

Human Health Risk Assessment of Mercury Vapors in Wilder Hall

Steven Boomhower, Ph.D.

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Introduction

Steven Boomhower, Ph.D.

- Principal Toxicologist at Gradient (Boston, MA)
- Gradient is a risk science consulting firm committed to excellence in scientific analysis on complex environmental, health, and safety issues

My Qualifications

- PhD, specialized in neurotoxicology
- Began researching the toxicology of mercury compounds in 2013
- Received funding awards from National Institutes of Health (NIH) and National Science Foundation (NSF) for mercury-related research
- Teach courses in toxicology and pharmacology at Harvard University's Division of Continuing Education

Objectives

Gradient Was Hired by Dartmouth to:

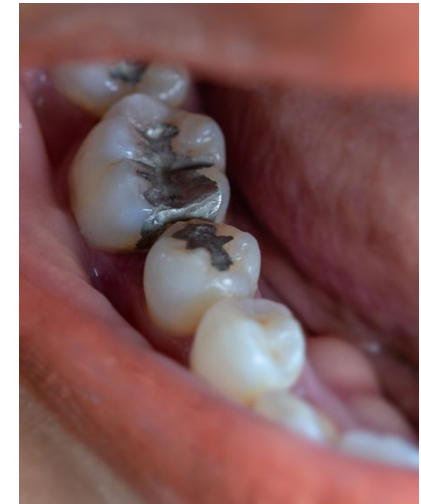
1. Independently review mercury data collected at Wilder Hall in recent years
2. Perform a risk assessment applicable to members of the College community who use the building

My Objectives:

1. Present the available data (note: Gradient report is available)
2. Describe the risk assessment: how it was done, and the results of the analysis
3. Data from Wilder Hall do not indicate that current mercury levels are of concern
4. Answer audience member questions

What is Elemental Mercury?

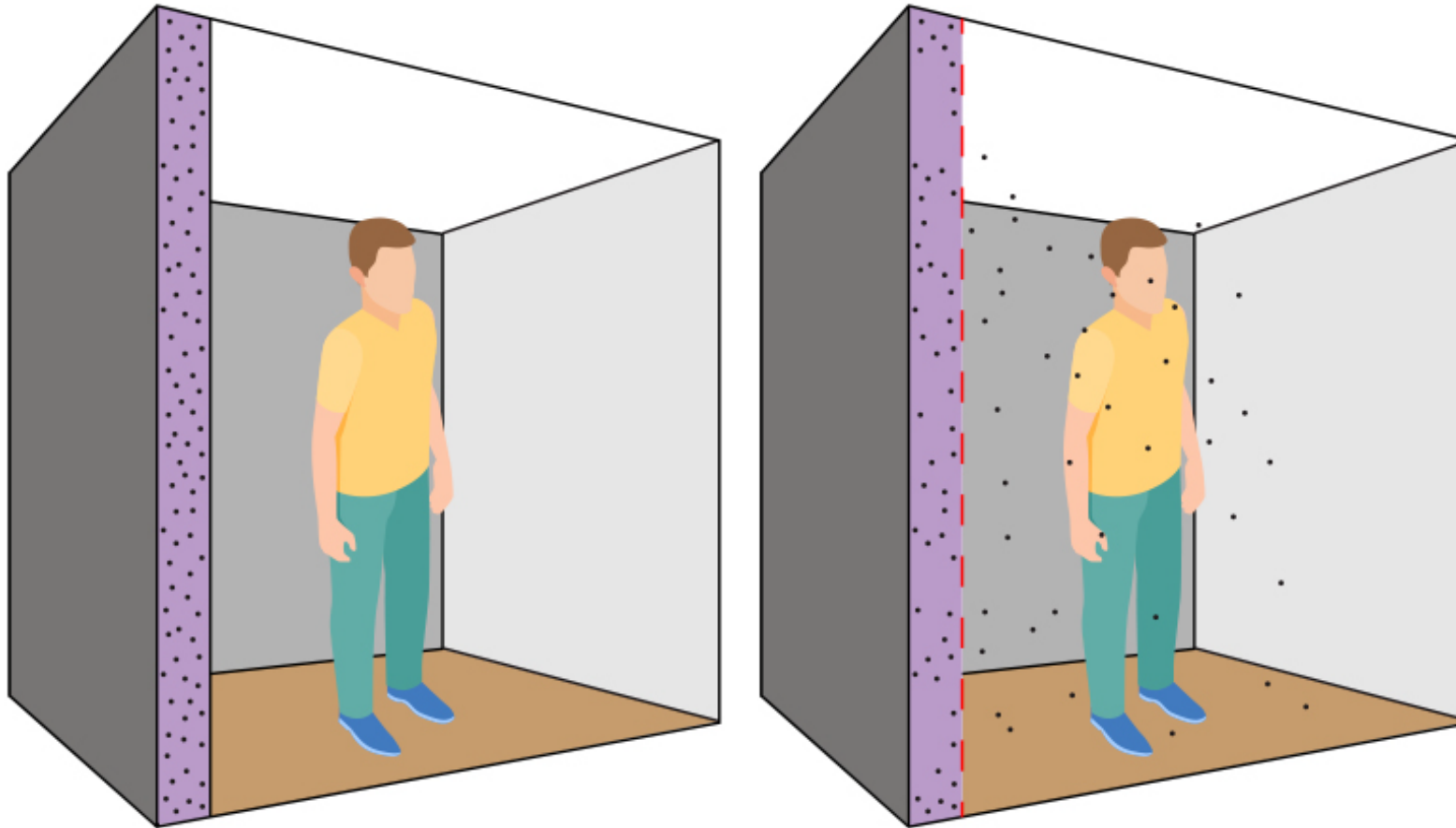
- There are different forms and sources of mercury.
- Elemental mercury is a metal that sometimes was used in:
 - Older thermometers and barometers
 - Fluorescent light bulbs
 - Dental fillings
 - Some laboratory experiments
- Mercury is a liquid at room temperature, but due to its physical properties, it can evaporate into vapors
 - Mercury vapors are heavier than air, so they tend to remain close to the ground
 - Inhalation is the primary concern and focus of the current risk assessment



Elemental Mercury Toxicity

- Exposure to elemental mercury for prolonged periods of time (*e.g.*, many years) or exposure to very high levels of mercury has been associated with **neurological** symptoms, such as:
 - Tremors
 - Difficulty with coordination
 - Impaired vision
 - Memory loss
 - Mood changes
 - Fetal neurological development (pregnancy)
- Neurological symptoms are considered the most sensitive, so protecting against these symptoms also protects against other chronic mercury-related symptoms
- **Note:** Data from Wilder Hall do not indicate that current levels are of concern for these effects

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$



What is Risk Assessment?

- A scientific process that results in an estimate of the likelihood of adverse (negative) health effects in people who may be exposed to a chemical hazard
- Mercury-related health effects depend on the route (inhalation), amount (dose), and duration of exposure

Risk Assessment Fundamentals

Hazard

- Can mercury cause health effects?
- If yes, at what levels or doses?

Exposure

- Is there a complete exposure pathway (am I exposed)?
- If yes, how much exposure is there (dose)?

Risk

- What is the likelihood that mercury-related health effects can occur at the level or dose encountered?

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$

Risk Assessment for Wilder Hall

Scenario 1: Normal Occupancy

- Applicable to: Faculty, students, office staff, custodial staff
- Key assumptions:
 - Normal daily activities
 - Building materials are not being disturbed during daily activities
 - No visible liquid mercury

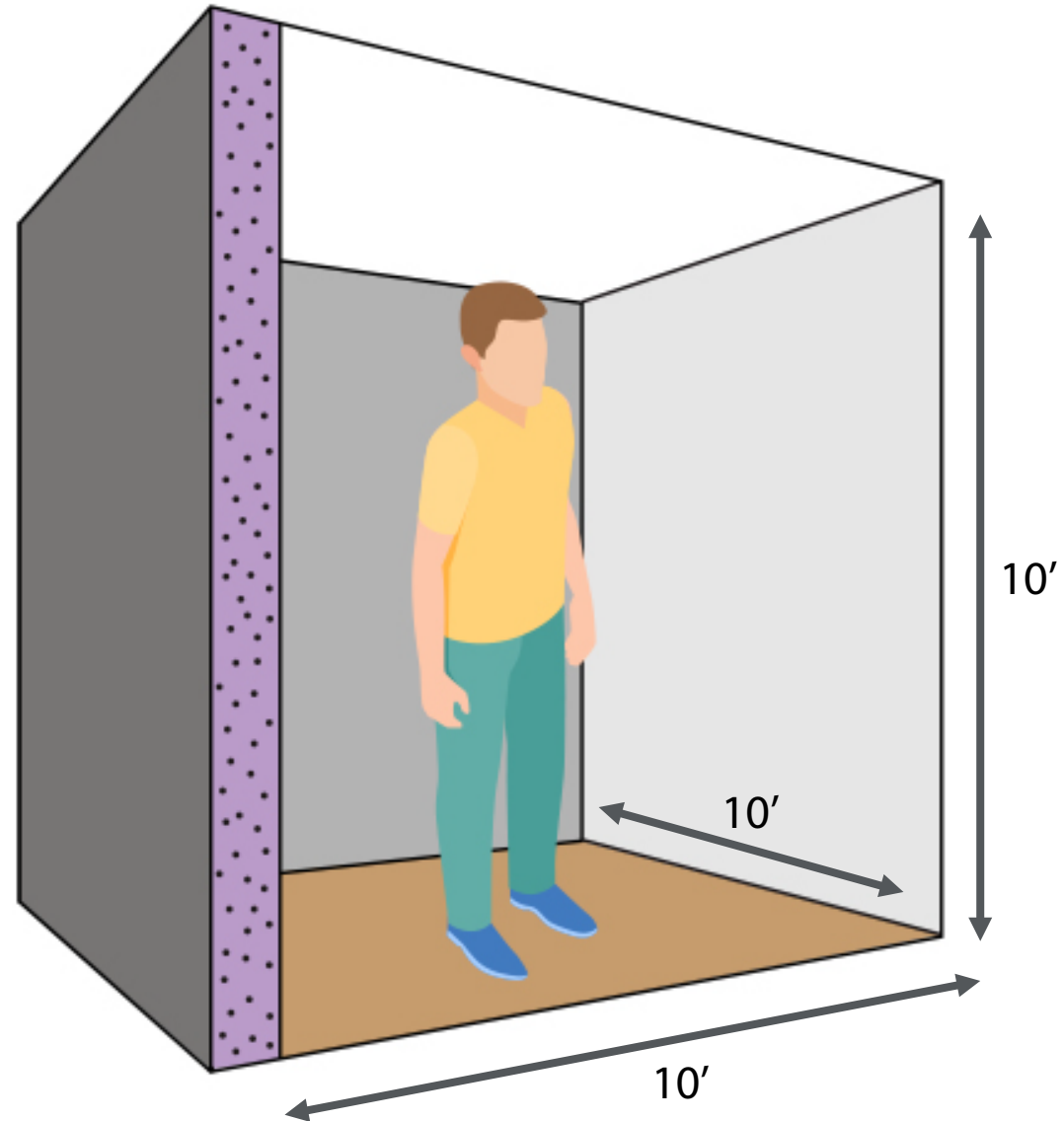
Scenario 2: Destructive Repair/Renovation

- Applicable to: Facility workers doing repairs, workers performing renovation
- Key assumptions:
 - Building materials actively disturbed (floor or wall removals, *etc.*)
 - No visible liquid mercury

How much is 1 microgram (μg) per cubic meter (m^3)?



Less than $\frac{1}{2}$ of a grain of salt



Health-Based Exposure Limits for Mercury Inhalation

- Exposure limits are levels at which health effects are unlikely to occur
 - Exceedance of an exposure limit does not mean an adverse health effect will occur because the assumptions made in calculations are meant to err on the side of caution

Exposure Limit	Air Conc. ($\mu\text{g}/\text{m}^3$)	Assumed Exposure Duration	Applicable Population
US EPA Reference Concentration (RfC)	0.3	24 hrs/day, 365 days/year, 70 years	General Population
ATSDR Chronic Minimal Risk Level (MRL)	0.3	24 hrs/day, 365 days/year, 70 years	General Population
ATSDR Action Level	≤ 1	24 hrs/day, 365 days/year, 70 years	Residential Occupants
ATSDR Action Level	≤ 3	8 hrs/day, 240 days/year, 40 years	Commercial Setting Occupants School Occupants
ACGIH Threshold Limit Value (TLV) (Time-Weighted Average)	25	8 hrs/day, 240 days/year, 40 years	Workers
OSHA Permissible Exposure Limit (PEL) (Time-Weighted Average and Ceiling Limit)	100	8 hrs/day, 240 days/year, 40 years	Workers

Notes: ACGIH = American Conference of Governmental Industrial Hygienists; ATSDR = Agency for Toxic Substances and Disease Registry; OSHA = Occupational Safety and Health Administration; US EPA = United States Environmental Protection Agency.

Health-Based Exposure Limits for Mercury Inhalation

Normal Occupancy

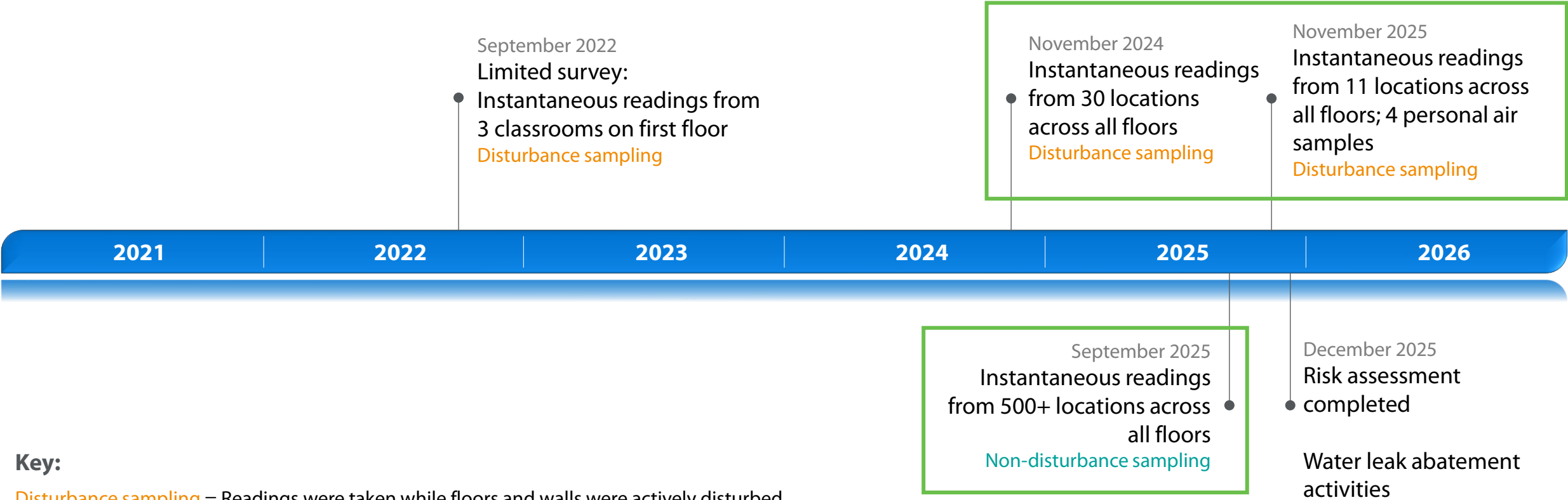
- **1 $\mu\text{g}/\text{m}^3$**
 - Protective against potential health effects from mercury vapor for pregnant individuals
 - Assumes exposure 24 hrs/day, 365 days/year, 70 years
- **3 $\mu\text{g}/\text{m}^3$**
 - Protective against potential health effects from mercury vapor for non-pregnant individuals
 - ATSDR's action level for normal occupancy of commercial buildings, including schools and educational institutions

Destructive Repair/Renovation

- **25 $\mu\text{g}/\text{m}^3$**
 - Equivalent to ACGIH Threshold Limit Value
 - 8-hour average air concentration
 - Protective against potential health effects from mercury vapor exposure for workers
- **100 $\mu\text{g}/\text{m}^3$**
 - Equivalent to OSHA Permissible Exposure Limit
 - Regulatory (legal) standard for workplace

Recent Mercury Data Surveys in Wilder Hall

Data Were Collected by Third-party Firms and Provided to Gradient for Review and Risk Assessment.



Key:
Disturbance sampling = Readings were taken while floors and walls were actively disturbed.
Non-disturbance sampling = Data were taken without disturbing building materials.
Green box = Data used in risk assessment.

Recent Mercury Data Surveys in Wilder Hall

Scenario	Survey Date	Sample Type*	Number of Samples or Readings	Range of Mercury Vapor Concentrations Detected (µg/m³)	Average Mercury Concentration (µg/m³)
Normal Occupancy	Sept. 2025	Instantaneous	529	0.01 – 0.8	0.068
Destructive Renovation/ Repair	Nov. 2024	Instantaneous	30	0.1 – 43.2	7.31
	Nov. 2025	Instantaneous	11	0.4 – 106	14.3
		Personal full-shift	4	1.5 – 5.2	2.98

Notes:

- Instantaneous readings were taken using a mercury vapor analyzer instrument. These readings indicate vapor levels present in a small area at a particular moment in time.
- Personal breathing zone air samples were collected by four workers over the course of several hours to simulate exposures for a full work shift. Samplers were worn by the workers to capture air in their breathing zone as they performed different activities.

Risk Assessment Results

Location	Estimated Exposure Conc. ($\mu\text{g}/\text{m}^3$)	Comparison to 3 $\mu\text{g}/\text{m}^3$ Action Level for Non-Pregnant Individuals	Comparison to 1 $\mu\text{g}/\text{m}^3$ Action Level for Pregnant Individuals
Basement	0.12	Below	Below
1 st Floor	0.12	Below	Below
2 nd Floor	0.064	Below	Below
3 rd Floor	0.056	Below	Below
All Floors	0.078	Below	Below

Normal Occupancy

- Exposure concentration = High-end estimate of the average
- All mercury readings below the 3 $\mu\text{g}/\text{m}^3$ action level
- All mercury readings below 1 $\mu\text{g}/\text{m}^3$, the residential action level
- High-end average exposure estimates are below more stringent mercury exposure limits (e.g., 0.3 $\mu\text{g}/\text{m}^3$)

Risk Assessment Results

Survey Date and Type	Location	Estimated Exposure Conc. ($\mu\text{g}/\text{m}^3$)	Comparison to 25 $\mu\text{g}/\text{m}^3$ Action Level for Workers	Comparison to 100 $\mu\text{g}/\text{m}^3$ OSHA PEL
November 2024 Instantaneous Readings	Basement	26.5	Above	Below
	1 st Floor	3.12	Below	Below
	2 nd Floor	22.9	Below	Below
	3 rd Floor	43.2	Above	Below
	All Floors	13.7	Below	Below
November 2025 Instantaneous Readings	Basement	56.6	Above	Below
	1 st Floor	17.0	Below	Below
	2 nd Floor	3.00	Below	Below
	3 rd Floor	1.30	Below	Below
	All Floors	31.4	Above	Below
November 2025 Personal Air Samples	All floors	0.91 – 3.15 (Time-Weighted Averages)	Below	Below

Destructive Repair/Renovation

- Some mercury readings are $>25 \mu\text{g}/\text{m}^3$. However, full-shift personal air samples are all well below $25 \mu\text{g}/\text{m}^3$
 - Temporary peaks in airborne mercury levels decrease quickly and do not necessarily mean elevated exposures over a work shift
 - Being above $25 \mu\text{g}/\text{m}^3$ does not mean that health effects will occur
- These concentrations reflect what a worker wearing no protective equipment (no personal protective equipment, no ventilation, etc.) may encounter

December 2025 Water Leak Abatement

- Water leak impacted rooms 002, 106, and 203
- Abatement activities took place between December 16-30, 2025
- A total of 367 instantaneous readings, 12 personal air samples, and 8 ambient air samples were collected
- Some elevated readings and personal samples were observed during floor demolition and cleanup in Room 106
- No mercury was detected in ambient air readings throughout Wilder Hall (data not presented here)

Sample Type	Work Area	Work Activity	Range of Vapor Concentrations (µg/m³)	Average Concentration During Activity (µg/m³)
Instantaneous Readings	Room 002	Ceiling Demolition	0 – 15.07	4.36
		Cleaning	0 – 17.11	10.09
		Clearance	0 – 0.87	0.26
	Room 106	Ambient	0 – 0.77	0.22
		Ceiling Demolition	0 – 1.51	0.20
		Final Clean	0 – 8.47	3.32
		Floor Demolition	0 – 149.1	21.53
		Re-Check	0 – 2.76	1.03
		Wall Demolition	0 – 1.43	0.12
		Clearance	0 – 2.44	1.02
	Room 203	Floor Demolition	0 – 0.67	0.09
		Final Clean	0 – 0.68	0.13
		Re-Check	0 – 2.16	1.56
		Clearance	0 – 0.99	0.33
Personal Samples	Throughout	Mixed	Not Detected – 59	18.38

Risk Assessment Results – Including Water Event from December 2025

Sample Type	Location	Estimated Exposure Conc. (µg/m³)	Comparison to 25 µg/m³ Action Level	Comparison to 100 µg/m³ OSHA PEL
November 2024 Instantaneous Readings	Basement	26.5	Above	Below
	1 st Floor	3.12	Below	Below
	2 nd Floor	22.9	Below	Below
	3 rd Floor	43.2	Above	Below
	All Floors	13.7	Below	Below
November 2025 Instantaneous Readings	Basement	56.6	Above	Below
	1 st Floor	17.0	Below	Below
	2 nd Floor	3.00	Below	Below
	3 rd Floor	1.30	Below	Below
	All Floors	31.4	Above	Below
November 2025 Personal Air Samples	All floors	0.91 – 3.15 (Time-Weighted Averages)	Below	Below
December 2025 Instantaneous Readings	Room 002	7.23	Below	Below
	Room 106	8.22	Below	Below
	Room 203	0.25	Below	Below
December 2025 Personal Air Samples	Rooms 002, 106, and 203	Not Detected – 34.4 (Time-Weighted Averages)	Above	Below

December 2025 Abatement

- Exposure concentration = High-end estimate of the average
- 10 out of 367 instantaneous readings and 2 out of 12 personal air samples were >25 µg/m³
- These concentrations reflect what a worker wearing no protective equipment (no personal protective equipment, no ventilation, etc.) may encounter

Conclusions

Based on the available data, the risk assessment shows:

- Under the Normal Occupancy scenario, levels of mercury in Wilder Hall are **unlikely to** pose a risk to students, faculty, or staff, including pregnant individuals
- Under the Destructive Repair/Renovation scenario, levels of mercury in Wilder Hall are **unlikely to** pose a risk to workers

What does “**unlikely to** pose a risk” mean?

- This risk assessment makes assumptions about how Wilder Hall is typically used and is based on the available data
- If there are conditions that differ significantly from these assumptions, or if more data are collected that show very different results, then additional assessment may be needed

Response

- While not expected to happen, if you see liquid mercury: leave the room, close the door, and notify Dartmouth EHS.
- Dartmouth EHS has engaged with a third-party firm to develop Health and Safety Plans for minor projects and for major renovations. This will be shared and integrated into Planon in the coming months.
- For any major construction projects, a Health and Safety Plan will be implemented prior to beginning work.



Health and Safety Plans

Health and Safety Work Plan Development



- Hired Woodard & Curran to develop work plans for:
 - General Cleaning and Custodial Activities
 - Minor Disturbance and Small-Scale Renovation Activities
 - Demolition and Major Renovation Activities
- Contents of work plans:
 - Safe work practices and limits of work
 - Personal protective equipment, if required
 - Air monitoring, if required
 - Abatement procedures, if required

Resources for Additional Information

- [Dartmouth EHS memo and FAQ](#) on the Wilder Hall assessment
 - Links to Gradient report
- [US Environmental Protection Agency \(US EPA\): Information about Mercury](#)
- [Agency for Toxic Substances and Disease Registry \(ATSDR\): Mercury](#)
- [Occupational Safety and Health Administration \(OSHA\): Mercury Vapor](#)

Questions?

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