BUILDING CLIMATE RESILIENCE

Strategies for Indoor Heat Risk Workplace Adaptation

By Scott Gunderson

The built environment is strongly linked to geography and climate. In the early 19th century, members of the Lewis and Clark Expedition built a fort from wood, plentiful on the Pacific Coast of North America, to stay dry through the winter rain.

Decades later, settlers in the plains of the North American Midwest dug sod houses, both because there was little wood to harvest in this area and for effective shelter against the extreme winter and summer temperatures. Further examples can be found around the world and even in fiction, such as the Skywalker farm in *Star Wars*, with living and working spaces built underground for protection from the heat of their desert planet.

However, a changing climate means that buildings and their occupants must contend with temperatures and other weather conditions beyond the previously normal ranges for which they were designed and prepare (Evans, 2024). The author, who grew up and continues to live and work in the Pacific Northwest, remembers months of rainfall from autumn to spring and predictably mild summers with little need for air conditioning. But the continuous drizzle of the past has been replaced with long stretches of dry weather interrupted by atmospheric rivers of brief and very heavy rain. The occasional occurrence of a few days with temperatures greater than 90 °F was once known as a heat wave, but the region now sees weeks at a time with temperatures at or above this level every summer. These trends have been developing for several years, and 2024 was another record year for heat both for the United States and worldwide (NASA, 2025; NOAA, 2025a, 2025b).

Heat Exposure in the Built Environment

A heat wave with record high temperatures struck the Pacific Northwest in 2021, with an unprecedented temperature of 116 °F in Portland, OR, on June 28, 2021 (Samayoa, 2021). Public health professionals and climate scientists have warned that similar record-breaking events should be expected in the future both locally and globally (IPCC, 2023; OHA, 2023). Much attention within the occupational environmental, health and safety (EHS) profession has focused on heat exposure risks for outdoor workers, and ASSP issued its consensus standard for managing heat stress for workers during construction and demolition operations in 2024 (ANSI/ASSP, 2024). Public health professionals in Multnomah County (2022), OR, specifically included indoor heat exposure in their review of the 2021 heat wave in the Pacific Northwest, identifying lack of air conditioning as a key driver of mortality.

Building professionals such as architects and civil engineers have identified the need for updated building standards and codes due to climate change (AIA, 2020; ASCE, 2024). Modeling conditions from the 2021 heat wave in the Pacific Northwest, Squire and Le (2024) identified several passive cooling features such as shade, insulation and ventilation to be effective strategies in design for resilience in a changing climate. Their baseline modeling scenario, without these features, "pushes into the 'extreme danger' range and temperatures remain dangerously high over the following weeks as accumulated heat has no way to escape." But a modified scenario with a "quality enclosure, coupled with night venting and occupant education, keeps living spaces habitable . . . when a space is designed and operated correctly, hazards can be avoided" (Squire & Le, 2024).

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While Squire and Le modeled the effects of heat in a residential building, NIOSH's recommended standard for heat illness prevention includes opportunities for preparing indoor workplaces for heat. Acknowledging challenges such as the expense of air conditioning for large workplaces, NIOSH recommends other methods for cooling such as "reverse winterization of the site, that is, open windows, doors, skylights, and vents according to instructions and if appropriate (e.g., outside temperatures are cooler) for greatest ventilating efficiency at places where high air movement is needed" (Jacklitsch et al., 2016).

Hazard Assessment for Heat in the Indoor Workplace

The NIOSH recommended standard for heat illness prevention includes recommendations for measurement of environmental heat in workplaces using the wet-bulb globe thermometer method "at least hourly, during the hottest portion of each work shift, during the hottest months of the year, and when a heat wave occurs or is predicted" (Jacklitsch et al., 2016). During 2021 and 2022, the author worked at a large manufacturing facility in the Pacific Northwest that was built more than 50 years ago, prior to the regular occurrence of increasingly hot weather. When at the facility, the author found it necessary to measure environmental heat in multiple indoor areas due to the size of the facility. Air conditioning was available in office areas, but no air conditioning was present in general manufacturing or warehouse areas. Additionally, the location was generally porous, with numerous overhead doors that typically remained open for material handling by forklifts. The resulting "heat map" revealed summer indoor temperature ranges with significant variability by area and time.

- Mezzanines and other fixed elevated platforms had the highest temperature levels at all times due to warm air rising to ceiling level, where it accumulated due to the low number of roof vents. Workers on warehouse order pickers described similar heat exposure when raising their

ADDRESSING INCREASED INDOOR HEAT RISK IN A CHANGING CLIMATE

•**Map indoor heat variability.** Assess multiple indoor areas for heat exposure at different times of day and year to identify high-risk zones and prioritize control measures.

•**Use passive cooling strategies.** Improve insulation, install shade structures and enable nighttime ventilation to reduce heat accumulation.

•**Collaborate with building professionals.** Work with architects and engineers to identify feasible upgrades and adaptations to mitigate the impact of rising temperatures and weather effects of a changing climate.

•**Plan for multi-hazard environments.** Consider potential secondary hazards, such as the accumulation of exhaust or airborne contaminants when closing overhead doors.

•**Institutionalize climate risk reviews.** Set a regular schedule for reassessing building risk factors and updating heat mitigation plans as climate patterns shift.

SMARTBOY10/DIGITALVISION VECTORS/GETTY IMAGES

EHS professionals working with qualified building professionals can support changes for safer indoor work in a world facing increasing frequency of extreme outdoor weather conditions.

vehicle platforms to place or pull materials at upper storage areas.

•Indoor areas near open overhead doors had high levels of heat during the afternoon due to exposure to warm outside air as well as passive solar heating because of sunlight on interior walls and floors. However, these areas were the coolest in the morning due to exposure to cool night and morning air and the ability to ventilate warm interior air to the outside overnight.

•An indoor area near the center of the facility revealed the opposite issue; it remained the relatively coolest area during the afternoon because it was far from the open overhead doors, but without any method to effectively ventilate accumulated heat, it remained warm overnight and was warmer in the morning than other ground-level areas.

•Loading docks and the trailers backed into them had different temperature ranges depending on their location. Loading docks and trailers on the south side of the facility had the highest levels of heat due to sun exposure. A north-facing loading dock with a fixed cover extending from the exterior wall was cooler due to continuous shade.

Controls for Heat in the Indoor Workplace

The NIOSH recommended standard for heat illness prevention adopts the hierarchy of controls, describing engineering controls for environmental heat to which the worker is exposed, and administrative controls for metabolic heat which the worker generates during activity. Engineering controls include:

•convective heat control such as lowering building or area air temperature,

•radiant heat control such as shields or shades, and

•evaporative heat control such as increasing air movement.

While engineering controls are more effective than administrative controls such as increasing break frequency and duration for workers, engineering controls can be expensive. For example, installing air conditioning to lower interior temperature in a large facility built before the need for air conditioning would be prohibitively expensive. To help address this issue, the NIOSH recommended standard includes descriptions of smaller-scale engineering controls such as local air movement and spot cooling.

Old Buildings in a Changing Climate

The increasing frequency and severity of climate change hazards continue to challenge EHS professionals and the workers and organizations they support. Older indoor workplaces may not provide adequate shelter from increasing temperatures and other environmental hazards since they were designed before these hazards were common. Based on past experience, the author recommends best practices for addressing heat in indoor workplaces:

•**Regulatory compliance is a baseline expectation.** Identify regulatory requirements applicable to the organization such as rules for heat illness prevention for workers and follow them. Note that while some rules for heat illness prevention may be limited to outdoor work, rules such as those in Oregon apply to both indoor and outdoor work (Oregon OSHA, 2022).

•**Do not assume uniform exposure to heat in the indoor workplace.** Assess heat levels in multiple areas both seasonally and at different times of day to identify hazards and prioritize controls.

•**Work with qualified professionals such as architects and facilities**

engineers. Identify local building codes requiring or permitting improvements such as ventilating warm air to the outside, allowing cool overnight air inside, and controlling passive solar heating of interior spaces.

•**Recognize that local codes may not be adequate for rising temperatures.** While architects and facilities engineers may design to local building codes, current local codes may not have been updated to account for climate change or require design for cooling. When reviewing proposed building changes, ask what controls are in place for extreme heat regardless of what is required by code.

•**Do not limit review to extreme heat.** Identify other hazards of climate change applicable to the organization such as wildfires and wildfire smoke, and evaluate opportunities for improvement appropriate for the location (Gunderson, 2023; Roman, 2025).

•**Evaluate other hazards that may follow a proposed building change.** For example, if closing overhead doors to contain cool air and prevent entry of warm air and wildfire smoke into a building, verify hazards such as accumulation of forklift exhaust or other airborne contaminants.

•**Expect heat and other hazards of climate change to continue to escalate.** Establish a regular cadence of horizon scanning for changes in environmental conditions driving the need for updated risk assessments (Gunderson, 2024; ISO, 2021).

Conclusion

The author frequently drives past buildings in the Pacific Northwest where he worked decades ago performing jobs such as grinding sharp edges off products in a welding shop, cleaning parts in a machine shop and sanding fiberglass boats in a marina garage. The senior workers at these locations probably retired a long time ago, and the younger workers inside likely have no memory of mild summers. Instead of cool breeze and fresh air, open overhead doors now bring them intense heat and wildfire smoke.

EHS professionals supporting workers in indoor environments should review the hazards brought by a changing climate, and evaluate whether the buildings they work inside provide adequate shelter from these hazards. From passive controls such as limiting interior sun exposure and allowing overnight ventilation, to active controls such as air conditioning and mechanical ventilation, EHS professionals working with qualified building professionals can support changes in their built environment for safer indoor work in a world facing increasing frequency of extreme outdoor weather conditions. **PSJ**

EHS professionals should review and evaluate whether buildings provide adequate shelter from changing climate hazards.

Disclaimer

The opinions in this article are the author's and do not represent official positions of Oregon OSHA or any other affiliated agency.

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Scott Gunderson, M.A., M.Eng., CSP, ARM, is a senior safety professional in Portland, OR. His safety experience includes work in the semiconductor industry, vehicle manufacturing and Oregon OSHA. He holds an M.A. and an M.Eng. from Portland State University, a certificate in climate resilience from Antioch University, and a certificate in climate change and health from the Yale School of Public Health. Gunderson is a professional member of ASSP's Columbia-Willamette Chapter.

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