Evaluation of Exposure to Polychlorinated Biphenyls (PCBs) and Cancer Concerns Among University Employees

HHE Report No. 2024-0053-3431

March 2026

Authors: **Jessica L. Rinsky, PhD, MPH**

Sophia K. Chiu, MD, MPH

Nancy Burton, PhD, MPH, MS, CIH

Dylan T. Neu, BS

Karl D. Feldmann, MS, REHS/RS, CIH

Analytical Support: Kaitlin Kelly-Reif, Steve Bertke, Amel Omari

Desktop Publisher: Shawna Watts

Editor: Jennifer Tyrawski

Data Support: North Carolina Central Cancer Registry

Keywords: North American Industry Classification System (NAICS) 611300 (Colleges, Universities, and Professional Schools), Cancer, Polychlorinated Biphenyls, PCBs, North Carolina

Program Description

The National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 [29 USC 669a(6)]. The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations [42 CFR Part 85].

Disclaimer

This document is a NIOSH health hazard evaluation report prepared in response to a specific workplace or technical assistance request. The recommendations in this report are made on the basis of the findings at the workplace evaluated and may not be applicable to other workplaces. As such, this health hazard evaluation report is not intended as industrywide Centers for Disease Control and Prevention (CDC) or NIOSH guidelines or policy, and it does not establish new health standards, guidance, or regulatory requirements.

Mention of any company or product does not constitute endorsement by NIOSH/CDC. In addition, citations to websites, national guidelines, or recommendations external to NIOSH/CDC do not constitute NIOSH/CDC endorsement of the sponsoring organizations or their programs, products, or guidelines. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

Availability of Report

Copies of this report have been sent to the employer and employees at the university. The state health department and the Occupational Safety and Health Administration Regional Office and State Plan Office have also received a copy. This report is not copyrighted and may be freely reproduced.

Recommended Citation

NIOSH [2026]. Evaluation of exposure to polychlorinated biphenyls (PCBs) and cancer concerns among university employees. By Rinsky JL, Chiu SK, Burton N, Neu DT, Feldmann KD. Cincinnati, OH: Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard Evaluation Report 2024-0053-3431, https://www.cdc.gov/niosh/hhe/reports/pdfs/2024-0053-3431.pdf.

Table of Contents

Main Report

Supporting Technical Information

Introduction

Request

Management from a university requested a health hazard evaluation concerning potential workplace exposure to polychlorinated biphenyls (PCBs) and the occurrence of cancer among employees working in a university building. The request was prompted by employee health concerns and environmental sampling that revealed PCBs were present in indoor air and on surfaces throughout the building.

About PCBs

PCBs are a group of human-made chemicals that were widely used in building materials and electrical equipment before they were mostly banned in the United States in 1979. PCBs do not readily break down and can stay in the environment for a long time. PCBs have been associated with adverse health effects, including cancer.

Although there are many different kinds of PCBs, people are usually exposed to mixtures of these chemicals rather than just one kind. Therefore, we refer to PCBs generally as a group throughout this report and highlight specific commercial product names when relevant.

Workplace

The seven-story university building was completed in late 1970 and opened in 1971. It housed offices, classrooms, computer laboratories, libraries, and other workspaces. Faculty, staff, graduate and undergraduate student workers, students, and visitors used the building. In November 2023, university management temporarily closed the building due to concerns about PCB exposure. As of the publication of this report, the building remains closed. The university has publicly announced remediation plans.

To learn more about the workplace, go to Section A in the Supporting Technical Information

Our Approach

Using principles described in the Centers for Disease Control and Prevention's (CDC) Guidelines for Examining Unusual Patterns of Cancer and Environmental Concerns, NIOSH designed this evaluation to address the following questions:

- Was exposure to PCBs at levels known or suspected of causing cancer occurring at the workplace?
- Have employees experienced more of a specific type or related types of cancer than expected?
- Have employees experienced an unusual distribution of a specific type or related types of cancer?
- Has enough time passed since a potential exposure began for excess cancer rates or an unusual pattern of cancer to be observed among employees?

We completed the following activities during our evaluation:

- Reviewed available scientific literature about cancer types associated with PCB exposure.
- Reviewed reports prepared by university staff and a consultant describing environmental assessments and air, surface, and bulk building material sampling conducted for PCBs from April 2018–April 2024.
- Worked with the state cancer registry to estimate the number of cases of melanoma, breast cancer, and non-Hodgkin lymphoma that occurred among university employees who worked in the building of interest during 1995–2022 (hereafter, "employees").
    - We focused on these three cancer types because there is sufficient evidence in the scientific literature that PCB exposure is associated with these cancer types in humans. A focus on these three types of cancer is supported by the findings described in a 2015 International Agency for Research on Cancer (IARC) monograph.
    - Employees included faculty, staff, and graduate or undergraduate students employed by the university. The Occupational Safety and Health Act of 1970 ("OSH Act") authorizes NIOSH to conduct research and provide services, such as health hazard evaluations (HHEs), for the prevention of work-related injury and illness. This evaluation did not include students who were not employed by the university and, therefore, outside of the occupational scope of the OSH Act.
- Compared the occurrence of each cancer type among employees to the number of cases expected if employees experienced the same cancer rates as the general population of the state. We conducted this part of the evaluation for all employees, and separately for female and male employees.

We also reviewed environmental sampling results for lead paint and asbestos from building renovation projects during May 2006–April 2023, as well as university plans for managing these materials. However, our review did not identify exposure concerns, so we do not include details about that review in this report.

To learn more about our methods, go to Section B in the Supporting Technical Information

Our Key Findings

PCBs were detected in air and on surfaces in workspaces, indicating that employees could have been exposed.

- During April 2018–April 2024, air, surface, and bulk building material samples were collected in workspaces and the heating, ventilation, and air conditioning (HVAC) systems throughout the building. Each sample was analyzed for nine different Aroclor products, the most common trade name for PCB products in the United States.

- PCBs were present in air samples, with and without the HVAC systems running. All air samples were below the United States Environmental Protection Agency (EPA) Exposure Levels for Evaluating PCBs in Indoor School Air for adults 19 years and older of 0.5 micrograms per cubic meter of air ($\mu g/m^3$).
- PCBs were present in surface samples. Two surface samples from windowsills exceeded the EPA threshold for PCBs on non-porous surfaces (10 $\mu g/100$ square centimeters [cm^2]); all others were below this threshold.
- PCBs were present in bulk building materials (for example, insulation sealants, lined duct insulation facing, window caulk). PCB concentrations exceeded the Toxic Substances Control Act (TSCA) PCB Bulk Product Waste criterion of 50 mg/kg in most samples.
- Four of the nine different Aroclor products were detected in the building. One product, Aroclor-1262, was detected in all three sample types (air, surface, and bulk building material).
- The consultant determined that the gold-colored insulation sealant (bulk building material) found in the HVAC supply ductwork was likely the primary source of PCBs found in the air and surface samples.
- These sample results cannot show when the potential for PCB exposure began or how levels have changed over time; therefore, it remains unclear if employees were exposed at levels known or suspected of causing cancer.

During 1995–2022, the number of observed cases of melanoma, and possibly breast cancer, was greater than what was expected, mainly among female employees.

- Of 4,660 employees assigned to the building at any time during 1995–2022, there were 111 cases reported to the state cancer registry of melanoma, breast cancer, or non-Hodgkin lymphoma diagnosed after the employee began work at the university.
- Cancer takes time to develop. The estimated minimum amount of time that it takes for cancer to develop after an exposure is called latency. Considering latency helps focus on cancer cases that are more plausibly related to a specific exposure. After considering latency, 92 cases of these cancers were included in the analysis.
- Considering latency, the number of observed melanoma cases during 1995–2022 was approximately twice what was expected based on the general population of the state. When evaluating male and female employees separately, we observed a statistically significant excess only among female employees.
- Considering latency, the number of observed breast cancer cases during 1995–2022 was elevated but not statistically different from what was expected based on the general population of the state. When evaluating male and female employees separately, we observed a statistically significant excess of breast cancer only among female employees during 1995–2009.
- Considering latency, the number of observed non-Hodgkin lymphoma cases during 1995–2022 was similar to or less than expected based on the general population of the state.

These findings do not tell us why an unusual pattern of cancer occurred.

- There are many reasons why one group of people might have more cancer than another.
    - It could be due to exposure to harmful substances at work. It can also be because of other factors like differences in access to medical care and cancer screening, lifestyle differences, general variability in the occurrence of cancer, or limitations in evaluation methods.
    - Differences in access to medical care and cancer screening may be an important factor to consider when interpreting these results. If employees had better access to medical care and cancer screening than the general population, more cancers would be found earlier and therefore employees could appear to have a higher rate of cancer.
- The evaluation presented here was not able to assess whether each employee was exposed to PCBs during their work in the building, and if so, when and at what levels.
- To find out if PCB exposure in the building is associated with cancer risk among the population of people who spent time in the building, a specially designed epidemiologic study would be needed.
    - A specially designed epidemiologic study would look closely at employees' exposures, health, and other factors over time to see if there is a link between levels of PCB exposure in the building and developing cancer.
    - However, such a study might be difficult to do depending on what information is available. Also, even if the study were done, it might not lead to additional actions beyond what are recommended in this report.

To learn more about our results, go to Section B in the Supporting Technical Information

Our Recommendations

The potential benefits of improving workplace health and safety are:

↑ Improved worker health and well-being	↑ Enhanced image and reputation
↑ Better workplace morale	↑ Superior products, processes, and services
↑ Easier employee recruiting and retention	↑ Increased overall cost savings

The recommendations below are based on the findings of our evaluation. These recommendations are workplace-specific, based on the information available for the workplace evaluated, and are intended to improve the workplace's conditions. For each recommendation, we list a series of actions you can take to address the issue at your workplace. The actions at the beginning of each list are preferable to the ones listed later. The list order is based on a well-accepted approach called the "hierarchy of controls." The hierarchy of controls is a way of determining which actions will best control exposures. In most cases, the preferred approach is to eliminate hazards or to replace the hazard with something less hazardous (i.e., substitution). Installing engineering controls to isolate people from the hazard is the

next step in the hierarchy. Until such controls are in place, or if they are not effective or practical, administrative measures and personal protective equipment might be needed. Read more about the hierarchy of controls on the NIOSH website.

We encourage management to use a health and safety committee to discuss our recommendations and develop an action plan. Both employee representatives and management representatives should be included on the committee. Helpful guidance can be found in Recommended Practices for Safety and Health Programs.

Recommendation 1: Continue to work with the U.S. EPA, local authorities, and subject matter experts to follow their guidance on building remediation.

Why? PCBs were found in the air, on surfaces throughout the building, and in bulk materials. PCBs do not readily break down in the environment, and exposure to PCBs is associated with an increased risk of cancer and other health effects. Therefore, it is important that building remediation activities are conducted in a way that minimizes exposure to employees and surrounding communities and prevents further contamination of the building and surrounding environment.

How? At your workplace, we recommend these specific actions:

Take steps to protect individuals entering the building and collecting personal belongings or university materials.

- Consult available guidance from the EPA's Practical Actions for Reducing Exposure to PCBs in Schools and Other Buildings about how to safely clean personal belongings and other materials.

Continue to consult with agencies and subject matter experts on guidance for how to protect employees and the university community during planned building renovation, remediation, or demolition work.

- See the EPA's Steps to Safe PCB Abatement Activities for more information.

Recommendation 2: Encourage employees who spent time in the building to discuss their health concerns and how existing cancer screening guidelines apply based on their personal risk factors with their healthcare providers.

Why? Cancer screening tests are used to find cancer before it causes symptoms. Screening may find some types of cancers early, when treatment is likely to work best. Cancer screening recommendations in the United States are developed and adopted by expert organizations to balance the benefits and risks of the screening test. Healthcare providers can advise their patients on the appropriate screening based on their age, sex, family history, and other risk factors.

How? At your workplace, we recommend these specific actions:

Encourage employees to work with their healthcare providers to determine what cancer screenings are recommended for them based on personal risk factors such as age, sex, and family history or personal history of cancer.

- Provide employees with information about cancer, including information on cancer risks and prevention methods. Include information specifically about skin cancer, which includes melanoma, and breast cancer.
- Information about screening for melanoma and breast cancer and can be found at Screening for Skin Cancer and Screening for Breast Cancer.
- Specifics about screening, such as at what age to start and stop and which test to use, can vary for individuals based on their specific personal risk factors. Therefore, having input about screening from a healthcare provider is important.
- Because cancer screening tests are not without risks, employees should consult with a healthcare provider before pursuing screening tests beyond those recommended based on their personal risk factors.

Encourage employees to tell their healthcare providers about their work in the building.

- Employees can share a copy of this report with their healthcare provider.
- If employees need assistance identifying a primary care provider, refer them to their health insurance plan to identify available providers in their area. For those without health insurance, refer them to their local health department for assistance.

Recommendation 3: Work with individuals familiar with the building and subject matter experts to assess whether it is practical and useful to conduct a specially designed epidemiologic study to better understand if PCB exposure in the building or some other combination of risk factors is linked to increased cancer risk.

Why? This evaluation found that employees may have been exposed to PCBs in the building and the occurrence of some cancers among employees was more than expected. However, this evaluation was not designed to identify the cause of the excess of cancer. For example, this evaluation was not able to assess whether each employee with or without cancer was exposed to PCBs during their work in the building, and if so, when and at what levels. Consistent with CDC's Guidelines for Examining Unusual Patterns of Cancer, the next step is to consider whether further study would be practical and helpful. This is called a feasibility assessment. It looks at factors such as data availability, adequate sample size to detect meaningful differences or associations, public health staff capacity and expertise,

and other resources such as funding. It is also important to assess how additional study will inform actions. If additional study is unlikely to change recommendations, it may be better to direct time and resources toward implementing existing recommendations. The recommendations listed here can be implemented before and regardless of whether an additional study is conducted.

How? At your workplace, we recommend these specific actions:

Consider establishing a committee to assess the feasibility and benefits of a specially designed epidemiologic study.

- Ideally, the committee would include university management representatives and representatives of groups that used the building such as employees.
- University management should consider working with public health authorities and practitioners to identify and select scientists and public health practitioners such as epidemiologists, biostatisticians, physicians, toxicologists, exposure assessment experts, and chronic disease or cancer control experts who would be helpful to include on a committee.
- The committee should consider what information is available to: identify the study population and study period; conduct an exposure assessment and identify available historical exposure records; measure relevant health outcomes; understand risk factors that need to be part of a specially designed epidemiologic study; and consider the time and resources needed to conduct such a study. The committee should also consider whether a specially designed epidemiologic study would change the actions taken or recommendations provided to the university or individuals.
    - If the committee concludes a specially designed epidemiologic study is not feasible or is unlikely to result in other recommendations, the committee may decide it is not a helpful use of time or resources.
    - If the committee determines a specially designed epidemiologic study is feasible and would be informative for recommendations, the committee may decide to recommend an additional epidemiologic study be designed and carried out.

Consider assisting the committee in sharing their findings with the university community.

- After completing the assessment, the university should consider working with the committee to communicate their findings publicly in a report or through other means.
    - If the committee does not recommend moving forward with a specially designed epidemiologic study, a communication explaining the rationale for the decision would be helpful to affected populations including employees.

- If the committee recommends moving forward with a study, a communication explaining the rationale for the decision and setting expectations for next steps would be helpful to affected populations including employees. The university should also consider continuing to work with the committee to identify resources to support the evaluation, design the protocol, carry out the work, and communicate progress to the potentially affected populations and the public regularly.

Supporting Technical Information

Evaluation of Exposure to Polychlorinated Biphenyls (PCBs) and Cancer Concerns Among University Employees

HHE Report No. 2024-0053-3431

March 2026

Section A: Workplace Information

Building

Construction of the seven-story building was completed in late 1970. The building opened for use in 1971. The building housed offices, classrooms, computer laboratories, libraries, and other workspaces. Faculty, staff, graduate and undergraduate student workers, students, and visitors used the building.

The building was served by six heating, ventilation, and air conditioning (HVAC) units that formed four ventilation zones. The two units serving the first and second floors were in separate mechanical rooms on the first floor. Four units of the same make and model served the third through seventh floors; two units were housed in each of the two roof penthouses located in the diagonal corners.

The HVAC units were original to the initial construction and have not undergone any major renovations. Some of the mixing boxes and air control valves were replaced in 2010. All supply ductwork is internally lined with yellow fiberglass that has a black facing and sealants of various colors (red, gold, gray, and yellow) at the seams. The return ductwork is externally lined with foil-faced insulation. In this setting, supply means ductwork that supplies heated or cooled air to occupied spaces and return means ductwork that returns air to the HVAC unit.

The building ventilation design was a dual deck (hot deck/cold deck) system using steam or chilled water for heating or cooling, respectively. The boiler and chiller were in the basement. The HVAC units were controlled via thermostat and the building's automation system; there were no additional humidity controls.

The first and second floors had supply ductwork in the ceilings that delivered air through mixing boxes. The mixing boxes had dampers installed on the supply ducts, which originally had a screw system, but were later computerized. The returns were ducted to shafts at the ends of the hallways and returned air to the HVAC units on the first floor.

The ductwork for the perimeter of the upper floors was located on the exterior face of the building in a structure called the bump-out. The ducts were encased in lathe and plaster. The supply grilles were located below the windows and had pleated filters. The interior spaces used mixing boxes from ducted supplies, like the lower floors. The air was returned back through two shafts at the end of the hallways that go from the third floor to a penthouse. The return air was ducted from the shafts to a penthouse, which served as an open plenum. There was an economizer exhaust fan installed in both penthouses that was used under various temperature conditions to save energy costs. An economizer uses cooler outdoor air to cool the building instead of operating the air conditioning compressor. It also allows for the dilution of indoor air with outdoor air to help control odors and humidity, and to improve occupant comfort.

The HVAC units were run by a main control system. There were various set-back times for the classrooms, offices, and other spaces for unoccupied times depending on class and office occupancy schedules before the building's closure. The occupied mode was usually from 4 a.m. to 11 p.m. and the unoccupied mode was from 11 p.m. to 4 a.m. The settings could be changed for special events. The HVAC units used a setting of approximately 20% outdoor air for normal occupancy. The lower HVAC units' spaces had louvers in the walls, and the upper HVAC units' penthouses had grilles in the walls to

allow for infiltration of make-up air. The air delivery temperature was about 55°F for cold air and 100°F for hot air to the mixing boxes.

The units were on quarterly and annual maintenance schedules. Each HVAC unit had a single bank of pleated panel filters rated at Minimum Efficiency Reporting Values (MERV) 13. The MERV rating is a scale that measures the efficiency of air filters in capturing particles from the air. The MERV scale ranges from 1 to 16, with higher ratings indicating a greater ability to filter out smaller particles, such as dust, pollen, and mold spores. Prior to changes due to COVID-19, MERV 8 filters were used. The recirculated air also went through a second set of bag (pocket) filters. They were changed every 3 months. Belts were changed annually. Coils were cleaned when needed.

According to facility management, the HVAC set-up for the building was evaluated and adjustments were made when undergoing renovations. There was no report of an HVAC test and balance or commissioning of the HVAC system. However, the university had a re-commissioning team made up of technical staff that works on optimizing building operations, like HVAC controls.

Employee Information

As of November 2023, approximately 180 employees were assigned to the building; additional employees spent time in the building as part of their jobs. Employees were not represented by a union.

History of Issue at Workplace

Management and employee representatives described that the university started to receive concerns from employees about health issues that included cancer diagnoses in August 2023. In response to these concerns, the university began an environmental review of the building and performed environmental sampling for asbestos, lead, and PCBs in October 2023. The detection of PCBs prompted the university to seek additional evaluations of the potential for exposure and occurrence of cancer. The building was closed and the HVAC system turned off in November 2023. As of the publication of this report, the building remains closed, and the university has publicly announced remediation plans.

Section B: Methods, Results, and Discussion

Using principles described in the Centers for Disease Control and Prevention's (CDC) Guidelines for Examining Unusual Patterns of Cancer and Environmental Concerns [CDC 2022], we designed this evaluation to address the following questions:

- Was exposure to PCBs at levels known or suspected of causing cancer occurring at the workplace?
- Have employees experienced more of a specific type or related types of cancer than expected?
- Have employees experienced an unusual distribution of a specific type or related types of cancer?
- Has enough time passed since a potential exposure began for excess cancer rates or an unusual pattern of cancer to be observed among employees?

We addressed these questions through the activities described in the following sections.

Methods: Review of Prior Consultant Reports and Sampling Data

We requested results of environmental sampling conducted in the building during the previous 20 years (2004–2024), and reviewed the provided documents:

- Air, surface, and bulk building material sampling reports for PCBs. The samples were collected inside the building by the university's Environmental Health and Safety department in October and November 2023.
- Environmental assessment reports performed by a consultant hired by the university, dated February and June 2024, respectively. Air and indoor wipe sampling was performed in December 2023 and April 2024. Bulk samples were collected in January and March 2024. These assessments measured levels of PCBs inside the building and described the role the HVAC system had in the movement of contaminants.
- A sampling report for PCBs for bulk samples of building materials taken from the exterior of the building in April 2018 collected by a consultant hired by the university.

Sampling results were compared to the following reference values.

- Air: U.S. Environmental Protection Agency (EPA) Exposure Level for Evaluating PCBs in School Indoor Air for adults 19 years and older of 0.5 micrograms per cubic meter of air ($\mu g/m^3$). Assuming average background levels for PCB exposure from other sources, this level would result in estimated total daily exposure to PCBs from all sources remaining below the oral reference dose (20 nanograms PCB/kilogram of body weight per day) [EPA 2025a]. The air levels were derived to serve as health protective values intended for evaluation purposes. They should not be interpreted nor applied as a "not-to-exceed criteria," but may be used to guide thoughtful evaluation of indoor air quality in schools.
- Surface: EPA threshold for non-porous surfaces of 10 micrograms per 100 square centimeters ($\mu g/100\ cm^2$) for high-occupancy areas. High-occupancy areas are locations where people spend

a significant amount of time, such as homes, schools, and workplaces. The threshold accounts for the increased likelihood of exposure due to prolonged occupancy.

- Bulk: Toxic Substances Control Act (TSCA) PCB Bulk Product Waste criterion of 50 milligrams per kilogram (mg/kg) as defined under 40 CFR 761.61. This is a threshold to determine if PCB-containing materials should be removed from a building and how to properly dispose of them.

In response to our request for sampling records, we were also provided with and reviewed environmental sampling results for lead paint and asbestos associated with building projects during the relevant period. We also reviewed documents from the university titled Asbestos Management Plan (dated July 2016), Management of Paint Containing Lead (dated October 2016), and Management of Building Demolition Debris (dated May 2018). However, we are not reporting on them here because we did not identify any exposure or exposure pathway concerns and these documents were outside of the focus of this evaluation.

Results: Review of Prior Consultant Reports and Sampling Data

Interior PCB Environmental Sampling Data Summary

Bulk, surface wipe, and air samples were collected and analyzed for nine PCB products (Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Aroclor-1262, and Aroclor-1268). Sampling was conducted between October 2023 and April 2024.

The following summarizes the results for each set of samples:

- In samples taken in October 2023 (with the building HVAC units on), Aroclor-1262 was detected in 9 of 10 bulk building material samples (e.g., insulation facing, insulation sealant, insulation fibers) (range: 52–1,900 mg/kg). All of these samples exceeded the TSCA PCB Bulk Product Waste criterion of 50 mg/kg. A window surface sample was collected but was not able to be analyzed. Additionally, Aroclor-1254 was detected at 25 mg/kg in 1 bulk sample labeled Air Handling Unit 1 (Room 100).
- In samples taken in November 2023 (with the building HVAC units on), no PCBs were detected in the two air samples collected (Rooms 310P and 520E). The University reported on their publicly facing website that these air samples could not be analyzed for Aroclor-1262; the laboratory report did not specify why. Aroclor products were detected in bulk and surface samples collected.
    - Aroclor-1262 was detected in 6 of 6 bulk samples of insulation material (range: 8–592 mg/kg).
    - Aroclor-1262 was detected in 7 of 10 surface wipe samples (median: 1.8 µg/100 cm^2; range: not detected [ND]–12 µg/100 cm^2). One sample [Room 730], described by the consultant to be from a windowsill, exceeded the EPA threshold for non-porous surfaces.
    - Aroclor-1254 was detected in 1 of 10 surface wipe samples at 2.3 µg/100 cm^2. This result is from the same sample as the one mentioned above [Room 730, windowsill].

- In samples taken in December 2023 (with the building HVAC units off), Aroclor-1262 was detected in air and surface wipe samples. None of the other eight PCB products were detected in air or surface wipe samples.
    - Aroclor-1262 was detected in all 15 (including one duplicate) air samples collected from throughout the building; concentrations ranged from 0.0131–0.121 μg/m^3 (median: 0.0384 μg/m^3). Air sample results were below the EPA Exposure Levels for Evaluating PCBs in School Indoor Air of 0.5 μg/m^3 for adults 19 years and older [EPA 2025].
    - Aroclor-1262 was detected in 25 of 67 (including three duplicates) surface wipe samples (median: 1.62 μg/100 cm^2; range: 0.529–74.6 μg/100 cm^2). One sample, taken from a windowsill (74.6 μg/100 cm^2) exceeded the EPA threshold for non-porous surfaces of 10 μg/100 cm^2 [EPA 2025b]. All other samples were below this threshold. Though under the EPA threshold, 15 locations with sample results >1 μg/100 cm^2 included other windowsills, desks, product dispensers, shelves, books, a metal box, and HVAC supply vents.
- The consultant collected 111 bulk building material samples throughout the building (with the building HVAC units off) on January 4–5 and March 5–8, 2024. Bulk building materials sampled included HVAC insulation, caulking, and air filters from the HVAC units.
    - Aroclor-1262 was detected in 110 bulk samples; concentrations ranged from 0.91–53,000 mg/kg. Concentrations of Aroclor-1262 were greatest in insulation sealants and lined duct insulation facing. The average concentrations of Aroclor-1262 in these bulk building materials were one to two orders of magnitude higher than in other materials.
    - Other PCB products were also detected in bulk samples. Aroclor-1242 (11 mg/kg), Aroclor-1254 (13 mg/kg), and Aroclor-1262 (7.7 mg/kg) were found in foamboard construction adhesive from the HVAC #1 air handler mechanical room. Aroclor-1242 (1.9 mg/kg) and Aroclor-1262 (11 mg/kg) were detected in a gray insulation sealant sample from the hot supply duct from the HVAC #1 air handler mechanical room. Aroclor-1260 (2,500 mg/kg) was detected in a pink insulation adhesive sample from the HVAC #1 air handler fan box.
    - Most bulk building material samples (103/111, 93%) exceeded the TSCA PCB Bulk Product Waste criterion of 50 mg/kg.
- In air samples taken in April 2024, Aroclor-1262 was detected in each of the 17 air samples; concentrations ranged from 0.077–0.155 μg/m^3. The air samples were collected in the same locations as in the December 2023 sampling. Air samples were collected 8 days after the HVAC units were turned on again and 6 days after the HVAC system was running on the alternating occupied and unoccupied schedule with outdoor air set at 10%. All air samples collected with the HVAC system operating were below EPA exposure levels for evaluating PCBs in School Indoor Air for adults 19 years and older of 0.5 μg/m^3 [EPA 2025].

- The consultant concluded that the gold-colored insulation sealant found in the HVAC supply ductwork was likely the primary source of PCBs in the building. The gold-colored insulation sealant was the most common type of sealant and more than half of gold-colored sealant samples contained Aroclor-1262 in the range of 10,000 to 50,000 mg/kg.

Exterior Bulk Building Material PCB Sampling Data Summary

In April 2018, the university contracted a consulting company to collect samples of exterior caulking of the building prior to scheduled caulk replacement. Two samples were collected. Neither contained Aroclor-1262, which was the most commonly detected PCB product in indoor testing as described above. The exterior window caulk sample collected from Room 602M contained Aroclor-1254 (6,000 mg/kg) and Aroclor-1268 (17,000 mg/kg). The caulk sample collected from the East Loading Dock also contained Aroclor-1254 (2,700 mg/kg) and Aroclor-1268 (12,000 mg/kg).

Methods: Assessment of the Occurrence of Cancers

The environmental assessments indicated that an opportunity existed for building occupants to have been exposed to PCBs, although the duration and intensity of this exposure is unknown. Because exposure to PCBs was possible, we evaluated the occurrence of cancer types that are known or suspected to be associated with PCBs in the scientific literature.

Evaluation Population

The university provided a roster of employees who were assigned to work in the building at any point from the time when information about cancer diagnoses in the state became reliable (January 1995) to when the building was closed (November 2023). State cancer registry data about cancer diagnoses available at the time of this evaluation were finalized through December 31, 2022.

We defined employees as faculty, staff, and graduate or undergraduate students employed by the university. Persons who only had the role of student did not meet the criteria for being considered an employee and are thus outside the NIOSH Health Hazard Evaluation Program's statutory scope and authority. Therefore, they were not included in this evaluation. The university determined whether an employee was assigned to the building using their primary system of record that maintains details about onboarding, hire, classification and pay actions, and separation information.

We included employees working in the building during 1995–2022 in the subsequent analysis, because this was a period during which (1) the building was in use, (2) human resource records of employment were available, and (3) the state cancer registry data were reliable and finalized.

The roster included unique identifiers for each employee, employee type, employment begin and end dates, college, department, last known address, and (if known) a date of death for any deceased former employees. If an employee held different jobs over time, information on each job was included. We assumed that an employee's start date was the date that the employee began work in the building, as no other tracking of work location was available.

Outcome Assessment

To determine which cancer types to focus on, we reviewed available summaries of the scientific literature published by multiple agencies including the Agency for Toxic Substances and Disease

Registry [ATSDR 2000, 2011], National Toxicology Program [NTP 2021], EPA [1996], and the International Agency for Research on Cancer (IARC) [2015]. The IARC Monographs Volume 107: Polychlorinated Biphenyls and Polybrominated Biphenyls was the most recent, comprehensive review of the available literature that evaluated the evidence for associations with specific cancer types [IARC 2015]. We also reviewed individual studies published after these comprehensive reviews to identify any potential developments regarding findings of carcinogenicity following publication of these summaries.

The IARC working group concluded and published in a 2015 monograph that there is sufficient evidence in humans that PCB exposure causes melanoma and positive associations have been observed for breast cancer and non-Hodgkin lymphoma [IARC 2015]. Some individual studies included in or published after the comprehensive reviews found that PCB exposure was associated with increased burden of other cancer sites in adults including cancer of the prostate, brain, liver and biliary tract, extrahepatic biliary tract, lung and respiratory tract, thyroid, stomach, pancreas, colon and rectum, urothelial organs, and uterus and ovary. However, associations between PCB exposure and these other cancer sites were not consistently observed across studies and populations. Therefore, we selected a case definition that reflects a focus on the cancer types identified by IARC as having sufficient evidence of associations with PCB exposure in humans.

Case Definition

For this analysis, we defined a case as melanoma, breast cancer, or non-Hodgkin lymphoma diagnosed in a current or former university employee who was assigned to the building at any time during 1995–2022 and whose cancer was reported to the state cancer registry during the same period.

Case Ascertainment

Using the roster, we created a dataset and securely transmitted it to cancer registry staff at the state health department, where the university was located. A cancer registry statistician used Match*Pro (version 2.5.3, 2024) to match employees in the dataset with cancer cases reported to the state cancer registry during 1995–2022. Match*Pro, developed for the National Cancer Institute, performs probabilistic record linkage [NCI 2024]. The method assigns probabilities to potential record pairs to determine the likelihood of a true match [NCI 2024]. Cancer registry staff manually reviewed any questionable matches from Match*Pro to confirm accuracy.

State cancer registry staff provided us with the following information:

- Counts of cases of each type of cancer diagnosed among employees stratified by sex (male, female) and broad age groups (20–39 years, 40–64 years, ≥65 years). These broad age groups were used to ensure sufficient case counts to protect employee privacy.
- Population estimates, counts of cases, and incidence per 100,000 population of each type of cancer among the general population in the state stratified by sex (male, female) and 5-year age groups (20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, ≥80 years). Because age strongly affects rates of cancer, using narrower age groups helps provide more precise estimates of how many cases of cancer would be expected among employees if they experienced the same rate of cancer as the general population of the state.

The state cancer registry staff provided this information for the entire period (1995–2022) as well as 1995–2009 and 2010–2022. We chose these smaller intervals to be able to examine the potential for a change in the incidence of cancers over time and ensure adequate sample size for reporting.

Person-time

For employees who were assigned to the building at any time during 1995–2022, we used information from the roster to estimate person-time, or how long we followed an employee after they began work in the building to observe a cancer diagnosis.

- An employee's follow-up began on their first employment start date at the university. We assumed that an employee's start date was the date that the employee began work in the building, as no other tracking of work location was available. If an employee's start date at the university was before January 1, 1995, we used January 1, 1995, as the beginning of follow-up.
- An employee's follow-up ended on December 31, 2022 (the last date with finalized cancer information from the state cancer registry at the time of the evaluation), or on their date of death, whichever occurred first. To identify dates of death, we matched the roster to the Social Security Administration's Death Master File. We manually reviewed questionable matches to confirm accuracy. For any employee with a confirmed match, we abstracted the reported date of death.

We calculated person-time as the difference between an employee's beginning and end of follow-up dates. We then summed person-time for employees stratified by sex (male, female), 5-year age groups during 1995–2022, and time period (1995–2009 and 2010–2022).

Latency Assumptions

Latency is the time between first exposure to a hazardous agent and clinical recognition of disease. Cancers can have long latency periods. Latency periods vary by cancer type but are usually estimated to be a minimum of 10–12 years [Rugo 2004], with estimates as short as 4 years for solid tumors and 0.4 years for lymphoproliferative and hematopoietic cancers, which are blood cancers such as leukemias, lymphomas, and myelomas [Howard 2015].

Information about latency periods for specific cancer types in the scientific literature is limited. To address the minimum latency periods for each cancer type and be as inclusive as possible, we applied restrictions to follow-up using estimates of latency developed by NIOSH for compensation eligibility in the World Trade Center Health Program [Howard 2015].

For melanoma and breast cancer, we defined the beginning of follow-up with the latency assumption applied as 4 years after either employment start date or January 1, 1995, whichever is later. For non-Hodgkin lymphoma, we defined beginning of follow-up with the latency assumption applied as 0.4 years (146 days) after either employment start date or January 1, 1995, whichever is later.

We applied these latency assumptions by adjusting person-time calculations to begin follow-up 4 years after beginning work for analyses of melanoma and breast cancer, and 0.4 years after beginning work for analyses of non-Hodgkin lymphoma. The state cancer registry also provided case counts restricted to only cancer diagnoses that met the latency assumption for each cancer type.

Statistical Analysis

We calculated standardized incidence ratios (SIRs) and 95% confidence intervals (CIs) for each cancer type. An SIR is a ratio of the number of observed cancer cases among employees assigned to the building compared to the number of cases expected if the employees experienced the same cancer rates as the general population of the state. An SIR > 1 indicates that more cancer cases were observed than expected if employees had experienced cancer at the same rate as the state, while an SIR < 1 indicates that fewer cancer cases were observed than expected if employees had experienced cancer at the same rate as the state.

We calculated the expected number of cases among employees by multiplying the rate of each cancer type in the general population of the state by the total person-time in each sex and 5-year age group. We then summed the total number of expected cases into the broad age groups of 20–39 years, 40–64 years, and ≥65 years.

To calculate SIRs, for each cancer type without and with latency assumptions applied, we summed the total number of observed cases and expected cases across the broad age groups and then divided the observed number of cases by the expected number of cases. We calculated SIRs in this way, overall and stratified by sex and time period. We calculated 95% CIs using Byar's approximation of the exact Poisson distribution [Bertke and Kelly-Reif 2024; NCI 2025; Rothman and Boice 1979, 1982]. The width of the 95% CI illustrates the precision of the SIR estimate: the wider the CI, the less precise the estimate. We considered 95% CIs that do not include 1.00 to be statistically significant, indicating that the observed number of cancer cases is statistically different than what is expected based on the cancer rate for the state.

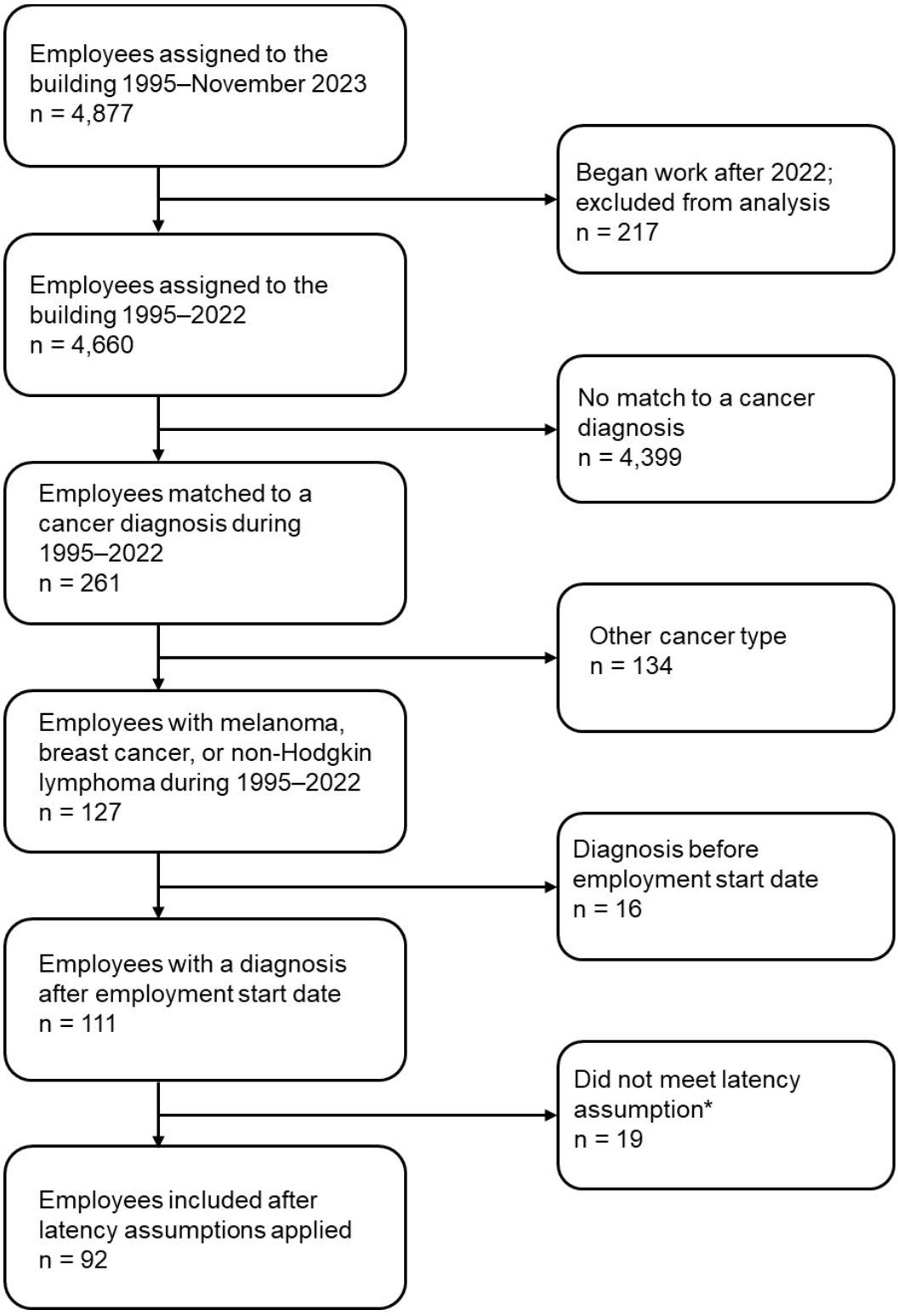
We conducted all statistical analyses with SAS® statistical software (SAS 9.4, SAS Institute, Cary, North Carolina) and R statistical software (version 4.4.0; R Foundation for Statistical Computing). We generated figures using Microsoft Excel (version 2408).

Results: Assessment of the Occurrence of Cancers

Description of Employees

The roster of employees included 4,877 employees assigned to the building at any point during January 1995–November 2023 (Figure B1). Among these, 217 employees began work after 2022 and, therefore, we excluded them from analysis.

During 1995–2022, 4,660 employees were assigned to the building at some point during their employment (Table C1). Most employees were female and less than 40 years old when they began work at the university. Employees included faculty, staff, postdoctoral fellows, and graduate and undergraduate student workers. Some employees moved among these job titles over time; therefore, employees were counted in more than one category. The median duration of employment was approximately 2 years (range: <1–52 years).



* Latency assumptions of 4 years for melanoma and breast cancer and 0.4 years (146 days) for non-Hodgkin lymphoma were applied.

Figure B1. Flow chart showing the identification of cancer cases for inclusion in the analysis among 4,660 university employees assigned to the building during 1995–2022.

Occurrence of Selected Cancer Types

Among the 4,660 employees, 261 matched to a cancer diagnosis reported to the state cancer registry during 1995–2022 (Figure B1). Of those, 127 employees received a diagnosis of melanoma, breast cancer, or non-Hodgkin lymphoma. Sixteen of these employees received their cancer diagnosis before beginning work at the university. Therefore, we excluded these cases, leaving 111 cases of cancer for inclusion in this analysis. Nineteen of these cases did not meet latency assumptions for the respective cancer types, meaning they were diagnosed within 0.4 years for non-Hodgkin lymphoma or within 4 years of starting work at the university for melanoma and breast cancer. Therefore, we included 92 cancer cases in analyses where we applied latency assumptions.

Figure B2 and Table C2 show SIRs with 95% CIs comparing the occurrence of melanoma, breast cancer, and non-Hodgkin lymphoma among all employees to the general population of the state without and with latency assumptions applied for the full period (1995–2022). Table C2 also provides estimates stratified into two periods (1995–2009 and 2010–2022) to consider change in the incidence over time. Table C3 shows SIRs with 95% CIs for male and female employees separately during the same periods.

Melanoma

During 1995–2022, the overall observed cases of melanoma among employees (n = 30) was more than 2 times what was expected (n = 12.44) based on the rate of melanoma in the general population of the state (SIR: 2.41; 95% CI: 1.63, 3.44) (Figure B2; Table C2). This elevation was seen over time and when we applied the latency assumption (SIR: 2.28; 95% CI: 1.44, 3.42). When stratified by sex (Table C3), we observed more melanoma cases than expected in both female and male employees, but a significant elevation remained only among female employees when we applied the latency assumption. SIRs for female employees were higher in the period 1995–2009 compared with 2010–2022 but were based on relatively small numbers and therefore the estimates were imprecise.

Breast Cancer

During 1995–2022, the overall observed number of cases of breast cancer among employees (n = 76) was higher than what was expected (n = 60.25) based on the rate of breast cancer in the general population of the state, without (SIR: 1.26; 95% CI: 0.99, 1.58) and with latency assumptions applied (SIR: 1.27; 95% CI: 0.98, 1.63) (Figure B2; Table C2). However, most of these estimates were not statistically significant. With the latency assumption applied, the number of observed cases was statistically greater than was expected based on the rate of breast cancer in the general population of the state during 1995–2009.

When stratified by sex, we observed a similar pattern, with SIRs > 1 in all periods but only a statistically significant excess of breast cancer cases among female employees when we applied the latency assumption during 1995–2009 (Table C3). Breast cancer was rare among male employees and in the general population; therefore, SIR estimates were imprecise. Although we saw an elevated SIR during 2010–2022 among male employees, it was based on small numbers and the elevation was no longer significant after applying the latency assumption.

Non-Hodgkin Lymphoma

During 1995–2022, the observed number of cases of non-Hodgkin lymphoma among employees (n = 5) appeared similar to or less than what was expected based on the general population without (n = 8.32) and with the latency assumption (n = 8.22) applied (Figure B2; Table C2). However, the numbers of cases were small and therefore estimates are imprecise. Results were similar but less precise when stratified by sex (Table C3).

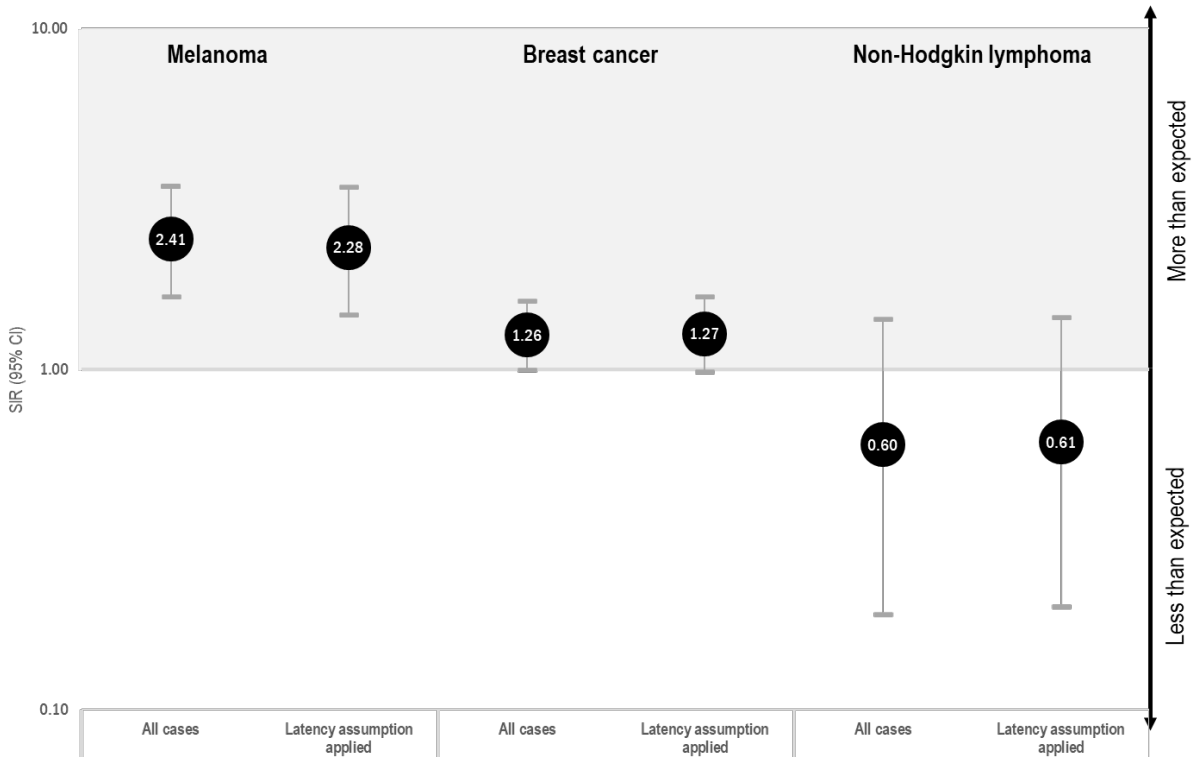


Figure B2. Standardized incidence ratios (SIRs) and 95% confidence intervals (CIs) comparing observed and expected cases of malignant melanoma, breast cancer, and non-Hodgkin lymphoma among university employees without and with latency assumptions applied. Estimates were standardized by age and sex.

Discussion

On the basis of the environmental assessments performed by the university and its contractors, it is possible that employees working in this university building were exposed to PCBs, a known carcinogen, while at work. However, based on current sampling, we are unable to determine when exposure may have begun, how exposure may have changed over time, and whether past exposure occurred at levels associated with increased risk of adverse health effects in humans. After examining the occurrence of melanoma, breast cancer, and non-Hodgkin lymphoma — three cancer types with sufficient evidence in humans of an association with PCB exposure — we observed that more cases of melanoma had occurred among employees working in the building than expected. We also observed evidence of more breast cancer cases than expected among specific groups of employees, but this elevation was not consistently seen over time, by sex, or when taking into account latency assumptions. Although these findings indicate the potential for exposure to a human carcinogen and an excess of specific types of cancer, this evaluation was not designed to determine what may have caused excess cancer among

employees. Additional evaluation would be required to determine whether exposure to PCBs in the building was associated with the excess of cancer seen among employees.

We designed this evaluation using an approach that follows principles from the CDC's Guidelines for Examining Unusual Patterns of Cancer and Environmental Concerns [2022]. Using this approach, we considered several questions to evaluate whether an unusual pattern of cancer has occurred among employees and if evidence suggests that those cancers are likely to be associated with a workplace exposure. Those questions included:

- Was exposure to a specific chemical substance or physical agent at levels known or suspected of causing cancer occurring at the workplace?
- Have employees experienced more of a specific type or related types of cancer than expected?
- Have employees experienced an unusual distribution of a specific type or related types of cancer?
- Has enough time passed since a potential exposure began for excess cancer rates or an unusual pattern of cancer to be observed among employees?

Below we provide answers to these questions based on our findings.

Was exposure to a specific chemical substance or physical agent at levels known or suspected of causing cancer occurring at the workplace?

Possibly. Sampling demonstrated that PCBs were present in the air and in dust settled on surfaces throughout the workplace. Sampling also demonstrated PCBs were present in bulk building materials. Levels of PCBs in the air (with and without the HVAC units running) were below the EPA Exposure Levels for Evaluating PCBs in School Indoor Air for adults over 19 years old of 0.5 μg/m^3 [EPA 2025a]. The EPA has also established lower levels to protect children aged 3–<6 years (0.2 μg/m^3) and aged 6–<12 years (0.3 μg/m^3). All air samples were below these levels as well. The EPA established these exposure levels so that children and adult school employees who breathed in PCBs at or below these levels while attending school for the typical number of hours per day and days per week of a typical school year would not experience increased risks of adverse health effects [EPA 2015]. However, these exposure levels are not intended as a threshold; they are instead intended to be used as a guide in evaluating indoor air quality in schools.

Some occupational exposure limits (OELs) exist for PCBs. The Occupational Safety and Health Administration (OSHA) has set permissible exposure limits (PELs) specifically for Aroclor-1242 (1,000 μg/m^3) and Aroclor-1254 (500 μg/m^3) in air [OSHA 2016]. OSHA PELs are expressed as an 8-hour time-weighted average; the concentration of a substance to which most workers can be exposed without an adverse health effect averaged over a normal 8-hour workday or a 40-hour workweek.

NIOSH has a recommended exposure limit (REL) for PCBs of 1 μg/m^3 in air based on the minimum reliable detectable concentration and multiple adverse health outcomes of PCB exposure (i.e., potential carcinogenicity, adverse reproductive outcomes, liver injury) [NIOSH 1977, 2014, 2019a,b]. NIOSH RELs are exposure limits for an 8- or 10-hour time-weighted-average exposure (or ceiling). NIOSH also recommends that all workplace exposures to occupational carcinogens be reduced to the lowest feasible level [NIOSH 2014]. The American Conference of Governmental Industrial Hygienists (ACGIH®) has

a threshold limit value (TLV®) for Aroclor-1254 of 500 µg/m³ in air expressed as a time-weighted average; it is the concentration of a substance to which most workers can be exposed without adverse health effects.

It is important to note that results from the air samples that were collected are not directly comparable to these limits because they were not personal exposure samples. For more information about OELs, see Section D.

Two surface samples from windowsills exceeded the EPA threshold for non-porous surfaces of 10 µg/100 cm². All other surface samples were below this threshold. Though under the EPA threshold, 15 locations had sample results >1 µg/100 cm², which is the reference level recommended in earlier NIOSH evaluations because it was the lowest feasible level considering background contamination at the time [NIOSH 1990]. The locations included other windowsills, desks, product dispensers, shelves, books, a metal box, and HVAC supply vents. Some of these are high-touch surfaces that provide opportunities for exposure.

All bulk building material samples contained PCBs identified as one or more Aroclor products. The consultant concluded that the gold-colored insulation sealant found in the HVAC supply ductwork was likely the primary source of PCBs in the building. They presumed that the gold-colored sealant was manufactured to contain Aroclor-1262. The levels of PCBs found in bulk materials throughout the building exceeded the TSCA PCB bulk product waste criterion of 50 mg/kg as defined under 40 CFR section 761.61. Designation as PCB bulk product waste makes a material subject to regulations about removal and how it needs to be disposed, but is not a direct indication of exposure intensity for building occupants [EPA 2021].

The concentration of PCBs in bulk building materials is important for identifying potential sources of PCBs found in workplaces and dictating appropriate disposal methods. However, the presence of PCBs in bulk building materials alone does not indicate exposure to building occupants at levels associated with adverse health effects. Off-gassing or source product degradation must occur for PCBs to be released from materials [EPA 2015]. As buildings age, the rate of these processes may change over time. Although studies show that buildings containing materials with PCBs, specifically caulks and sealants, can have elevated indoor levels of PCBs [Herrick et al. 2016], the level of exposure a specific employee may experience is not directly correlated with the level of PCBs in samples of bulk building materials. Once PCBs are released from materials through various processes, building occupants can be exposed to PCBs through inhalation or ingestion after contact with contaminated surfaces. Dermal exposure to PCBs has also been shown to be possible in industrial settings, but this is typically not the main route of exposure [EPA 2015].

The presence of PCBs in bulk building materials remains an important issue because (1) previous work has estimated approximately 60% of US building stock may be affected by manufactured PCB products [EPA 2021] and (2) PCBs have been identified as human carcinogens and may also be associated with an increased risk of a variety of non-cancer health effects [EPA 2015, 2025c; IARC 2015]. For background information on the potential health effects of PCB exposure, see the EPA webpage about PCBs. Most studies of occupational exposure to PCBs have been conducted among workers who produce PCBs [IARC 2015]. Some previous work completed during the 1980s has evaluated

background levels of PCBs in air and high-touch surfaces in office settings [NIOSH 1987a,b]. Those evaluations found air concentrations ranging from not detected to 0.18 μg/m^3 and concentrations on high skin contact surfaces from not detected to 0.059 μg/100 cm^2. More recent work in New York City schools showed air concentrations ranging from 0.049 μg/m^3 to 2.92 μg/m^3, with great variability in levels both between and within sampled schools [Herrick et al. 2016].

Considered together, this evidence indicates that while there was potential for exposure to PCBs, a known human carcinogen, in the university building, most sample results were below relevant reference levels, and similar to levels of PCBs found in office and school buildings in previous studies. However, as monitoring of PCB levels in air or on surfaces over time is not available, it remains unclear when exposure began, whether exposures reached levels associated with adverse health outcomes in humans, or how exposures might differ by employee.

Have employees experienced more of a specific type or related types of cancer than expected?

Yes. We observed evidence that employees may have experienced more than expected numbers of specific types of cancer. We observed evidence that during 1995–2022, when latency was considered, mainly female employees experienced more cases of melanoma than expected based on the occurrence of the cancer in the general population of the state. We also observed evidence of more than expected breast cancer cases among female employees; however, this excess was not consistently observed during the full evaluation period. Non-Hodgkin lymphoma was rare in the cohort of employees and the number of cases observed was similar to what was expected.

We focused on these three cancer types because, according to IARC, there is enough scientific evidence to consider PCBs a cause of melanoma and associated with an increased risk of breast cancer and non-Hodgkin lymphoma [IARC 2015]. The determination of PCBs as a cause of melanoma was based on multiple observational studies of both occupational exposure in different industries and studies of exposure in the general population across multiple countries, including the United States. Some of these studies demonstrated exposure-response relationships using different methodologies. Associations between PCB exposure and breast cancer and non-Hodgkin lymphoma were observed across multiple observational studies. However, PCB exposure was not considered causal for these cancers because some heterogeneity existed in associations seen across multiple high-quality studies.

The findings of an excess of melanoma and breast cancer among female employees is notable as some of the limitations of this analysis may have resulted in an underestimate of cancer cases among employees. For example, we do not know how many employees may have left the state after working at the university or whether these former employees have or have not been diagnosed with the three types of cancer evaluated here; these former employees could have received a cancer diagnosis while living elsewhere. Diagnoses made in other states would not have been included in this analysis, which would result in an underestimate of the number of observed cases and could bias the SIR downward. See the Limitations section below for a more detailed discussion of the limitations of this analysis.

Although an excess of melanoma and breast cancer was observed among female employees during the period included in this evaluation, this analysis was only designed to tell us if an excess of cancer occurred among employees based on the cancer rates of the state. It was not designed to tell us why an excess occurred. Excesses of cancer can be observed in one population compared with another for

many reasons besides a common exposure; a few examples include variability in the occurrence of disease across different populations because of differences in social determinants of health, genetic susceptibility, or behavior patterns; differential access to or use of medical care and cancer screening between populations; or the limitations associated with statistical methods, especially in small populations. To figure out the cause of an excess of cancer, a specially designed epidemiologic study that evaluates the association between a specific occupational exposure and cancer, as well as the influence of other factors, is needed.

Have employees experienced an unusual distribution of a specific type or related types of cancer?

The distribution of cancers by demographics such as sex and age among employees appeared similar to what would be expected based on the epidemiology of these cancer types, with a few exceptions.

We observed an excess of melanoma in both male and female employees, but when the latency assumption was applied, the excess was statistically significant only among female employees, especially during 1995–2009. The risk of melanoma in the general population increases with increasing age, although it is one of the most common cancers that occur in people younger than 30 years old, especially women [ACS 2023]. Before age 50, females have a higher risk of melanoma; after age 50, the risk is higher among men. In the present analysis, the age and sex distribution among employees differed from that of the general population of the state. A majority of employees were female and were young when starting work at the university. When calculating SIRs, we accounted for differences in the age and sex distribution among employees compared with the general population of the state through standardization [CDC 2022]. However, because the population of employees was predominately female and many were young when beginning work at the university, it is not surprising that more cases occurred among female employees than male employees.

Most breast cancer cases occurred among female employees, as expected. However, we observed an excess of male breast cancer specifically during 2010–2022; this finding may indicate a true excess or be attributable to the small number of observed cases among male employees. We also did not have information about personal risk factors these employees might have had for breast cancer. Moreover, this elevation was no longer statistically significant after applying the latency assumption and evidence on the relationship between PCB exposure and male breast cancer is limited, reducing our confidence in it being a true elevation that could be related to a workplace exposure.

It is also important to note, that generally, women with higher educational levels and income have better access to medical care and screenings than the general population. One study found that U.S. counties with higher socioeconomic indicators such as education and income have a higher incidence of melanoma, but it is unclear whether this is related to different behaviors related to ultraviolet (UV) light exposure or greater access to health care services [Singh et al. 2011]. Better access to medical care and screening can also result in higher observed breast cancer incidence compared with the general population [Ozcan et al. 2024]. For this evaluation, we did not have information on cancer stage at diagnosis. Incorporating information about cancer stage at diagnosis into future work may help illustrate whether the elevated rates of melanoma and breast cancer seen here were of cancers at earlier stages compared with the public, suggesting that the excess or unusual pattern may be explained at least partially by access to medical care and breast cancer screening practices.

Has enough time passed since a potential exposure began for excess cancer rates or an unusual pattern of cancer to be observed among employees?

Latency is the time between exposure to a cancer-causing agent and clinical recognition of the disease. Latency periods vary by cancer type but are usually estimated to be a minimum of 10–12 years [Rugo 2004], with some estimates as short as 4 years for most solid tumors and for 0.4 years for hematopoietic cancers [Howard 2015]. Because of this, exposures in the past are typically more relevant than recent or current exposures when determining potential causes of cancers occurring today.

We addressed latency by applying latency assumptions to SIR calculations. Our findings of an excess of melanoma and breast cancer remained among female employees during specific periods when we considered a 4-year latency assumption. Latency can vary by exposure and its intensity and duration, cancer type being evaluated, and personal factors of the population affected. The scientific literature on latency for specific exposures and cancer types is limited. Some studies indicate that longer latency periods than what was used here for PCB exposure may be relevant. For example, authors of a previous study of PCB exposure and breast cancer used a 10-year latency assumption based on considerations about biologic plausibility [Silver et al. 2009]; however, they also found that assuming no latency provided good model fit and results did not differ substantially with various latency assumptions applied. In a study of electric utility workers exposed to PCBs, authors selected 20 years as a better estimate of latency for mortality from melanoma than 0, 5, or 10 years [Loomis et al. 1997].

We selected minimum latency assumptions to be as inclusive as possible while still focusing on a period that was possibly more relevant to an exposure that occurred at work than applying no latency assumption. However, the latency assumptions used here were not specific to PCB exposure or the specific types of cancers evaluated; they were based on a review of the available literature for different groups of cancers conducted by the NIOSH World Trade Center Health Program [Howard 2015]. The review was conducted to inform decisions about the minimum amount of time that is required to have elapsed between initial exposure and a cancer diagnosis for the diagnosis to be covered by the Program. These estimates are shorter than others in the literature because they account for variability in characteristics of the exposure and the person such as underlying medical conditions, which can affect the time it takes for cancers to develop. Applying longer latency assumptions, such as 10 years, to this analysis, or applying them using different statistical methods, could result in alternative conclusions, especially because the employee population was relatively small.

Understanding Next Steps

This evaluation was focused on answering specific questions about whether an exposure was present in the workplace at levels known or thought to cause cancer and, independently, whether an unusual pattern of cancer exists among employees. Similar to the steps outlined by CDC to address community concerns about unusual patterns of cancer, it is helpful to answer these initial questions to decide on next steps. This phased approach allows public health practitioners to share information with the community throughout the process and work with the affected community to determine whether additional evaluation is possible and useful. On the basis of the findings of this evaluation, we have provided recommendations to assist: (1) individuals in identifying next steps by working with their personal healthcare providers and (2) the university in identifying next steps for the greater university community.

Considerations for Individuals

Because it remains unclear whether employees were exposed to levels of PCBs associated with adverse health effects, individuals who spent time in the building may understandably be concerned about how their health may have been affected. We did not find any specific cancer screening recommendations for individuals who might have been exposed to PCBs. In addition, interpreting levels of PCBs in blood is difficult; such testing is only suggested to be considered in persons with signs and symptoms suggestive of a high level of PCB exposure [ATSDR 2024]. Further, no known consistent causal associations exist between PCB levels in the blood and specific adverse health effects, making this information unlikely to affect clinical decisions. Below is information about the cancer types we included in this evaluation and current screening recommendations. We are providing this information to help inform employees and encourage them to have conversations with their healthcare providers about what screenings are appropriate for them based on their personal risk factors.

Melanoma

Melanoma makes up approximately 1% of skin cancers but causes a majority of deaths from skin cancer [ACS 2026]. In 2026, it is estimated that 112,000 new cases of melanoma will be diagnosed and approximately 8,510 people are expected to die from melanoma in the United States [ACS 2026]. Exposure to UV light, most commonly from the sun, is the major risk factor for melanoma. Other risk factors include having many or atypical moles, lighter skin, hair and eye color, family or personal history, weakened immune system, age, male sex, and xeroderma pigmentosum (a rare inherited condition associated with lower ability to repair DNA damage) [ACS 2023]. Limited evidence is available to guide screening for melanoma or skin cancer among the general population. The U.S. Preventive Services Task Force (USPSTF) states there is insufficient evidence to determine whether a visual skin examination by a clinician should be recommended [USPSTF 2023]; no U.S. professional organizations recommend skin cancer screening performed by a clinician for the general population [Henrikson et al. 2023]. Because skin cancer in general, including melanoma, is treatable when diagnosed early, the American Academy of Dermatology (AAD) recommends that people regularly conduct skin self-exams and consult a dermatologist about their individual skin cancer risk [AAD 2023]. More information about performing skin self-exams can be found on the American Academy of Dermatology webpage.

Breast Cancer

Breast cancer is the most common cancer among women in the United States (excluding non-melanoma skin cancer) and is the second leading cause of cancer death among women [ACS 2026; CDC 2025]. It is much rarer in men. In 2026, it is estimated that 321,910 new cases of invasive breast cancer will be diagnosed in women in the United States and approximately 42,140 women are expected to die from the disease [ACS 2026]. For men in the United States, 2,670 new cases and 530 deaths are estimated in 2026 [ACS 2026]. The lifetime risk of developing breast cancer for a woman in the United States is about 1 in 8, or approximately 12%–13%. Key risk factors for breast cancer include age, sex, family history of breast cancer, genetic mutations (such as *BRCA1* and *BRCA2*), lifestyle factors like alcohol consumption, other socioeconomic factors such as higher educational and income levels, reproductive factors, obesity, and certain types of hormone replacement therapy. Although less common, studies have shown that some occupational exposures, such as those to certain carcinogens and endocrine disruptors in industry sectors like plastics and textiles, can increase risk [Brophy et al. 2012; Fenga 2016]. Screening

can lead to earlier detection, when breast cancer is easier to treat. For example, the USPSTF recommends mammography for screening every 2 years for women aged 40–74 years at average risk for breast cancer [USPSTF 2024]. However, the recommendations do not apply to women at high risk (e.g., those with *BRCA1* and *BRCA2* variants) or who have a history of high-dose chest radiation or breast cancer [USPSTF 2024]. In addition, other professional organizations have slightly different screening recommendations [Cadet et al. 2025]. Thus, decisions about screening are best made though discussion with a healthcare provider who is familiar with a person's unique circumstances.

Considerations for the University

Consistent with CDC guidance for evaluating cancer concerns, it is important to consider the feasibility of next steps and how they will inform action. Considering feasibility and utility is vital because information needed to perform a more detailed study to identify an association between a specific exposure and adverse health outcomes may or may not be available. It is also necessary to consider whether having additional information about whether an association exists between a specific exposure and adverse health outcomes would change the recommendations provided based on currently available information. Understanding what information is available, whether further study is possible, and whether the findings of such a study would inform action, will allow for the most efficient and effective use of time and resources.

From the evaluations conducted to date, clear action can be taken to reduce potential opportunities for future exposure to the building and minimize potential adverse health outcomes among those who spent time in the building. To reduce potential for future exposure, as publicly communicated by university representatives, the university is working with consultants and agencies such as the EPA on plans for building remediation and reconstruction. Further, individuals who spent time in the building might benefit from following existing cancer screening recommendations applicable to their personal risk factors, which can help find and treat some types of cancer early, reducing the chance that it spreads or becomes more serious.

Although the NIOSH Health Hazard Evaluation (HHE) Program responds to many requests to evaluate cancer concerns in workplaces each year [Shi et al. 2024], a feasibility assessment and any further study would need to be led by another agency or subject matter expert. A feasibility assessment would extend beyond NIOSH's scope of work. For example, a feasibility assessment would likely include an assessment about whether students or other visitors to the building should be included in future work and whether information needed to assess their potential exposure and health outcomes is available. Therefore, other agencies or subject matter experts who are not limited to the worker population may be better equipped to lead this effort. However, NIOSH scientists remain available to discuss the findings and recommendations presented in this report and answer questions about occupational health with university and employee representatives as well as a committee convened to help inform next steps.

Limitations and Strengths

The NIOSH HHE Program is authorized under the Occupational Safety and Health Act of 1970, which limits its scope to workplace health and safety. Thus, non-employee students and visitors who spent time in the building were not included in the HHE. However, employees are a group who likely

spent the most time in the building and had the most complete and readily available documentation indicating time spent in the building. Therefore, although the findings presented here may not be generalizable to non-employee students or visitors, focusing on employees allowed us to focus on a population with well-documented potential for having spent time in the building.

Because we used human resources records regarding office assignments to identify who spent time in the building, it is likely that we did not include groups of workers who spent time in but did not have an assigned workspace in the building. This may include custodial, janitorial, or maintenance staff, as well as faculty, staff, or student workers spending time in the building for specific activities (e.g., classes or laboratory work). Although this is an important limitation, we used the best data available at the time to conduct this evaluation.

Although cancer is common, the occurrence of specific types of cancer in a relatively small, healthy working-age population can be rare. In addition, many types of cancer can take a long time to develop. In this evaluation, the number of employees was relatively small compared with the population living in a geographical area such as a county or state. In addition, the population and amount of follow-up time for employees was limited by the availability of reliable information on working in the building and the development of cancer. These characteristics can result in variability in the occurrence of cancer between populations, and reduced precision around SIRs, which may make interpretation of comparisons in the occurrence of cancer challenging. The relatively small number of cancer cases, especially when stratified by sex and time period, also limited our ability to look at additional factors. Any future analysis could consider whether additional data are available to begin follow-up earlier or extend follow-up further to help reduce concerns about the effect of these challenges on findings.

Limitations in the types of information available for the evaluation may have affected our results and should be considered when interpreting the findings presented here. For example, the state's cancer registry does not have information about cancer diagnosed in residents of other states. This means that employees who did not live in the state at the time of their cancer diagnosis (e.g., employees who commute from a neighboring state or have moved away after leaving the university) would not be identified as meeting the case definition. We do not know how many employees were non-residents of the state and whether or not they have been diagnosed with cancer. In addition, NIOSH and the state cancer registry do not have information about when employees might have moved out of the state. If this information were available, we would have ended follow-up for such an employee in the year they moved away, reducing the amount of person-time included in the analysis, or considered obtaining cancer information from other state registries. The Social Security Administration [2025] notes that the Death Master File is not a comprehensive record of all deaths in the country. Thus, it is possible that we have misclassified persons who have died as remaining alive. The effect of this misclassification would be that follow-up would not have ended appropriately, leading to additional accrual of person-time when the employee was not at risk of developing cancer. Each of these limitations could result in an underestimate of the number of cancer cases or an overestimate in the person-time we followed employees, making it more difficult to detect an excess of cancer if one exists. More rarely, persons who are alive might have been erroneously added to the Death Master File, leading to the opposite effect if they happened to also be an employee on the roster.

In addition, limitations of epidemiologic and statistical methods may have affected our results. First, we observed small numbers of cases among certain groups of employees. This resulted in imprecise estimates, meaning there are a wide range of values that may be a true estimate of the burden of a particular cancer type. Second, use of a 4-year latency assumption may overestimate the number of observed cancer cases plausibly related to a common workplace exposure. Using a longer latency assumption, such as 10 years, could have effects on the magnitude of the SIRs or reduce their precision, which could lead to alternative conclusions, such as a finding of no excess of cancer. Third, we received aggregate data about cases from the cancer registry in an effort to provide results as quickly as possible and protect employee privacy. Because we used broad age groupings for observed cases, there could be residual confounding by age affecting our results, potentially in either direction. We calculated expected cases using finer age categories to try to reduce bias as much as possible. In addition, as previously described we did not have information about cancer stage at diagnosis. Cancer stage at diagnosis may have been helpful in understanding whether the elevated rates seen here were a result of increased cancer detection at earlier stages among employees because of better access to medical care and cancer screening, as opposed to a true excess. Staging information would be important to consider in any future epidemiologic study, as it could fully or partially explain differences in the occurrence of cancer among employees and residents of the state.

Finally, we did not have individual-level information about PCB exposure or time spent in the building. Instead, we had to rely on dates of employment at the university, a crude proxy for when exposure plausibly could have begun and ended. It is possible that university employment start date did not accurately indicate when an employee began spending time in the building. This may have biased results in different ways, which limits our ability to interpret these findings. In addition, although we had information about when employment ended, we did not look at whether excess cancer existed by categories of employment duration. We did not evaluate this for two reasons: (1) in the university setting, employment duration may not be an accurate proxy for amount of time spent in the building and therefore, a poor proxy for potential exposure, making results difficult to interpret; and, (2) the number of cases of each type of cancer was relatively small, limiting our ability to consider additional categorizations for analysis. Although these are limitations of the present analysis, determining what types of exposure assessment information are available is something that could be addressed during a feasibility assessment. We also did not have individual-level information about employees such as smoking history or sun exposure, which could confound our results.

Nonetheless, this evaluation had several strengths. The university provided a roster that included former as well as current employees, which allowed us to include a longer period of follow-up than possible if only current employees were included. The use of cancer registry data for case ascertainment provides a more complete picture of cancer experienced by employees during this period than other methods of case ascertainment, despite the limitations noted above. Focusing on employees as the population and cancer types most associated with PCB exposure in scientific literature as health outcomes helps increase the ability to detect an excess of cancer cases if one exists. This is because employees likely have the clearest documentation of having spent time in the building, and therefore, if a building exposure was related to cancer, we would be more likely to be able to see an elevated rate of cancer if one existed.

Conclusions

This evaluation suggests that the incidence of melanoma, and possibly breast cancer, was greater than expected based on statewide rates during the period evaluated, mainly among female employees assigned to the building. However, NIOSH cannot draw conclusions about the causes of these cancers among employees based on this information alone. The excesses of cancer observed here may be due to many different factors, including differences in access to cancer screening and medical care between employees and the general population. These results begin to address employee and university concerns about the potential for exposure to PCBs in the building and the occurrence of cancer among employees, indicate steps that affected individuals can take, and support the need to consider whether further investigation of the potential for exposure over time and health effects among building occupants is possible and would substantially benefit the university community.

Section C: Tables

Table C1. Demographics of employees who worked in the building during 1995–2022 (N = 4,660)

	N	%
Gender		
Female	3,229	69
Male	1,431	31
Age, years at start of employment, median (range)	27 (16–79)	
Age categories		
<40	3,776	81
40–64	837	18
≥65	47	1
Employee type*		
Faculty	219	5
Staff	2,509	54
Postdoctoral fellow	27	<1
Graduate student worker	1,452	31
Undergraduate student worker	1,324	28
Duration of employment, years (median, range)	2 (<1–52)	

* Employees can be counted in more than one category; counts do not sum to the total and percentages do not sum to 100%.

Table C2. Observed and expected cases and standardized incidence ratios (95% confidence intervals) for melanoma, breast cancer, and non-Hodgkin lymphoma among university employees assigned to the building at any point during 1995–2022 presented by time period

Melanoma

	All cases			4-year latency assumption applied		
Time Period	Observed N	Expected N	SIR (95% CI)*	Observed N	Expected N	SIR (95% CI)*
1995–2022	30	12.44	2.41 (1.63, 3.44)	23	10.10	2.28 (1.44, 3.42)
1995–2009	8	2.39	3.35 (1.44, 6.59)	6	1.44	4.17 (1.52, 9.09)
2010–2022	22	10.94	2.01 (1.26, 3.04)	17	9.60	1.77 (1.03, 2.83)

Breast cancer

	All cases			4-year latency assumption applied		
Time Period	Observed N	Expected N	SIR (95% CI)*	Observed N	Expected N	SIR (95% CI)*
1995–2022	76	60.25	1.26 (0.99, 1.58)	64	50.26	1.27 (0.98, 1.63)
1995–2009	17	12.12	1.40 (0.82, 2.25)	15	7.66	1.96 (1.10, 3.23)
2010–2022	59	49.59	1.19 (0.91, 1.53)	49	44.03	1.11 (0.82, 1.47)

Non-Hodgkin lymphoma

	All cases			146-day latency assumption applied		
Time Period	Observed N	Expected N	SIR (95% CI)*	Observed N	Expected N	SIR (95% CI)*
1995–2022	5	8.32	0.60 (0.19, 1.40)	5	8.22	0.61 (0.20, 1.42)
1995–2009	—	—	0.55 (0.01, 3.06)	—	—	0.57 (0.01, 3.14)
2010–2022	—	—	0.62 (0.17, 1.59)	—	—	0.63 (0.17, 1.61)

SIR = standardized incidence ratio

CI = confidence interval

— = case counts suppressed for confidentiality

* The SIR is the ratio of the number of observed cases among employees to the number of cases expected if the employees experienced the same cancer rates as the general population of the state.

Table C3. Observed and expected cases and standardized incidence ratios (95% confidence intervals) for melanoma, breast cancer, and non-Hodgkin lymphoma among university employees assigned to the building at any point during 1995–2022 presented by sex and time period

Melanoma

Female	All cases			4-year latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	18	7.33	2.46 (1.45, 3.88)	15	5.71	2.63 (1.47, 4.33)
1995–2009	6	1.38	4.35 (1.59, 9.47)	5	0.77	6.50 (2.09, 15.16)
2010–2022	12	6.50	1.85 (0.95, 3.23)	10	5.51	1.81 (0.87, 3.34)

Melanoma

Male	All cases			4-year latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	12	5.11	2.35 (1.21, 4.10)	8	4.39	1.82 (0.78, 3.59)
1995–2009	—	—	1.98 (0.22, 7.14)	—	—	1.50 (0.02, 8.33)
2010–2022	10	4.44	2.25 (1.08, 4.14)	7	4.09	1.71 (0.69, 3.53)

Breast cancer

Female	All cases			4-year latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	74	60.04	1.23 (0.97, 1.55)	63	50.07	1.26 (0.97, 1.61)
1995–2009	17	12.07	1.41 (0.82, 2.26)	15	7.63	1.97 (1.10, 3.24)
2010–2022	57	49.42	1.15 (0.87, 1.49)	48	43.88	1.09 (0.81, 1.45)

Breast cancer

Male	All cases			4-year latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	—	—	9.33 (1.05, 33.68)	—	—	5.28 (0.07, 29.39)
1995–2009	—	—	NC	—	—	NC
2010–2022	—	—	11.89 (1.34, 42.92)	—	—	6.34 (0.08, 35.27)

Non-Hodgkin lymphoma

Female	All cases			146-day latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	—	—	0.22 (0.00, 1.21)	—	—	0.22 (0.00, 1.23)
1995–2009	—	—	NC	—	—	NC
2010–2022	—	—	0.28 (0.00, 1.54)	—	—	0.28 (0.01, 1.55)

Non-Hodgkin lymphoma

Male	All cases			146-day latency assumption applied		
	Observed	Expected		Observed	Expected	
Time Period	N	N	SIR (95% CI)*	N	N	SIR (95% CI)*
1995–2022	—	—	1.08 (0.29, 2.76)	—	—	1.09 (0.29, 2.78)
1995–2009	—	—	1.12 (0.01, 6.22)	—	—	1.14 (0.01, 6.35)
2010–2022	—	—	1.07 (0.22, 3.13)	—	—	1.08 (0.22, 3.15)

SIR = standardized incidence ratio; CI = confidence interval

— = case counts suppressed for confidentiality; NC = not calculated due to small numbers

* The SIR is the ratio of the number of observed cases among employees to the number of cases expected if the employees experienced the same cancer rates as the general population of the state.

Section D: Occupational Exposure Limits

NIOSH investigators refer to mandatory (legally enforceable) and recommended occupational exposure limits (OELs) for chemical, physical, and biological agents when evaluating workplace hazards. OELs have been developed by federal agencies and safety and health organizations to decrease the risk of adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure that most employees may be exposed to for up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects.

However, not all employees will be protected if their exposures are maintained below these levels. Some may have adverse health effects because of individual susceptibility, a preexisting medical condition, or a hypersensitivity (allergy). In addition, some hazardous substances act in combination with other exposures, with the general environment, or with medications or personal habits of the employee to produce adverse health effects. Most OELs address airborne exposures, but some substances can be absorbed directly through the skin and mucous membranes.

Most OELs are expressed as a time-weighted average (TWA) exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limits (STEL) or ceiling values. Unless otherwise noted, the STEL is a 15-minute TWA exposure. It should not be exceeded at any time during a workday. The ceiling limit should not be exceeded at any time.

In the United States, OELs have been established by federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits; others are recommendations.

- OSHA, an agency of the U.S. Department of Labor, publishes permissible exposure limits [29 CFR 1910 for general industry; 29 CFR 1926 for construction industry; and 29 CFR 1917 for maritime industry] called PELs. These legal limits are enforceable in workplaces covered under the Occupational Safety and Health Act of 1970. The Occupational Safety and Health Act requires employers to provide a safe workplace.
- NIOSH recommended exposure limits (RELs) are recommendations based on a critical review of the scientific and technical information and the adequacy of methods to identify and control the hazard [NIOSH 2020a]. NIOSH RELs are published in the NIOSH Pocket Guide to Chemical Hazards [NIOSH 2007]. NIOSH also recommends risk management practices (e.g., engineering controls, safe work practices, employee education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects.
- Another set of OELs commonly used and cited in the United States includes the threshold limit values or TLVs, which are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH TLVs are developed by committee members of this professional organization from a review of the published, peer-reviewed literature. TLVs are not consensus standards. They are considered voluntary exposure guidelines for use by industrial

hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2025].

Outside the United States, OELs have been established by various agencies and organizations and include legal and recommended limits. The Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance) maintains a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the United States. The database contains international limits for more than 2,000 hazardous substances and is updated periodically

OSHA (Public Law 91-596) requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm. This is true in the absence of a specific OEL. It also is important to keep in mind that OELs may not reflect current health-based information.

When multiple OELs exist for a substance or agent, NIOSH investigators generally encourage employers to use the lowest OEL when making risk assessment and risk management decisions.

PCBs

Background

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 chlorinated compounds that were manufactured in the United States from 1929 to 1979, most commonly marketed under the trade name Aroclor [ATSDR 2000; EPA 2025c].* Aroclors are often characterized by a four-digit code number. The first two digits denote the type of compound, ("12" indicating biphenyl), and the latter two digits give the weight percentage of chlorine, with the exception of Aroclor 1016. In other commercial preparations, the number code may indicate the approximate mean number of chlorine atoms per PCB molecule (Phenoclor, Clophen, Kanechlor) or the weight percentage of chlorine (Fenclor). PCB mixtures found in the environment differ in composition from the commercial mixtures because of partitioning, biotransformation, and bioaccumulation [EPA 1996].

PCBs were widely used because they are heat stable; resistant to chemical oxidation, acids, bases, and other chemical agents; and stable to oxidation and hydrolysis in industrial use. Additionally, they possess favorable dielectric properties; have low solubility in water, low flammability, low vapor pressure at ambient temperatures; and display viscosity temperature relationships suitable for a wide range of industrial applications. PCBs have been used commercially for many products, including insulating fluids in electrical equipment, hydraulic fluids, heat transfer fluids, lubricants, plasticizers, and components of surface coatings and inks [ATSDR 2000].

* NIOSH names commercial products in this report for accuracy and trade recognition purposes, but this does not constitute an endorsement of any product by NIOSH, CDC, HHS or the federal government.

Health Effects

Exposure to PCBs may occur through inhalation, ingestion, or skin contact. PCBs are lipid soluble and primarily deposit in adipose tissue, the liver, and kidneys. Exposures to high concentrations of PCBs may cause skin conditions such as acne and rashes. Chronic inhalation exposure to PCBs has been reported to result in respiratory tract symptoms, such as cough and tightness of the chest, gastrointestinal effects including anorexia, weight loss, nausea, vomiting, abdominal pain, mild liver effects, and effects on the skin and eyes such as chloroacne, skin rashes, and eye irritation [ATSDR 2000]. Tests exist to measure PCB levels in blood, body fat, and breast milk. However, the tests cannot determine when or how long persons were exposed or whether they will develop health effects [ATSDR 2014].

NIOSH considers PCBs potential occupational carcinogens [NIOSH 1977]. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens [ATSDR 2000]. In 1996 at the direction of Congress, EPA completed a reassessment of PCB carcinogenicity, which was peer reviewed by 15 experts on PCBs who agreed that PCBs are probable human carcinogens. The EPA reassessment concluded that the type of PCBs likely to be bioaccumulated in fish and in sediments is the most carcinogenic mixture [EPA 2025c]. In 2015, IARC published a monograph reporting its determination that PCBs are carcinogenic to humans (Group 1) [IARC 2015].

Airborne Exposure

The NIOSH REL for PCBs is 1 μg/m^3 determined as a TWA for up to a 10-hour workday, 40-hour workweek [NIOSH 1986]. This REL was based on the findings of adverse reproductive effects in experimental animals, on the conclusion that PCBs are carcinogens in rats and mice (and therefore potential human carcinogens in the workplace) and on the conclusion that human and animal studies have not demonstrated a level of exposure to PCBs that will not subject the worker to possible liver injury [NIOSH 1977]. The NIOSH REL also includes a "skin" notation. It is a hazard-specific notation identifies specific hazards posed by skin exposure, which in the case of PCBs include direct effects on skin and systemic toxicity [NIOSH 2020b, 2022].

The OSHA PEL is 1,000 μg/m^3 for airborne PCB containing 42% chlorine (Aroclor-1242) and 500 μg/m^3 for chlorodiphenyl products containing 54% chlorine (Aroclor-1254), determined as 8-hour TWA concentrations (29 CFR 1910.1000) [OSHA 2016]. The OSHA PEL includes a "skin" notation, which refers to the potential contribution to overall exposure by the cutaneous route, including the mucous membranes and eyes, by either airborne or direct skin contact with PCB.

ACGIH has a TLV for Aroclor-1254 of 500 μg/m^3 in air expressed as a TWA, which represents the concentration of a substance to which most workers can be exposed without adverse effects [ACGIH 2025].

Surface Exposure

Results of several investigations of PCB surface contamination in office buildings conducted during the 1980s indicate that there was a "background" level of surface contamination in the range of 0.5 to 1 μg/100 cm^2 [NIOSH 1987a,b,c]. During this period, NIOSH investigators recommended that PCB contamination not exceed 1 μg/100 cm^2 (the lowest feasible level considering background

contamination) for surfaces in the occupational environment that may be routinely contacted by the unprotected skin [NIOSH 1990]. Today, current background levels of PCBs in office buildings may be lower due to restrictions on the use of items containing PCBs, the removal of PCB-containing materials during renovation, and the passage of time.

Section E: References

AAD [2023]. AAD statement on USPSTF recommendation on skin cancer screening. Schaumburg, IL: American Academy of Dermatology, https://www.aad.org/news/aad-statement-uspstf-cancer-screeening.

ACGIH [2025]. TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, https://www.acgih.org/tlv-bei-guidelines/policies-procedures-presentations/.

ACS [2023]. Risk factors for melanoma skin cancer. Atlanta, GA: American Cancer Society, https://www.cancer.org/cancer/types/melanoma-skin-cancer/causes-risks-prevention/risk-factors.html.

ACS [2026]. Cancer facts & figures 2026. Atlanta, GA: American Cancer Society, https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/annual-cancer-facts-and-figures/2026/2026-cancer-facts-and-figures.pdf.

ATSDR [2000]. Toxicological profile for polychlorobiphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, https://www.atsdr.cdc.gov/ToxProfiles/tp17.pdf.

ATSDR [2011]. Addendum to the toxicological profile for polychlorobiphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, https://www.atsdr.cdc.gov/toxprofiles/pcbs_addendum.pdf.

ATSDR [2014]. ToxFAQs™ for polychlorobiphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, https://www.atsdr.cdc.gov/toxfaqs/tfacts17.pdf.

ATSDR [2024]. Clinician brief: PCBs. Atlanta, GA: U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, https://www.atsdr.cdc.gov/environmental-medicine/hcp/clinicianbriefpcbs/index.html#cdc_generic_section_6-clinical-evaluation.

Bertke S, Kelly-Reif K [2024]. Introducing LTASR, a new package based on the NIOSH Life Table Analysis System. Occup Environ Med *79*(11):792, https://doi.org/10.1136/oemed-2022-108462.

Brophy JT, Keith MM, Watterson A, Park R, Gilbertson M, Maticka-Tyndale E, Beck M, Abu-Zahra H, Schneider K, Reinhartz A, Dematteo R, Luginaah I [2012]. Breast cancer risk in relation to occupations with exposure to carcinogens and endocrine disruptors: a Canadian case-control study. Environ Health *11*:87, http://doi.org/10.1186/1476-069X-11-87.

Cadet MJ, Ajay G, Drago CI, Stelmark J [2025]. Understanding recommendations from various breast cancer screening guidelines. J Nurse Pract *21*(1), https://doi.org/10.1016/j.nurpra.2024.105238.

CDC [2022]. Unusual patterns of cancer, the environment, and community concerns. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, https://www.cdc.gov/cancer-environment/php/guidelines/index.html.

CDC [2025]. Breast cancer statistics. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, https://www.cdc.gov/breast-cancer/statistics/index.html.

CFR [2025]. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register, https://www.ecfr.gov/.

EPA [1996]. Polychlorinated biphenyls (PCBs); CASRN 1336-36-3. Washington, DC: U.S. Environmental Protection Agency, https://iris.epa.gov/static/pdfs/0294_summary.pdf.

EPA [2015]. PCBs in building materials—questions & answers. Washington, DC: U.S. Environmental Protection Agency, https://www.epa.gov/sites/default/files/2016-03/documents/pcbs_in_building_materials_questions_and_answers.pdf.

EPA [2021]. PCBs in building materials: determining the presence of manufactured PCB products in buildings or other structures. Washington, DC: U.S. Environmental Protection Agency, https://www.epa.gov/sites/default/files/2021-05/documents/final_pcb_buildings_fact_sheet_05-10-2021_to_upload.pdf.

EPA [2025a]. Exposure levels for evaluating polychlorinated biphenyls (PCBs) in indoor school air. Washington, DC: U.S. Environmental Protection Agency, https://www.epa.gov/pcbs/exposure-levels-evaluating-polychlorinated-biphenyls-pcbs-indoor-school-air.

EPA [2025b]. Fact sheet: performance-based cleanup and disposal under section 761.61(b). Washington, DC: U.S. Environmental Protection Agency, https://www.epa.gov/pcbs/fact-sheet-performance-based-cleanup-and-disposal-under-section-76161b.

EPA [2025c]. Learn about polychlorinated biphenyls. Washington, DC: U.S. Environmental Protection Agency, https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls.

Fenga C [2016]. Occupational exposure and risk of breast cancer. Biomed Rep *4*(3):282–292, http://doi.org/10.3892/br.2016.575.

Henrikson NB, Ivlev I, Blasi PR, Nguyen MB, Senger CA, Perdue LA, Lin JS [2023]. Screening for skin cancer: an evidence update for the U.S. Preventive Services Task Force. Evidence Synthesis, No. 225, Chapter 1, Introduction. Rockville, MD: Agency for Healthcare Research and Quality, https://www.ncbi.nlm.nih.gov/books/NBK591450/.

Herrick RF, Stewart JH, Allen JG [2016]. Review of PCBs in US schools: a brief history, estimate of the number of impacted schools, and an approach for evaluating indoor air samples. Environ Sci Pollut Res Int *23*(3):1975–1985, https://doi.org/10.1007/s11356-015-4574-8.

Howard J [2015]. Minimum latency & types or categories of cancer. National Institute for Occupational Safety and Health, https://www.cdc.gov/wtc/pdfs/policies/WTCHP-Minimum-Cancer-Latency-PP-01062015-508.pdf.

IARC [2015]. IARC monographs on the evaluation of carcinogenic risks to humans. Polychlorinated biphenyls and polybrominated biphenyls. Volume 107. Lyon, France: World Health Organization, International Agency for Research on Cancer, https://publications.iarc.fr/131.

Loomis D, Browning SR, Schemch AP, Gregory E, Savitz DA [1997]. Cancer mortality among electric utility workers exposed to polychlorinated biphenyls. Occup Environ Med *54*(10):720–728, https://doi.org/10.1136/oem.54.10.720.

NCI [2024]. Match*Pro Software. Bethesda, MD: National Cancer Institute Surveillance, Epidemiology, and End Results Program, https://seer.cancer.gov/tools/matchpro/.

NCI [2025]. Standardized incidence ratio and confidence levels. Bethesda, MD: National Cancer Institute, Surveillance, Epidemiology, and End Results Program, https://seer.cancer.gov/help/seerstat/equations-and-algorithms/standardized-incidence-ratio-and-confidence-levels.

NIOSH [1977]. NIOSH criteria for a recommended standard: occupational exposure to polychlorinated biphenyls. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-225, https://stacks.cdc.gov/view/cdc/19399/cdc_19399_DS1.pdf.

NIOSH [1986]. Current intelligence bulletin 45: polychlorinated biphenyls (PCB's): potential health hazards from electrical fires or failures. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No.86-111, https://stacks.cdc.gov/view/cdc/209474.

NIOSH [1987a]. Health hazard evaluation and technical assistance report. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-112-1819, https://www.cdc.gov/niosh/hhe/reports/pdfs/1986-0112-1819.pdf.

NIOSH [1987b]. Health hazard evaluation and technical assistance report. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-166-1835, https://www.cdc.gov/niosh/hhe/reports/pdfs/1987-0166-1835.pdf.

NIOSH [1987c]. Health hazard evaluation and technical assistance report. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-472-1832, https://www.cdc.gov/niosh/hhe/reports/pdfs/1986-0472-1832.pdf.

NIOSH [1990]. Health hazard evaluation and technical assistance report. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-0510-2032, https://www.cdc.gov/niosh/hhe/reports/pdfs/1986-0510-2032.pdf.

NIOSH [2007]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149, http://www.cdc.gov/niosh/npg/.

NIOSH [2014]. NIOSH chemical carcinogen policy. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, https://www.cdc.gov/niosh/cancer/about/niosh-chemical-carcinogen-policy.html.

NIOSH [2019a]. NIOSH pocket guide to chemical hazards: chlorodiphenyl (42% chlorine). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149, https://www.cdc.gov/niosh/npg/npgd0125.html.

NIOSH [2019b]. NIOSH pocket guide to chemical hazards: chlorodiphenyl (54% chlorine). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149, https://www.cdc.gov/niosh/npg/npgd0126.html.

NIOSH [2020a]. Current intelligence bulletin 69: NIOSH practices in occupational risk assessment. By Daniels RD, Gilbert SJ, Kuppusamy SP, Kuempel ED, Park RM, Pandalai SP, Smith RJ, Wheeler MW, Whittaker C, Schulte PA. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2020-106 (Revised 03/2020), https://doi.org/10.26616/NIOSHPUB2020106revised032020.

NIOSH [2020b]. NIOSH skin notation profile: chlorodiphenyl (42% chlorine). By Hudson NL. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2021-10, http://doi.org/10.26616/NIOSHPUB2021100.

NIOSH [2022]. NIOSH skin notation profile: chlorodiphenyl (54% chlorine). By Hudson NL. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2022-118, https://doi.org/10.26616/NIOSHPUB2022118.

NTP [2021]. Report on carcinogens, Fifteenth Edition. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, https://doi.org/10.22427/NTP-OTHER-1003.

OSHA [2016]. CFR 1910.1000 Table Z-1 limits for air contaminants. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration, https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000TABLEZ1.

Ozcan BB, Dogan BE, Mootz AR, Hayes JC, Seiler SJ, Schopp J, Kitchen DL, Porembka JH [2024]. Breast cancer disparity and outcomes in underserved women. Radiographics *44*(1):e230090, https://doi.org/10.1148/rg.230090.

Rothman KJ, Boice JD, Jr. [1979]. Epidemiologic analysis with a programmable calculator (NIH Publication 79-1649). Washington DC: U.S. Government Printing Office.

Rothman KJ, Boice JD, Jr. [1982]. Epidemiologic analysis with a programmable calculator, New Edition. Boston, MA: Epidemiology Resources, Inc.

Rugo H [2004]. Occupational cancer. In: LaDou J, ed. Current occupational and environmental medicine. 3rd ed. New York: McGraw Hill Companies, Inc.

Shi DS, Rinsky JL, Grimes GR, Chiu SK [2024]. Health hazard evaluations of occupational cancer cluster concerns: the USA, January 2001–December 2020. Occup Environ Med *81*(2):109–112, https://doi.org/10.1136/oemed-2023-108988.

Silver SR, Whelan EA, Deddens JA, Steenland NK, Hopf NB, Waters MA, Ruder AM, Prince MM, Yong LC, Hein MJ, Ward EM [2009]. Occupational exposure to polychlorinated biphenyls and risk of breast cancer. Environ Health Perspect *117*(2):276–282, https://pmc.ncbi.nlm.nih.gov/articles/PMC2649231/.

Singh SD, Ajani UA, Johnson CJ, Roland KB, Eide M, Jemal A, Negoita S, Bayakly RA, Ekwueme DU [2011]. Association of cutaneous melanoma incidence with area-based socioeconomic indicators–United States, 2004–2006. J Am Acad Dermatol *65*(5 Suppl 1):S58.e51–S58.e12, https://doi.org/10.1016/j.jaad.2011.05.035.

SSA [2025]. Requesting SSA's death information. Baltimore, MD: Social Security Administration, https://www.ssa.gov/dataexchange/request_dmf.html.

USC [2026]. United States Code. Washington, DC: U.S. Government Publishing Office, https://uscode.house.gov/.

USPSTF [2023]. Screening for skin cancer: US Preventive Services Task Force recommendation statement. JAMA *329*(15):1290–1295, https://doi.org/10.1001/jama.2023.4342.

USPSTF [2024]. Screening for breast cancer: US Preventive Services Task Force recommendation statement. JAMA *331*(22):1918–1930, https://doi.org/10.1001/jama.2024.5534.

National Institute for Occupational Safety and Health

NIOSH®

Promoting productive workplaces through safety and health research

HHE®

HHE Report No. 2024-0053-3431