Evaluation of Cancer Concerns Among Employees at a Hospital

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Authors: **Rachael Zacks, MD, MPH**

Mark Methner, PhD, CIH

Duane Hammond, MS, PE

Desktop Publisher: Shawna Watts

Editor: Cheryl Hamilton

Logistics: Joseph Hartwell

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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.

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Availability of Report

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

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Introduction

Request

Employees from a hospital confidentially requested a health hazard evaluation concerning several cases of a rare cancer among hospital employees who worked in a section of the hospital called the Tower. Employees were concerned that helicopter exhaust could be entering the hospital's ventilation systems and contributing to the cancer cases.

Workplace

The workplace was an acute care hospital with about 600 beds and a Level I adult trauma center (highest level of adult care for complex injuries). The hospital provided a full range of inpatient and outpatient medical services and operated 24 hours per day, 7 days per week, supporting emergency, surgical, critical care, and specialty services. The hospital employed about 5,000 people.

The hospital campus consisted of multiple interconnected buildings, including several multistory patient care areas. The area of interest, the Tower, had six levels: a bottom level or terrace that included a cardiac catheterization laboratory and loading dock, the main level or atrium, a second floor (Tower 2) with a cardiac step-down unit, a third floor (Tower 3) with the neurology/trauma step-down unit, and a fourth floor (Tower 4), which included a cesarean step-down unit and maternity. Located above the fourth floor was the penthouse, which housed the outdoor air intakes and heating, ventilation, and air-conditioning (HVAC) equipment serving the hospital. Only maintenance employees could access this area.

The hospital campus had a helipad that was relocated in 2016 from the northeast side of the hospital to the southwest side, between the main level and Tower 2 (Figure 1). The hospital's HVAC systems include four large outdoor air intakes located on the southwest side of the patient care tower, located about 100 to 300 feet from the helipad.

Figure 1. Photo taken from helipad showing the location of four pairs of rectangular outdoor air intake grilles (red arrows) located at the penthouse level on the southwest side of the building. (This photo was altered to remove the name of the hospital on the helipad.) Photo by NIOSH.

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

Our Approach

Following 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:

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

- Met with management and confidential employee requestors regarding the concerns.
- Reviewed the medical records for three identified cases of primary mediastinal B-cell lymphoma (PMBCL), a rare cancer, among hospital employees.
- Reviewed hospital helicopter arrival and departure logs from February–June 2025, a management-run odor complaint log during February–June 2025, and the Occupational Safety and Health Administration (OSHA)'s Form 300 Log of Work-Related Injuries and Illnesses for the past 7 years (2019–2025).
- Reviewed previous computational fluid dynamics (CFD) simulations (computer models of how helicopter exhaust spread) and environmental sampling conducted in 2025.
- Reviewed a list of chemical products used in the Tower and their safety data sheets.

We conducted a site visit at the hospital on September 16 and 17, 2025. During our visit, we completed the following activities:

- We toured multiple work areas and visually inspected the hospital HVAC systems and their parts.
- We continuously measured levels of carbon monoxide, carbon dioxide, and airborne particulates for about 30 hours in several areas of the Tower. We selected the locations based on where employees most often reported odor concerns.
- We held open office hours for both day- and night-shift employees to privately express concerns to a NIOSH medical professional.
- We met with hospital engineering and facilities staff and contractors hired by the hospital to review HVAC system operations. Some of the topics discussed were airflow, building pressure monitoring sensors, air filtration, maintenance practices, and studies of how helicopter exhaust moved around the hospital.
- We met with Employee Health and Safety staff and an indoor environmental quality contractor to review previous air and surface test results. We also learned about actions the hospital had taken to reduce possible exposures. These included sealing areas where air could enter the building and changes made to the hospital's HVAC systems.
- We observed a helicopter arrive and depart from the helipad. We noted its flight path, how close it came to the building air intakes and doorways, the direction of its exhaust on the helipad, and how long it idled before takeoff and after landing.

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

Our Key Findings

We observed that more hospital employees had been diagnosed with a type of rare cancer than expected

- Based on medical records, three hospital employees were diagnosed with PMBCL during 2023–2024. PMBCL is a rare, fast-growing subtype of diffuse large B-cell lymphoma, the most common type of non-Hodgkin lymphoma in the United States.
- Based on national cancer data, about 2 to 3 out of a million people are diagnosed with PMBCL each year. In a workforce of about 5,000 employees, fewer than one case would be expected in a typical year. At this workplace, one employee was diagnosed in 2023 and two employees were diagnosed in 2024.
- We could not draw conclusions about the causes of PMBCL among employees. According to the scientific literature, no specific carcinogens (things that cause cancer) have been associated with PMBCL.

Employees expressed concerns about odors, health effects, and communication

- OSHA 300 Logs described one event in 2024 and another in 2025 related to "chemical irritation from fumes from the vents." One employee in 2025 received care in an emergency department for treatment related to exposure to "helicopter fumes."
- In meetings with a NIOSH medical professional, employees described occasions when they detected "exhaust/fuel-like" odors during their work shift. These employees discussed their concerns that the odors could be related to reports of rare cancers among hospital staff.
- Employees said they felt management was active in finding and correcting the hazard they were concerned about. However, they also said the hospital could improve communication about the evaluation and steps being taken to address their concerns by communicating more information through channels open to all employees.

We found many signs that helicopter exhaust could enter the hospital HVAC systems

- Helicopter arrivals and departures were on a helipad within 100 to 300 feet of outdoor air intakes and some building entrances.
- Employee odor complaints often happened within minutes of helicopter arrivals or departures.
- Air monitoring in four occupied areas of the hospital showed that the number of airborne particles increased and peaked within minutes after a helicopter landed on the helipad before decreasing to background levels within 20 minutes. The number of airborne particles increased to a smaller extent at some locations after the helicopter departed and returned to near-background levels within minutes.

- Airflow modeling showed that helicopter exhaust could reach some hospital air intakes under certain conditions.
- The hospital installed air filters containing activated carbon and potassium permanganate in the outdoor air intakes of the HVAC systems to reduce odors. However, this type of filter may not completely remove helicopter exhaust odors because of limited contact time between the air stream and the filter.
- Loading dock doors were left open even though no trucks were present. The open doors could allow exhaust from both trucks and helicopters to enter and move to different areas. Air curtains were at each door but were not used during our visit, so we were not able to see if the air curtains would stop outdoor air from entering.

Most environmental sampling results showed that exposures were below occupational exposure limits in evaluated areas

- We measured area air levels of carbon monoxide, carbon dioxide, and airborne particulates during our site visit where employees typically worked. All levels were well below recommended guidelines and occupational exposure limits. While these were not personal samples, the measurements were collected in areas where employees typically worked.
- We reviewed a contractor's area air sampling results that showed benzene and formaldehyde, known cancer-causing agents, in some work areas. Benzene exposure has been associated with an increased risk of diffuse large B-cell lymphoma, but not PMBCL, the specific cancer observed in this evaluation. Both chemicals can be produced when aviation or diesel fuel is burned, like in an engine. Formaldehyde may also come from hospital disinfectants. Because these were area samples and not personal breathing-zone samples, we did not compare them with occupational exposure limits.
    - Follow-up full-shift personal air sampling by a contractor detected formaldehyde in some samples. One of 58 samples was above the NIOSH recommended exposure limit, although it was below other occupational exposure limits. The sampling did not detect benzene in any of the personal air samples.
    - Some surface wipe samples collected by the contractor showed the presence of dioxins.

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 this 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 controls 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 OSHA's Recommended Practices for Safety and Health Programs.

Recommendation 1: Consider actions to reduce helicopter or other vehicle exhaust from entering the hospital's HVAC systems

Why? We found signs that suggest helicopter exhaust could enter the hospital through outdoor air intakes and the HVAC systems. The current location of outdoor air intakes near the helipad, combined with high air flow rates into the air handling units, may allow exhaust from helicopter operations to be drawn into the building and distributed to occupied areas.

While the hospital has attempted to reduce these exposures, including installing activated carbon and potassium permanganate air filters and sealing parts of the building, these actions may be limited in keeping exhaust from entering the building.

Our evaluation showed that reducing the chance for exhaust to enter the air intakes would likely be more effective than air filtration alone. One approach is increasing the distance between the helipad and the air intakes. Reducing exhaust at its entry point may provide more consistent and reliable control of indoor air quality.

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

Consider increasing the distance between the helipad and outdoor air intakes. This might include evaluating whether the air intakes or the helipad could be moved to a different location.

- Consider consulting with an engineer experienced with outdoor air dispersion modeling who can conduct CFD modeling to identify the best location of outdoor air intakes in relation to the location of the helipad.
- After completing the CFD modeling study, consider working with a licensed engineering firm experienced with hospital ventilation systems to see if either relocating outdoor air intakes or the helipad is possible. Have the firm develop design options based on the airflow modeling results.
- When considering relocating the air intakes or helipad, choose locations that are away from other potential air pollution sources, reduce the chance that contaminated outdoor air enters the hospital's intake air supply, and meet applicable hospital ventilation codes, standards, and recognized best practices.
- Helicopter operators and hospital leadership might work together to review helicopter arrival and departure paths and, when possible, reduce the amount of exhaust directed toward current or relocated outdoor air intakes.

Consider long-term strategies to reduce the effects of helicopter exhaust on indoor air quality at the source.

- Ask for performance data from the filter manufacturer (ASHRAE 145.2 or the equivalent ISO 10121-2) for the air filters with activated carbon and potassium permanganate. Leadership can use these data to determine if the filters are effective in removing air contaminants such as benzene, formaldehyde, and dioxins under actual ventilation system operating conditions.
- Consider working with air medical service providers to discuss helicopter exhaust concerns, operational practices, and any available options to reduce emissions during ground operations, such as minimizing idling time while on the helipad when possible.
- Consider working with other hospitals that operate helipads to share experiences and strategies related to reducing helicopter exhaust and increasing indoor environmental quality. Also consider combining ideas from emerging lower-emission technologies into long-term planning to help reduce exhaust impacts at the source.

Reduce the potential for vehicle exhaust to enter the hospital at the loading docks.

- Keep the loading dock doors closed when not in use.
- Make sure the air curtains that are installed at each dock door opening are always used when doors are open for loading or unloading trucks. Investigate ways to engage the air curtains automatically when dock doors open (and to turn off when doors are closed) to minimize the dependence on workers turning on and off air curtains manually.
- Limit the amount of time vehicles spend idling when parked at the dock. If possible, designate the loading dock area an "Idle-Free Zone."

Recommendation 2: Continue communicating, reporting, and sharing information with employees about building-related issues

Why? NIOSH frequently finds that management and employees do not always communicate effectively about workplace health concerns and the actions taken to address them. Employees may worry about being singled out or facing negative responses from management or other employees when they speak up about their concerns. Communication is often more effective when management promotes anonymous (nameless) reporting systems and gives employees a clear way to track actions taken to address concerns and report new issues.

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

Consider creating an online location where employees can track ongoing efforts to address workplace concerns.

- The hospital's occupational safety and health committee actively reviewed odor reports submitted through the QR code reporting system. The committee compared those reports with helicopter logs and coordinated efforts to address concerns. However, employees have no way of knowing what actions were being taken and still experienced odors. Having a communication channel employees can easily access and check on the status of the evaluation and corrective actions may help reduce employee frustration or confusion.
- Tell employees to continue using the established QR code odor reporting system to better track odor reports and understand if new efforts to reduce exposures are successful.
- Encourage employees with questions or new workplace health concerns to continue reporting them using anonymous reporting through the established hospital communication channels or by reaching out to supervisors or environmental health and safety staff.

Recommendation 3: Encourage employees to discuss with their healthcare providers any signs or symptoms they have that might be related to PMBCL

Why? Some types of cancer have established risk factors and screening tests. Cancer risk factors are characteristics, conditions, or behaviors that increase the likelihood of developing cancer. Cancer screening tests are used to find cancer before it causes symptoms. Screening can help detect and treat cancer early, reducing the chance for it to spread or become more serious.

Unfortunately, the rarity of PMBCL means that there is little evidence-based research available on specific risk factors. Currently, there is no screening test for this type of cancer. Therefore, encouraging employees to be aware of possible signs or symptoms will be important to facilitate discussions between employees and qualified healthcare providers.

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

Encourage employees to speak with their healthcare providers to determine if their symptoms require further evaluation based on their medical history.

- Provide employees with information about cancer and PMBCL from the American Cancer Society. More information about PMBCL can also be found at the National Comprehensive Cancer Network.
- PMBCL is seen more often in those 30–40 years of age and is more common in women.
- PMBCL is a fast-growing cancer that generally has symptoms similar to a tumor growing in the center of the chest. Symptoms include cough, shortness of breath, or swelling of the head and neck. Employees might consult with a healthcare provider before pursuing any testing as these symptoms can be related to health conditions besides cancer.

Recommendation 4: Encourage employees to discuss their health concerns with a qualified health professional if they are experiencing work-related symptoms

Why? When employees are concerned that workplace exposures may be related to health symptoms or an illness, it can be useful to have a qualified health professional who specializes in workplace-related exposures evaluate their concerns.

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

Encourage employees with work-related health concerns to tell their healthcare providers about them and their work.

- Employees can share a copy of this report with their healthcare provider.
- Employees who need assistance finding a primary care provider can be referred to their health insurance plan for available providers in their area.
- Employees who need assistance finding a specialist in workplace exposures can find occupational medicine healthcare providers through a variety of sources, including the Association of Occupational and Environmental Clinics and the American College of Occupational and Environmental Medicine. In addition, employees can consider using the occupational medicine services provided by their employer.

Supporting Technical Information

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Section A: Workplace Information

Building

The hospital was a Level 1 trauma center (highest level of adult care for complex injuries) that handled helicopter transport of critically ill or injured patients from the local community. The hospital complex included multiple buildings. The building that contained the area of interest, the Tower, was located near a two-lane city street, a parking garage, and a helipad. The Tower had six levels: a bottom level or terrace that included a cardiac catheterization laboratory and loading dock; the main level or atrium; a second floor (Tower 2) with a cardiac step-down unit; a third floor (Tower 3) with the neurology/trauma step-down unit; a fourth floor (Tower 4), which included a cesarean step-down unit and maternity; and a penthouse.

The penthouse, located above Tower 4, housed the heating, ventilation, and air-conditioning (HVAC) systems for the Tower building. These HVAC systems included four penthouse air handling units (AHUs): AHU-100, AHU-101, AHU-102, and AHU-103. Each AHU was associated with two side-by-side outdoor air intakes located on the southwest side of the Tower building just below the roofline. This configuration allowed outdoor air to be drawn directly into the penthouse units. Based on system design drawings and discussions with hospital staff, these AHUs supplied approximately 50,000 cubic feet per minute (CFM) of air each, including approximately 17,000 CFM of outdoor air per unit at the time of our evaluation.

Outdoor air entering the AHUs was mixed with recirculated return air and distributed throughout the building. The return air was routed to the AHUs via a network of return air ducts located throughout the hospital. The exhaust components of the HVAC systems were routed through multiple roof-mounted exhaust fans serving general exhaust, isolation areas, and specialty spaces. The systems were designed to maintain ventilation, temperature, humidity, and pressurization requirements appropriate for a healthcare facility, including maintaining airflow relationships between spaces. A test and balance of the HVAC systems was conducted in December 2024. In February 2025, building pressure monitoring sensors were installed to provide monitoring of airflow and pressurization conditions across all AHUs.

Filtration within the systems included Minimum Efficiency Reporting Value (MERV) 8 panel pre-filters and MERV 15 final filters, located upstream of the AHUs. The hospital installed activated carbon filters treated with potassium permanganate (Model HS-400M, Hydrosil International, Ltd.) as an odor mitigation measure. These filters were replaced approximately 2 weeks prior to our site visit. In addition, a separate AHU serving the cardiac catheterization laboratory expansion (identified as AHU-115) was reported to include high-efficiency particulate air (HEPA) final filters. The HVAC systems operated continuously and served multiple floors of the Tower building through ductwork connected to each AHU. The Tower's HVAC systems outdoor air intakes were located on the southwest side of a patient care tower, ranging approximately 100 feet from the outdoor air intakes closest to the helipad to 300 feet from the outdoor air intakes furthest away from the helipad.

Employee Information

At the time of this evaluation in 2025, approximately 5,000 employees worked in the hospital, including healthcare providers (e.g., physicians, nurses), administrators, laboratorians, and environmental services staff. No union represented employees at this hospital.

History of Issue at Workplace

Employees became concerned about an excess number of rare cancer diagnoses in 2024 when two employees who worked in the Tower were diagnosed with primary mediastinal B-cell lymphoma (PMBCL) within the same year. Employees were concerned that a possible cause for multiple cases of cancer could be related to exposure to fuel or diesel exhaust odors that employees often smelled. Employees reported that intermittent odor complaints of "exhaust" began as far back as 2016 after the hospital helipad was moved to a location adjacent to the emergency department due to expansion and remodeling of the hospital grounds. Employee odor complaints became more consistent after construction on the grounds removed a nearby building in 2023, which changed wind patterns on the campus.

The cancer concern was brought to the attention of leadership in the Employee Health and Safety Department. They began an internal investigation in May 2024. The internal investigation reviewed medication inventory to screen for possible carcinogenic exposures and contacted a consultant to assess potential environmental exposures. In June 2024, a consultant conducted an initial assessment that included area air sampling, dioxin surface wipe sampling, and water testing. Based on initial results, the contractor recommended additional environmental sampling, which was conducted in August and September 2024. In January 2025, management implemented a QR code reporting system to allow employees in the Tower to report any odor complaints. In February 2025, hospital management began to track helicopter arrivals and departures to evaluate if there were any odor patterns that might be associated with helicopter traffic.

In March 2025, employees submitted a confidential health hazard evaluation (HHE) request to assist in the interpretation of previous sampling results and assist management in remediation efforts.

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:

- 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?
- Was exposure to a specific chemical substance or physical agent at levels known or suspected of causing cancer occurring at the workplace?
- 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: Evaluation of Reported Employee Cancer Cases

We reviewed data provided by management of how many individuals had worked in the Tower section of the hospital from 2016–2025, organized by sex and job title.

We reviewed medical records of three known cases of PMBCL provided by management. The employees had given permission for NIOSH to review the medical records. We extracted diagnosis date based on date of confirmed biopsy and reviewed family history of cancer for each employee to see if any type of lymphoma was listed.

We calculated two variables for employees with medical records ("age at diagnosis" and "time between hire date and diagnosis date"). Age at diagnosis in years was estimated by subtracting the employee's diagnosis date from their date of birth. Time between hire date and diagnosis date was estimated by subtracting the employee's diagnosis date from their hire date.

Latency is defined as the time between first exposure to a hazardous agent and clinical recognition of a disease. Latency periods vary by cancer type but are usually estimated to be a minimum of 10–12 years [Rugo 2004]. Some latency estimates are 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]. We calculated the number of years between hire date and diagnosis and compared it with the appropriate latency assumption of 0.4 years for PMBCL.

Results: Evaluation of Reported Employee Cancer Cases

The best estimate of the total number of people who worked at the hospital during the past 10 years (January 2016–December 2025) was 23,022 employees. In the past 10 years, the number of employees who worked at any point in the Tower was 6,845. Of those 6,845 employees, 5,068 (74%) were female, 1,225 (18%) were male, and 552 (8%) had no information available for sex. Nurses made up 26% (1,799/6,845) of the employees working in the Tower.

According to medical records reviewed, all three employees had biopsy-confirmed diagnoses of PMBCL with no known family history of lymphoma. As the cancer cases reviewed were lymphomas, we considered a 0.4-year latency assumption when evaluating whether diagnoses could plausibly be related to a workplace exposure. All the cancer diagnoses met the latency assumption.

The employees with cancer diagnoses were all female, nurses, and diagnosed in their 30s and 40s. All the cancers were diagnosed over 2 years (2023–2024), and the median time between hire date and diagnosis date was approximately 11 years.

We also were told by employees about two additional reported cases of follicular lymphoma among nurses who had previously worked in the Tower. As medical records or contact information for these individuals were not available, we were not able to confirm or extract any additional information.

Methods: Evaluation of Potential Helicopter Exhaust Migration Into HVAC Systems

Record Review

We reviewed all relevant consultant reports provided to us by management for evaluations that occurred in 2024–2025 including indoor environmental quality (IEQ) evaluations (i.e., area air monitoring, personal badge sampling, dioxin wipe sampling) and computational fluid dynamics (CFD) reports.

Additionally, management provided a list of products currently used in the hospital, including fixatives, cleaners, detergents, and tissue adhesives. We reviewed the Safety Data Sheets (SDSs) for 351 products to determine whether those used in the Tower contained dioxin, benzene, or formaldehyde.

Lastly, we reviewed OSHA's Form 300 Log of Work-Related Injuries and Illnesses for the past 7 years (2019–2025) to identify if employees sought emergency care related to exhaust exposure, IEQ, or cancer in the workplace in the past 7 years. We recorded an instance if they identified fumes as the possible workplace exposure.

QR Code Employee Odor Complaint System

We reviewed the form used to capture employee-reported odor complaints. We also reviewed odor complaint logs and helicopter arrival/departure logs provided by management (February–June 2025). For 2 months with different weather conditions and duration since implementation of the QR code system, February and June, we assessed the proportion of helicopter arrival and departure pairs with an associated odor complaint. A pair was determined to be associated with an odor complaint if the "time of odor" recorded in the QR code system was within 5 minutes prior to or 30 minutes after a recorded helicopter arrival or departure time. We also assessed the proportion of odor complaints linked to a helicopter arrival or departure event with the same time parameters.

Site Visit

We conducted a site visit on September 16–17, 2025. Activities during our site visit included the following:

- Observation during a walkthrough of the Tower and helipad.
- Visual inspection of all HVAC systems that serviced areas in the Tower where employees had odor complaints.

- Open office hours for employees to confidentially express concerns to a NIOSH medical professional. The time slots for these discussions were 12–3 p.m. and 8–11 p.m. on September 16, 2025, and 12–3 p.m. on September 17, 2025. This schedule was arranged to accommodate both day and night shifts.
- Measurement of airborne particulate number concentrations using Condensation Particle Counters (CPCs).
- Measurement of common IEQ indicators: carbon monoxide (CO), carbon dioxide (CO_2), temperature (Temp), and relative humidity (RH).

CPC Methodology

We measured airborne particulate number concentration using TSI® Model 3007 CPCs in four locations: the supply/loading dock (TT Supply), cardiac catheterization laboratory hallway (TTCath3Hallway), Tower 2 C pod (T2PodC), and Tower 3 C pod (T3PodC). All CPCs were set to log particle number concentrations every second in the size range of 0.01 to > 1 μm, including ultrafine particles (smaller than 0.1 μm). The data output was expressed as the total number of particles per cubic centimeter (#/cm^3) of sampled air. The instrument was capable of measuring detectable airborne particle concentrations ranging from 0 to 100,000 particles per cm^3.

IEQ Measurements (CO, CO_2, Temp, RH)

We used TSI Q-Trak™ indoor air quality monitors to measure CO, CO_2, Temp, and RH in the same four locations as the CPCs. The monitors were set to log data every 30 seconds.

Results: Evaluation of Potential Helicopter Exhaust Migration Into HVAC Systems

Record Review

Air Sampling Record Review

Stationary area air sampling was conducted at six locations by an IEQ consultant in June 2024 and June 2025 to identify air contaminants at multiple locations within the facility. These are the six locations: loading dock (TT Dock South), cardiac catheterization laboratory (TT North), Tower 2 (South) nurse station, Tower 2 (North) nurse station, Tower 3 (South) nurse station, and Tower 3 (North) nurse station. Using thermal desorption tubes in accordance with U.S. Environmental Protection Agency Method TO-17 [EPA 1999], the samples were analyzed for volatile organic compounds (VOCs), including but not limited to benzene and formaldehyde.

We reviewed the initial area air sampling results collected in June 2024, which identified benzene concentrations of 0.3 parts per billion (ppb) at the loading dock (TT Dock South) and 0.1 ppb at the nursing station in Tower 2 (South). Benzene was not detected at the other sampling locations. In June 2025, benzene was detected at all six sampled locations, including the cardiac catheterization laboratory (TT North) and nurse stations in Tower 2 and Tower 3 (North and South locations). Reported benzene concentrations were similar across all samples at approximately 0.2 ppb. These measurements represent area concentrations of unknown duration and are not directly comparable to occupational exposure limits (OELs), which are based on full-shift personal breathing zone exposures. The generally consistent low-level concentrations in the samples across locations suggest a relatively uniform presence of benzene at low levels during the sampling periods. However, these data are from a limited number of locations and may not capture variability associated with differences in helicopter operations, ventilation conditions, other work areas, or other factors.

Additionally, in June 2024, the IEQ consultant collected area air samples at the same six locations within the facility for formaldehyde. Formaldehyde was detected at or above the NIOSH recommended exposure limit (REL) of 16 ppb on five of the six samples (range: 16 to 28 ppb). The area sample collected at Tower 3 (North) nurse station did not exceed the REL. Area air sampling at these six locations in June 2025 showed that formaldehyde was above the NIOSH REL at the cardiac catheterization laboratory (TT North) (17 ppb) and at the Tower 3 (North) nurse station (23 ppb), but was below the REL at the other sample locations. Helicopter activity on the days of sampling was unknown, which makes it difficult to determine whether the formaldehyde measured in those work locations was related to helicopter exhaust (which can contain formaldehyde) that had entered the building or was possibly from other sources.

Since benzene and formaldehyde were detected in area air samples, the IEQ consultant conducted voluntary full-shift (approximately 12 hours) personal air monitoring for these chemicals on four non-consecutive days in September 2025. This personal air monitoring effort was intended to quantify exposure to these chemicals while concurrently documenting helicopter arrival and departures during the work shift. A total of 58 passive badge air samples were collected on staff across 10 job titles. The majority of samples were collected on nurses, technicians, and managers working in various areas that had reported “fuel/exhaust” type odors. These staff worked in the following areas: cardiac catheterization laboratory, cardiology, loading dock (TT Supply), Tower 2, Tower 3, and Tower 4.

None of the badge samples detected benzene at levels above the analytical limit of detection, which ranged from 0.11 to 0.53 parts per million (ppm) and varied by sample. However, for formaldehyde, 38 of 58 (66%) samples were detected above the limit of detection, which ranged from 0.0035 to 0.016 ppm and varied by sample. One sample (0.021 ppm) exceeded the NIOSH REL. This sample was collected on a nurse in the cardiac catheterization laboratory. However, it should be noted that there was no reported helicopter traffic during that nurse’s shift. For 81% of the samples collected, no helicopter traffic was reported.

Dioxin Wipe Sampling

During an IEQ evaluation in August 2024, the IEQ consultant collected a single surface wipe at each of three locations (cardiac catheterization laboratory, Tower 2, and Tower 3) to determine the presence of dioxins. Results indicated that the cardiac catheterization laboratory surface wipe showed the presence of octochlorodibenzo-p-dioxin (24 picograms [pg] on the surface wipe). Dioxin was not detected at the other two locations. During a follow-up evaluation conducted by the same consultant in June 2025, surface wipe sampling was repeated in the same three areas. Results from this sampling effort indicated that dioxins were present in all three locations, ranging from 22 to 3,600 pg per surface wipe. The report did not indicate the area of surface that was sampled at each location. The lowest sample amount was collected in Tower 3 (heptachlorodibenzo-p-dioxin), and the highest amount was collected in the cardiac catheterization laboratory (octochlorodibenzo-p-dioxin).

CFD Record Review

The hospital provided CFD modeling conducted by consultants, which we reviewed to evaluate the potential for helicopter exhaust to travel from the helipad toward the Tower building's outdoor air intakes. The modeling simulated exhaust dispersion under selected conditions, including different helicopter orientations (tail facing north and south), operating states (idling and takeoff), and wind speeds (9 and 16 miles per hour from the south). Model outputs were presented as dilution ratios, where lower dilution ratios (e.g., 1:1 near the exhaust source, increasing with distance from the source) represented higher concentrations of exhaust in the air plume, and dilution ratios below approximately 2,000:1 were noted as potentially detectable by odor.

Under some modeled conditions, particularly during idling with winds from the south at modeled speeds (approximately 9 and 16 miles per hour) and at specific helicopter orientations, exhaust plumes were shown to travel toward and enter some outdoor air intakes (for example, AHU-100 and AHU-101), while other intakes were not impacted under those specific simulated conditions. Under other conditions, such as higher wind speeds or during helicopter takeoff, the model indicated greater dispersion and reduced potential for exhaust to reach the air intakes, including scenarios where rotor wash directed emissions away from the building. Because the modeling represents specific scenarios based on specific assumptions and a small number of input conditions, the results are not representative of all possible operating or environmental conditions. However, they did provide information on potential routes for helicopter exhaust air movement, potential for the exhaust to enter outdoor air intakes, and variability in impacts across air intakes.

SDS Record Review

We found two products that contained 37% formaldehyde: both were fixatives used in the histology/pathology laboratories. Other products such as cleaners, detergents, and tissue adhesives contained lower amounts of formaldehyde or chemicals that release formaldehyde as they degrade or cure.

We found only one SDS whose product had the potential for containing dioxins. The product, generically known as hexachlorophene, may contain impurities such as dioxins as a result of the manufacturing process. This product was used in the cardiac catheterization laboratory to sterilize equipment. No SDSs we reviewed identified products that contained benzene.

OSHA Logs

OSHA 300 Logs described one event in 2024 and one event in 2025 related to "chemical irritation from fumes from the vents." In December 2024, four employees reported symptoms (e.g., sensation of eyes burning, nausea, palpitations, chest pain) that were described as possible chemical exposures from an unknown source in Tower 2. One of the four employees said the fumes came from the vents. There was no mention of helicopter or diesel exhaust for that event. Additionally, in January 2025, one employee who worked in Tower 2 sought care in the emergency department for treatment of respiratory complaints (e.g., shortness of breath) related to exposure to "helicopter fumes."

QR Code Employee Odor Complaint System

In February 2025, there were 48 helicopter arrivals and departures, with a median of one helicopter arrival and departure per day (range: 0–5 helicopter arrivals and departures). Of the 48 helicopters, 10 (21%) had an odor complaint submitted within 5 minutes prior or 30 minutes after either the helicopter arrival or departure time.

Of the 60 odor complaints submitted in February 2025, 40 (67%) described the type of odor as "helicopter or diesel fumes," "fuel odors," or "unknown synthetic smell" and were associated with a helicopter arrival or departure time.

In June 2025, there were 61 helicopter arrivals and departures, with a median of 2 helicopter arrivals and departures per day (range: 0–8 helicopter arrivals and departures). Of the 61 helicopters, 27 (44%) had an odor complaint submitted within 5 minutes prior or 30 minutes after either the helicopter arrival or departure time.

Of the 92 odor complaints submitted in June 2025, 82 (89%) described the type of odor as "helicopter or diesel fumes" or "fuel odors" and were associated with a helicopter arrival or departure time.

Site Visit

Building Observations

During our site visit, we conducted a walkthrough in multiple areas within the Tower, including patient care areas, corridors, and administrative support spaces where employees had reported odor concerns.

When walking through the loading dock, we observed dock doors left open even though no trucks were present. Air curtains, which are used to prevent the migration of outdoor pollutants into the enclosed loading dock area, were present at each dock door but were not observed to be in use during our visit.

The building consisted of multiple interconnected floors with patient care and administrative support areas served by centralized HVAC systems. Outdoor air intakes for the Tower were located on the southwest side of the building on the penthouse level just below the roofline and in proximity to the helipad. We observed a helicopter arrival and departure during our visit and noted that the helicopter operated near the building and the building's outdoor air intakes. Shortly after the helicopter arrival, we noted reports of odors in indoor areas within the building that coincided with increases in airborne particle number concentrations measured by the CPCs. We also observed that the hospital had recently installed activated carbon filters treated with potassium permanganate in the HVAC systems as well as other mitigation measures including sealing exterior gaps and cracks in the building.

Employee Concerns

During meetings with a NIOSH medical professional, employees described incidents of detecting "exhaust/fuel-like" odors and discussed concerns that the odors could be related to reports of rare cancers among hospital staff. Employees reported positive feedback that management was engaged in efforts to identify and mitigate the perceived hazard. Employees identified communication of the evaluation process and mitigation efforts as an area of improvement for management. They recommended using established online communication channels available to all employees at any time of day as a recommended communication route, instead of only in-person communication during meetings with management.

CPC Results

Figure B1 shows airborne particle number concentrations measured with CPCs at four locations within the tower during a helicopter arrival and departure on September 17, 2025. Following the helicopter's arrival at the helipad, particle number concentrations first increased in the TTCath3 Hallway, followed sequentially by increases at the loading dock (TT Supply), T2PodC, and T3PodC. Particle concentrations at all four locations continued to increase after the helicopter shut down its engine, peaking about 5 to 8 minutes after the helicopter arrived, depending on location. Particle concentrations then gradually decreased over time, returning nearly to background levels when the helicopter departed about 32 minutes after arrival. When the helicopter engine restarted and the helicopter departed using a departure path over the outdoor air intakes, particle number concentrations again showed a brief increase for about 8 minutes across these four locations before returning to background levels.

The timing and order of these increases and subsequent decreases were consistent across the time-synchronized instruments and aligned with helicopter arrival, engine shutdown, restart, and departure events. Historical weather data from the nearest available airport weather station indicated generally light southerly winds (approximately 5–8 miles per hour) during the observed helicopter arrival and departure. These data may not fully represent airflow conditions near the hospital because of local building effects and helicopter rotor wash. Additionally, some management staff visited the cardiac catheterization laboratory hallway a few minutes after the arrival of the helicopter when staff submitted a QR odor log and also noticed a distinct "jet fuel-like" odor.

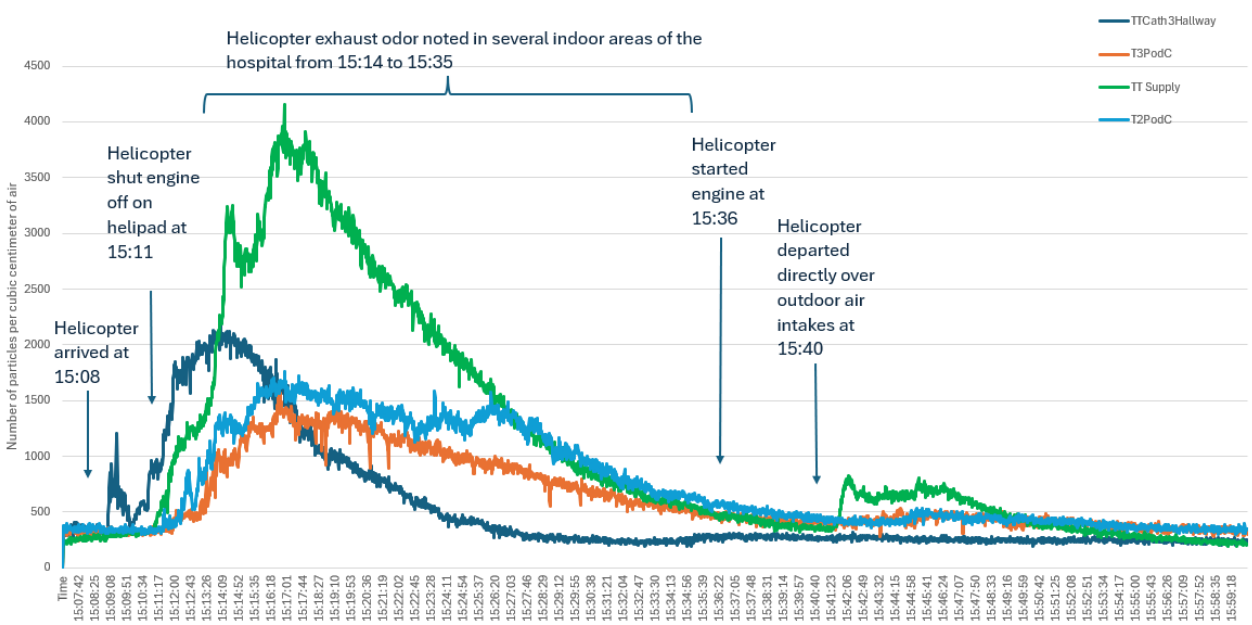

Figure B1. Particle concentrations measured with condensation particle counters at four locations within the hospital during a helicopter arrival and departure on September 17, 2025.

IEQ Measurements (CO, CO_2, Temp, RH)

The direct-reading data logging instrument results are summarized in Table C1. CO concentrations measured at all locations were low, generally at or near zero and no higher than approximately 2 ppm. They were within recommended IEQ guidelines and/or below applicable occupational exposure limits [ASHRAE 2025b; OSHA 2026]. Temp and RH measurements ranged from approximately 67°F–76°F and 43%–68%, respectively, which are generally consistent with ranges described in ASHRAE Standard 170 for healthcare facilities [ASHRAE 2025c]. These measurements represent area conditions and were used to characterize general indoor air quality during the site visit.

Mean CO_2 concentrations varied across the four locations, ranging from 426 to 571 ppm and the short-duration maximum concentration ranged from 701 to 3,709 ppm. All of these were below occupational exposure limits. With the exception of the measurement of 3,709 ppm at T3PodC (which was likely a brief high level from exhaled breath from employee conversation near the measurement probe), all were also within recommended IEQ guidelines. At the T3PodC and T2PodC locations, CO_2 measurements included brief, isolated increases above background levels. These increases were short in duration (less than approximately 90 seconds), did not coincide with helicopter arrivals or departures, and were not observed concurrently at the other monitored locations. CO_2 concentrations at both locations returned quickly to typical background levels following these brief increases. Because the instruments were deployed as unattended area monitors in occupied spaces, we could not determine the specific source of these short-duration increases.

Discussion

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. These questions are shown in the headings below.

After reviewing the available information, we found evidence that employees working in the Tower had an excess of a specific type of cancer, PMBCL, and an unusual distribution of cancer, with multiple employees diagnosed with this rare type of cancer. However, we were unable to determine if any exposure to a specific carcinogen occurred at levels known or suspected of causing cancer due to multiple factors. Reasons included a lack of available research on PMBCL and limitations in environmental sampling methods.

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

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

Yes. We observed evidence that there were more cases of PMBCL across two years (2023 and 2024) than expected based on the occurrence of this cancer in the general population.

Given the limitations in estimating cancer rates in a small working population, we use proportions to give us an idea on whether there may be an excess number of cancer cases among employees at the workplace. Our calculations using proportions make many assumptions that may not be appropriate for every workplace. Of approximately 6,845 employees who worked in the Tower from 2016–2025, five employees reported two different cancer diagnoses. Of those five employees, three had medical records documenting biopsy-confirmed PMBCL, and two were employees with reported diagnoses of follicular lymphoma. Both PMBCL and follicular lymphoma are rare cancers that fall under the larger cancer family of diffuse large B-cell lymphoma (DLBCL).

If we focus on the employees with confirmed diagnoses, three employees with PMBCL corresponds to approximately 0.04% (3/6,845) of employees who worked in the Tower in the last 10 years. A large U.S. population-based analysis found that approximately 2.4 cases per 1,000,000 people were diagnosed with PMBCL in 2018, making the incidence in the general population very low [Zhou et al. 2023]. PMBCL is so rare that one would not necessarily expect to see a single case in a population of approximately 7,000 employees over 10 years. Therefore, three cases within 2 years is a higher-than-expected observed number.

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

Yes. Occupational exposure-related cancer is more likely when employees have been diagnosed with the same type of cancer, related types of cancer, or a rare type of cancer that is not common in the general population. The distribution of cancer among employees who have worked in the Tower does appear unusual due to multiple cases of PMBCL, a rare type of cancer that is not common in the general population.

Although having multiple cases of a rare cancer within a single workplace is unusual, the employees diagnosed with PMBCL share demographic characteristics that align with what is typically observed in this disease. PMBCL most often occurs in females and is commonly diagnosed in people in their 30s and 40s [NCCN 2025]. Because the affected employees fall within these demographic groups, their diagnoses—while notable due to the rarity of the cancer—are consistent with known risk patterns for PMBCL.

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

Possibly. The data contained in the IEQ sampling reports indicate that some carcinogens may be present in the air (formaldehyde, benzene) and on some surfaces (dioxins).

Of the air sampling reports reviewed, only one personal, full-shift, air monitoring sample for formaldehyde exceeded the NIOSH REL. Personal air samples for benzene were below detection limits. The results of area air sampling for benzene indicated that levels were at or below ambient benzene concentrations [Sekar et. al. 2019; Weisel 2010].

Dioxins were found on surface wipe samples collected in the loading dock area, the cardiac catheterization laboratory, and Tower 2. There are no relevant OELs for dioxins on surfaces for comparison.

PMBCL is a rare disease. There are no large-scale epidemiological studies specifically about PMBCL. We found no specific carcinogens in the literature that have been identified as having a causative relationship with PMBCL. We discuss the specifics of these possible carcinogenic exposures below and use literature associated with DLBCL and non-Hodgkin lymphoma (NHL), the larger families of cancer that includes PMBCL, to provide more details on our overall conclusions.

Benzene and Formaldehyde

The International Agency for Research on Cancer (IARC) classifies benzene and formaldehyde as Group 1 carcinogens, its highest designation that means "known to be carcinogenic in humans" [IARC 2006, 2018].

Benzene exposure has been associated with increased risk of NHL and DLBCL in observational studies and meta-analysis [Bassig et al. 2015; Rana et al. 2021]. However, the benzene exposures estimated in those studies were substantially higher than the range of 0.1 to 0.3 ppb measured during the consultant's area air sampling in this hospital. Bassig et al. [2015] modeled estimated benzene concentrations of approximately 1,300–3,400 ppb across job intensity categories. Among studies with reported benzene levels in the meta-analysis by Rana et al. [2021], concentrations varied widely from approximately 13–25,000 ppb.

While reviewing SDSs of products used in the Tower to evaluate possible routes of exposure to benzene, we did not identify any products currently used that could be responsible for benzene presence in the workplace. This finding indicates that the presence of benzene is potentially due to a source or sources external to the interior of the workplace or from a product that does not list benzene on the SDS.

The data for an association between formaldehyde and DLBCL is less clear, as most studies look at an association between the larger family of NHL and not DLBCL specifically. A large meta-analysis found no association between formaldehyde exposure and NHL, with insufficient evidence for a causal link between formaldehyde and lymphohematopoietic cancers due to inconsistent findings and a lack of biological plausibility [Vincent et al. 2024]. The primary rationale for formaldehyde's Group 1 carcinogen designation by IARC is due to its association with nasopharyngeal cancer and possibly leukemia, not lymphoma [IARC 2018].

For formaldehyde, after reviewing the SDSs for products used throughout the facility, we identified some products that contained formaldehyde in varying concentrations (up to 37%). Most of the products that contained formaldehyde were used for disinfection, sterilization, or histology purposes and could contribute to the presence of this chemical in the air within the workplace. Also, the presence of formaldehyde on air samples that were collected when no helicopter arrivals/departures occurred indicates that the products containing formaldehyde could contribute to the overall presence in the air within this workplace.

Products of combustion of Jet A fuel, which is used in helicopters, are potential sources of benzene and formaldehyde in this workplace. Other potential sources are the products of combustion products of diesel fuel. Local sources of diesel exhaust could include the nearby parking garage, traffic from a nearby surface street, the loading dock, or the ambulance bay. In an attempt to better identify the most likely route, we considered both quantitative data as well as the qualitative reports of employee odor complaints of "fuel odors." We noticed odors typically associated with fuel and exhaust odors in the Tower within minutes of the arrival of a helicopter and observed increases in particle number concentrations on the CPC (Figure B1) during helicopter arrival and departure. Furthermore, in conversations with management and employees, helicopters were most often identified as the precipitating factor prior to fuel odor complaints. In summary, evidence suggests helicopter exhaust can enter the building through the HVAC systems via the outdoor air intakes located adjacent to the helipad.

Considered together, this evidence indicates that while there was likely exposure to small amounts of benzene and formaldehyde in the air, the sample results were below relevant OELs. It is unknown how repeated low levels of exposure in the air over time could affect cancer risk or adverse health outcomes in humans.

Dioxins

IARC classifies the dioxin congeners found on the surfaces in the hospital as Group 3 (not classifiable as to their carcinogenicity to humans) [IARC 1997]. Group 3 indicates insufficient evidence to determine carcinogenicity. The only dioxin that IARC considers a Group 1 carcinogen is 2,3,7,8-TCDD (tetrachlorodibenzo-p-dioxin), which was not detected in the surface wipe samples.

Dioxins were detected in some surface wipe samples; however, based on our discussions with the consultant, the sampling procedures used may have differed from established methods, which can affect the interpretation of wipe sampling results. It is important to note that surface deposits of dioxins do not have established OELs. We reviewed the SDSs of cleaning and disinfection products used in the hospital and only one had the potential for containing dioxins. The product, generically known as hexachlorophene, may contain impurities such as dioxins as a result of the manufacturing process. This product was used in the cardiac catheterization laboratory to sterilize equipment. Therefore, it is plausible that the detectable amounts of dioxins may have been collected on surface wipe samples in areas that use this sterilization product. In addition, dioxins can be produced via combustion of Jet A fuel and/or diesel fuel and become an air contaminant. If such an air contaminant infiltrated into an indoor space, it could settle onto surfaces. Overall, since there are multiple possible explanations of why dioxins were detected on surfaces, the exact source of dioxins remains unknown.

Considered together, the findings on dioxin indicate that there was potential for exposure to dioxins on surfaces. There are no OELs for surface dioxins. Also, there is insufficient evidence to determine carcinogenicity of the congeners found in the hospital.

Overall, the available data do not indicate exposures to any carcinogens (benzene, formaldehyde or dioxins) at levels known to cause NHL or DLBCL. However, the presence of benzene in indoor air samples and the potential for intermittent entry of helicopter exhaust into the building suggests that occupational exposures to carcinogens from helicopter exhaust may be occurring among hospital workers. It remains unclear how repeated low exposure to benzene may affect health or DLBCL cancer rates.

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

Yes. 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]. These estimates can be 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]. 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 selected a minimum latency assumption of 0.4 years for lymphoproliferative cancers based on the review of available literature conducted for different groups of cancers by the NIOSH World Trade Center Program [Howard 2015]. By using a conservative minimum latency assumption of 0.4 years, we remained as inclusive as possible in evaluating hospital employees' cancer diagnoses.

It is unclear whether the relocation of the helipad to its current location in 2016 could have led to possible exposure events during helicopter arrivals and departures. Because there was no clear date when exposure began and no clear evidence that occupational exposures to carcinogens occurred at levels known to cause cancer, we estimated latency for the three employees with PMBCL by calculating the time between their hire and cancer diagnosis dates. This approach captured the time the employee was in the workplace. All three cases (100%) had calculated latency estimates greater than the latency assumption of 0.4 years.

Understanding Next Steps

Considerations for Employees

It remains unclear whether employees were exposed to levels of carcinogens associated with adverse health effects, but with the finding of an excess number of a rare type of cancer among the workforce, individuals who worked in the Tower may understandably be concerned about how their health may have been affected. Due to the rarity of PMBCL diagnoses and lack of available research, screening recommendations do not currently exist. Nonetheless, we encourage employees to have conversations with their healthcare providers if they develop signs or symptoms suggestive of a mass in their chest so their provider can appropriately discuss with them next steps based on their personal risk factors.

Considerations for Management

Hospital management has taken several steps to investigate and mitigate the potential for helicopter exhaust entering the building, including sealing portions of the building envelope, upgrading filtration, and engaging consulting firms to conduct multiple rounds of air sampling and perform CFD modeling.

The hospital had installed activated carbon filters treated with potassium permanganate as a mitigation measure intended to reduce chemical constituents of helicopter exhaust entering the building through the HVAC systems. Gas-phase filtration using activated carbon and potassium permanganate relies on adsorption and chemisorption processes, which require sufficient contact time between the contaminated air and the filter media to achieve meaningful contaminant removal.

The effectiveness of adsorption-based filtration depends on multiple factors, including airflow velocity, media depth, residence time, and the chemical characteristics and concentration of the contaminants [ASHRAE 2025a]. Hospital HVAC systems are designed to move large volumes of air at relatively high velocities to meet ventilation, pressurization, and infection control requirements. When gas-phase adsorption media are installed in such systems with limited media depth, residence time within the filter bed is short, which can substantially limit contaminant removal efficiency. The potassium permanganate and activated carbon filters installed at the hospital were relatively thin and were installed in HVAC systems operating at approximately 50,000 CFM of airflow per AHU. Under these conditions, contact time between the airstream and the adsorption media would be limited, reducing the likelihood that chemical constituents of helicopter exhaust (e.g., formaldehyde) would be effectively removed before the air is distributed to occupied areas.

In addition, adsorption media has finite capacity and may experience reduced effectiveness over time as the media becomes saturated. Based on these considerations, the installed potassium permanganate and activated carbon filters may not be effectively removing chemical constituents of helicopter exhaust entering the building through the HVAC systems under current operating conditions.

Despite these efforts, multiple indicators from our evaluation, including review of employee odor reports provided by the hospital, time-synchronized particle number concentration measurements, and review of ventilation systems design, suggest that helicopter exhaust can enter the hospital through outdoor air intakes under the current configuration. The proximity of the helipad to these intakes and the direct intake of outdoor air into high-capacity AHUs may influence this potential pathway. As a result, management may consider additional or alternative engineering approaches that reduce the likelihood of exhaust entering the ventilation systems, such as evaluating alternative locations for outdoor air intakes away from the helipad, modifications to helicopter operating practices, or potential relocation of the helipad if possible. The feasibility and effectiveness of these options would depend on site-specific factors and should be evaluated through appropriate engineering analyses, such as additional airflow modeling and assessment of the impact of any proposed changes on building ventilation performance. A combination of strategies may be needed to reduce the potential for exhaust entry while maintaining required ventilation and operational needs.

Limitations

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, nonemployee patients and visitors who spent time in the hospital were not included in the HHE. Although the findings presented here may not be generalizable to nonemployee patients or visitors, focusing on employees allowed us to focus on a population with well-documented potential for having spent time in the hospital.

Limitations in the types of information available for the evaluation may have affected our results. We acknowledge that additional cases of cancer beyond those considered here may exist. Examples of missed cases could include former employees who left the workplace and their diagnoses were never reported to management. This may mean that there are more employees with PMBCL diagnoses that may have been left out of the evaluation and the actual percentage of employees with cancer is higher.

Direct-reading instruments were deployed as unattended area monitors in occupied spaces. As a result, short-duration changes in measured concentrations may have been influenced by localized activities or conditions near the instruments that we could not directly observe or document. These localized influences could affect short-term measurements without reflecting broader indoor air conditions.

Particle number concentration measurements using the CPC instruments were collected over a limited time period and captured a single helicopter arrival and departure. Helicopter operations, meteorological conditions, building occupancy, and ventilation systems operations can vary over time and may influence the presence, magnitude, and distribution of helicopter exhaust within the hospital. As a result, the conditions observed during our evaluation may not represent all possible operating scenarios or conditions.

We reviewed CFD modeling and prior air sampling conducted by consultants hired by the hospital. Our evaluation of these materials was limited to the scope, assumptions, and conditions represented in the information provided. We did not conduct independent modeling or replicating of the consultant's air sampling, and our conclusions related to these materials are based on our review rather than direct testing.

Although we measured particle number concentrations and other general air quality parameters along with review of contractor data, we did not directly measure specific chemical constituents of helicopter exhaust during helicopter arrivals and departures. Therefore, we could not directly quantify chemical exposures attributable to helicopter exhaust, and our conclusions regarding potential exhaust entry into the hospital are based on multiple indirect indicators rather than direct chemical measurements. Furthermore, the results of any sampling represent a snapshot in time and may not be representative of conditions and exposure across longer periods of time.

Conclusions

This evaluation suggests that the number of cases of PMBCL in employees was greater than expected based on incidence in the general population. However, NIOSH cannot draw conclusions about the causes of this cancer among employees based on this information alone. The excess 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. We found evidence of possible migration of aviation fuel exhaust into the hospital HVAC systems under certain conditions. Therefore, our recommendations focused on considering activities to reduce helicopter exhaust from entering the hospital HVAC systems and avoid the potential for carcinogenic exposure. Engineering controls that reduce the potential for helicopter exhaust to enter the ventilation systems, along with continued communication with employees, are expected to be the most effective strategies for addressing these concerns and promoting the continued health and safety of employees at the workplace.

Section C: Tables

Table C1. Summary of direct-reading air measurements* collected with Q-Trak instruments, September 16–17, 2025

Location	Carbon monoxide (ppm) Mean (Range)	Carbon dioxide (ppm) Mean (Range)	Temperature (°F) Mean (Range)	Relative humidity (%) Mean (Range)
Cardiac Catheterization Laboratory Hallway 3 (TTCath3Hallway)	0.0 (0.0–0.0)	426 (371–701)	69.4 (68.0–71.6)	52.7 (48.9–57.0)
Loading Dock (TT Supply)	0.0 (0.0–0.0)	520 (465–777)	68.8 (67.0–71.2)	54.9 (49.5–67.5)
Tower 2 Pod C (T2PodC)	1.2 (0.0–1.6)	571 (497–1,053)	73.2 (72.1–75.4)	47.6 (43.5–51.1)
Tower 3 Pod C (T3PodC)	0 (0.0–0.4)	481 (393–3,709†)	73.7 (70.5–75.7)	46.5 (43.4–52.8)

ppm = parts per million; °F = degrees Fahrenheit; % = percentage of water vapor in air as relative humidity

*Measurements were collected using direct-reading instruments and represent area conditions, not personal exposures.

†The recorded unusually high result may be due to a localized source of carbon dioxide near the measurement probe (e.g., exhaled breath due to a nearby conversation at the counter).

Section D: References

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