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Interim Report, Missile Community Cancer Study, Vandenberg Space Force Base

Lt Col Scott M. Boyd
Occupational & Environmental Health Department

Report Date
18 April 2024

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13. SUPPLEMENTARY NOTES

14. ABSTRACT
At the request of the Air Force Global Strike Commander (AFGSC/CC), the United States Air Force School of Aerospace Medicine (USAFSAM) Defense Centers for Public Health-Dayton Occupational and Environmental Health Department (DCPH-D/OE) performed an environmental health (EH) survey for the 377th Test and Evaluation Group (TEG) and 532nd Training Squadron (TRS) at Vandenberg SFB, California. The purpose of this EH survey was to characterize worker potential exposures among the 377th TEG and 532nd TRS personnel, cadre, and students. This survey occurred from 12 to 16 February 2024 and reinforced ongoing EH assessments occurring at Malmstrom, F.E. Warren and Minot Air Force Bases (AFBs).

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18 April 2024

MEMORANDUM FOR: AFGSC/SGPB
ATTN: Lt Col Raymond Mak

FROM: DCPH-D/OE
2510 Fifth Street, Building 840
WPAFB OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-TR-2024-0006, Missile Community Cancer Study, Vandenberg Space Force Base (SFB) Results

References: (a) United States Environmental Protection Agency, *Volatile Organic Compounds' Impact on Indoor Air Quality*. (Washington, D.C.: EPA, 2023).

(b) Agency for Toxic Substances and Disease Registry, *Polychlorinated Biphenyls ToxFAQs* (GA: ATSDR, 2014).

(c) National Archives, *40 CFR 761.61* (Washington, D.C.: CFR, 2023).

(d) United States Environmental Protection Agency, *Learn About Polychlorinated Biphenyls* (Washington, D.C.: EPA, 2023).

(e) United States Environmental Protection Agency, *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (Washington, D.C.: EPA, 1996).

1. INTRODUCTION

At the request of the Air Force Global Strike Commander (AFGSC/CC), the United States Air Force School of Aerospace Medicine (USAFSAM) Defense Centers for Public Health-Dayton Occupational and Environmental Health Department (DCPH-D/OE) performed an environmental health (EH) survey for the 377th Test and Evaluation Group (TEG) and 532nd Training Squadron (TRS) at Vandenberg SFB, California. The purpose of this EH survey was to characterize worker potential exposures among the 377th TEG and 532nd TRS personnel, cadre, and students. This survey occurred from 12 to 16 February 2024 and reinforced ongoing EH assessments occurring at Malmstrom, F.E. Warren and Minot Air Force Bases (AFBs). The EH survey at Vandenberg SFB included volatile organic compound (VOC) and polychlorinated biphenyl (PCB) personal air screening, area air sampling, radon sampling, and PCB swipe sampling of surfaces in:

A. Two of three Launch Facilities (LFs)

B. One of five Missile Procedure Trainers (MPTs)

C. One operational Launch Control Center (LCC) within the Missile Alert Facilities (MAFs)

D. One Peacekeeper LCC

E. Missile Maintenance Trainers within the Missile Maintenance Training Bay

The EH survey replicated ongoing studies at Malmstrom, F.E. Warren and Minot AFBs with the following intended exceptions:

A. The spatial volume of the LFs deemed area air sampling insufficient to assess Polychlorinated Biphenyl (PCB) and Volatile Organic Carbon (VOC) exposures to 377th TEG missile maintainers and 532nd TRS cadre. The area air sampling was replaced with personal air screening sampling which assessed environmental conditions during LF occupant movement.

B. Organophosphate soil and area air sampling was eliminated considering Vandenberg SFB operations are not located adjacent to agricultural operations which exist at Malmstrom, F.E. Warren, and Minot AFBs.

C. Drinking water sampling for Dioxins, Diquat/Paraquat, Pesticides, Semi Volatile Organic Compounds, PCBs, and Total Nitrate/Nitrite was eliminated considering Vandenberg SFB utilizes municipal water for its drinking water. By using municipal water with more sophisticated water treatment systems, Vandenberg SFB personnel are less vulnerable to water quality concerns which may be more prevalent in water systems at Malmstrom, F.E. Warren, and Minot MAFs.

DCPH-D/OE personnel executing the OEH survey:

A. Capt Leigh Durden, Environmental Health Consultant

B. SSgt Jose Chavez-Reyes, Occupational & Environmental Health Technician

Vandenberg SFB personnel supporting the EH survey:

A. Lt Col Luke Stover, 377th TEG Deputy Commander

B. Lt Col Frank Scopa, 532nd TRS Commander

C. Maj Carlos Juarez, 377th TEG Executive Officer

D. Capt Brian Thompson, 30th Operational Medical Readiness Squadron Bioenvironmental Engineering Flight Commander

E. Capt Caleb Seibert, 532nd TRS Maintenance Training Flight Commander

F. Capt Austin Van Hoesen, 576th Flight Test Squadron (FLTS) Director of Operations

G. MSgt Nicholas Flowers, 377th TEG Maintenance Operations Flight Chief

H. MSgt Charles Martin, 532nd TRS Maintenance Training Flight Chief

Equipment Used:

A. Scientific Kit Corporation (SKC) Air Sampling Pumps

B. MESA LABS Air Sampling Pump Calibrator

C. Ancillary equipment including sterile containers, cassettes, tubes, swipes, and other items to facilitate sample collection and analysis

Certified Analytical Laboratories Used: Independent laboratories outside of the DoD were used to analyze the air and swipe samples.

A. Bureau Veritas North America in Fort Lauderdale, Florida analyzed the air samples

B. Summit Environmental Technologies, LLC. in Cuyahoga Falls, Ohio analyzed the PCB swipe samples

2. BACKGROUND

The sampling plan targeted known and suspected carcinogens through dermal and inhalation exposure pathways. The potential health hazards/concerns associated with each carcinogen and the other parameters sampled will be discussed in Section 3: Health Hazard Summary.

The 377th TEG is an Air Force Global Strike Command (AFGSC) organization aligned under the 377th Air Base Wing located at Kirtland AFB, New Mexico. The 377th TEG conducts three intercontinental ballistic missile (ICBM) launches per year, as well as many other operational tests, all with variations in missile crew members. The 377th TEG is composed of the 576th FLTS, the 377th Flight Test Missile Maintenance Squadron (FTMMXS), and the 377th Test Support Squadron (TSS). The 576 FLTS includes Nuclear and Missile Operations Officers (13N) and Electromechanical Technicians (2M0X1) who oversee test planning, execution, analysis, and reporting for all ICBM Minuteman III Tests. This includes:

A. Simulated Electronic Launch Minuteman, where test operators and support personnel travel to the operational missile wings to conduct a five-week test posturing and execution exercise for operational LFs and LCCs.

B. Software Operational Test for which test operators and line crew travel to the Strategic Missile Integration Complex (SMIC) at Hill AFB to conduct dry-run and test execution over four-to-six weeks in an operationally realistic LCC.

C. Operational Test Launch where missileers from the operational wing travel to Vandenberg SFB to perform operational alert duties for approximately four weeks until a pre-scheduled launch date.

D. Additionally, the unit develops and tests tactics, techniques & procedures (TTP) development and testing, as well as many sustainment programs supporting the Minuteman III lifecycle.

The 377th FTMMXS (specialties: 2M0X1, X2, X3, 2W2, and 2W0) oversee ICBM & LF maintenance, build, and maintain Joint Test Assemblies as well as provide conventional munitions support for Operational Test Launch and the Space Launch Delta base defense. Non-nuclear ICBMs are selected by AFGSC then transported to Vandenberg SFB where 377th FTMMXS and maintenance Task Force personnel retrofit the missile with appropriate test/data sensors, install into a test LF, and directly support launch activities and site recovery. The 377th FTMMXS is responsible for two LCCs (MAF-01A and MAF-01E) and two LFs (LF-09 & LF-10). One LCC (Peacekeeper) is not operational and serves as a Distinguished Visitor location for test launches. The active LCC Malmstrom AFB LCC infrastructure with a topside equipment

room. Due to a planned launch in February, LF-10 was not available for EH surveillance during the visit.

The 377th TSS oversees airfield management operations at Kirtland Air Force Base. Four 13Ns will be assigned to the unit and support test operations at Vandenberg SFB in various capacities in the future.

The 532nd TRS is aligned under the 82nd Training Group, an Air Education and Training Command (AETC) organization under the 2nd Air Force. The 532nd TRS provides AFSC training to approximately 450 13Ns and 2M0s each year. Missile operators attend approximately nine months of training focused on LCC operations. The MPTs are composed of Simulator Control Rooms (for the cadre) and replica LCCs (for the students) which contain deviations from operational LCCs at operational missile bases to include reduced communication networks and reduced alternative power redundancies (back-up generators & batteries). Training for 2M0s occurs for three-to-six months aimed at maintaining LCCs and LFs. Some 2M0s attend periodic retraining at Vandenberg SFB composed of a two-week 7-level upgrade training and a two-month technical engineering training. Training curriculum for 2M0 students include access and oversight to multiple training systems and one LF (LF-08). Cadre for both 13N training and 2M0 training follow the typical three-to-four-year assignment cycle.

3. HEALTH HAZARD SUMMARY

This section details the potential health hazards and other parameters measured in the MPT, LFs, LCCs and 532nd TRS Missile Maintenance Training Bay (Building 7425). All samples were used to characterize and identify potential hazards in the work centers.

3.1 VOLATILE ORGANIC COMPOUNDS

VOCs are a group of chemicals which include 1,2,3-trichloropropane, Benzene, Carbon Tetrachloride, Dibromochloropropane (DBCP), Ethylene dibromide, Bromodichloromethane, Methylene chloride, and Trichloroethylene (TCE). VOCs are substances that have a high vapor pressure and low water solubility. VOCs easily change from a liquid or solid to a gas phase which increases potential for inhalation exposure. Exposure limits for VOCs are unique to each chemical. They are commonly found in both industrial environments and household products such as cleaning supplies, varnishes, plug-in air fresheners, essential oils, and pesticides (United States Environmental Protection Agency, 2023). Some VOCs (acetone, for example) can be present in the outdoor environment. Health effects from VOC exposure vary from eye, nose, and throat irritation to headaches and damage to the liver, kidney, and central nervous system (Ibid, 2023). VOCs can accumulate in an indoor setting if there is insufficient ventilation and thereby affect the quality of indoor air. Eight (8) air samples were collected. Each sample was analyzed for fifty-one (51) VOCs.

3.2 POLY CHLORINATED BIPHENYLS (PCBs)

PCBs are synthetic organic chemicals used for a variety of industrial and commercial purposes. They were commonly used as synthetic dielectric and coolant fluids in electrical components, capacitors, and transformers. PCBs were developed in the 1940’s and used through the late 1970’s. In the late 1970’s, they were banned from domestic manufacturing because of evidence that PCBs accumulate in the environment and may be toxic to humans and wildlife.

PCBs remain present in electrical components of equipment in the LCCs because of their ability to insulate and regulate equipment temperatures (Agency for Toxic Substances and Disease Registry, 2014). Forty (40) Code of Federal Regulations (CFR) 761.61 establishes a standard for PCB spills to be cleaned to ten micrograms per one hundred square centimeters (10 µg/100 cm^2) (National Archives, 2023). The United States Environmental Protection Agency (USEPA) classifies PCBs as a probable human carcinogen based on studies in animals which provided inconclusive evidence of carcinogenicity and in studies with capacitor manufacturing workers which raised further concern of potential carcinogenicity (USEPA, 2023). Although the USEPA determined PCB carcinogenicity from ingestion studies only, the USEPA deems there is a reasonable basis to expect similar effects from dermal or inhalation exposures (USEPA, 1996).

4. METHODOLOGY & ANALYSIS

This section summarizes sampling plans used to ensure proper collection, analysis, and validity of results. Detailed sampling plans for each potential health hazard sampled will be included in the final report. National Institute for Occupational Safety and Health (NIOSH) and USEPA-approved methods were used to develop sampling plans and execute sample analysis. The individual methods for sampling can test for multiple analytes or chemical compounds. Laboratory analysis included two methods for air sampling and one method for PCB swipe sampling. The tables in the appendices of this report contain sample type, location, analyte, result, and applicable detection limit. All samples were collected in the MPT, MAFs, and LFs. A summary of analytical methods and number of samples taken for each method can be found in Chart 1. Samples were shipped from Vandenberg SFB to two independent, civilian, accredited laboratories to conduct the analysis. DCPH-D/OE validated results as they were received from the laboratories.

4.1 AIR

Air sampling quantifies the concentration of analytes within the volume of air sampled. Area air samples were collected to characterize the indoor air environment in the MPT in Building 8195, 532nd TRS Missile Maintenance Training Bay, MAF-01A LCC and MAF-01E LCC. Personal air screening samples were collected to characterize environmental exposures in LF-08 and LF-09. DCPH-D/OE used one sampling method to analyze for fifty-one (51) VOC analytes and one sampling method to analyze for seven (7) PCB analytes. The following area air samples were collected for each method:

A. PCB Area Air Sampling: eight-hour sample in the MPT, Missile Maintenance Training Bay (Building 7425), MAF-01A and MAF-01E

B. VOC Area Air Sampling: eight-hour sample in MAF-01A and MAF-01E

C. VOC and PCB Personal Air Screening Sampling: representative sample for environmental exposures encountered during a 420-minute cadre/student training in LF-08 (532nd TRS)

D. VOC and PCB Personal Air Screening Sampling: representative sample for a 140-minute LF components check within LF-09 (377th TEG)

In addition to the personal air screening samples and area air samples collected, field and media blanks were also provided and analyzed. Media blanks are never exposed to the

environment and are used to ensure there is no contamination of media during the equipment/media manufacturing and handling processes. Field blanks are opened to the environment to assess any initial contamination that may be associated with the handling of the samples and then are capped, meaning no tested air would have flowed through the sample media. Media and field blanks are a standard quality assurance practice in environmental sampling studies.

4.2 PCB SWIPES

Swipe sampling was conducted for PCBs. A total of 116 swipes were collected consisting of eleven (11) swipes in the MPT, twenty-six (26) swipes on Missile Maintenance Trainers, fifteen (15) swipes in LF-08, twenty (20) swipes in LF-09, twenty (20) swipes in MAF-01A, and twenty-four (24) swipes in MAF-01E. Swipes were collected in locations historically known or suspected to contain PCBs (e.g., panels & batteries) as well as commonly touched areas and equipment (e.g., display screens, & keyboards). Surfaces of a ten-centimeter by ten-centimeter (100 cm^2) area were swiped horizontally and vertically within the same location, side to side, then up and down. The media used to swipe the surfaces was a cotton gauze pad saturated with ten milliliters of hexane. Once the surface was swiped, the cotton gauze pad was placed into a glass vial, labelled, stored, and shipped in accordance with laboratory specifications. When possible, for equipment being swiped, both a surface swipe and ground level or underside of the piece of equipment was swiped to capture any potential PCB equipment leakage.

Chart 1: Summary of Analytical Methods and Sample Quantity for Each Potential Health Hazard

Potential Health Hazard	Analytical Laboratory (Location)	Analytical Method	Matrix	No. of Samples
VOCs	Bureau Veritas North America (Fort Lauderdale, FL)	EPA TO 17	Air (Area)	4
VOCs	Bureau Veritas North America	EPA TO 17	Air (Personal Screening)	4
PCBs	Bureau Veritas North America	NIOSH 5503	Air (Area)	8
PCBs	Bureau Veritas North America	NIOSH 5503	Air (Personal Screening)	4
PCB Swipe Sampling	Summit Environmental Technologies, LLC (Cuyahoga Falls, OH)	EPA 8082A	Surface	116

5. RESULTS & DISCUSSION

This section summarizes the findings of all samples collected at Vandenberg SFB. Sample results were received from the laboratories and checked for quality assurance and control. All results are documented in the appendices of this report. Each location result can be found as its own appendix: Appendix 1 for MPT sampling, Appendix 2 for Missile Maintenance Trainer

sampling, Appendix 3 for LF-08 sampling, Appendix 4 for LF-09 sampling, Appendix 5 for MF-01A sampling, and Appendix 6 for MAF-01E sampling.

5.1 PCB SWIPE SAMPLING

Swipe sampling for PCBs were compared to the 40 CFR 761 clean-up standard of 10 µg/100 cm^2. PCBs were not detected in the MPT, Missile Maintenance Trainers, LF-08, and MAF-01E. Of the 116 swipes collected, LF-09 had one detectable surface level for PCBs and MAF-01A had two detectable surface levels of PCBs for a total of three locations. The concentrations were below the limit mandated by 40 CFR 761.61.

5.2 PERSONAL AIR SCREENING SAMPLING

5.2.1. LF-08

Of the 51 VOCs each sampled, one VOC was detected in one of the personal air screening samples. Twenty-nine micrograms per cubic meter (29 µg/m^3) of 1,2-Dichloroethane was detected in LF-08. The concentration of 1,2-Dichloroethane detected was below the American Conference of Government Industrial Hygienist (ACGIH) eight-hour exposure limit of 100 parts per million (ppm), which is equivalent to 40,474 micrograms per cubic meter (40,474 µg/m^3). In LF-08, PCBs were below the laboratory limit of detection.

5.2.2. LF-09

Both the PCBs and VOCs were below the laboratory limit of detection.

5.3 AREA AIR SAMPLING

All PCB and VOC area air samples collected in MAF-01A and MAF-01E were below the laboratory limit of detection.

5.4 RADON

Due to the length of time required to collect the radon samples and complete analysis, results from radon sampling will be captured in a separate report.

6. CONCLUSIONS

The results presented in this report are a part of a multi-faceted study to characterize the environment in which the missile community works. If you have any questions, please contact Capt Leigh Durden at 937-938-3297 or by e-mail at leigh.durden@us.af.mil.

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SCOTT M. BOYD, Lt Col, USAF, BSC
Chief Consulting Executive

Appendix 1: Missile Procedure Trainer (Building 8195) Results – 532nd TRS

Table 1A: PCB Swipe Sampling
15 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
Battery Charger Access Surface	Total PCBs	Not Detected	<10
Battery Charger Access (Bottom Seam)	Total PCBs	Not Detected	<10
Right Keyboard Above T1/T2/T3	Total PCBs	Not Detected	<10
Right Display Console Screen	Total PCBs	Not Detected	<10
Left Keyboard Above T1/T2/T3	Total PCBs	Not Detected	<10
Left Display Console Screen	Total PCBs	Not Detected	<10
LCPA Panel Surface (Inside)	Total PCBs	Not Detected	<10
LCPA Panel Surface, Underside	Total PCBs	Not Detected	<10
Electrical Equipment Cabinet (URD 1389)	Total PCBs	Not Detected	<10
MPT Exit Door Inside	Total PCBs	Not Detected	<10
AC Power (Top Panel)	Total PCBs	Not Detected	<10

Table 1B: Area Air Sampling Results – PCBs
15 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0021
Aroclor 1221	<0.0021
Aroclor 1232	<0.0021
Aroclor 1242	<0.0021
Aroclor 1248	<0.0021
Aroclor 1254	<0.0021
Aroclor 1260	<0.0021

Appendix 2: Missile Maintenance Trainers Results – 532nd TRS

Table 2A: PCB Swipe Sampling
15 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
ASU contact - Red Box on Left (T21)	Total PCBs	Not Detected	<10
ASU Shelf (T21)	Total PCBs	Not Detected	<10
LDA Panel (T21)	Total PCBs	Not Detected	<10
Main Distribution Panel (T21)	Total PCBs	Not Detected	<10
Instructor Control panel (T21)	Total PCBs	Not Detected	<10
LDPA Panel (T21)	Total PCBs	Not Detected	<10
Battery Simulator (T21)	Total PCBs	Not Detected	<10
Battery Access Charger - Surface (QDA10)	Total PCBs	Not Detected	<10
Missile Simulator (QDA10)	Total PCBs	Not Detected	<10
Instructor Panel (QDA10)	Total PCBs	Not Detected	<10
Battery Access Charger - Inside (QDA01)	Total PCBs	Not Detected	<10
MPC Power Supply (Back of Box)	Total PCBs	Not Detected	<10
Instructor Power Panel (QDA01)	Total PCBs	Not Detected	<10
ARF850 (Tower to Right of Old Computer)	Total PCBs	Not Detected	<10
Instructor Control Panel (QDA01)	Total PCBs	Not Detected	<10
Missile Simulator (QDA02)	Total PCBs	Not Detected	<10
Programmer Group (Inside Bottom Panel) (QDA02)	Total PCBs	Not Detected	<10
Control Monitor (Bottom Panel Surface) (QDIT)	Total PCBs	Not Detected	<10
ARF850 (Old Computer) (Rm 1111)	Total PCBs	Not Detected	<10
Security Trainer Battery Access Charger, Bottom Surface Inside	Total PCBs	Not Detected	<10
Filter 10443 - Surface	Total PCBs	Not Detected	<10
Power/Battery Trainer LF Motor Generator	Total PCBs	Not Detected	<10
LF Batter Charger - Surface (URD475)	Total PCBs	Not Detected	<10
LCC Battery Charger - Surface	Total PCBs	Not Detected	<10
LCC Motor Generator (Inside Open Panel)	Total PCBs	Not Detected	<10
LCC DBOX Open Panel (URD364)	Total PCBs	Not Detected	<10

Table 2B: Area Air Sampling Results – PCBs
15 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0021
Aroclor 1221	<0.0021
Aroclor 1232	<0.0021
Aroclor 1242	<0.0021
Aroclor 1248	<0.0021
Aroclor 1254	<0.0021
Aroclor 1260	<0.0021

Appendix 3: Launch Facility (LF-08) Results – 532nd TRS

Table 3A: PCB Swipe Sampling
13 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
IBOX (URF 479) - Surface	Total PCBs	Not Detected	<10
Battery Access Charger - Bottom Seam	Total PCBs	Not Detected	<10
Battery Access Charger - Surface	Total PCBs	Not Detected	<10
Battery Access Charger (Open, 2nd Rack From Top)	Total PCBs	Not Detected	<10
AC Panel - Surface	Total PCBs	Not Detected	<10
DC Panel - Surface	Total PCBs	Not Detected	<10
Programmer Group (403A7) Bottom Rack - Surface	Total PCBs	Not Detected	<10
Chiller Unit, coolant - Surface	Total PCBs	Not Detected	<10
Instructor Control Panel	Total PCBs	Not Detected	<10
Power Distribution Box	Total PCBs	Not Detected	<10
Wing 5 LDB Panel (Open)	Total PCBs	Not Detected	<10
Wing 5 LDB Panel - Underside	Total PCBs	Not Detected	<10
Battery Storage (URD 461) - Lower LER	Total PCBs	Not Detected	<10
ASU in MPP - Red Panel in Launch Support Bldg	Total PCBs	Not Detected	<10
MPP in Launch Support Bldg	Total PCBs	Not Detected	<10

Table 3B: Personal Air Screening Sampling Results – PCBs
14 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0023
Aroclor 1221	<0.0023
Aroclor 1232	<0.0023
Aroclor 1242	<0.0023
Aroclor 1248	<0.0023
Aroclor 1254	<0.0023
Aroclor 1260	<0.0023

Table 3C: Personal Air Screening Sampling Results – VOCs
14 February 2024

Analyte	Result (µg/m^3)
1,1,1,2-Tetrachloroethane	<14
1,1,1-Trichloroethane	<14
1,1,2,2-Tetrachloroethane	<14
1,1,2-Trichloroethane	<14
1,1-Dichloroethane	<14
1,1-Dichloroethylene	<14
1,1-Dichloropropylene	<14
1,2,3-Trichlorobenzene	<14
1,2,3-Trichloropropane	<14
1,2,4-Trichlorobenzene	<14
1,2,4-Trimethylbenzene	<14
1,2-Dibromo-3-chloropropane (DBCP)	<14
Ethylene Dibromide	<14
1,2-Dichlorobenzene	<14
1,2-Dichloroethane	29*****
1,2-Dichloropropane	<14
1,3,5-Trimethylbenzene	<14
1,3-Dichlorobenzene	<14
1,3-Dichloropropane	<14
1,4-Dichlorobenzene	<14
2-Chlorotoluene	<14
4-chlorotoluene	<14
Benzene	<14
Bromobenzene	<14
Bromochloromethane	<14
Bromodichloromethane	<14
Bromoform	<14
Carbon Tetrachloride	<14
Chlorobenzene	<14
Chloroform	<14
cis-1,2-Dichloroethylene	<14
cis-1,3-Dichloropropene	<14
Dibromochloromethane	<14
Ethylbenzene	<14
Hexachlorobutadiene	<14
Isopropylbenzene	<14
***** Concentration below ACGIH eight-hour exposure limit of 40,474 µg/m^3	

Table 3C: Personal Air Screening Sampling Results – VOCs Cont.

14 February 2024

Analyte	Result (µg/m^3)
Methylene Chloride (Dichloromethane)	<14
p+m-Xylene	<14
Naphthalene	<14
n-Butylbenzene	<14
n-Propylbenzene	<14
o-Xylene	<14
p-isopropyltoluene	<14
sec-butylbenzene	<14
Styrene	<14
tert-butylbenzene	<14
Tetrachloroethylene	<14
Toluene	<14
trans-1,2-Dichloroethylene	<14
trans-1,3-Dichloropropene	<14
Trichloroethylene	<14

Appendix 4: Launch Facility (LF-09) Results – 377th TEG

Table 4A: PCB Swipe Sampling
13 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
Distro Box - Underside	Total PCBs	Not Detected	<10
Distro Box Cable #W947	Total PCBs	Not Detected	<10
Power Signal Distro Unit	Total PCBs	Not Detected	<10
Programmer Group Box on Right	Total PCBs	Not Detected	<10
AC Power Panel (Open)	Total PCBs	Not Detected	<10
DC Power Panel (Open)	Total PCBs	Not Detected	<10
IBox 1422 - Cable W4518 J2	Total PCBs	Not Detected	<10
Battery Access Charger Handles	Total PCBs	Not Detected	<10
Battery Access Charger - Surface	Total PCBs	Not Detected	<10
Wing 5 LDB Panel	Total PCBs	Not Detected	<10
Wing 5 LDB Panel - Underside	Total PCBs	Not Detected	<10
Arrester Assembly Electrical Surge (Right Side) - Top Row 3rd From left	Total PCBs	1.53	<10
Arrester Assembly Electrical Surge (Right Side) - 3rd Row From Top, 4th From Left	Total PCBs	Not Detected	<10
Arrester Assembly Electrical Surge - Top Row, 2nd From Right	Total PCBs	Not Detected	<10
Arrester Assembly Electrical Surge - 3rd Row From Top, Far Left	Total PCBs	Not Detected	<10
Ballistic Gas Generator (BGG) Cables - Top Part	Total PCBs	Not Detected	<10
Power Supply Group - Top Panel	Total PCBs	Not Detected	<10
Switch Box SWU - 80/F (URD 10490) - Surface	Total PCBs	Not Detected	<10
Storage Battery (SN01A0804)	Total PCBs	Not Detected	<10
Cable Air Dryer (Gas Filter Cabinet) - Surface	Total PCBs	Not Detected	<10

Table 4B: Personal Air Screening Sampling Results – PCBs
13 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0062
Aroclor 1221	<0.0062
Aroclor 1232	<0.0062
Aroclor 1242	<0.0062
Aroclor 1248	<0.0062
Aroclor 1254	<0.0062
Aroclor 1260	<0.0062

Table 4C: Personal Air Screening Sampling Results – VOCs
13 February 2024

Analyte	Result ($\mu g/m^3$)
1,1,1,2-Tetrachloroethane	<35
1,1,1-Trichloroethane	<35
1,1,2,2-Tetrachloroethane	<35
1,1,2-Trichloroethane	<35
1,1-Dichloroethane	<35
1,1-Dichloroethylene	<35
1,1-Dichloropropylene	<35
1,2,3-Trichlorobenzene	<35
1,2,3-Trichloropropane	<35
1,2,4-Trichlorobenzene	<35
1,2,4-Trimethylbenzene	<35
1,2-Dibromo-3-chloropropane (DBCP)	<35
Ethylene Dibromide	<35
1,2-Dichlorobenzene	<35
1,2-Dichloroethane	<35
1,2-Dichloropropane	<35
1,3,5-Trimethylbenzene	<35
1,3-Dichlorobenzene	<35
1,3-Dichloropropane	<35
1,4-Dichlorobenzene	<35
2-Chlorotoluene	<35
4-chlorotoluene	<35
Benzene	<35
Bromobenzene	<35
Bromochloromethane	<35

Table 4C: Personal Air Screening Sampling Results – VOCs Cont.
14 February 2024

Analyte	Result (µg/m^3)
Bromodichloromethane	<35
Bromoform	<35
Carbon Tetrachloride	<35
Chlorobenzene	<35
Chloroform	<35
cis-1,2-Dichloroethylene	<35
cis-1,3-Dichloropropene	<35
Dibromochloromethane	<35
Ethylbenzene	<35
Hexachlorobutadiene	<35
Isopropylbenzene	<35
Methylene Chloride (Dichloromethane)	<35
p+m-Xylene	<35
Naphthalene	<35
n-Butylbenzene	<35
n-Propylbenzene	<35
o-Xylene	<35
p-isopropyltoluene	<35
sec-butylbenzene	<35
Styrene	<35
tert-butylbenzene	<35
Tetrachloroethylene	<35
Toluene	<35
trans-1,2-Dichloroethylene	<35
trans-1,3-Dichloropropene	<35
Trichloroethylene	<35

Appendix 5: Missile Alert Facility (MAF-01A) Results – 377th TEG

Table 5A: PCB Swipe Sampling
14 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
Battery Charger Access Surface	Total PCBs	Not Detected	<10
Battery Charger Access (Bottom Seam)	Total PCBs	Not Detected	<10
Digital Data Group (Bottom Panel) - Surface	Total PCBs	Not Detected	<10
Digital Data Group - Underside	Total PCBs	Not Detected	<10
Left Keyboard Above T1/T2/T3 (SN C110176)	Total PCBs	Not Detected	<10
Left Side Visual Display Screen (SN 0619B032)	Total PCBs	Not Detected	<10
Launch Control Panel (Left Side)	Total PCBs	Not Detected	<10
Right Side Keyboard Above T1/T2/T3	Total PCBs	Not Detected	<10
Right Side Visual Display Screen	Total PCBs	Not Detected	<10
Launch Enable Panel (Right Side)	Total PCBs	Not Detected	<10
Processor Digital Data Group - Underside	Total PCBs	Not Detected	<10
I/O Filter - Surface	Total PCBs	Not Detected	<10
Black DC/VF Patch - Surface	Total PCBs	Not Detected	<10
Power Supply Circuit Breaker - Underside	Total PCBs	Not Detected	<10
Power Supply Circuit Breaker - Surface	Total PCBs	Not Detected	<10
LCPA, Circuit - Surface	Total PCBs	1.90	<10
LCPA, Circuit - Underside	Total PCBs	1.18	<10
LCB Circuit in LCEB (Left Side)	Total PCBs	Not Detected	<10
LCDA Section 2 in LCEB (Right Side)	Total PCBs	Not Detected	<10
LCDC Panel, Circuit in LCEB Room	Total PCBs	Not Detected	<10

Table 5B: Area Air Sampling Results – PCBs
14 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0021
Aroclor 1221	<0.0021
Aroclor 1232	<0.0021
Aroclor 1242	<0.0021
Aroclor 1248	<0.0021
Aroclor 1254	<0.0021
Aroclor 1260	<0.0021

Table 5C: Area Air Sampling Results – VOCs
14 February 2024

Analyte	Result ($\mu g/m^3$)
1,1,1,2-Tetrachloroethane	<10
1,1,1-Trichloroethane	<10
1,1,2,2-Tetrachloroethane	<10
1,1,2-Trichloroethane	<10
1,1-Dichloroethane	<10
1,1-Dichloroethylene	<10
1,1-Dichloropropylene	<10
1,2,3-Trichlorobenzene	<10
1,2,3-Trichloropropane	<10
1,2,4-Trichlorobenzene	<10
1,2,4-Trimethylbenzene	<10
1,2-Dibromo-3-chloropropane (DBCP)	<10
Ethylene Dibromide	<10
1,2-Dichlorobenzene	<10
1,2-Dichloroethane	<10
1,2-Dichloropropane	<10
1,3,5-Trimethylbenzene	<10
1,3-Dichlorobenzene	<10
1,3-Dichloropropane	<10
1,4-Dichlorobenzene	<10
2-Chlorotoluene	<10
4-chlorotoluene	<10
Benzene	<10
Bromobenzene	<10
Bromochloromethane	<10
Bromodichloromethane	<10

Table 5C: Area Air Sampling Results – VOCs Cont.
14 February 2024

Analyte	Result (µg/m^3)
Bromoform	<10
Carbon Tetrachloride	<10
Chlorobenzene	<10
Chloroform	<10
cis-1,2-Dichloroethylene	<10
cis-1,3-Dichloropropene	<10
Dibromochloromethane	<10
Ethylbenzene	<10
Hexachlorobutadiene	<10
Isopropylbenzene	<10
Methylene Chloride (Dichloromethane)	<10
p+m-Xylene	<10
Naphthalene	<10
n-Butylbenzene	<10
n-Propylbenzene	<10
o-Xylene	<10
p-isopropyltoluene	<10
sec-butylbenzene	<10
Styrene	<10
tert-butylbenzene	<10
Tetrachloroethylene	<10

Appendix 6: Missile Alert Facility (MAF-01E) Results – 377th TEG

Table 6A: PCB Swipe Sampling
14 February 2024

Location	Analyte	Result (µg/100 cm^2)	Standard (40 CFR Part 761) (µg/100 cm^2)
Battery Charger Access Surface	Total PCBs	Not Detected	<10
Battery Charger Access (Bottom Seam)	Total PCBs	Not Detected	<10
DC Power panel on Power Supply Group	Total PCBs	Not Detected	<10
AC Power Panel on Power Supply Group	Total PCBs	Not Detected	<10
Commander Console - Top Cavity	Total PCBs	Not Detected	<10
Commander Console - Right Side Cavity	Total PCBs	Not Detected	<10
Digital Data Group (Bottom Panel) - Surface	Total PCBs	Not Detected	<10
Digital Data Group - Underside	Total PCBs	Not Detected	<10
Message Process Auxiliary Cavity	Total PCBs	Not Detected	<10
Top of Command Message Processing Group	Total PCBs	Not Detected	<10
Receiver Transmitter - Surface	Total PCBs	Not Detected	<10
Deputy Console Keyboard	Total PCBs	Not Detected	<10
CB1 Circuit Breaker - Underside (SN009)	Total PCBs	Not Detected	<10
Top of Repeater Telephone Set (SN0000002)	Total PCBs	Not Detected	<10
Repeater Telephone Set (SN0000002) - Underside	Total PCBs	Not Detected	<10
LCPA Power Panel (Open)	Total PCBs	Not Detected	<10
LCPA - Underside	Total PCBs	Not Detected	<10
Deputy phone	Total PCBs	Not Detected	<10
Commander phone	Total PCBs	Not Detected	<10
Memory Unit Plated Wire - Surface	Total PCBs	Not Detected	<10
Box with PCB Sticker in LCEB	Total PCBs	Not Detected	<10
LCD Section 1 LCF-O1E in LCEB	Total PCBs	Not Detected	<10
LCD Section 2 LCF-O1E in LCEB	Total PCBs	Not Detected	<10
Telephone Connecting and Switching Set (SN0000088) in LCEB	Total PCBs	Not Detected	<10

Table 6B: Area Air Sampling Results – PCBs
14 February 2024

Analyte	Result (mg/m^3)
Aroclor 1016	<0.0021
Aroclor 1221	<0.0021
Aroclor 1232	<0.0021
Aroclor 1242	<0.0021
Aroclor 1248	<0.0021
Aroclor 1254	<0.0021
Aroclor 1260	<0.0021

Table 6C: Area Air Sampling Results – VOCs
14 February 2024

Analyte	Result ($\mu g/m^3$)
1,1,1,2-Tetrachloroethane	<10
1,1,1-Trichloroethane	<10
1,1,2,2-Tetrachloroethane	<10
1,1,2-Trichloroethane	<10
1,1-Dichloroethane	<10
1,1-Dichloroethylene	<10
1,1-Dichloropropylene	<10
1,2,3-Trichlorobenzene	<10
1,2,3-Trichloropropane	<10
1,2,4-Trichlorobenzene	<10
1,2,4-Trimethylbenzene	<10
1,2-Dibromo-3-chloropropane (DBCP)	<10
Ethylene Dibromide	<10
1,2-Dichlorobenzene	<10
1,2-Dichloroethane	<10
1,2-Dichloropropane	<10
1,3,5-Trimethylbenzene	<10
1,3-Dichlorobenzene	<10
1,3-Dichloropropane	<10
1,4-Dichlorobenzene	<10
2-Chlorotoluene	<10
4-chlorotoluene	<10
Benzene	<10
Bromobenzene	<10
Bromochloromethane	<10

Table 6C: Area Air Sampling Results – VOCs Cont.
14 February 2024

Analyte	Result (µg/m^3)
Bromodichloromethane	<10
Bromoform	<10
Carbon Tetrachloride	<10
Chlorobenzene	<10
Chloroform	<10
cis-1,2-Dichloroethylene	<10
cis-1,3-Dichloropropene	<10
Dibromochloromethane	<10
Ethylbenzene	<10
Hexachlorobutadiene	<10
Isopropylbenzene	<10
Methylene Chloride (Dichloromethane)	<10
p+m-Xylene	<10
Naphthalene	<10
n-Butylbenzene	<10
n-Propylbenzene	<10
o-Xylene	<10
p-isopropyltoluene	<10
sec-butylbenzene	<10
Styrene	<10
tert-butylbenzene	<10
Tetrachloroethylene	<10
Toluene	<10
trans-1,2-Dichloroethylene	<10