Dichlorovos	ND	ND	ND	ND	ND	ND	ND
Dimethoate	ND	ND	ND	ND	ND	ND	ND
Disulfoton	ND	ND	ND	ND	ND	ND	ND
EPN	ND	ND	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND	ND	ND
Fensulfothion	ND	ND	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND	ND	ND
Merphos	ND	ND	ND	ND	ND	ND	ND
Methyl parathion	ND	ND	ND	ND	ND	ND	ND
Mevinphos	ND	ND	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND	ND	ND
Stirofos	ND	ND	ND	ND	ND	ND	ND
Sulfotepp	ND	ND	ND	ND	ND	ND	ND
TEPP	ND	ND	ND	ND	ND	ND	ND
Tokuthion	ND	ND	ND	ND	ND	ND	ND
Trichloronate	ND	ND	ND	ND	ND	ND	ND

ND = None detected; concentration was below laboratory limits of detection

Attachment 7 (continued). Organophosphorus Pesticides Soil Sampling EPA Method 8141A (continued)

Chemicals	S-Vent East (GM000013)	S-Vent West (GM000016)	S-Outside West (GM000019)	T-Vent (GM000025)	T-Outside West (GM000028)
Azinphosmethyl	ND	ND	ND	ND	ND
Bolstar	ND	ND	ND	ND	ND
Chloropyrifos	ND	ND	ND	ND	ND
Coumaphos	ND	ND	ND	ND	ND
Demeton, Total	ND	ND	ND	ND	ND
Diazinon	ND	ND	ND	ND	ND
Dichlorovos	ND	ND	ND	ND	ND
Dimethoate	ND	ND	ND	ND	ND
Disulfoton	ND	ND	ND	ND	ND
EPN	ND	ND	ND	ND	ND
Ethoprop	ND	ND	ND	ND	ND
Fensulfothion	ND	ND	ND	ND	ND
Fenthion	ND	ND	ND	ND	ND
Malathion	ND	ND	ND	ND	ND
Merphos	ND	ND	ND	ND	ND
Methyl parathion	ND	ND	ND	ND	ND
Mevinphos	ND	ND	ND	ND	ND
Parathion	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND
Ronnel	ND	ND	ND	ND	ND
Stirofos	ND	ND	ND	ND	ND
Sulfotepp	ND	ND	ND	ND	ND
TEPP	ND	ND	ND	ND	ND
Tokuthion	ND	ND	ND	ND	ND
Trichloronate	ND	ND	ND	ND	ND

ND = None detected; concentration was below laboratory limits of detection

Attachment 8. Herbicide Soil Sampling EPA Method 8151A

Chemicals	P-Vent (GM000041)	P-Outside West (GM000032)	Q-Vent (GM000038)	Q-Outside West (GM000044)	R-Vent East (GM000002)	R-Vent West (GM000005)	R-Outside West (GM000008)	Risk Based Concentration Standard Soil Industrial (EPA Region 3)
Dalapon	ND	ND	ND	ND	ND	ND	ND	
2,4-D	ND	ND	ND	ND	ND	ND	ND	
2,4-DB	ND	ND	ND	ND	ND	ND	ND	
2,4,5-T	ND	ND	ND	ND	ND	ND	ND	
2,4,5-TP (Silvex)	ND	ND	ND	ND	ND	ND	ND	
Dicamba	ND	ND	ND	ND	ND	ND	ND	
Dichloroprop	ND	ND	ND	ND	ND	ND	ND	
Dinoseb	ND	ND	ND	ND	ND	ND	ND	
3,5-Dichlorobenzoic Acid	ND	ND	ND	ND	ND	ND	ND	
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	
Pentachlorophenol	***0.030 mg/Kg-dry***	ND	ND	***0.054 mg/Kg-dry***	***0.014 mg/Kg***	***0.075 mg/Kg-dry***	***0.1 mg/Kg-dry***	**48 mg/kg**
Bentazon	ND	ND	ND	ND	ND	ND	ND	
Picloran	ND	ND	ND	ND	ND	ND	ND	
Aciflourofen	ND	ND	ND	ND	ND	ND	ND	
Chloramben	ND	ND	ND	ND	ND	ND	ND	
MCPP	ND	ND	ND	ND	ND	ND	ND	
MCPA	ND	ND	ND	ND	ND	ND	ND	

ND = None detected; concentration was below laboratory limits of detection

Attachment 8 (continued). Herbicide Soil Sampling EPA Method 8151A

Chemicals	S-Vent East (GM000014)	S-Vent West (GM000017)	S-Outside West (GM000020)	T-Vent (GM000026)	T-Outside West (GM000029)	Risk Based Concentration Standard Soil Industrial (EPA Region 3)
Dalapon	ND	ND	ND	ND	ND	
2,4-D	ND	ND	ND	ND	ND	
2,4-DB	ND	ND	ND	ND	ND	
2,4,5-T	ND	ND	ND	ND	ND	
2,4,5-TP (Silvex)	ND	ND	ND	ND	ND	
Dicamba	ND	ND	***0.021 mg/Kg-dry***	ND	ND	**61,000 mg/kg**
Dichloroprop	ND	ND	ND	ND	ND	
Dinoseb	ND	ND	ND	ND	ND	
3,5-Dichlorobenzoic Acid	ND	ND	ND	ND	ND	
4-Nitrophenol	ND	ND	ND	ND	ND	
Pentachlorophenol	***0.086 mg/Kg***	***0.064 mg/Kg***	ND	ND	ND	**48 mg/kg**
Bentazon	ND	ND	ND	ND	ND	
Picloran	ND	ND	ND	ND	ND	
Aciflourofen	ND	ND	ND	ND	ND	
Chloramben	ND	ND	ND	ND	ND	
MCPP	ND	ND	ND	ND	ND	
MCPA	ND	ND	ND	ND	ND	

ND = None detected; concentration was below laboratory limits of detection

Attachment 9. Organochlorine Pesticide Soil Sampling EPA Method 8081A

Chemicals	P-Vent (GM000042)	P-Outside West (GM000033)	Q-Vent (GM000039)	Q-Outside West (GM000045)	R-Vent East (GM000003)	R-Vent West (GM000006)	R-Outside West (GM000009)	Risk Based Concentration Standard Soil Industrial (EPA Region 3)
Aldrin	*0.004 mg/Kg-dry*	ND	ND	ND	ND	ND	ND	**34 mg/kg**
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	
beta-BHC	ND	ND	ND	ND	ND	ND	ND	
delta-BHC	ND	ND	ND	ND	ND	ND	ND	
gamma-BHC	ND	ND	ND	ND	ND	ND	ND	
alpha-Chlordane	ND	ND	ND	ND	ND	*0.065 mg/Kg-dry*	ND	**16 mg/kg (as chlordane)**
gamma-Chlordane	*0.006 mg/Kg-dry*	ND	ND	ND	ND	*0.046 mg/Kg-dry*	ND	**16 mg/kg (as chlordane)**
4,4-DDD	ND	ND	ND	ND	ND	ND	ND	
4,4-DDE	ND	ND	ND	ND	ND	ND	ND	
4,4-DDT	*0.011 mg/Kg-dry*	ND	ND	ND	ND	*0.052 mg/Kg-dry*	ND	**17 mg/kg (as DDT)**
Dieldrin	*0.004 mg/Kg-dry*	ND	ND	ND	ND	ND	ND	**36 mg/kg**
Endosulfan 1	ND	ND	ND	ND	ND	ND	ND	
Endosulfan 2	ND	ND	ND	ND	ND	ND	ND	
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	
Endrin	ND	ND	ND	ND	ND	ND	ND	
Endrin aldehyde	*0.004 mg/Kg-dry*	ND	ND	ND	ND	ND	ND	**610 mg/kg (as endrin)**
Endrin ketone	*0.018 mg/Kg-dry*	ND	ND	ND	ND	ND	*0.007 mg/Kg-dry*	**610 mg/kg (as endrin)**
Heptachlor	ND	ND	ND	ND	ND	ND	ND	
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	
Methoxychlor	ND	ND	ND	ND	ND	*0.043 mg/Kg-dry*	ND	**10,000 mg/kg**
Toxaphene	ND	ND	ND	ND	ND	ND	ND	

ND = None detected; concentration was below laboratory limits of detection

Attachment 9 (continued). Organochlorine Pesticide Soil Sampling EPA Method 8081A

Chemicals	S-Vent East (GM000015)	S-Vent West (GM000018)	S-Outside West (GM000021)	T-Vent (GM000027)	T-Outside West (GM000030)	Risk Based Concentration Standard Soil Industrial (EPA Region 3)
Aldrin	ND	ND	ND	ND	ND	
alpha-BHC	ND	ND	ND	ND	ND	
beta-BHC	ND	ND	ND	ND	ND	
delta-BHC	ND	ND	ND	ND	ND	
gamma-BHC	ND	ND	ND	ND	ND	
alpha-Chlordane	ND	***0.045 mg/Kg-dry***	ND	ND	ND	**16 mg/kg (as chlordane)**
gamma-Chlordane	ND	***0.068 mg/Kg-dry***	ND	ND	ND	**16 mg/kg (as chlordane)**
4,4-DDD	ND	ND	ND	ND	ND	
4,4-DDE	ND	ND	ND	ND	ND	
4,4-DDT	***0.18 mg/Kg-dry***	ND	ND	***0.042 mg/Kg-dry***	ND	**17 mg/kg (as DDT)**
Dieldrin	ND	ND	ND	ND	***0.004 mg/Kg-dry***	**36 mg/kg**
Endosulfan 1	ND	ND	ND	ND	ND	
Endosulfan 2	ND	ND	ND	ND	ND	
Endosulfan sulfate	ND	ND	ND	ND	ND	
Endrin	ND	ND	ND	ND	ND	
Endrin aldehyde	ND	ND	ND	ND	ND	
Endrin ketone	ND	***0.091 mg/Kg-dry***	ND	ND	ND	**610 mg/kg (as endrin)**
Heptachlor	ND	ND	ND	ND	ND	
Heptachlor epoxide	ND	ND	ND	ND	ND	
Methoxychlor	ND	ND	ND	ND	ND	
Toxaphene	ND	ND	ND	ND	ND	

ND = None detected; concentration was below laboratory limits of detection

Hodgkin's Disease and Non-Hodgkin's Lymphoma
General Facts and Information

U.S. AIR FORCE

This fact sheet answers some of the more common health questions about Hodgkin's disease and non-Hodgkin's lymphoma. This fact sheet will provide some basic information on the lymphoid system, how lymphomas originate within the lymphoid system, common characteristics of both Hodgkin's disease and non-Hodgkin's lymphomas, and known risk factors for these types of cancer.

What are lymphomas?

Lymphomas are cancers that develop in the lymphoid system, part of the body's natural defenses.

What is the lymphoid system?

The lymphoid system is a network of organs, vessels, and nodes that connect with the blood circulatory system to move a watery substance called lymph throughout the body. The lymphoid system produces white blood cells, called lymphocytes, and moves these blood cells wherever the body needs them. These cells produce antibodies that help fight infections.

Lymphocytes normally live a short period of time and only grow to a certain size. When someone has a lymphoma, their lymphocytes live much longer, reproduce much faster, and grow far larger than normal. This is what causes pain and swelling at the main cancer site. These cancerous lymphocytes can then spread throughout the body.

What causes lymphomas?

The cause of lymphomas is still not known, despite lots of research. Many studies focused on industrial chemicals, various occupations, electromagnetic fields, ultraviolet radiation, ionizing radiation, family history, social class, diet, and other potential exposures.

Many occupational studies have looked at people who work directly with wood or pesticides. There is a moderate association between occupational exposure to wood dust and Hodgkin's disease, although not all studies agree.

The association between chemical exposure and Hodgkin's disease is more varied than those seen with wood exposure. Organic solvents, pesticides containing chlorophenoxy herbicides, and other chemicals have been implicated in some studies, but follow-up studies could not confirm the association.

Associations between non-Hodgkin's lymphoma and chemical exposures have also been extensively studied with variable results. Benzene, known to cause leukemia, has not been associated with non-Hodgkin's lymphoma.

Studies of farmers have found an association between pesticide usage and non-Hodgkin's lymphoma, particularly for those who mixed or applied the pesticide. The association was stronger the more days a person worked with pesticides.

Ionizing radiation (like x-rays) causes some types of cancer and researchers wondered if it might cause non-Hodgkin's lymphoma, but the majority of studies failed to show any relationship.

Though the cause of these lymphomas is not known, there are certain risk factors we do understand. It is important to realize that even though Hodgkin's disease and non-Hodgkin's lymphoma are cancers of the lymphoid system, they are separate and distinct diseases with different risk factors, as shown below.

What are the risk factors for Hodgkin's disease?

Gender is a risk factor for Hodgkin's disease. Men, regardless of ethnicity, are more likely to develop the disease than women, with white men having the highest rate of disease. Recently, there has been a dramatic increase in the number of young women diagnosed with Hodgkin's disease, but it remains more common in men.

Age is another risk factor and there are two age ranges in which an individual is most likely to get Hodgkin's disease, between 15 and 34, and over 55 years old with the risk continuing to increase as an individual ages. These are the most common ages, but keep in mind that children and middle-aged adults occasionally get Hodgkin's lymphoma, too.

Brothers and sisters of those with Hodgkin's disease are at increased risk of developing this disease. Hodgkin's disease runs in families in about 5% of the cases. The risk is also higher for small families.

People from a higher social class, with advanced degrees, and from homes with good hygiene appear to be at higher risk for Hodgkin's disease.

Certain viral infections appear to play a role in Hodgkin's disease with the Epstein-Barr virus (the virus that causes mononucleosis) being the main suspect. However, viral infections aren't found in all cases of Hodgkin's disease.

What are the risk factors for non-Hodgkin's lymphoma?

Age is the most important risk factor for non-Hodgkin's, with the risk increasing *exponentially* with age. Non-Hodgkin's lymphoma is now the sixth most common cancer in the United States. Males are at slightly increased risk over females, with the white ethnic group at slightly higher risk than the black ethnic group. But remember, people of any age can develop non-Hodgkin's lymphoma.

Diet has been extensively studied as a risk factor for non-Hodgkin's lymphoma and those who eat lots of saturated fats (found in animal products and tropical oils) are at increased risk. Those who consumed unsaturated fats were not at higher risk. Other dietary factors, such as eating vegetables, taking antioxidant vitamins, and eating more fiber seemed to offer no protection from developing non-Hodgkin's lymphoma, although people whose diet was rich in fruit had a much lower risk.

Certain viral infections seem to increase one's risk for non-Hodgkin's lymphoma, especially Epstein-Barr, Human T-cell Leukemia Virus (HTLV-1) and the hepatitis C virus.

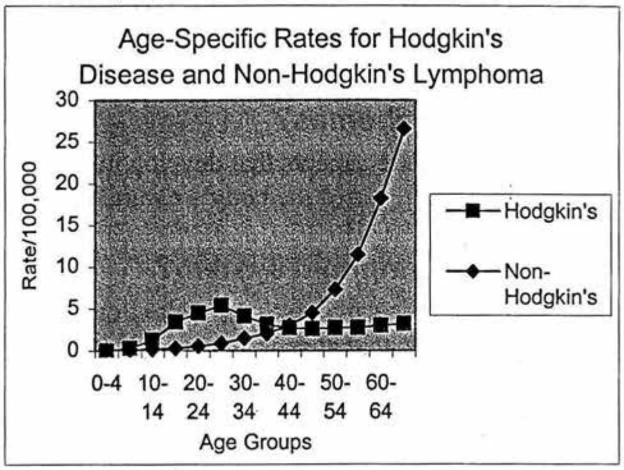
How are Hodgkin's disease and non-Hodgkin's lymphoma similar?

Both of these diseases are cancers that originate inside the lymphoid system, specifically from lymphocytes. These diseases also share some of the same risk factors, such as viruses, advanced age, and men being affected more often than women.

They also share the fact that medical professionals do not know exactly what causes either disease, despite extensive research.

How are Hodgkin's disease and non-Hodgkin's lymphoma different?

One's age-related risk is the major difference, with non-Hodgkin's lymphoma increasing dramatically with age, and Hodgkin's disease affecting two different age groups, as shown in the graph below (age-adjusted rates from the National Cancer Institute for 1994-1998).



The other major difference is how the two diseases progress. Non-Hodgkin's lymphoma is less predictable than Hodgkin's disease and is much more likely to spread to other areas of the lymphoid system and to sites outside the lymphoid system. Given non-Hodgkin's lymphoma's more aggressive nature, it generally has a less favorable long-term prognosis, compared to Hodgkin's disease.

Luckily, medical researchers continue to find better forms of treatment and the survival rates for these diseases continue to improve. Your best protection? Eat a nutritious diet, get regular exercise and avoid tobacco.

Of course, be sure and talk to your doctor if you ever notice the common symptoms of a lymphoma, such as swollen lymph nodes in your neck, armpit, or in the groin; persistent or recurrent fevers; drenching night sweats; widespread itchy skin; or unexpected weight loss.

Where can I get more information? Source for more information:

- **Air Force Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA)** Phone: 1-888-232-ESOH (3764), Internet URL: **https://www.afms.mil/afiera/**
- ***WebMDHealth*: WebMD (http://www.webmd.com)**
- **Cancer Epidemiology and Prevention, second edition. Schottenfeld, David; Fraumeni, Joseph. Oxford University Press, 1996**
- **Centers for Disease Control and Prevention web page: http://www.cdc.gov/**
- **National Cancer Institute: http://www.nci.nih.gov/atlasplus/index.html**

AFIERA MAF Survey: 564 MS
2 – 5 July 2001
General Facts and Information

U.S. AIR FORCE

This fact sheet summarizes the results of a 2 to 5 July 2001 survey performed by the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis (AFIERA) to assess potential health risks to missile crews working in the Launch Control Centers (LCCs) of Missile Alert Facilities (MAFs) P, Q, R, S, and T. AFIERA's Industrial Hygiene team was asked to evaluate the working environment in response to concerns over possible links to various medical conditions reported by some crew members.

What was assessed?

The AFIERA team, working together with the 341st Medical Group's Bioenvironmental Engineering personnel, conducted an evaluation of the five LCCs for air and drinking water quality.

During the survey, the team collected samples of the air in each LCC for organic compounds, organophosphate and organonitrate pesticides, chlorinated and organonitrogen herbicides, and chlorophenols. Organic compounds are primary components of diesel fuel in the Launch Control Equipment Building (LCEB). The primary potential source of pesticides, herbicides, and chlorophenols is agricultural application in the farming area surrounding several of the MAFs.

The drinking water was analyzed for pesticides, herbicides, and metals.

Surface soil beneath the top-side ventilation system, where air is drawn into the LCEB, was analyzed for pesticides and herbicides.

The team assessed general Indoor Air Quality by measuring the temperature, relative humidity, and carbon dioxide levels in sites P, S, and T. The amount of fresh air brought into the LCC was measured at every site.

What chemicals did you find in the air?

Concentrations of all substances sampled in the air were below laboratory limits of detection. In other words, we didn't find any of the chemicals sampled and the air is safe to breathe.

Is the soil hazardous?

The sampled soil contained trace amounts of several pesticides and herbicides. This would be expected in areas surrounded by farmland. The measured levels were compared to current Environmental Protection Agency (EPA) risk models. At these concentrations, the risk of developing a cancer from these substances is far less than 1 in a million, based on EPA data. This is considered to be a very low risk.

It is also important to note that any air containing suspended dust is drawn down from the surface and is filtered before being brought into the LCC, further limiting exposures.

What did you find in the water?

Low levels of some pesticides (Romeo), herbicides (Papa and Romeo), and metals are present in the drinking water (all 5 sites). All concentrations are less than the Maximum Concentration Limits (MCLs) allowed by the state of Montana and the EPA. This means that for these substances, the water meets acceptable primary (health-related) drinking water standards and does not present a health risk.

However, there was no residual chlorine remaining in the LCC tap water at any of the five sites. Although bacteria did not grow from these water samples, chlorine should be present to ensure the water remains free of bacteria. Also, the water is fed to the LCC through black iron pipes. Black iron pipes may release metals that degrade the water's aesthetic qualities.

Additional samples should be collected to further assess the potability of the water.

Do we get enough fresh air?

In sites P, Q, R, and T, all temperatures, and relative humidity levels, and carbon dioxide concentrations in the LCCs fell within the indoor air guidelines established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers. The rate of fresh air brought into these LCCs is adequate.

At site Sierra, the make-up air fan was broken at the time of our survey. Consequently, carbon dioxide measurements were slightly higher than ASHRAE-recommended levels, but well below the level where most people get symptoms (headache, etc.). Elevated carbon dioxide levels are simply indicators that more fresh air is needed to keep the environment comfortable and free from offensive odors. The carbon dioxide levels measured in site S do not pose a health hazard to personnel.

What other potential hazards are there?

The working group addressing LCC health hazard issues suggested assessing other possible hazards as well. Each of these are addressed below:

- Polychlorinated biphenyls (PCBs): In the past, PCBs were commonly used in dielectric fluid of electrical components. However, unless an individual comes into direct skin contact with PCB-containing fluid, ingests it, or is exposed to combustion products during a fire, it is not considered to be a health hazard. PCBs remain in liquid form and do not evaporate into the air.
- Radiation: There are no known sources of ionizing radiation, such as x-rays and radioactive materials that could present a risk to crewmembers. 341 MDG/Bioenvironmental Engineering measured ionizing and radiofrequency radiation in the LCC during AFIERA's visit and found nothing above normal background levels. 341 MDG radon testing in MAFs Papa, Quebec, Romeo, and Sierra conducted this year shows exposures to be within EPA guidelines.
- Crypto tape burning: Laboratory analysis indicates that most combustion products from the tape are simple asphyxiants. A small amount of carbon monoxide is also released. However, because of the large volume of air present in each LCC, burning small quantities of tape within the capsule is acceptable.
- Corrosion Control Activities: Application of coatings to the interior of LCCs may release solvent vapors into the air. Existing sampling data from 1998 shows levels to be very low. Additional sampling is recommended to further evaluate potential exposures.
- Organic growth in LCC Base: Some biological growth was evident at the base of some LCCs, most notably in Quebec LCC. It appears the sump pump is not functioning adequately to remove HVAC condenser water. Since the growth is wet, in an area where little air flow is present, it does not pose an exposure risk to personnel.

What was your overall assessment?

The Launch Control Centers provide a safe and healthy working environment for missile crews. The LCCs, as they exist now, provide a safe and healthy environment, but there are ways to improve the comfort and further strengthen existing safeguards.

What recommendations do you have?

In order to maintain and enhance the quality of life for crewmembers and to ensure future exposures are within safe limits, the survey team provided several recommendations:

- Further assess LCC drinking quality.
- Assess corrosion control activities to determine exposures during coating applications inside LCCs.
- Repair the make-up air fan in Sierra LCC and acquire spare fan assemblies for future use.
- Fix and maintain sump pumps at the bottom of the LCCs to remove residual condenser water and infiltrated groundwater.

Where can I get more information? Sources for more information include:

- **U.S. Environmental Protection Agency,** Internet URL: http://www.epa.gov
- **Occupational Safety and Health Administration (OSHA),** Internet URL: http://www.osha.gov
- **Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis (AFIERA),** Internet URL: https://www.afms.mil/afiera/, or 1-888-232-ESOH
- **National Institute for Occupational Safety and Health (NIOSH) Indoor Air Quality References:** Internet URL: http://www.cdc.gov/niosh/iaqpg.html
- **United States Environmental Protection Agency – Indoor Air Pollution Information:** Internet URL: http://www.epa.gov/ebtpages/aindoorairpollution.html
- **American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):** Internet URL: http://www.ashrae.org/

AFIERA
Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis