Toward a Legal Standard of Tolerable Heat

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INTRODUCTION

Heat is the leading cause of weather-related mortality in the United States.[1] Over the past 30 years, extreme heat has claimed,

1. Diane M. Gubernot et al., *The Epidemiology of Occupational Heat Exposure in the United States: A Review of the Literature and Assessment of Research Needs in a Changing Climate*, 58 INT'L. J. BIOMETEOROLOGY 1779, 1780 (2014). Even though this note will limit its analytical scope to extreme heat in the United States, extreme heat is undoubtedly a global threat to human health and safety. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 73 (Rajendra K. Pachauri & Leo Meyer eds., 2014) [hereinafter IPCC 2014 SYNTHESIS REPORT] (asserting that "climate change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger"); Jennifer Marlow & Jennifer Krencicki Barcelos, *Global Warring and the Permanent Dry: How Heat Threatens Human Security in a Warmer World*, 1 SEATTLE J. ENVTL. L. 19 (2011) (framing extreme heat in the context of climate justice by examining its impact on global health, food and water, security, equity, and justice); Geoffrey Heal & Jisung Park, *Reflections—Temperature Stress and the Direct Impact of Climate Change: A*

on average, more lives per year than floods and hurricanes combined.[2] The Centers for Disease Control and Prevention reports that extreme heat kills approximately 618 people per year,[3] though, because heat exposure often exacerbates underlying medical conditions, it is likely that many heat-related deaths go misdiagnosed or unrecognized.[4]

Despite its significant hazards, the "invisible" threat of extreme heat has gained little traction in the national conversation on climate change, with superstorms and increasingly regular 100-year floods, instead, dominating the media. Recently, however, the dangers of extreme heat—and our lack of preparedness for its impacts—have become far more visible. In September 2017, 14

Review of an Emerging Literature, 10 REV. ENVTL. ECON. & POL'Y 347, 347 (2016) (arguing that the impact of extreme heat on global economics "can take the form of damage to human health, reductions in labor productivity and supply, and possible reductions in the rate of human capital accumulation—all of which may decrease gross domestic product (GDP) and overall social welfare in both the short and long run").

2. *Weather Fatalities 2018*, NAT'L WEATHER SERV. (Apr. 29, 2019), http://www.nws.noaa.gov/om/hazstats.shtml [https://perma.cc/QJ84-LWGR]. The National Weather Service ("NWS") and the Centers for Disease Control and Prevention ("CDC") utilize different data compilation methods, and thus, have conflicting reports on total heat-related deaths. Both agencies agree, however, that extreme heat is the deadliest weather-related phenomenon in the U.S. For instance, the NWS attributes just 108 deaths to extreme heat in 2018, whereas the CDC estimates over 600 fatalities annually. *2018 Heat Related Fatalities*, NAT'L WEATHER SERV. (Apr. 29, 2019), https://www.nws.noaa.gov/os/hazstats/heat17.pdf [https://perma.cc/J4KS-HZAP]; *Extreme Heat*, CTRS. FOR DISEASE CONTROL & PREVENTION (June 19, 2017), https://www.cdc.gov/disasters/extremeheat/index.html [https://perma.cc/M5UH-NRMC]. The NWS relies on "information contained in *Storm Data*, a report comprising data from NWS forecast offices in the 50 states, Puerto Rico, Guam and the Virgin Islands." *Weather Fatalities 2018*, NAT'L WEATHER SERV., *supra* note 2. The NWS compiles this empirical data from a variety of sources, including: "state and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others." *Storm Data FAQ Page*, NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/stormevents/faq.jsp [https://perma.cc/5YVH-KY52] (last visited Jan. 27, 2019). The CDC approximates annual heat-related deaths through direct attribution (i.e., "link[ing] health outcomes to temperatures based on assigned diagnosis codes in medical records such as hospital admissions and death certificates") and statistical studies that "measure the impact of temperature on death and illness using methods that relate the number of cases . . . to observed weather conditions and other socio-demographic factors." Marcus C. Sarofim et al., *Temperature-Related Death and Illness*, *in* U.S. GLOB. CHANGE RESEARCH PROGRAM, THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES: A SCIENTIFIC ASSESSMENT 47 (Allison Crimmins et al. eds., 2016). These statistical studies help to establish the relationship between heat and premature deaths and illnesses. *Id.*

3. *Extreme Heat*, CTRS. FOR DISEASE CONTROL & PREVENTION, *supra* note 2.

4. CTRS. FOR DISEASE CONTROL & PREVENTION, PICTURE OF AMERICA REPORT: HEAT-RELATED ILLNESS 1 (2017).

residents of a Florida nursing home died when Hurricane Irma knocked out power to the building's air-conditioning system, and indoor temperatures swelled to 99°F. Extreme heat in the summer of 2017 forced airlines to cancel dozens of flights scheduled to depart from Phoenix Sky Harbor International Airport, because, at 118°F, it is too hot for planes to take off safely.[5] In late-October 2017, large swaths of Southern California experienced temperatures near 110°F, the hottest weather ever recorded in the United States so late in the calendar year.[6] The extreme heat in California amplified a devastating season of wildfires—in 2017 alone, 9,000 wildfires ravaged the state, burning 1.2 million acres of land, destroying over 10,800 structures, and killing upwards of 46 people.[7] In November 2018, California experienced its most deadly and destructive wildfire in modern history, when the Camp Fire in Butte County killed at least 84 people and virtually destroyed the town of Paradise, then home to 27,000 people.[8] In Southern California, the Woolsey Fire burned close to 100,000 acres of land in Ventura and Los Angeles Counties.[9]

As anthropogenic climate change yields higher temperatures and humidity across the globe, the United States will likely experience a long-term upward trend in heat-related mortality and morbidity.[10] Indeed, in 2016, the Obama administration released a scientific

5. Amy B. Wang, *It's So Hot in Phoenix that Airplanes Can't Fly*, WASH. POST (June 21, 2017), http://wapo.st/2tJysSE?tid=ss_mail&utm_term=.91be5176f08a [https://perma.cc/WRC3-4STF]. Bombardier CRJ planes can only operate at temperatures of 118°F or below; larger Airbus and Boeing planes can operate at maximum temperatures of 127°F and 126°F degrees, respectively. *Id.*

6. Jason Samenow, *Southern California Stews in the Most Extreme Heat the Nation Has Seen So Late in the Year*, WASH. POST (Oct. 25, 2017), http://wapo.st/2y77A0S?tid=ss_mail&utm_term=.8bff33155d34 [https://perma.cc/B25H-7WXH].

7. Mike McPhate, *California Today: Heat Wave Hits Southern California*, N.Y. TIMES (Oct. 23, 2017), https://nyti.ms/2h2Qdsg [https://perma.cc/6YZR-KKYV]; Lauren Tierney, *The Grim Scope of 2017's California Wildfire Season Is Now Clear. The Danger's Not Over.*, WASH. POST (Jan. 4, 2018), http://wapo.st/california-fires-2017?tid=ss_mail [https://perma.cc/5APK-D8T5].

8. Morgan Winsor, *California Wildfires Death Toll Climbs to 87, Almost 500 Still Unaccounted For,* ABC NEWS (Nov. 23, 2018, 11:59 PM), https://abcnews.go.com/US/relentless-california-wildfires-leave-87-dead-600-unaccounted/story?id=59262994 [https://perma.cc/NN45-MRZ4].

9. *Id.*

10. Ann E. Carlson, *Heat Waves, Global Warming, and Mitigation*, 26 UCLA J. ENVTL. L. & POL'Y 169, 170 (2008) (citing Laurence S. Kalkstein & J. Scott Greene, *An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change*, 105 ENVTL. HEALTH PERSP. 84, 90 (1997)).

assessment of the impact of climate change on public health, predicting that more than 11,000 additional heat-related deaths may occur during the summer of 2030, with that number increasing to 27,000 additional deaths during the summer of 2100.[11] Moreover, the Intergovernmental Panel on Climate Change ("IPCC") reports, with virtual certainty, that there will be more frequent daily and seasonal extreme heat events as the 21st century progresses.[12] Climatologists predict that by mid-century, there will be 20 to 30 more days per year with temperatures over 90°F in most areas of the contiguous United States, with the Southeast experiencing increases of 40 to 50 days.[13] By 2100, some areas of Texas may experience more than 100 days over 100°F per year.[14] According to Michael E. Mann, a leading climatologist and professor of meteorology at Pennsylvania State University, what we now deem "extreme heat" may soon be called "mid-summer."[15]

As demonstrated by both climate science and recent events, extreme heat is a relevant and significant threat to human health and safety. Currently, however, there is no standardized approach to protecting the populace from extreme heat, let alone a legal standard of tolerable heat applicable to the workplace, housing, or other affected environments.[16] This Note investigates existing laws, regulations, and guidelines on extreme heat in a variety of contexts, and considers the possibility of a quantifiable and uniform standard of acceptable heat. It will analyze proven best

11. Press Release, The White House, Fact Sheet: What Climate Change Means for Your Health and Family (Apr. 4, 2016), https://obamawhitehouse.archives.gov/the-press-office/2016/04/04/fact-sheet-what-climate-change-means-your-health-and-family [https://perma.cc/KUC3-MNQ3].

12. IPCC 2014 SYNTHESIS REPORT, *supra* note 1, at 60.

13. R.S. Vose et al., *Temperature Changes in the United States*, *in* U.S. GLOB. CHANGE RESEARCH PROGRAM, CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, VOLUME I 199 (D.J. Wuebbles et al. eds., 2017).

14. *Extreme Heat—NIHHIS*, U.S. CLIMATE RESILIENCE TOOLKIT (June 7, 2017), https://toolkit.climate.gov/topics/human-health/extreme-heat [https://perma.cc/MU8W-E7NF].

15. Lydia O'Connor, *Get Used to These Extreme Summer Heat Waves*, HUFFPOST (July 24, 2016, 8:13 PM), https://www.huffingtonpost.com/entry/summer-heat-wave-climatechange_us_57951438e4b02d5d5ed1f7eb [https://perma.cc/HJ3N-E48E].

16. *See also* Carlson, *supra* note 10, at 172–73 (postulating that because heat waves are not usually accompanied by property damage, they quickly recede from the public consciousness, and thus, policymakers pay limited attention to the large annual heat-related death tolls).

practices for tolerating heat and present the most viable small- and large-scale resiliency strategies to prepare for a warming climate.

Part I will explain the meteorological and climatological parameters of extreme heat. It will define various methodologies for measuring extreme heat, and, using climate projections, anticipate future threats to human health and safety. Part II will explain the physiological effects of extreme heat, relying on the classification system of heat-related illnesses promulgated by the CDC,[17] as well as public health reports published by the CDC, the National Weather Service ("NWS"), and epidemiologists.

Parts III and IV serve as the substantive heart of this Note. Part III will present the current legal approaches to heat, with a focus on standards for workplace heat. It will go on to analyze heat in a variety of other legal contexts including habitability standards for public housing, and statutes and regulations aimed at protecting vulnerable populations from heat-related hazards. Part IV will evaluate and recommend adaptive strategies to safeguard individuals against extreme heat. It will assess the efficacy of local warning systems and emergency response plans for heat waves, along with more conventional heat mitigation strategies, such as the installation of air conditioning. Part IV will also discuss efforts to reduce the urban heat island ("UHI") effect—an oft-reported phenomenon in which metropolitan areas become significantly warmer than surrounding areas—and whether or not these UHI mitigation strategies can actually produce long-term, quantifiable reductions in urban heat. It will go on to recommend best practices gleaned from occupational health and safety standards and consider whether these practices can be adopted on a broader scale. This Note will conclude by acknowledging the limitations of a uniform legal standard of tolerable heat but advocating for

17. While this Note will reference the CDC's heat-related illness classification system, these standards are also employed by the Office of the Assistant Secretary for Preparedness and Response ("ASPR"), the Environmental Protection Agency ("EPA"), the Federal Emergency Management Agency ("FEMA"), the National Institute for Occupational Safety and Health ("NIOSH"), the National Oceanic and Atmospheric Administration ("NOAA"), the Occupational Safety and Health Administration ("OSHA"), and the Substance Abuse and Mental Health Services Administration ("SAMHSA"). *See Toolkit*, NAT'L INTEGRATED HEAT HEALTH INFO. SYS., https://toolkit.climate.gov/nihhis/ [https://perma.cc/B8EY-8GHU] (last visited Feb. 4, 2019). Heat-related resources from these agencies are compiled by the National Integrated Heat Health Information System, a resource administered by the CDC and the Climate Program Office of NOAA. *Id.*

adaptive policies based on context and population, with a particular focus on local mitigation techniques.

I. DEFINING EXTREME HEAT

The term "extreme heat" means different things in different contexts. Several variables contribute to extreme heat events ("EHEs"), including geographic location, prevailing weather conditions—such as temperature, humidity, and cloud cover—and the time of year.[18] For instance, several days of 90°F in Minneapolis in early summer would likely be considered an EHE, whereas a similar temperature trend in Phoenix would constitute an average stretch of summer weather.

A. Measuring Extreme Heat

The most basic measurement of heat is the dry-bulb temperature; it is the temperature of the ambient air measured with a thermometer, and reflects raw temperature data.[19] While simple and easy to measure, the dry-bulb temperature provides a fairly limited data set, as it does not incorporate other salient factors of EHEs, such as humidity and solar ultraviolet radiation.

Because of the limitations of the dry-bulb temperature, meteorologists and climatologists are more apt to measure EHEs using the wet-bulb temperature.[20] The wet-bulb temperature is an adjusted measurement that factors in both the dry-bulb

18. U.S. ENVTL. PROT. AGENCY & CTRS. FOR DISEASE CONTROL & PREVENTION, EPA 430-R-16-061, CLIMATE CHANGE AND EXTREME HEAT: WHAT YOU CAN DO TO PREPARE 3 (2016), https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf [https://perma.cc/8XHD-CGSJ].

19. *Temperature*, WEATHER.GOV, https://www.weather.gov/source/zhu/ZHU_Training_Page/definitions/dry_wet_bulb_definition/dry_wet_bulb.html [https://perma.cc/WKB9-FS4X] (last visited May 15, 2019).

20. Rebecca Harrington, *This Saudi City Could Soon Face Unprecedented and Unlivable Heat Levels*, BUS. INSIDER (Oct. 29, 2015, 4:54 PM), http://www.businessinsider.com/dhahran-saudi-arabia-most-intolerabe-heat-climate-change-2015-10 [https://perma.cc/M6UJ-VJ5K]; *U.S. Faces Dramatic Rise in Extreme Heat, Humidity*, CLIMATE CENT. (July 13, 2016), http://www.climatecentral.org/news/sizzling-summers-20515 [https://perma.cc/H8VW-2MJR]. The wet-bulb temperature is similar to the "heat index," as both measurements incorporate the dry-bulb temperature and humidity. The heat index is an adjusted measurement system adopted by the National Weather Service to measure the "apparent" or "felt air" temperature, which is how the temperature is perceived by humans. *See* Sarofim et al., *supra* note 2, at 46; *Heat Index*, NAT'L WEATHER SERV., https://www.weather.gov/safety/heat-index [https://perma.cc/9KC4-PBUD] (last visited Jan 27, 2019).

temperature and the humidity, and represents the temperature a thermometer would display if it were wrapped in a thin wet cloth in a blowing wind.[21] The wet-bulb temperature indicates the lowest temperature that can be reached under ambient conditions solely through the evaporation of moisture.[22] Thus, the wet-bulb temperature assesses the danger of EHEs more accurately than the dry-bulb temperature alone, because the moisture content of the air has a direct effect on the way the body sheds heat.[23] The human body primarily sheds heat through evaporative cooling, more simply known as sweating, which is directly inhibited by high humidity; the higher the humidity—or the more saturated the air—the closer the air and the surface of the skin move toward equilibrium.[24] As these two moisture contents converge, the more difficult it is for the body to shed heat, resulting in reduced evaporation and a subsequent decrease in cooling.[25]

In addition to evaporative cooling, the body also sheds heat to the surrounding environment through three other modes of thermoregulation: conduction, convection, and radiation.[26] Whereas evaporation is a uni-directional form of heat exchange, meaning that during evaporative cooling, heat is only transferred from the skin to the environment and not vice-versa, conduction, convection, and radiation are bi-directional.[27] In bi-directional cooling, heat transfer between the skin and the environment depends on the temperature gradient between the air and the surface of the skin. If the temperature of the air is higher than that of the skin, the skin will absorb the heat. This bi-directional phenomenon explains why electric fans are of limited use during EHEs—if a fan blows air that is warmer than the surface temperature of the skin, the skin will absorb that heat.[28] Consequently, when both heat and humidity are elevated, the

21. Steven C. Sherwood & Matthew Huber, *An Adaptability Limit to Climate Change Due to Heat Stress*, 107 PROC. NAT'L ACAD. SCI. 9552, 9552 (2010).

22. Robert Kopp, Jonathan Buzan & Matthew Huber, *The Deadly Combination of Heat and Humidity*, N.Y TIMES: OPINION (June 6, 2015), https://nyti.ms/2k9wG8t [https://perma.cc/G6KB-8WTT].

23. *Id.*

24. *Id.*

25. *Id.*

26. Chin Leong Lim et al., *Human Thermoregulation and Measurement of Body Temperature in Clinical Settings*, 37 ANNALS ACAD. MED. SING. 347, 348–49 (2008).

27. *Id.* at 348.

28. *Id.* at 349.

body's natural methods of thermoregulation become appreciably compromised.

A wet-bulb temperature of 35°C (or 77°F) is an upper limit to survivable temperature.[29] At this wet-bulb temperature, environmental conditions are too hot for bi-directional methods of thermoregulation and too humid for evaporative cooling.[30] Without the physical ability to shed heat, the human body will rapidly overheat, resulting in heat illness and, eventually, death.[31] Indeed, scientists estimate that exposure to wet-bulb temperatures higher than 35°C for more than 6 hours is fatal for humans.[32] A wet-bulb temperature of 35°C has yet to be officially recorded, and presently, wet-bulb temperatures rarely exceed 31°C.[33] Nevertheless, recent EHEs in the Middle East and South Asia have produced wet-bulb temperatures approaching this fatal threshold. For instance, on July 31, 2015, the city of Bandar Mahshahr, Iran experienced an unofficial wet-bulb temperature of 34.7°C and a concurrent heat index, or apparent temperature, of 74°C (165°F).[34]

In scientific literature, the wet-bulb temperature has emerged as the standard empirical index of extreme heat, since it establishes a tangible thermodynamic limit on physiological cooling.[35] However, the Occupational Safety and Health Administration ("OSHA"), the U.S. military, industrial hygienists, and several athletic associations have long used the wet-bulb globe temperature ("WBGT") to determine the likelihood of heat stress.[36] The WBGT estimates the combined effect of temperature, humidity, wind speed, and radiation on the human body; because the WBGT uses four factors

29. Sherwood & Huber, *supra* note 21, at 9552.

30. *Id.*; Kopp, Buzan & Huber, *supra* note 22.

31. Kopp, Buzan & Huber, *supra* note 22.

32. Sherwood & Huber, *supra* note 21, at 9554.

33. Jeremy S. Pal & Elfatih A. B. Eltahir, *Future Temperature in Southwest Asia Projected to Exceed a Threshold for Human Adaptability*, 6 NATURE CLIMATE CHANGE 197, 197 (2016).

34. Jason Samenow, *Iran City Hits Suffocating Heat Index of 165 Degrees, Near World Record*, WASH. POST (July 31, 2015), https://www.washingtonpost.com/news/capital-weather-gang/wp/2015/07/30/iran-city-hits-suffocating-heat-index-of-154-degrees-near-world-record/?utm_term=.952d94a4d32d [https://perma.cc/D5ZN-UYAV].

35. Ethan D. Coffel et al., *Temperature and Humidity Based Projections of a Rapid Rise in Global Heat Stress Exposure During the 21st Century*, 13 ENVTL. RES. LETTERS 1, 2 (2017).

36. *Id.* The military developed the WBGT as an environmental monitoring instrument in the early 1950s to respond to heat-related illnesses and fatalities in training camps of the U.S. armed services. Grahame M. Budd, *Wet-bulb Globe Temperature (WBGT)–Its History and Its Limitations*, 11 J. SCI. & MED. IN SPORT 20, 22 (2008).

to calculate an adjusted temperature, it is useful in ascertaining potential heat hazards.[37] Still, the WBGT is limited in the sense that tolerance to a given WBGT value could vary significantly among individuals according to variations in clothing, activity level, and the extent of acclimatization.[38]

Even though the wet-bulb temperature and the WBGT are useful indices of extreme heat, the NWS does not incorporate these metrics into official terminology and warning systems. Instead, the NWS defines a heat wave merely as a "period of abnormally and uncomfortably hot and unusually humid weather [that typically] lasts two or more days."[39] Likewise, it is the official policy of the NWS to issue heat advisories "within 12 hours of the onset of the following conditions: heat index of at least 105°F but less than 115°F for less than 3 hours per day, or nighttime lows above 80°F for 2 consecutive days."[40] In practice, regional NWS Forecast Offices issue heat-related watches and warnings as conditions warrant, taking into consideration local parameters of preparedness, but it is unclear if local offices take account of meteorological conditions beyond the ambient temperature and heat index.[41]

B. Climate Projections

While the progression of anthropogenic climate change depends largely on the extent and immediacy of efforts to reduce greenhouse gas ("GHG") emissions, climate simulations using a range of scenarios predict that the global mean temperature will increase anywhere from 3°C to 5°C by the end of the 21st century.[42] In a business-as-usual scenario, which would likely result in 3°C to 4°C of warming by 2100, major cities along the Persian Gulf, including Dhahran, Doha, Dubai, and Abu Dhabi, could reach wet-

37. Budd, *supra* note 36, at 24.

38. Coffel et al., *supra* note 35, at 7. *But see infra* Part III.A.3.d (explaining that the American Conference of Governmental Industrial Hygienists uses a WBGT adjusted for clothing).

39. *Glossary*, NAT'L WEATHER SERV. (June 25, 2009, 1:01 PM), http://w1.weather.gov/glossary/index.php?letter=h [https://perma.cc/25NX-P93G].

40. *Id.*

41. *Heat Watch vs. Warning*, NAT'L WEATHER SERV., http://www.nws.noaa.gov/om/heat/ww.shtml [https://perma.cc/J9SM-CV8J] (last visited Jan. 27, 2018).

42. Tom Miles, *Global Temperatures on Track for 3–5 Degree Rise by 2100: U.N.*, REUTERS, Nov. 29, 2018, https://www.reuters.com/article/us-climate-change-un/global-temperatures-on-track-for-3-5-degree-rise-by-2100-u-n-idUSKCN1NY186 [https://perma.cc/5R53-RZ3B].

bulb temperatures of 35°C several times over the next 30 years.[43] Continuing on this trajectory into the 22nd century, areas of the Middle East may no longer be habitable by humans without extensive adaptation measures.[44]

Mounting heat and humidity over the course of the century will also have dire consequences for the United States. For instance, from 1981 to 2010, the average American experienced about four dangerously humid days with wet-bulb temperatures exceeding 26.7°C; by 2030, that level is expected to grow to approximately 10 days per summer.[45] Without robust efforts to curb GHG emissions, the average American could expect to see 17 dangerously humid days in a typical summer by 2050, and 35 days by 2090.[46] In such a scenario, some summer days would be so unbearably hot and humid that a healthy individual would suffer heat stroke in less than an hour of moderate, shaded outdoor activity.[47]

II. THE PHYSIOLOGICAL EFFECTS OF EXTREME HEAT

It is clear that extreme heat directly inhibits the body's ability to cool itself off. Extreme heat produces a broad spectrum of heat-related illnesses, each with different signs, symptoms, and environmental triggers. The CDC has developed a widely-adopted[48] warning system for heat-related illnesses that provides a readily understandable overview of heat hazards in distinct categories of environmental conditions.

43. Christoph Schär, *Climate Extremes: The Worst Heat Waves to Come*, 6 NATURE CLIMATE CHANGE 128, 128–29 (2016).

44. *Id.* at 129. *But see* Sherwood & Huber, *supra* note 21, at 9554 ("In principle humans can devise protections against the unprecedented heat such as much wider adoption of air conditioning, so one cannot be certain that [a wet-bulb temperature of 35°C] would be uninhabitable. But the power requirements of air conditioning would soar; it would surely remain unaffordable for billions in the third world and for protection of most livestock; it would not help the biosphere or protect outside workers; it would regularly imprison people in their homes; and power failures would become life-threatening. Thus, it seems improbable that such protections would be satisfying, affordable, and effective for most of humanity.").

45. Kopp, Buzan & Huber, *supra* note 22.

46. *Id.*

47. *Id.*

48. *See Toolkit*, NAT'L INTEGRATED HEAT HEALTH INFO. SYS., *supra* note 17.

A. Heat-Related Illnesses

The most serious form of heat-related illness is heat stroke.[49] During a heat stroke, the sweating mechanism fails and the body is unable to control its temperature, resulting in a rapid increase in body temperature.[50] Heat stroke progresses quickly: the internal body temperature can rise to 106°F or higher within 10 to 15 minutes of onset.[51] Adding to its danger, heat stroke is accompanied by serious, potentially life-threatening symptoms, including confusion, dizziness, hallucinations, coma, and seizures.[52] Survivors of heat stroke remain at high risk for organ failure or death within a year.[53]

More mild forms of heat-related illness are characterized by a core temperature of less than 104°F (40°C) and no acute mental symptoms.[54] Heat exhaustion occurs when the body loses critical amounts of water and salt, particularly through excessive sweating; symptoms include headache, nausea, dizziness, and weakness.[55] Similarly, rhabdomyolysis, the rapid death of muscle tissue, emerges after prolonged physical exertion in the heat.[56] When muscle tissue breaks down and ruptures, electrolytes and proteins are released into the bloodstream, and can cause irregular heart rhythms, seizures, and kidney damage.[57] Common symptoms of rhabdomyolysis include muscle cramps, weakness, and exercise

49. *Types of Heat-Related Illnesses*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH (June 6, 2018), https://www.cdc.gov/niosh/topics/heatstress/heatrelillness.html [https://perma.cc/ZA4K-86QP].

50. *Id.*

51. *Id.*

52. *Id.*

53. Michael A. McGeehin & Maria Mirabelli, *The Potential Impacts of Climate Variability and Change on Temperature-Related Morbidity and Mortality in the United States*, 109 ENVTL. HEALTH PERSP. 185 (2001).

54. Jonathan A. Becker & Lynsey K. Stewart, *Heat-Related Illness*, 83 AM. FAM. PHYSICIAN 1325, 1326 tbl.1 (2011).

55. *Types of Heat-Related Illnesses*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, *supra* note 49.

56. *Id.*

57. BRENDA JACKLITSCH ET AL., NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, DHHS PUB. NO. 2016-106, CRITERIA FOR A RECOMMENDED STANDARD: OCCUPATIONAL EXPOSURE TO HEAT AND HOT ENVIRONMENTS 52 (2016), https://www.cdc.gov/niosh/docs/2016-106/pdfs/2016-106.pdf [https://perma.cc/97VC-KBU2] [hereinafter NIOSH CRITERIA DOCUMENT].

intolerance, but it can also be asymptomatic.[58] Heat syncope, or heat-related fainting, usually occurs when an individual stands for prolonged periods of time in the heat, or suddenly rises from a sitting or supine position.[59] During bouts of heat syncope, blood pools in the peripheral veins, resulting in temporary heart failure.[60] Dehydration and lack of acclimatization to prevailing environmental conditions can contribute to heat syncope.[61]

Less serious heat-related illnesses include heat cramps (cramps resulting from decreased salt and water levels in the body) and heat rash (a skin irritation caused by excessive sweating in hot and humid conditions).[62] While these illnesses are readily treated through hydration, salt-intake, and relocation to a cooler, less humid area, they can also be precursors to heat exhaustion or heat stroke, and like other heat illnesses, exacerbate underlying medical conditions.[63] Likewise, heat fatigue and sunburn are common heat-related illnesses which may also be antecedents to more serious conditions, including skin cancer.[64]

B. Public Health Trends

From a public health perspective, the dangers of extreme heat are interwoven with a complex set of variables, including: age; access to healthcare; economic status; geographic location; personal living environment; access to air conditioning; and social isolation.[65] Extreme heat aggravates preexisting medical conditions, such as respiratory and cardiovascular diseases, and can also worsen cerebral and psychiatric conditions.[66] Health-related

58. *Types of Heat-Related Illnesses*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, *supra* note 49.

59. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 57.

60. *Id.*

61. *Id.*

62. *Types of Heat-Related Illnesses*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, *supra* note 49.

63. *Id.*

64. *Id.*; *see generally* AK Bharath & RJ Turner, *Impact of Climate Change on Skin Cancer*, 102 J. ROYAL SOC'Y MED. 215 (2009).

65. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY PART B: REGIONAL ASPECTS 1464 (Vincente R. Barros et al. eds., 2014); Jeffrey Berko et al., *Deaths Attributed to Heat, Cold, and Other Weather Events in the United States, 2006–2010*, 76 NAT'L HEALTH STAT. REP. 1, 2 (2014).

66. Berko et al., *supra* note 65, at 1 ("[P]atients receiving psychotropic drug treatment for mental disorders and those taking medications that affect the body's heat regulatory system or have anticholinergic effects are more susceptible to heat effects.").

threats also extend to "[a]lcoholics, narcotics users, [and] persons confined to bed or unable to care for themselves."[67]

Numerous studies have indicated that older adults, young children (ages 0 to 4), males, and African Americans are most vulnerable to heat-related mortality and morbidity.[68] According to data compiled by the NWS, men over age 50 experienced the highest rate of heat-related fatalities in the United States in 2018.[69] Based on 2018 statistics, one of the most dangerous places to be during an EHE was in a permanent home, likely with little or no air conditioning, where a reported 26 people died.[70] In fact, age is one of the most salient risk factors in determining an individual's predisposition to heat-related illnesses.[71] For instance, during the devastating Chicago heatwave of 1995, which killed at least 700 people, a reported 73% of the victims were over the age of 65.[72]

In the United States, minority groups suffer an elevated rate of mortality and morbidity during EHEs, with African Americans being the most vulnerable group.[73] This trend may be attributable to the fact that minority groups are more likely to be socio-economically disadvantaged, work in high-risk occupations, and live in areas affected by the urban heat island effect.[74] Moreover, recent data shows that Hispanic immigrants in California and the Southwest—a subpopulation overrepresented in the construction and agricultural sectors—are disproportionately vulnerable to heat-related fatalities.[75] Thus, extreme weather events, including heat waves, are poised to amplify environmental justice concerns by disproportionately affecting low-income communities and communities of color.[76]

67. *Id.* at 2.

68. *Id.*; Carlson, *supra* note 10, at 176.

69. *2018 Heat Related Fatalities*, NAT'L WEATHER SERV., *supra* note 2.

70. *Id.*

71. *See* U.S. GLOB. CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 228 (Jerry M. Melillo, Terese (T.C.) Richmond & Gary W. Yohe eds., 2014) (observing that "[o]lder people are at much higher risk of dying during extreme heat events" than the population at large).

72. Carlson, *supra* note 10, at 178; *see also* ERIC KLINENBERG, HEAT WAVE: A SOCIAL AUTOPSY OF DISASTER IN CHICAGO 40–41 (2002).

73. Alana Hansen et al., *Vulnerability to Extreme Heat and Climate Change: Is Ethnicity a Factor?*, 6 GLOBAL HEALTH ACTION 1, 2 (2013).

74. *Id.* at 1–2.

75. *Id.* at 2–3.

76. U.S. GLOB. CHANGE RESEARCH PROGRAM, *supra* note 71, at 229 (predicting with high certainty that extreme weather events, including heat waves, will amplify environmental

III. THE CURRENT LEGAL FRAMEWORK OF EXTREME HEAT

There is no question that rising temperatures will engender an increasing number of heat-related public health crises as the 21st century progresses. Currently, however, the U.S. legal system is ill-equipped to safeguard the populace from heat hazards, let alone EHEs.

This section will present a comprehensive analysis of current approaches to extreme heat, beginning with an overview of regulations and best practices promulgated by federal and state agencies and industry organizations. It will observe that, despite the existence of quantifiable standards of temperature tolerance, and a decidedly uniform collection of best practices, such standards are largely noncompulsory and unenforceable, thereby lacking any legal teeth.

Next, this section will consider heat in the context of housing, with a focus on the scant public housing standards on heat. It will go on to examine state and federal regulations to protect vulnerable populations—including the elderly, childre, prison inmates, and the homeless—from EHEs and consider whether these standards can be applied to the entire U.S. populace. Finally, this section will contemplate extreme heat in other legal contexts, looking at miscellaneous statutes that can perhaps give insight to the development of a consistent standard.

A. Extreme Heat in the Workplace

1. Federal Regulations & Recommended Standards

Remarkably, OSHA does not have a rule on maximum temperatures for hot work environments. Rather, under Section 5(a)(1) of the Occupational Safety and Health Act, commonly known as the General Duty Clause, an employer is legally required to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his

justice concerns by disproportionately affecting low-income communities and communities of color).

employees."[77] As demonstrated by OSHA guidance, heat hazards fall within the scope of the General Duty Clause.[78]

OSHA has promulgated regulations to enforce the General Duty Clause, many of which are applicable to heat-related hazards. Under the Personal Protective Equipment standard, employers are required to evaluate the conditions of the workplace to determine the appropriate personal protective equipment ("PPE") to adequately protect workers from workplace-specific heat hazards.[79] Such protective equipment includes "personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers."[80] Employers have discretion as to the necessity of PPE in a given work environment; however, once the employer has established the need for PPE, he or she assumes the legal burden of verifying the safety of the PPE, even if an employee provides his or her own protective equipment.[81]

Other OSHA regulations relevant to workplace heat include the Sanitation standards, which require employers to provide employees with potable water,[82] and the Medical Services and First

77. 29 U.S.C. § 654(a)(1) (2018).

78. *Occupational Heat Exposure*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/SLTC/heatstress/standards.html [https://perma.cc/2B24-8NYY] (last visited Feb. 2, 2019).

79. 29 C.F.R. § 1910.132(d) (2018). OSHA provides a limited number of occupation-specific PPE rules. *See id.* §§ 1915.152 (shipyard), 1917.95 (maritime), 1926.28 (construction).

80. 41 C.F.R. § 50-204.7 (2018) ("Protective equipment . . . shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in function of any part of the body through absorption, inhalation or physical contact.").

81. *Id.* ("Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance and sanitation of such equipment."); *see also* Letter from Thomas Galassi, Acting Dir., Directorate of Enf't Programs, Occupational Health & Safety Admin., to Corey S. Retter (May 18, 2010), https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27578 [https://perma.cc/5GRZ-KEZA] ("While OSHA does not have a specific standard covering heat stress hazards, the agency has previously cited employers who have allowed their employees to be exposed to serious physical harm from excessively hot work environments.").

82. 29 C.F.R. §§ 1910.141, 1915.88, 1917.127, 1918.95, 1926.51, 1928.110 (2018). In its campaign to prevent occupational heat stress for outdoor workers, OSHA suggests that drinking water "should have a palatable (pleasant and odor-free) taste and the water temperature should be 50° F to 60° F, if possible." *Protective Measures to Take at Each Risk Level*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/SLTC/

Aid standards, which require employers to ensure the ready availability of persons onsite to render first aid in the absence of medical facilities in "near proximity" of the workplace.[83] Likewise, pursuant to the Injury and Illness Recordkeeping and Reporting standard, employers must log and report to OSHA work-related injuries and illnesses that resulted in employee medical treatment or loss of consciousness.[84]

To supplement these regulations, OSHA offers two tiers of heat-exposure guidance of varying degrees of scientific complexity. The first is OSHA's Heat Illness Prevention Campaign ("Campaign") for outdoor workers, which promulgates easy-to-understand recommendations, such as wearing a hat and light-colored clothing outdoors. While the Campaign is best exemplified by its simple social-media hashtag #WaterRestShade,[85] it does contain more substantive guidance, such as a four-part precautionary framework for working in outdoor heat based on the NWS's heat index.[86]

The second, more complex tier of OSHA heat exposure guidance is the OSHA Technical Manual ("OTM"). The OTM

heatillness/heat_index/protective_high.html [https://perma.cc/JB4F-JS8T] (last visited Feb. 2, 2019).

83. 29 C.F.R. §§ 1910.151, 1915.87, 1917.26, 1918.97, 1926.50 (2018). *See also* Letter from Richard E. Fairfax, Dir., Directorate of Enf't Programs, Occupational Safety & Health Admin., to Charles F. Brogan, Pro Med Training Ctr., LLC (Jan. 16, 2007), https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATION S&p_id=25627 [https://perma.cc/QLJ8-7D6N] ("While the standards do not prescribe a number of minutes, OSHA has long interpreted the term 'near proximity' to mean that emergency care must be available within no more than 3-4 minutes from the workplace, an interpretation that has been upheld by the Occupational Safety and Health Review Commission and by federal courts.").

84. 29 C.F.R. § 1904.7(b)(5) (2018). Employers are not required to report worker conditions that necessitated only first aid. *See Occupational Heat Exposure*, OCCUPATIONAL SAFETY & HEALTH ADMIN., *supra* note 78 ("For example, if a worker requires intravenous fluids, the worker's condition must be recorded. But if a worker is only instructed to drink fluids for relief of heat stress, the worker's condition is not recordable."). Other regulations invoked by OSHA to enforce the General Duty Clause include the Hazardous Waste Operations and Emergency Response ("HAZWOPER") standard (applying safety standards to employees who are exposed or potentially exposed to hazardous substances) and the Safety Training and Education standard (requiring employers in the construction industry to "instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury"). 29 C.F.R. §§ 1910.120, 1926.21(b)(2) (2018).

85. *See Protective Measures to Take at Each Risk Level,* OCCUPATIONAL SAFETY & HEALTH ADMIN., *supra* note 82.

86. *See generally Using the Heat Index: A Guide for Employers*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/SLTC/heatillness/heat_index/ [https://perma.cc/73Q7-8CRV] (last visited Apr. 10, 2019).

offers technical information to employers on the implementation of effective workplace health and safety programs, and serves as an enforcement and outreach manual for OSHA's Compliance Safety and Health Officers. In regard to workplace heat, the OTM outlines four key components of an effective heat-related illness prevention program, namely, an acclimatization program, a medical monitoring program, a training program, and a heat alert program, as well as a four-step process to assess the presence of a workplace heat hazard.[87] Unlike the Heat Illness Prevention Campaign, the OTM employs the WBGT to quantify heat-related hazards. Further, in developing heat safety procedures, the OTM relies on peer-reviewed occupational exposure guidelines from the American Conference of Governmental Industrial Hygienists ("ACGIH"),[88] and, significantly, on the recommended occupational safety standards developed by the National Institute for Occupational Safety and Health ("NIOSH").

NIOSH, a subdivision of the CDC established by the Occupational Safety and Health Act of 1970 ("OSH Act"), is charged with "develop[ing] and establish[ing] recommended occupational safety and health standards."[89] In 1972, NIOSH published its first heat-related criteria document ("Criteria Document") delineating "heat exposure levels that are safe for various periods of employment, including but not limited to the exposures at which no worker will suffer diminished health, functional capacity, or life expectancy because of his or her work experience."[90] NIOSH first revised the Criteria Document in 1986, and released a second revised version in 2016 to acknowledge the growing risk of heat-related workplace hazards.[91]

Like the OSHA OTM, the Criteria Document utilizes the WBGT as its primary heat measurement. However, the Criteria Document

87. These procedures are: (1) Determine the WBGT; (2) Add a clothing adjustment factor; (3) Determine the metabolic work rate; and (4) Determine the Threshold Limit Value® or Action Limit. Due to the complexity—and financial costs—of these procedures, it is unlikely that employers will implement this framework without the aid of industry professionals or OSHA guidance. *OSHA Technical Manual, Section III: Chapter 4, Heat Stress*, OCCUPATIONAL SAFETY & HEALTH ADMIN. (Sept. 15, 2017), https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html [https://perma.cc/CSG7-DEQG].

88. *See infra* Part III.A.3.d.

89. Occupational Safety and Health Act of 1970, Pub. L. No. 91-596, § 22, 84 Stat. 1601, 1612.

90. NIOSH CRITERIA DOCUMENT, *supra* note 57, at iii.

91. *Id.* at v.

does not rely solely on the WBGT in developing a recommended standard. Instead, the Criteria Document analyzes the WBGT in conjunction with metabolic rates, acclimatization levels, and work intervals. Using this physiology-based approach, NIOSH developed Recommended Exposure Limits ("RELs"), which are suggested heat stress exposure limits for acclimatized workers, and Recommended Alert Limits ("RALs"), which are suggested heat stress exposure limits for non-acclimatized workers.[92] These indices serve as the scientific basis for the Criteria Document's recommended standards, and inform NIOSH's best practices for workplace heat-stress mitigation.

In articulating recommended standards, the Criteria Document emphasizes the importance of acclimatization in the prevention of heat-related stress. NIOSH defines acclimatization as "[t]he physiological changes that occur in response to a succession of days of exposure to environmental heat stress and reduce the strain caused by the heat stress of the environment."[93] Through acclimatization, individuals are able to work in warmer environments with greater efficiency and reduce his or her risk of heat-related injury.[94] While there is individual variation in acclimatization levels, most workers, with repeated exposure to hot environments, can perform work with a reduced thermoregulatory strain and no symptoms of heat-illness within 7 to 14 days. Full acclimatization requires only brief daily exposures to workplace heat, with the minimum exposure time being two hours per day.

It is important to note, however, that employer compliance with the Criteria Document is not mandatory; NIOSH only "urges employers to use and disseminate the information to workers, and requests that professional associations and labor organizations inform their members about the hazards of occupational exposure to heat and hot environments."[95] Admittedly, it would be next to

92. *Id.* at 93.

93. *Id.* at xix.

94. *Id.* at 32 ("On repeated exposure to a hot environment, there is a marked adaptation in which the principal physiologic benefit appears to result from an increased sweating efficiency evidenced by earlier onset of sweating, greater sweat production, and lower electrolyte concentration[,] and a concomitant stabilization of the circulation.").

95. Indeed, the practices and guidelines set forth in the NIOSH Criteria Document pervade heat-related guidance disseminated by professional associations and labor organizations. Further, NIOSH acknowledges that it considered recommendations from U.S. organizations and agencies in compiling the Criteria Document. *See generally* NIOSH CRITERIA DOCUMENT, *supra* note 57, at 100–07.

impossible for employers to monitor metabolic rates and calculate RELs and RALs for each employee with currently available technology, but the use of the average REL and RAL for a given workplace would be an important first step. Other recommended standards in the Criteria Document, such as environmental engineering (including industrial fans)[96] and administrative controls,[97] are highly implementable—and potentially life-saving. Part IV of this note will evaluate the efficacy of such heat stress mitigation techniques and suggest best practices conducive to mandatory, widespread implementation.

2. State Regulations & Recommended Standards

Under Section 18 of the OSH Act, states may adopt and operate their own occupational health and safety programs, provided that the state plans are at least as effective as the federal OSHA program.[98] Accordingly, state plans may have more stringent requirements and enforcement mechanisms than the federal program. Currently, there are 28 OSHA-approved state plans, 5 of which cover only state and local government workers.[99]

Even though states are afforded considerable latitude in developing their own workplace safety programs, just three states have adopted regulations for occupational heat exposure: Washington for outdoor heat exposure, Minnesota for indoor heat

96. NIOSH recommended engineering controls are environmental adjustments aimed at reducing the production of body heat, maximizing evaporative cooling, and reducing radiative and convective loads. Examples include the installation of furnace wall insulation and metallic reflective screens. *Id.* at 71–74.

97. NIOSH recommended administrative controls consist primarily of five strategies: "(1) limiting or modifying the duration of exposure time; (2) reducing the metabolic component of the total heat load; (3) enhancing the heat tolerance of the workers by, for example, heat acclimatization and physical conditioning; (4) training the workers in safety and health procedures for work in hot environments; and (5) medical screening of workers to be aware of which individuals have low heat tolerance and/or low physical fitness." *Id.* at 75.

98. 29 U.S.C. § 667 (2018).

99. The following 28 states and territories have OSHA-approved state plans: Alaska, Arizona, California, Connecticut, Hawaii, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Michigan, Minnesota, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, the U.S. Virgin Islands, Virginia, Washington, and Wyoming. In Connecticut, Illinois, Maine, New Jersey, New York, and the U.S. Virgin Islands, the state plans cover only state and local government workers, and not private-sector workers. *State Plans: Frequently Asked Questions*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/dcsp/osp/index.html [https://perma.cc/42R9-NVSD] (last visited Apr. 13, 2019).

exposure, and California for both.[100] California became the first state to commit to establishing heat exposure regulations for indoor and outdoor workers when, in October 2016, Governor Jerry Brown signed Senate Bill 1167.[101] The law directed California's Division of Occupational Safety and Health, better known as Cal/OSHA, "to propose to the Occupational Safety and Health Standards Board for the board's review and adoption, a heat illness and injury prevention standard applicable to workers working in indoor places of employment" by January 1, 2019.[102] The law added section 6720 to the Labor Code, which instructs that "[the indoor heat exposure] standard shall be based on environmental temperatures, work activity levels, and other factors."[103] Cal/OSHA's proposed standard for heat illness prevention "applies to all indoor work areas where the temperature equals or exceeds 82 degrees Fahrenheit when employees are present," though as of publication of this Note, the standards are still under revision and subject to public comment.[104]

In regard to outdoor heat, California's Heat Illness Prevention Standard[105] applies to all outdoor places of employment at all temperature levels, and includes provisions on water,[106] shade access,[107] high-heat procedures for temperatures at or above

100. Gubernot et al., *supra* note 1, at 1780.

101. Alka Ramchandani, *California's Upcoming Indoor Heat Regulation*, OSHA LAW BLOG (Mar. 6, 2017), https://www.oshalawblog.com/2017/03/articles/californias-upcoming-indoor-heat-regulation/ [https://perma.cc/TKB3-QY56].

102. CAL. LEGIS. SERV. Ch. 839 (S.B. 1167) (2016).

103. Specifically, the law requires Cal/OSHA to "take into consideration heat stress and heat strain guidelines in the 2016 Threshold Limit Values and Biological Exposure Indices developed by the American Conference of Governmental Industrial Hygienist." CAL. LAB. CODE § 6720 (2016).

104. CAL. DEP'T OF INDUS. RELATIONS, HEAT ILLNESS PREVENTION DRAFT TEXT 1 (2019), https://www.dir.ca.gov/dosh/doshreg/Heat-Illness-Prevention-Indoors/Draft-revisions-Jan-29-2019.pdf [https://perma.cc/GH8X-7JUT].

105. CAL. CODE REGS. tit. 8, § 3395 (2015).

106. "Employees shall have access to potable drinking water . . . including but not limited to the requirements that it be fresh, pure, suitably cool, and provided to employees free of charge. The water shall be located as close as practicable to the areas where employees are working." *Id.* § 3995(c).

107. Under the shade provision, "[w]hen the outdoor temperature in the work area exceeds 80 degrees Fahrenheit, the employer shall have and maintain one or more areas with shade at all times while employees are present that are either open to the air or provided with ventilation or cooling." *Id.* § 3995(d)(1). When the temperature is below 80°F, the employer "shall either provide shade as per subsection (d)(1) or provide timely access to shade upon an employee's request." *Id.* There are, however, two exceptions to the shade requirement:

95°F,[108] emergency response procedures,[109] acclimatization,[110] training,[111] and heat illnesses prevention plans.[112] Washington State's Outdoor Heat Exposure Rule[113] is more limited than that of California, as it applies only from May 1st through September 30th when heat exposures are at or above a specific dry-bulb temperature.[114] The Washington Rule considers employee clothing

> (1) Where the employer can demonstrate that it is infeasible or unsafe to have a shade structure, or otherwise to have shade present on a continuous basis, the employer may utilize alternative procedures for providing access to shade if the alternative procedures provide equivalent protection. (2) Except for employers in the agricultural industry, cooling measures other than shade (e.g., use of misting machines) may be provided in lieu of shade if the employer can demonstrate that these measures are at least as effective as shade in allowing employees to cool.

Id. § 3995(d).

108. The high-heat procedures, to the extent practicable, shall include the assurance of "effective communication by voice, observation, or electronic means . . . and effective employee observation/monitoring." *Id.* § 3995(e)(1)–(2). The procedures also require a designated employee to call for emergency services, pre-shift meetings, and reminders throughout the shift to drink plenty of water and take a cool-down rest. *Id.* § 3995(e)(3)–(5). However, while the other provisions of the California Heat Illness Prevention Standard apply to all outdoor workers, the high-heat procedures apply only to workers in agriculture, construction, landscaping, oil and gas extraction, and transportation or delivery of products, "except for employment that consists of operating an air-conditioned vehicle and does not include loading or unloading." *Id.* § 3995(a)(2)(A)–(E). The agricultural sector is subject to additional requirements for high-heat conditions, including specific rules on shift lengths and rest periods. *Id.* § 3995(e)(6).

109. *Id.* § 3995(f).

110. Pursuant to the acclimatization plan, "[a]ll employees shall be closely observed by a supervisor or designee during a heat wave. For purposes of this section only, "heat wave" means any day in which the predicted high temperature for the day will be at least 80 degrees Fahrenheit and at least ten degrees Fahrenheit higher than the average high daily temperature in the preceding five days. An employee who has been newly assigned to a high heat area shall be closely observed by a supervisor or designee for the first 14 days of the employee's employment." *Id.* § 3995(g).

111. "Effective training in the following topics shall be provided to each supervisory and non-supervisory employee before the employee begins work that should reasonably be anticipated to result in exposure to the risk of heat illness: [t]he environmental and personal risk factors for heat illness . . . [t]he employer's procedures for complying with the requirements of this standard, including, but not limited to, the employer's responsibility to provide water, shade, cool-down rests, and access to first aid as well as the employees' right to exercise their rights under this standard without retaliation . . . [and the] different types of heat illness, the common signs and symptoms of heat illness, and appropriate first aid and/or emergency responses to the different types of heat illness" among others. *Id.* § 3995(h)(1)(A)–(I).

112. At a minimum, the Heat Illness Prevention Plan must include information on water, shade, high-heat procedures, emergency response procedures, and acclimatization measures. *Id.* § 3995(i)(1)–(4).

113. WASH. ADMIN. CODE §§ 296-62-095–296-62-09560 (2008).

114. *Id.* § 296-62-09510(2).

and PPE, and includes a table to match the prevailing outdoor temperature to the type of clothing or PPE worn by the employee.[115] Despite the fact that specific temperature-clothing combinations trigger the regulations, there is no legal requirement for employers to monitor worksite temperatures, let alone maintain records to ensure compliance and facilitate enforcement.[116] Instead, employers are only required to provide safety training to employees,[117] ensure the availability of drinking water,[118] and address heat-related illnesses in workplace Accident Prevention Programs.[119]

Minnesota's Rule on Indoor Ventilation and Temperature in Places of Employment[120] is noticeably more complex than the outdoor regulations of either California or Washington, perhaps due to the comparative ease of identifying indoor hazards. Whereas the California and Washington outdoor regulations use the dry-bulb temperature, the Minnesota Rule utilizes the more

115. The temperature thresholds that trigger compliance with the regulations are as follows: (1) Non-breathing clothes including vapor barrier clothing or PPE such as chemical resistant suits—52°F; (2) Double-layer woven clothes, including coveralls, jackets, and sweatshirts—77°F; and (3) All other clothing— 89°F. *Id.*

116. As required by section 34.05.325 of the Washington Code, the Washington Department of Labor and Industries Division of Occupational Safety and Health ("DOSH") addressed public comments and concerns regarding the regulation, including its lack of temperature monitoring, in its Concise and Explanatory Statement on the Outdoor Heat Exposure Rule. DOSH noted that employers are not required to monitor the temperature, but suggested "[w]hen employers *expect* temperatures to reach the temperature action levels at their worksites, employers can chose [sic] to ensure 1 quart of water is available for each employee every hour during the work shift and respond to any employee who shows sign of heat-related illness." WASH. DEP'T LABOR & INDUS., DIV. OCCUPATIONAL SAFETY & HEALTH, OUTDOOR HEAT EXPOSURE CONCISE EXPLANATORY STATEMENT 237 (2008), http://www.lni.wa.gov/rules/AO06/40/0640CES.pdf [https://perma.cc/LJG8-LBC7] (emphasis added).

117. "Training on the following topics must be provided to all employees who may be exposed to outdoor heat at or above the [aforementioned temperature thresholds]. . . . The environmental factors that contribute to the risk of heat-related illness [and g]eneral awareness of personal factors that may increase susceptibility to heat-related illness including, but not limited to, an individual's age, degree of acclimatization, medical conditions, drinking water consumption, alcohol use, caffeine use, nicotine use, and use of prescription and nonprescription medications that affect hydration or other the body's responses to heat[.]" WASH. ADMIN. CODE § 296-62-09560(1)(a)–(h) (2018).

118. "When employee exposure is at or above an [aforementioned temperature threshold] [e]mployers must ensure that a sufficient quantity of drinking water is readily accessible to employees at all times . . . [and] that all employees have the opportunity to drink at least one quart of drinking water per hour." *Id.* § 296-62-09540(1)(a)–(b).

119. *Id.* § 296-62-09530(1)(a).

120. MINN. R. 5205.0110 (2014).

nuanced WBGT; nonetheless, like the Washington regulation, it does not include a provision on temperature monitoring.[121] In developing its exposure limits, the Minnesota Rule identifies levels of work activity based on caloric needs, and provides a table of two-hour time-weighted averages of permissible heat exposure limits for fully clothed acclimatized workers. For example, "heavy work" such as heavy lifting and shoveling, requires 350 or higher kcal/hr and has an associated maximum WBGT exposure level of 77°F.[122] Further, all employees exposed to workplace heat must receive training in accordance with Minnesota's Hazardous Substances and Employee Right-To-Know training provision.[123] The provision, however, is not specific to heat and only mandates general workplace safety requirements, such as the promulgation of an Employee Right-To-Know program that includes information on training and labeling in regard to worksite hazards.[124]

3. Occupation-Specific Recommendations & Standards

a. U.S. Military

The heat safety program of the U.S. DOD is governed by the Technical Bulletin on Heat Stress Control and Heat Casualty Management (TB MED 507) ("DOD Bulletin"), produced in collaboration with the Office of the Surgeon General and published by the Department of the Army.[125] Last updated in 2003, the DOD Bulletin aims to "[d]evelop an evidence-based preventive program to protect military personnel from heat stress and associated adverse health effects."[126] Like the NIOSH Criteria Document, the DOD Bulletin employs the WBGT as its standard temperature index and emphasizes the importance of acclimatization as a heat-illness prevention mechanism.[127] Further,

121. Nearly all indoor workplaces have basic temperature thermometers. However, because WBGT thermometers are more complex—and more expensive—than ambient temperature thermometers, it is probable that many Minnesota employers would be reluctant to spring for the more expensive WBGT thermometer since compliance is not compulsory.

122. MINN. R. 5205.0110(2)(B) (2014).

123. *Id.* 5205.0110(2)(C), 5206.0700.

124. *Id.* 5206.0700(1)(B).

125. DEP'T OF THE ARMY AND AIR FORCE, TB MED 507, TECHNICAL BULLETIN: HEAT STRESS CONTROL AND HEAT CASUALTY MANAGEMENT (2003).

126. *Id.* at 1.

127. *Id.*

the DOD Bulletin utilizes a color-coded classification system of environmental heat stress that delineates acceptable levels of physical exertion in four different categories, each of which represents a range of WBGTs.[128] For each WBGT range, the DOD Bulletin recommends hydration frequencies[129] and work/rest cycles[130] for three different work-level classifications based on metabolic rate.[131]

In addition to presenting technical guidance, the DOD Bulletin also contains "Hot Weather Deployment Tips" for the mitigation of heat-related injuries.[132] The Hot Weather Deployment Tips address acclimatization and physical fitness;[133] hydration and nutrition;[134] work/rest cycles and the reduction of heat exposure;[135] clothing,

128. The DOD color-coded WBGT categories are: Green (78°F–81.9°F), Yellow (82°F–87.9°F), Red (88°F–89.9°F), and Black (>90°F). The classification system also provides adjustment factors for clothing. For instance, if wearing body armor in "humid climates," 5°F should be added to the WBGT. Likewise, if wearing "mission-oriented protective posture," 10°F should be added to the WBGT for easy work, and 20°F for moderate or hard work. *Id.* at 13 tbl.3-1. For the definition of easy, moderate, and hard work, *see infra* note 119. For the calculation of the WBGT, the DOD Bulletin offers a list of WBGT equipment and national stock numbers, along with 8 commercially-available WBGT heat stress monitors. *Id.* at 51–53.

129. Hydration frequencies are measured in quarts per hour. The guidelines note that hourly fluid intake should not exceed 1.5 quarts, and daily fluid intake should not exceed 12 quarts. *Id.*

130. Work/rest cycles are calculated in minutes per hour. For example, when performing hard work in the black WBGT category, 10 minutes of work must be alternated with 50 minutes of rest. The DOD Bulletin defines rest as "minimal physical activity (sitting or standing), accomplished in shade if possible." *Id.*

131. The DOD Bulletin defines light work as requiring approximately 250 watts, and moderate and hard work as requiring approximately 425 watts and 600 watts, respectively. One watt is equivalent to 0.86 kcal/hr. Examples of light work include weapon maintenance, marksmanship training, and ceremony, whereas examples of moderate work include calisthenics, patrolling, and defensive position construction. Examples of hard work are field assaults, walking at 3.5 mph with a load greater than 40lbs, and walking in loose sand at 2.5mph with any load. *Id.* at 55.

132. *Id.*

133. The DOD Bulletin recommends the maximization of physical fitness and heat acclimatization *prior* to deployment, adding that "[p]hysically fit soldiers acclimatize to heat faster than less fit soldiers." *Id.* (emphasis added).

134. In addition to following the WBGT guidelines for hydration, soldiers should "[m]onitor hydration status by noting the color and volume of a soldier's urine." *Id.* at 56. Interestingly, soldiers are not required to drink "carbohydrate and electrolyte beverages . . . [because f]or healthy soldiers, these beverages provide no advantage over water; however, they can enhance fluid consumption because of their flavor and reduce risk of hyponatremia because of sodium." *Id.*

135. To reduce heat exposure, soldiers should avoid resting on the hot ground. When heated by the sun, the ground can be 30 to 45 degrees hotter than the air, especially in desert conditions; thus, "the more body surface in contact with the ground, the greater the heat strain." *Id.*

equipment, and supplies;[136] first aid;[137] and the "weak link rule," which calls for an assessment of the entire unit when the first heat casualty occurs, which means the first time someone falls ill to heat.[138] Moreover, the DOD Bulletin allocates specific roles to military personnel to aid in administration of the guidance. For instance, unit commanders are tasked with "develop[ing] and implement[ing] controls for heat stress exposure . . . [and] enforc[ing] appropriate fluid replacement discipline and work-rest cycles."[139] Likewise, the DOD Bulletin requires soldiers to "[b]ecome familiar with recognizing the early signs and symptoms of becoming a heat casualty . . . and report as soon as possible to the unit medic/medical officer if they or their buddy develop symptoms."[140] In spite of these articulated roles, the DOD Bulletin is, ultimately, a guidance document, as it lacks a legal enforcement mechanism and is effectuated at the discretion of the unit commander.

While the 2003 DOD Bulletin is the core of the military's guidance on heat-related hazards, individual branches of the military have developed supplemental guidance with more tailored standards and recommendations. For example, in February 2009, the Department of the Navy, Bureau of Medicine and Surgery released a Manual of Naval Preventive Medicine ("Naval Manual") to delineate distinct heat safety standards for Navy service members when ashore, afloat, or participating in ground commands. When ashore, the Navy adopts the DOD Bulletin's color-coded WBGT categorizations in the form of "flag conditions."[141] Under this system, color-coded flags are flown in strategic locations at a base or

136. In regard to clothing, equipment, and supplies, soldiers should "[u]se hats, head cloths, goggles and sunscreen as necessary . . . [r]estrain the desire to loosen and take off clothing to improve ventilation because of the hazards from sun, wind and insect exposure . . . [k]eep clothing clean, since clean clothes protect better and help prevent skin rashes . . . [and c]hange socks at least twice a day, [because] wet socks can lead to foot injury (for example, blisters) or foot fungus ('athletes foot')." *Id.*

137. First aid tips include getting a soldier into shade and removing any heavy clothing, wetting the skin or t-shirt of the soldier to reduce body temperature, or, if possible, creating a field expedient immersion device from a tent canvas. *Id.* at 57.

138. *Id.* at 55.

139. *Id.* at 1.

140. *Id.* at 2–3.

141. DEP'T OF THE NAVY, NAVMED P-5010-3, MANUAL OF NAVAL PREVENTIVE MEDICINE: PREVENTION OF HEAT AND COLD STRESS INJURIES (ASHORE, AFLOAT, AND GROUND FORCES) 3-14 (2009). Because the Department of the Navy encompasses both the U.S. Navy and the U.S. Marine Corps, both military branches are governed by the Naval Manual.

installation to communicate hazardous heat conditions and encourage the adjustment of work/rest cycles.[142]

When afloat, the Navy identifies the risk of heat stress through a series of six physiological exposure limit ("PHEL") curves, which plot the WBGT against exposure time in hours.[143] Developed by the Navy in 1973, each PHEL curves corresponds to "various environmental conditions and individual work rates,"[144] and determines maximum exposure levels for acclimatized, healthy personnel wearing water-permeable clothing of at least 35 percent cotton fiber.[145] For shore commands, the Navy implements the ACGIH Threshold Limit Values® ("TLVs®") and work/rest criteria for a heat stress environment.[146] Additionally, the Naval Manual suggests tailoring shore command activities to outdoor conditions and time of day, and using shading techniques, such as camouflaged netting and tents, especially at hydration stations.[147]

Like the Department of the Navy, the Department of the Army released a Training Document on the Prevention of Heat and Cold Casualties (TRADOC Regulation 350-29) ("Army Training Document") that "prescribes policy and provides guidance to commanders for preventing environmental (heat or cold) casualties."[148] Compared to the DOD Bulletin, the Army Training Document offers more practical tools for the implementation of heat safety measures, such as a urine color chart to depict

142. *Id.* Flag conditions are largely comparable to the color-coded categories of the DOD Bulletin; however, flag conditions have a slightly altered correlation of WBGT index range to color: Green Flag (80°F–84.9°F), Yellow Flag (85°F–87.9°F), Red Flag (88°F–89.9°F), and Black Flag (90°F <). *Id.*

143. *Id.* at 3-15–3-17.

144. *Id.* at 3-15. PHEL curves allow the core temperature to rise to 102.2°F; at this temperature, the conditions of heat stress are apparent but reversible. The Naval Manual includes a table to identify which PHEL curve applies to each individual service member aboard a maritime vessel. For example, a throttleman aboard a diesel-propelled ship is assigned to PHEL curve I, which contains the least stringent exposure limits for both routine watch and casualty control drills. *Id.* at 3-20.

145. *Id.* at 3-16.

146. *Id.* *See also supra* note 87 and accompanying text.

147. DEP'T OF THE NAVY, *supra* note 141, at 3-28–3-29.

148. DEP'T OF THE ARMY, TRADOC REGULATION 350-29, PREVENTION OF HEAT AND COLD CASUALTIES (2016). Even though it is deemed a regulation, the Army Training Document does not have a legal enforcement mechanism, and only "prescribes policy and provides guidance to commanders in preventing environmental (heat or cold) casualties." *Id.* at 1.

hydration levels,[149] and a heat illness risk management checklist and worksheet to evaluate heat risks.[150]

Despite the surfeit of recommendations and technical guidance from the military, heat-related morbidity among service members remains a significant danger. In a 2018 report, the Defense Health Agency ("DHA") reported 464 cases of heat stroke in 2017, a decrease from the 484 cases reported in 2016.[151] Of the 10,458 heat-related illnesses diagnosed at over 250 military installations worldwide from 2013 to 2017, less than 5% occurred at installations outside of the United States.[152] Four military installations in the United States accounted for one-third (32.8%) of the total heat illness cases: Fort Benning, GA (1,328); Fort Bragg, NC (1,059); Fort Campbell, KY (606), and Fort Jackson, SC (442).[153] Accounting for these statistics, Dr. Francis G. O'Connor, a professor of Military and Emergency Medicine at the Uniformed Services University of the Health Sciences, states that the primary causes of heat-related illnesses among military service members are "not being adequately acclimatized to heat and humidity in a local environment, lack of adequate fitness for the demands of the task, and the competitiveness of the training environment."[154]

To counteract the growing threat of heat-related morbidity, the military has relied chiefly on education campaigns (i.e. promotion of the "buddy system")[155] and the dissemination of guidance criteria and preventative countermeasures through military leadership. However, the military is also turning to technology to

149. *Id.* at 18, fig.B-1.

150. *Id.* at 15–26.

151. *Update: Heat Illness, Active Component, U.S. Armed Forces, 2017*, MED. SURVEILLANCE MONTHLY REP., Apr. 2018, at 6, 6, 8 tbl.1. The DHA reports that in 2017, "incidence rates of both heat stroke and heat exhaustion were highest among service members aged 19 years or younger, Asian/Pacific Islanders, Marine Corps and Army members, and those in combat-specific occupations." *Id.* at 6. In terms of gender, "[t]he rate of heat stroke was markedly higher among males than females. In contrast, the rate of heat exhaustion among females was similar to that among males." *Id.*

152. *Id.* at 8.

153. *Id.*

154. Briana Booker, *Exertional Heat Injuries Pose Annual Threat to U.S. Service Members*, MIL. HEALTH SYS. (July 20, 2017), https://health.mil/News/Articles/2017/07/20/Exertional-Heat-Injuries-Pose-Annual-Threat-to-US-Service-Members [https://perma.cc/MV8K-K8BG].

155. *Heat Illness Prevention Use the Buddy System to Stay Cool and Safe*, MIL. HEALTH SYS., https://health.mil/News/Gallery/Infographics/2017/07/20/Heat-Illness-Prevention-Use-the-Buddy-System-to-Stay-Cool-and-Safe [https://perma.cc/VEV3-U56J] (last visited Feb. 11, 2018).

adapt to extreme heat. For instance, Dr. Mark Buller of the U.S. Army Research Institute of Environmental Medicine ("USARIEM") developed an Estimated Core Temperature ("ECTemp") algorithm that, when coupled with a non-invasive heart rate monitoring device, estimates core body temperature through an analysis of heart rate fluctuations.[156] While the algorithm is still in its research phase, the Army intends to use the ECTemp algorithm in lightweight chest monitors that will identify heat-related risks on a soldier-by-soldier basis in training and combat scenarios.[157] Similarly, the USARIEM designed an Android-based smartphone app called the Soldier Water Estimation Tool ("SWET") to determine hydration needs based on the combined physiological effects of activity level, attire, air temperature, relative humidity, and cloud cover.[158] According to Dr. Nisha Charkoudian, a research physiologist from the USARIEM, the SWET app "meets requests from the increasingly digital battlefield for paperless guidance that is simple, accurate, mission-specific and available in real time."[159]

b. Emergency Response & Cleanup

Certainly, fire fighters are at an elevated risk of heat stress from exposure to multiple, often compounding, sources of dangerous heat: radiant heat from fires; body heat generated by intense physical exertion in protective equipment; and, at times, ambient heat from warm weather events.[160] Thus, it is unsurprising that professional organizations and government agencies have developed myriad regulations, protocols, and best practices to safeguard firefighters from extreme heat.

i. Professional Associations

Established in 1896, the National Fire Protection Association ("NFPA") is a non-profit organization "devoted to eliminating

156. Mallory Roussel, *Airmen Dodge 30 Heat Stress Cases with USARIEM's ECTemp Algorithm*, U.S. ARMY (Apr. 24, 2017), https://www.army.mil/article/186577/ [https://perma.cc/JB2B-ZQBF].

157. *Id.*

158. Kelly Field, *Army Develops App to Determine Body's Water Needs*, U.S. ARMY (Oct. 24, 2014), https://www.army.mil/article/136391/army_develops_app_to_determine_bodys_water_needs [https://perma.cc/AW6P-JUKR].

159. *Id.*

160. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 54.

death, injury, property and economic loss due to fire, electrical and related hazards."[161] The NFPA has published 300 codes and standards designed to minimize such hazards and enhance fire safety, including NFPA 1500, the Standard on Fire Department Occupational Safety, Health, and Wellness Program. NFPA 1500 specifies the minimum requirements for an occupational safety and health program for fire departments and other emergency services.[162] While NFPA 1500 has no legal force on its own and presents only voluntary consensus standards, the NFPA encourages jurisdictions to adopt its provisions as the basis of emergency response occupational safety programs. NFPA 1500 is exceedingly broad in scope and includes both general procedural protocols and highly-nuanced technical requirements. For example, Chapter 7 on Protective Clothing and Protective Equipment dictates that "[p]rotective clothing and protective equipment shall be used whenever the member is exposed to the hazards for which it is provided,"[163] but goes on to require such things as a minimum of a two-inch overlap between a responder's protective coat and trousers, which must be maintained when the responder is bent forward at a 90-degree angle.[164]

Further, the International Association of Fire Fighters ("IAFF"), a labor union representing professional firefighters and emergency medical services personnel in the United States and Canada, has published a Thermal Stress Protocol ("IAFF Protocol") to provide more concise guidance to local union affiliates on heat stress.[165] The IAFF Protocol implements the same heat safety criteria for both fire-fighting and HAZMAT scenarios.[166] Rather than promulgate its own exposure limits and temperature indices, the

161. *NFPA Overview*, NAT'L FIRE PROTECTION ASS'N, https://www.nfpa.org/About-NFPA/NFPA-overview [https://perma.cc/535N-SHFU] (last visited Apr. 13, 2019).

162. NAT'L FIRE PROT. ASS'N, NFPA 1500 STANDARD ON FIRE DEPARTMENT OCCUPATIONAL SAFETY, HEALTH, AND WELLNESS PROGRAM (2018).

163. *Id.* at 19.

164. *Id.* at 20.

165. The IAFF Protocol is a paradigmatic example of IAFF's heat safety resources. IAFF provides many other resources, including training programs, health and safety guides, and educational tools. *See generally Programs and Services*, INT'L ASS'N. OF FIRE FIGHTERS, http://client.prod.iaff.org/#page=ProgramsAndServices [https://perma.cc/F95U-9ELY] (last visited Feb. 11, 2018).

166. INT'L ASS'N. OF FIRE FIGHTERS, THERMAL HEAT STRESS PROTOCOL FOR FIRE FIGHTERS AND HAZMAT RESPONDERS 1 (2018), http://www.iaff.org/hs/LODD_Manual/Resources/IAFF%20Thermal%20Stress%20Protocol.pdf [https://perma.cc/925C-JG7Z].

IAFF Protocol relies on established criteria, such as the color-coded WBGT classification system from the DOD Bulletin, and its corresponding hydration frequencies and work-rest cycles.[167] The IAFF Protocol also underscores the importance of measuring vital signs before entering the emergency response site and during rest periods. The IAFF Protocol recommends that "[a]ny personnel with pulse above 100 [beats per minute], blood pressure outside a range from 90/60 [mmHg to] 150/90 [mmHg,] or temperature above 99°F should not be allowed to enter the site."[168] Likewise, if during a rest period, a personnel's pulse exceeds the age-adjusted maximum heart rate[169] by 75%, the length of the responder's work cycle should be decreased by one-third.[170]

ii. Government Agencies

The U.S. Fire Administration ("USFA"), an entity of the Federal Emergency Management Agency ("FEMA"), provides guidance for "fire and emergency services stakeholders in prevention, preparedness and response."[171] In February 2008, the USFA published a revised edition of its Emergency Incident Rehabilitation ("USFA Manual")[172] in collaboration with the IAFF, which gives a comprehensive overview of the laws,[173] regulations,[174]

167. *Id.* at 4.

168. *Id.*

169. *Id.* For an explanation of age-adjusted maximum heart rates, see *Exercise Intensity: How To Measure It*, MAYO CLINIC (May 19, 2017), https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/exercise-intensity/art-20046887?pg=2 [https://perma.cc/9QEC-PPUJ] ("The basic way to calculate your maximum heart rate is to subtract your age from 220. . . . This is the maximum number of times your heart should beat per minute during exercise.").

170. INT'L ASS'N OF FIRE FIGHTERS, *supra* note 166, at 4.

171. *About the U.S. Fire Administration*, U.S. FIRE ADMIN. (Apr. 3, 2019), https://www.usfa.fema.gov/about/index.html [https://perma.cc/R59Z-SFRH].

172. U.S. FIRE ADMIN., EMERGENCY INCIDENT REHABILITATION (2008), https://www.usfa.fema.gov/downloads/pdf/publications/fa_314.pdf [https://perma.cc/74MU-4AFS].

173. Namely, the Occupational Safety and Health Act of 1970 and its state analogs. *Id.* at 15–16.

174. The USFA Manual cites the HAZWOPER standard as one of two sources federal regulations on fire fighter safety. *See supra* note 84 and accompanying text. The other source is Subpart L of OSHA Regulations, entitled "Fire Protection," which primarily enumerates fire safety requirements for the workplace, such as the installation of fire extinguishers and alarm systems. 29 C.F.R. § 1910 Subpart L (2018). OSHA does, however, provide some regulations for "fire brigades," which are defined as private or industrial fire departments consisting of "an organized group of employees who are knowledgeable, trained, and skilled in at least basic fire fighting operations." *Id.* § 1910.155(c)(18). Under these regulations, employers are legally required to "assure that employees who are expected

and occupational guidelines pertinent to emergency response, and touts NFPA 1500 as the gold standard in safety management.[175] Acknowledging that "approximately one-half of all firefighter fatalities and a significant percentage of injuries and illnesses [result from] stress and overexertion on firefighters involved in emergency scene operations and training exercises," the USFA Manual advocates for a proactive injury prevention program to minimize risk and build resistance to injuries.[176] Most importantly, it calls for a functioning rehabilitation area at every emergency response site.[177]

NIOSH, OSHA, the U.S. Environmental Protection Agency ("EPA"), and the U.S. Coast Guard ("USCG") have jointly published the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities ("HAZMAT Manual"), which delineates worker safety guidelines for HAZMAT scenarios.[178] The HAZMAT Manual notes that PPE increases an individual's susceptibility to heat stress, and therefore, regular monitoring of vital signs is an essential component of any heat safety protocol.[179] For workers wearing permeable clothing, the HAZMAT Manual recommends usage of the work-rest schedules in the ACGIH's

to do interior structural fire fighting are physically capable of performing duties which may be assigned to them during emergencies . . . [and to] provide training and education for all fire brigade members commensurate with those duties." *Id.* §§ 1910.156(b)(2), 1910.156(c)(1).

175. U.S. FIRE ADMIN., *supra* note 172, at 17–18.

176. The injury prevention program of the USFA Manual includes "a comprehensive and effective wellness program; a physical fitness program; a strong commitment to safety from both labor and management; a designated Safety Officer; an ergonomic analysis of all aspects of the workplace to identify potential injury causes and address unsafe conditions that can be corrected by improved design; a program to manage medical and injury rehabilitation to decrease time loss and reduce reinjury rates; an educational component that begins in the fire academy and continues throughout the entire career; a recognition system for personnel who practice, play, and preach safety; a relationship between labor, management, and risk management; and an integrated and participatory fire department 'near miss' program." *Id.* at 1.

177. The rehabilitation area should include, at a minimum, medical evaluation and treatment, food and fluid replenishment, relief from climatic conditions, rest and recovery, and member accountability. *Id.* at 92. The USFA Manual cites the NFPA1584 Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises as its source for rehabilitation guidelines. *Id.* at 75.

178. NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH ET AL., OCCUPATIONAL SAFETY AND HEALTH GUIDANCE MANUAL FOR HAZARDOUS WASTE SITE ACTIVITIES (1985), https://www.osha.gov/Publications/complinks/OSHG-HazWaste/all-in-one.pdf [https://perma.cc/6W53-6Z4E].

179. *Id.* at 8-36–8-37.

TLVs® for Heat Stress; however, for workers wearing semi-permeable or impermeable clothing, the HAZMAT Manual instead calls for monitoring of heart rate,[180] oral temperature,[181] and body water loss[182] whenever the adjusted air temperature[183] is above 70°F.[184] Further, the HAZMAT Manual suggests adherence to a monitoring frequency protocol based on the adjusted air temperature and type of clothing. For example, when the adjusted air temperature is above 90°F, workers wearing impermeable clothing should be monitored every 15 minutes.[185] Moreover, as part of its heat stress prevention program, the HAZMAT Manual recommends adjusting work schedules,[186] providing shelters for rest periods, maintaining hydration levels,[187] encouraging workers to maintain an optimal level of physical fitness,[188] providing cooling devices (such as field showers, hose-down areas, or cooling jackets), and training workers to recognize and treat heat stress.[189]

180. "If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same." *Id.* at 8-37.

181. "If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period . . . Do *not* permit a worker to wear a semi-permeable or impermeable garment when his/her oral temperature exceeds 100.6 °F (38.1 °C)." *Id.* at 8-38 (emphasis in original).

182. "Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day." *Id.*

183. The HAZMAT Manual calculates the adjusted air temperature using the rather imprecise equation: dry bulb temperature (°F) + (13 x % sunshine), where the percent sunshine is an estimate of the "percent time the sun is not covered by clouds that are thick enough to produce a shadow." *Id.*

184. *Id.* at 8-37–8-38.

185. *Id.* at 8-38.

186. In addition to modifying work/rest schedules in accordance with monitoring requirements, management should "[m]andate work slowdowns, . . . rotate personnel [to] alternate job functions, . . . [and] perform work during cooler hours of the day if possible." *Id.* at 8-38–8-39.

187. Strategies for adequate hydration include: "Maintain[ing] water temperature at 50° to 60°F (10° to 15.6°C); Provid[ing] small disposable cups that hold about 4 ounces (0.1 liter); Hav[ing] workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work; Urg[ing] workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break . . . [and] Weigh[ing] workers before and after work to determine if fluid replacement is adequate." *Id.* at 8-39.

188. The HAZMAT Manual cites acclimatization and weight maintenance as components of a physical fitness regimen. *Id.*

189. *Id.*

c. Construction

Often working outdoors or in poorly ventilated, closed spaces,[190] construction workers are particularly vulnerable to heat-related illnesses.[191] In 2016, 11 construction workers[192] died from exposure to "extreme environmental heat."[193] The Center for Construction Research and Training, which goes by the acronym "CPWR,"[194] provides resources to educate construction workers on the prevention of heat-related hazards, relying primarily on OSHA's Campaign to Prevent Heat Illness and various NIOSH materials, such as posters, infographics, and even a heat stress podcast.[195] As referenced above, OSHA has a specific PPE regulation for construction workers, albeit with minimal technical guidance on

190. OSHA records indicate that most heat-related citations in the construction industry under the General Duty Clause of the OSH Act involve outdoor heat exposure, but indoor contracting firms have also been cited for failure to protect workers from extreme heat. *Fatality Inspection Data*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/dep/fatcat/dep_fatcat.html [https://perma.cc/5USH-AYV2] (last visited Apr. 13, 2019) (search Hazard Description field for "heat"). For instance, in July 2017, a Louisiana air conditioning installation company was fined $6,211 when an employee working in a residential attic became overheated and died of heat exhaustion. Ostensibly, the relevant employees followed a heat stress mitigation protocol. According to OSHA's accident investigation report, a "cowoker [sic] told the [deceased] to go sit in the work truck to cool off in the air conditioning and drink some fluids. . . . Approximately 45 minutes later . . . [a]s the employee exited the vehicle, the coworker observed that the employee's lips were blue. Soon after, the employee collapsed. Emergency services were contacted and, upon their arrival, the employee was determined dead." *Inspection Detail 1248555.015—Ace Air Conditioning of Louisiana, LLC*, OCCUPATIONAL SAFETY & HEALTH ADMIN. (July 20, 2017), https://www.osha.gov/pls/imis/establishment.inspection_detail?id=1248555.015 [https://perma.cc/JQE7-YJGQ].

191. *Working in Hot Weather*, CTR. FOR CONSTRUCTION RES. & TRAINING, https://www.cpwr.com/research/working-hot-weather [https://perma.cc/K7U6-G24L] (last visited Apr. 13, 2019).

192. *Id.*

193. Kendall Jones, *Construction Leads All Industries in Total Worker Deaths*, CONSTRUCTCONNECT (Dec. 20, 2016), https://www.constructconnect.com/blog/construction-news/construction-leads-industries-worker-deaths/ [https://perma.cc/QS6L-UF9Z]; *see also About CPWR*, CTR. FOR CONSTRUCTION RES. & TRAINING, https://www.cpwr.com/about/about-cpwr [https://perma.cc/MMU3-T633] (last visited May 15, 2019).

194. Since 1990, the Center for Construction Research and Training, which goes by the acronym "CPWR," has worked with OSHA and NIOSH to implement a "safety culture" for the construction industry. CPWR has partnered with numerous research universities, including Duke University Medical Center and the University of California, to provide safety guidelines while lowering costs and increasing productivity. *About CPWR*, CTR. FOR CONSTRUCTION RES. & TRAINING, *supra* note 193.

195. *Working in Hot Weather*, CTR. FOR CONSTRUCTION RES. & TRAINING, *supra* note 191. OSHA materials, such as "Water, Rest, Shade" wallet cards and heat illness training posters are available in both Spanish and English. *Id.*

heat protection.[196] The regulation indicates that "[t]he employer is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions . . . ."[197] Nonetheless, "[t]he employer is *not* required to pay for . . . [o]rdinary clothing, skin creams, or other items, used solely for protection from weather, such as . . . ordinary sunglasses, and sunscreen."[198]

The CPWR relies predominantly on worker education to combat the dangers of heat stress. For instance, the CPWR recommends usage of the OSHA Heat Safety Tool App, which displays the heat index for the outdoor worksite, and based on the prevailing heat index, determines a heat-stress risk level for workers.[199] App-users can elect to receive workplace safety tips on hydration levels, break schedules, acclimatization, and the signs and symptoms of heat-related illnesses.[200] A caveat of the app, however, is that it does not factor in radiant heat from sunlight, which can increase the heat index by 15°F.[201] Regardless of this limitation, the app provides a quick and readily understandable resource for outdoor workers to assess the dangers of heat stress.

d. Manufacturing & Industrial Labor

The ACGIH, a non-profit scientific organization that develops proprietary guidelines for occupational and environmental health, publishes TLVs® and Biological Exposure Indices (BEIs®)[202] to aid industrial hygienists in making decisions on safe levels of exposure to chemical and physical hazards in the workplace. In regard to heat, the ACGIH's Heat Stress and Strain TLV® "refers to heat stress conditions under which it is believed that nearly all workers

196. *See supra* note 79.

197. 29 C.F.R. § 1926.28(a) (2018).

198. *Id.* § 1926.95(d)(4)(ii) (emphasis added).

199. *Heat Safety Tool*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html [https://perma.cc/4CDV-V99N] (last visited Apr. 13, 2019).

200. *Id.*

201. *Id.*

202. BEIs® are guidance values to assess biological monitoring results, or "concentrations of chemicals in biological media (e.g., blood, urine)," and thus, have minimal applicability to heat stress. *Permissible Exposure Limits—Annotated Tables*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/dsg/annotated-pels/index.html (last visited Apr. 13, 2019).

may be repeatedly exposed without adverse health effects."[203] This TLV® aims to keep core body temperature within +1°C of normal (37°C) (or, within roughly +1.8°F of 100.7°F) by incorporating environmental factors (expressed as the WBGT adjusted for clothing type) and metabolic heat production (expressed in four work-load categories ranging from light work to very heavy work based on kilocalories spent per hour).[204]

In addition to the ACGIH's Heat Stress and Strain TLV®, the manufacturing sector also implements industry-specific guidance from organizations such as the American Foundry Association ("AFA"). Surprisingly, the AFA does not offer a distinct temperature threshold for occupational heat exposure, despite acknowledging that foundry workers are regularly exposed "to molten metal sparks, splashes, and explosions in melting and casting operations," and "radiant heat from close proximity to melting equipment and to molten metal."[205] The AFA does, however, provide detailed information on PPE, hydration, employee supervision, and the duration of permissible exposure to excessive heat.[206] Further, labor unions, including the American Federation of Labor and Congress of Industrial Organizations ("AFL-CIO"), the International Brotherhood of Teamsters, and the American Federation of State, County, and Municipal Employees ("AFSCME") propagate OSHA, NIOSH, and ACGIH heat safety guidelines, and offer practical legal information on filing complaints under the General Duty Clause of the OSH Act.[207]

203. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 100; Press Release, ACGIH, ACGIH® Presents *ACGIH® TLV® for Heat Stress and Strain in the Context of Heat Stress Management* Webinar (Jan. 13, 2018), http://www.acgih.org/news/press-releases/press-release/acgih-sup-sup-presents-i-acgih-sup-sup-tlv-sup-sup-for-heat-stress-and-strain-in-the-context-of-heat-stress-management-i-webinar [https://perma.cc/782S-REQA].

204. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 100–01.

205. R.C. SCHOLZ, AM. FOUNDRY SOC'Y, ESTABLISHING A FOUNDRY HEAT STRESS MANAGEMENT PROGRAM 3-7 (2008).

206. *Id.* at 1-2, 3-7–3-9.

207. *See, e.g.*, *Workplace Health and Safety*, AM. FED. OF LABOR & CONG. OF INDUS. ORG., https://aflcio.org/issues/workplace-health-and-safety [https://perma.cc/AW5P-C7LG] (last visited Apr. 13, 2019); *Safety & Health Facts: Protecting Workers in Hot Environments*, INT'L BROTHERHOOD OF TEAMSTERS SAFETY & HEALTH DEP'T, https://teamster.org/protecting-workers-hot-environments [https://perma.cc/3M68-UGUV] (last visited Apr. 13, 2019); *Heat*, AM. FED'N OF ST., COUNTY & MUN. EMPS., https://www.afscme.org/news/publications/workplace-health-and-safety/fact-sheets/heat [https://perma.cc/8A5Z-FVUW] (last visited Apr. 13, 2019).

e. Extraction Industries

The Mine Safety and Health Administration ("MSHA") of the U.S. Department of Labor is charged with administering the Mine Safety and Health Act of 1977[208] ("MSH Act") and the Mine Improvement and New Emergency Response ("MINER") Act of 2006, which amends the MSH Act to include more robust emergency response provisions.[209] While the MSHA has not promulgated regulations specific to heat stress, MSHA guidance suggests 5 to 6 days of acclimatization for new workers, pre-employment medical examinations, regular rest periods, and the considered usage of "engineering controls such as air conditioning for cabs of heavy equipment, and ventilating and circulating fans."[210]

Likewise, many workers in the oil and gas industries are vulnerable to extreme heat due to safety protocols that mandate "long-sleeved and long-pant flame-retardant clothing, heavy steel-toed boots and hard hats at all times when outside at a well site."[211] Moreover, because many operational sites are active 24 hours per day, it is difficult to adjust work schedules to mitigate exposure to extreme heat and direct sunlight.[212] Despite these risks, the oil and gas extraction industries do not have a dedicated agency in the U.S. Department of Labor, and OSHA has not developed regulations specific to oil and gas extraction activities. Oil and gas "site

208. Federal Mine Safety & Health Act of 1977, Pub. L. No. 95-164, 91 Stat. 1290.

209. Mine Improvement and New Emergency Response Act of 2006, Pub. L. No. 109-236, 120 Stat. 493 (codified as amended at 29 U.S.C. § 671 & 30 U.S.C. §§ 811, 813, 818, 820, 825, 876, 951). While the MINER Act does not contain a particular provision on extreme temperatures, it does require health and safety training and "a program to improve accident preparedness and response at each mine," which must be reviewed at least every 6 months. 30 U.S.C. §§ 876(b)(1), 876(b)(2)(D) (2018). Nevertheless, as evidenced by both the text and legislative history of the MINER Act, accident preparedness is primarily aimed at mine collapses, fires, toxic gas releases, and similar emergencies, which, arguably, would only marginally implicate mine employees most susceptible to extreme heat, such as "shovel operators, bulldozer operators, drillers, laborers, and other workers [who work on the surface]." *Heat Stress*, MINE SAFETY & HEALTH ADMIN., https://arlweb.msha.gov/s&hinfo/heatstress/heat.htm [https://perma.cc/GN2T-AD6B] (last visited Apr. 13, 2019); *History of Mine Safety and Health Legislation*, MINE SAFETY & HEALTH ADMIN., https://www.msha.gov/about/history [https://perma.cc/J4ZU-XQZE] (last visited Apr. 13, 2019).

210. *Heat Stress*, MINE SAFETY & HEALTH ADMIN., *supra* note 209.

211. Adam Wilmoth, *Extreme Summer Heat Requires Oil-Field Adjustments in Oklahoma*, OKLAHOMAN (Aug. 3, 2012, 12:00 AM), http://newsok.com/article/3697789 http://newsok.com/article/3697789 [https://perma.cc/7J7M-3B32].

212. *Id.*

preparation," which includes "leveling the site, trenching, and excavation, . . . [is] covered by 29 C.F.R. Part 1926 [on Safety and Health Regulations for Construction],"[213] and all other occupational safety aspects of oil and gas drilling are governed by 29 C.F.R. Part 1910, OSHA's general Occupational Safety and Health Standards.[214] OSHA does, however, recommend implementation of ACGIH's Heat Stress and Strain TLV® for workers on land and offshore oil rigs.[215]

f. Athletics

Guidelines published by the American College of Sports Medicine ("ACSM") and the National Athletic Trainers' Association ("NATA") emphasize the importance of hydration[216] during outdoor physical exertion and recommend an acclimatization program of 7 to 14 days.[217] To effectuate a heat acclimatization program, athletes should "progressively increas[e] the intensity and duration of physical activity and phas[e] in protective equipment (if applicable)."[218]

213. *Oil and Gas Extraction: Standards and Enforcement*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/SLTC/oilgaswelldrilling/standards.html [https://perma.cc/8CJ4-GAX8] (last visited Apr. 13, 2019); Letter from Richard E. Fairfax, Dir., OSHA Directorate of Enf't Programs, to Kenny Jordan, Exec. Dir., Ass'n of Energy Serv. Cos. (Apr. 27, 2009), https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27995 [https://perma.cc/F3GR-9SFY].

214. *Oil and Gas Extraction: Standards and Enforcement*, OCCUPATIONAL SAFETY & HEALTH ADMIN., *supra* note 213; *see also supra* Part III.A.1.

215. *Oil and Gas Extraction: Standards and Enforcement*, OCCUPATIONAL SAFETY & HEALTH ADMIN., *supra* note 213. Notably, in the Executive Summary of the Criteria Document, NIOSH cites the Deepwater Horizon oil spill of 2010 as prompting reevaluation of the NIOSH Criteria Document, which, at that time, had last been updated in 1986. *See* NIOSH CRITERIA DOCUMENT, *supra* note 57, at v. During the response efforts, the Unified Area Command used heat exposure protocols from the U.S. Coast Guard and ACGIH to develop heat stress alert and management plans to aid workers in recognizing and abating potential heat hazards. David Michaels & John Howard, *Review of the OSHA-NIOSH Response to the Deepwater Horizon Oil Spill: Protecting the Health and Safety of Cleanup Workers*, PLOS CURRENTS DISASTERS, July 18, 2012, at 4 [https://perma.cc/425C-UZL7]. Even though at least 978 heat stress incidents were reported during the response, and the Gulf Coast experienced many days with temperatures at or above 100°F, "no workers involved in the clean-up and response developed serious heat illness," and there were no heat-related fatalities. *Id.*

216. *See generally* Brendon P. McDermott et al., *National Athletic Trainers' Association Position Statement: Fluid Replacement for the Physically Active*, 52 J. ATHLETIC TRAINING ASS'N. 877 (2017).

217. Douglas J. Casa et al., *National Athletic Trainers' Association Position Statement: Exertional Heat Illnesses*, 50 J. ATHLETIC TRAINING ASS'N. 986, 987 (2015).

218. *Id.* at 987–88.

The ACSM's youth guidance addresses the importance of fluid replacement during same-day bouts of exercise or consecutive days of exercise, noting that "physiological 'carry-over' effects" can cause "a heavily sweating older adolescent [to face] a substantial body water and sodium deficit."[219] Moreover, "some young athletes [will experience] greater cardiovascular and thermal strain during the second and subsequent sessions."[220] NATA has developed preseason heat-acclimatization plans for adolescents and secondary school athletic programs, which advise 3 to 5 days of progressive acclimatization as part of 14 total consecutive days of preseason conditioning.[221]

B. Extreme Heat & Housing

1. Rental Housing

All 50 states have laws and regulations to ensure safe, habitable living conditions in rental properties. While heat is universally required as part of a landlord's warranty of habitability, a vast majority of states do not require landlords to provide air conditioning.[222] If air conditioning is included in a signed lease agreement, however, the landlord is generally obligated to maintain and repair units.[223]

Unsurprisingly, Arizona has the most comprehensive statutory framework for tenants' rights to air conditioning. Under Arizona's

219. "Consuming 100 to 250 mL (approximately 3-8 oz.) every 20 minutes for 9- to 12-year-olds and up to 1.0 to 1.5 L (about 34-50 oz.) per hour for adolescent boys and girls during vigorous physical activity in the heat is generally enough to sufficiently minimize body water deficits, so long as preactivity hydration status is good." MICHAEL F. BERGERON, AM. COLL. SPORTS MED., YOUTH SPORTS—MAKING IT SAFE IN THE HEAT 1 (2017), http://www.acsm.org/docs/default-source/sports-medicine-basics/smb-youth-sports—making-it-safe-in-the-heat.pdf?sfvrsn=2 [https://perma.cc/BQN3-JYDA].

220. *Id.* at 2.

221. Douglas J. Casa et al., *Preseason Heat-Acclimatization Guidelines for Secondary School Athletics*, 44 J. ATHLETIC TRAINING 332, 332–33 (2009).

222. Stephanie Rabiner, *Do Landlords Have to Provide Air Conditioning?*, FINDLAW (May 31, 2011, 5:45 AM), http://blogs.findlaw.com/law_and_life/2011/05/do-landlords-have-to-provide-air-conditioning.html [https://perma.cc/6RA4-KBRD]. *See also* UNIF. RESIDENTIAL LANDLORD & TENANT ACT § 102(10) (UNIF. LAW COMM'N 2015) (stating that the term "essential service" in a residential lease includes air conditioning only "if required to be supplied to a tenant by the lease or law other than this [act] which, if not supplied to the tenant, would create a serious threat to the health, safety, or property of the tenant or immediate family member.").

223. Rabiner, *supra* note 222.

Residential Landlord and Tenant Act,[224] a landlord must "[s]upply running water and reasonable amounts of hot water, heating, and air conditioning or cooling, unless these services are exclusively controlled by the tenant and supplied by a direct public utility connection."[225] Further, if a tenant gives notice to the landlord of malfunctioning air conditioning and the landlord does not remedy the situation within a reasonable period of time, the tenant may "[p]rocure reasonable substitute housing during the period of the landlord's noncompliance, in which case the tenant is excused from paying rent for the period of the landlord's noncompliance."[226] If a landlord does not rectify a breach of the warranty of habitability within five days, he or she is in "material noncompliance" with the rental agreement, and the tenant may terminate the lease.[227]

2. Public Housing

a. Federal Standards & Regulations

At the federal level, the U.S. Department of Housing and Urban Development ("HUD") develops standards and regulations for public housing. In 1985, HUD released its Public Housing Modernization Standards Handbook ("HUD Handbook"), which "provides design, construction and environmental criteria for the rehabilitation of public housing, including Indian housing,"[228] and sets forth minimum mandatory standards for health and safety, structural and systems integrity, and energy conservation.[229] While the standards of the HUD Handbook are mandatory, they are not classified as building or construction codes; rather, the standards "must be used in conjunction with relevant local health, safety and building codes."[230] Thus, "[w]hen the HUD mandatory standards

224. ARIZ. REV. STAT. ANN. §§ 33-1301–33-1381 (2018).

225. *Id.* § 33-1324(A)(6).

226. *Id.* § 33-1364(A)(3).

227. *Id.* § 33-1361(A). However, "[t]he tenant may not terminate for a condition caused by the deliberate or negligent act or omission of the tenant, a member of the tenant's family or other person on the premises with the tenant's consent." *Id.* § 33-1361(A)(2).

228. U.S. DEP'T OF HOUS. & URBAN DEV., 7485.2, THE PUBLIC HOUSING MODERNIZATION STANDARDS HANDBOOK 1 (1985).

229. *Id.* at 1-1.

230. *Id.* at 1-3.

conflict with any local code, the more stringent requirement shall apply."[231]

Chapter 6 of the HUD Handbook discusses mechanical system requirements for public housing, mandating, in general, "[p]roper temperatures within buildings and spaces to maintain health, comfort and system safety without excessive energy usage."[232] The HUD Handbook explicitly calls for thermostats "factory set for a maximum temperature of no more than [75°F] for elderly dwelling units and [72°F] for non-elderly dwelling units," but these temperature mandates apply only to *heating* systems, and the HUD Handbook makes no mention of maximum tolerable indoor temperatures more generally. [233]

In regard to cooling systems, the HUD Handbook is decidedly restrictive, calling only for natural ventilation "through operable glazed openings that open directly to streets, courts or project site."[234] The HUD Handbook does, however, contemplate the potential installation of cooling systems, outlining prescriptive standards for their implementation. For instance, the HUD Handbook mandates that "[i]nterior spaces shall not be cooled to less than [78°F] . . . [or] dehumidified to less than 60% relative humidity."[235] Likewise, uninhabited spaces, such as storage rooms or mechanical maintenance areas, may not be cooled, and spaces "shall not have simultaneous cooling and heating."[236] The HUD Handbook also provides for electrical service outlets capable of supporting cooling units, but the "provision may be considered only when it is customary in the area to allow tenants in low- and moderate-income housing to install air-conditioning."[237]

Where climate conditions customarily necessitate cooling systems, HUD authorizes local public housing authorities ("PHAs") to provide residents with utility allowances.[238] Utility allowances "approximate a reasonable consumption of utilities by an energy-conservative household of modest circumstances consistent with the requirements of a safe, sanitary, and healthful living

231. *Id.* at 1-2.
232. *Id.* at 6-1.
233. *Id.* at 6-3.
234. *Id.* at 6-5.
235. *Id.* at 6-7.
236. *Id.*
237. *Id.*
238. 24 C.F.R. § 965.505 (2018).

environment."[239] PHAs calculate utility allowances through a consideration of multiple relevant factors, including "[t]he climatic location of the housing projects"[240] and "[t]he physical condition, including insulation and weatherization, of the housing project."[241] Nevertheless, in its Utility Allowances Handbook, HUD emphasizes that "[c]ooling and air-conditioning are not synonymous; cooling refers to air conditioning as well as other devices to improve comfort in the summer, such as fans and dehumidifiers."[242] Accordingly, energy used for air conditioning is generally not included in utility allowances, though HUD regulations authorize a limited exception for when a local PHA installs an air conditioning system that does not offer residents a control mechanism.[243] Under these circumstances, "residents are not to be charged, and these [air conditioning] systems should be avoided whenever possible."[244]

In response to President Barack Obama's Executive Orders 13514 and 13653, HUD released a Climate Change Adaptation Plan in October 2014 to assess the threat of climate change on HUD programs and infrastructure, and propose adaptive strategies for extreme weather events, sea level rise, temperature shifts, and changes in local precipitation.[245] HUD acknowledged that extreme heat "present[s] significant affordability challenges to the portfolio of HUD-assisted and public housing, as well as potential public health challenges to seniors and other residents."[246] Thus, HUD's stated goal is 160,000 energy retrofits and new green units for

239. *Id.* § 965.505(a).

240. *Id.* § 965.505(d)(2).

241. *Id.* § 965.505(d)(7).

242. Scott Hebert & Sandra Nolden, U.S. DEP'T OF HOUS. & URBAN DEV., 7485.2, UTILITY ALLOWANCE GUIDEBOOK 14 (1998).

243. 24 C.F.R. § 965.505(e) (2018).

244. *Id.* The HUD regulation goes on to explain that, if a PHA does provide air conditioning, it "shall provide, to the maximum extent economically feasible, systems that give residents the option of choosing to use air conditioning in their units. The design of systems that offer each resident the option to choose air conditioning shall include retail meters or checkmeters, and residents shall pay for the energy used in its operation. For systems that offer residents the option to choose air conditioning, the PHA shall not include air conditioning in the utility allowances. For systems that offer residents the option to choose air conditioning but cannot be checkmetered, residents are to be surcharged in accordance with § 965.506 [on surcharges for excess consumption of PHA-furnished utilities]." *Id.*

245. U.S. DEP'T OF HOUS. & URBAN DEV., CLIMATE CHANGE ADAPTATION PLAN 9–10 (2014), https://www.hud.gov/sites/documents/HUD2014CCADAPTPLAN.PDF [https://perma.cc/H2GR-BZVV].

246. *Id.* at 45.

various HUD programs, along with the more general goal of energy efficiency and clean energy use.[247]

b. Local Public Housing Authority Rules & Regulations

While governed by the minimum habitability standards promulgated by HUD, PHAs have some latitude in tailoring public housing codes to local needs;[248] however, few PHAs have implemented requirements for air conditioning. For instance, the New York City Housing Authority ("NYCHA"), the largest PHA in the United States, does not require air conditioning in residential units. Currently, less than half of the 176,066 public housing units in New York City have air conditioning, which includes units provided by NYCHA or personally purchased.[249] In stark contrast, nearly 90% of the total New York City population reports to having air conditioning.[250]

Further, public housing residents who opt to install air conditioning units, dishwashers, freezers, or any other appliance deemed non-essential by their PHA may be required to pay supplementary charges for the electricity used by such appliances.[251] The NYCHA does, however, administer a reasonable accommodation policy for any public housing resident with "a physical, medical, mental, or psychological impairment such as a

247. *Id.* at 44–45. As of publication of this note, the status of HUD's Climate Adaptation Plan is unclear. During his Senate confirmation hearing, when questioned by Senator Elizabeth Warren regarding HUD's climate policies, current HUD Secretary Dr. Ben Carson stated, "I am not an expert in this area [but will consult] the latest scientific data. . . . I do believe in energy efficiency and the responsibility we have to conserve our natural resources." Michelle Chen, *It Doesn't Matter if Cities Are Climate Change-Proof if No One Can Afford to Live in Them*, THE NATION (Oct. 24, 2017), https://www.thenation.com/article/it-doesnt-matter-if-cities-are-climate-change-proof-if-no-one-can-afford-to-live-in-them/ [https://perma.cc/L76K-F9ZE].

248. HUD has compiled a list of PHAs throughout the U.S. in its Housing Authority (HA) Profiles database. *HA Profiles*, U.S. DEP'T OF HOUSING & URB. DEV., https://pic.hud.gov/pic/haprofiles/haprofilelist.asp [https://perma.cc/RU2U-XJ8V] (last visited Apr. 13, 2019).

249. Sarah Gonzalez, *Without AC, Public Housing Residents Swelter Through the Summer*, WNYC NEWS (July 28, 2016), https://www.wnyc.org/story/life-new-york-public-housing-no-air-conditioning [https://perma.cc/Y479-H6BF].

250. *Id.*

251. *Section 8 Voucher Holder Portal: Frequently Asked Questions*, N.Y.C. HOUSING AUTH., https://eapps.nycha.info/s8apts/CityStateS8Faq.aspx#q13 [https://perma.cc/VE9H-NH9L] (last visited Apr. 14, 2019).

mobility, breathing, hearing or vision impairment."[252] Under this policy, NYCHA may make housing accommodations for such residents so long as the accommodation does not "result in an undue financial or administrative burden or create a fundamental change in a program."[253] Accommodations are reviewed on a case-by-case basis, but NYCHA recognizes that individuals with breathing or respiratory conditions may require air conditioning.[254] Moreover, NYCHA often requires confirmation of a disability by a medical professional, and the agency disclaims that "[j]ust because one person had an accommodation approved does not mean that all requests for that type of accommodation will be approved."[255]

3. Military Housing

As with public housing, military housing has been slow to adapt to the dangers of extreme heat associated with anthropogenic climate change. In 1982, Congress passed the Military Construction Codification Act ("MILCON Act") "to revise and codify the permanent provisions of law relating to military construction and military family housing."[256] The MILCON Act set forth "statutory maximum size limits for the construction, acquisition, and improvement of military family housing units by pay grade and number of bedrooms,"[257] but did not contain any provisions on climate-based housing needs, such as air conditioning.[258] To better align military housing units with their private sector counterparts, Congress amended Section 2826 of the MILCON Act through the National Defense Authorization Act for Fiscal Year 2001 to require that the "room patterns and floor areas

252. N.Y.C. HOUS. AUTH., NYCHA 036.041, REASONABLE ACCOMMODATION POLICY FOR TENANTS, HOUSING APPLICANTS AND SECTION 8 VOUCHER HOLDERS 1 (2017), https://www1.nyc.gov/assets/nycha/downloads/pdf/housing-reasonable-accommodation-policy-statement-036041-4-24-17.pdf. [https://perma.cc/MN6E-9A99]. NYCHA recognizes that "[t]his policy is in accordance with Section 504 of the Rehabilitation Act of 1973, the Fair Housing Act of 1968, as amended by the Fair Housing Amendments Act of 1988, the Americans with Disabilities Act of 1990 and the ADA Amendments Act of 2008, and the New York State and New York City Human Rights Laws." *Id.* at 2.

253. *Id.* at 1.

254. *Id.*

255. *Id.*

256. Military Construction Codification Act, Pub. L. No. 97-214, 96 Stat. 153 (1982).

257. NAT'L ASS'N OF HOME BUILDERS, MILITARY SERVICES FAMILY HOUSING STANDARDS STUDY ix (2003), https://www.acq.osd.mil/eie/Downloads/Housing/FH%20Stds%20Study%20-Rev%20Oct%202003.pdf [https://perma.cc/PVA8-6MSK].

258. Military Construction Codification Act §§ 2821–2832, 96 Stat. at 157–63.

of military family housing in a particular locality . . . are similar to room patterns and floor areas of similar housing in the private sector in that locality."[259] Congress did not mandate the use of air conditioning, even though the 1997 American Housing Survey reported that close to 90% of two- and three-bedroom housing units in the private sector had some type of air conditioning.[260] Instead, through the Military Construction Appropriations Act of 1998, Congress directed DOD to evaluate and establish uniformity standards for all military construction projects.[261] To this end, DOD has developed Unified Facilities Criteria ("UFC") to provide technical guidance and standards for the planning, design, construction, operation, and maintenance of DOD facilities.[262] In 2006, DoD published the UFC for military family housing, which contemplates the installation of air conditioning, but only "in locations where during the six warmest months of the year dry bulb temperature is 26.7 degrees C (80 degrees F), or higher for over 650 hours; or wet bulb temperature is 19.4 degrees C (67 degrees F), or higher for over 800 hours."[263]

In 2011, the Department of the Navy released a memorandum on Navy Housing Referral Services "to assist eligible personnel in locating safe, suitable and affordable housing."[264] The memorandum lays out minimum habitability criteria for housing referrals and asserts that housing units must include air conditioning or similar cooling systems and permanent heating systems.[265] Rather paradoxically, however, the memorandum

259. National Defense Authorization Act of 2001, Pub. L. No. 106-398, § 1, 114 Stat. 1654, 1645A-413 (2000); 10 U.S.C. § 2826 (2018).

260. *Id.*; NAT'L ASS'N. OF HOME BUILDERS, *supra* note 257, at 30.

261. U.S. DEP'T OF DEF., MIL-STD-3007F, STANDARD PRACTICE FOR UNIFIED FACILITIES CRITERIA AND UNIFIED FACILITIES GUIDE SPECIFICATIONS 2 (2006), http://www.wbdg.org/FFC/FEDMIL/std3007f.pdf [https://perma.cc/V44D-G76W].

262. U.S. DEP'T OF DEF., UFC 1-300-01, UNIFIED FACILITIES CRITERIA (UFC), CRITERIA FORMAT STANDARD 1 (2018), https://www.wbdg.org/FFC/DOD/UFC/ufc_1_300_01_2018.pdf [https://perma.cc/JLT3-XZ3G]. Through the Military Construction Appropriations Act of 1998, Congress directed DoD to evaluate and establish construction uniformity, thereby spurring the development of the UFCs.

263. U.S. DEP'T OF DEF., UFC 4-711-01, UNIFIED FACILITIES CRITERIA (UFC), FAMILY HOUSING 24–25 (2018), https://www.wbdg.org/FFC/DOD/UFC/ufc_4_711_01_2006.pdf [https://perma.cc/RBK6-9TE3].

264. NAVY INSTALLATIONS COMMAND, DEP'T OF THE NAVY, CNICINST 11103.1, NAVY HOUSING REFERRAL SERVICES 2 (2011), https://cnic.navy.mil/content/dam/cnic/hq/pdfs/Instructions/11000Series/CNICINST%2011103.1.pdf [https://perma.cc/76LZ-LCA3].

265. *Id.*

provides that "[h]eating and/or air conditioning systems may *not* be required in tropical climates or in geographic areas where heating/air conditioning systems are not historically included in construction practices or where not required by State, Federal or Local construction criteria."[266] Thus, at least in some cases, the availability of air conditioning for Navy personnel is tied to local custom, regardless of the acclimatization of personnel to the local climate.

C. Extreme Heat & Vulnerable Populations

While extreme heat poses an imminent threat to the population at large, certain subpopulations are particularly vulnerable[267] to heat due to physiological and/or circumstantial conditions. For instance, during the Chicago heat wave of July 1995, individuals aged 65 years or older accounted for 72%[268] of the more than 700 fatalities attributed to extreme temperatures.[269]

Reflecting this susceptibility, public health laws and regulations aimed at the elderly, children, and other vulnerable groups offer more discrete legal protections than those addressed to the general public, but both the efficacy and practical enforcement of such legal tools are decidedly unclear.

1. The Elderly

a. Physiological Susceptibility

Adults aged 65 years or older are more susceptible to heat stress, as the thermoregulatory mechanisms in older adults do not adjust

266. *Id.* (emphasis added).

267. A report by EPA and ICF International defines vulnerability in this context as "the degree to which the ability of individuals or populations to cope with climate stressors is impaired." Janet L. Gamble et al., *Climate Change and Older Americans: State of the Science*, 121 ENVTL. HEALTH PERSP. 15 (2013). Moreover, "vulnerability is a function of sensitivity, exposure, and adaptive capacity." *Id.*

268. Steven Whitman et al., *Mortality in Chicago Attributed to the July 1995 Heat Wave*, 87 AM. J. PUB. HEALTH 1515, 1516 (1997).

269. Cindy Schreuder, *The 1995 Chicago Heat Wave*, CHI. TRIB. (July 14, 2015, 6:05PM), http://www.chicagotribune.com/news/nationworld/politics/chi-chicagodays-1995heat-story-story.html [https://perma.cc/D7FQ-L7AN]. Though physiological vulnerability to extreme heat undoubtedly accounted for a majority of deaths among the elderly during the Chicago heat wave, certain behaviors and circumstances also contributed to the high death toll. The Chicago Tribune reported that some older individuals did not want to temporarily sacrifice their independence by moving in with others, and some simply did not have anywhere else to go to escape the heat.

as well to variation or sudden changes in temperature as those of younger individuals.[270] Older adults are also more likely to have chronic medical conditions or take prescription medicines that compromise the body's ability to regulate its internal temperature.[271] A 2012 study found that a 1°C increase in the summer temperature standard of deviation due to climate change would likely result in an increased risk of mortality in susceptible older populations.[272] The study predicted that this temperature variability would lead to a 5% increase in mortality among individuals 65 years or older with chronic medical conditions, which corresponds to an additional 14,000 deaths per year.[273] Notably, because this study limited its scope to a 1°C increase in the standard of deviation for summertime temperatures, this number is likely under-representative of the likely rise in fatalities in the elderly associated with EHEs and climate change.[274]

b. Statutes & Regulations

i. Nursing Homes

Federal regulations provide some temperature-related legal protections for residents of nursing homes and long-term care facilities that participate in Medicare and Medicaid programs. Title 42, Part 483 of the Code Federal Regulations sets forth the general right of residents to a "safe, clean, comfortable and homelike environment,"[275] which includes "[c]omfortable and safe temperature levels."[276] Long-term care facilities certified after October 1, 1990 are required to maintain a temperature range of 71°F to 81°F.[277] Facilities certified before this date are not subject

270. *Heat and Older Adults*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/disasters/extremeheat/older-adults-heat.html [https://perma.cc/4QFR-NPEK] (last visited May 22, 2018).

271. *Id.*

272. Antonella Zanobetti et al., *Summer Temperature Variability and Long-Term Survival Among Elderly People with Chronic Disease*, 109 PROC. NAT'L ACAD. SCI. 6608 (2012).

273. *Id.* at 6611.

274. *See generally* Daniel Oudin Åström et al., *Heat Wave Impact on Morbidity and Mortality in the Elderly Population: A Review of Recent Studies*, 69 MATURITAS 99 (2011).

275. 42 C.F.R. § 483.10(i) (2018).

276. *Id.* § 483.10(i)(6).

277. *Id.*

to these temperature standards, but are still required to maintain subjectively comfortable temperature levels.[278]

While no long-term care facilities are legally obligated to provide air conditioning for residents, regulations on heating and ventilation recognize that air conditioning may be necessary to maintain a comfortable environment. For instance, all bedrooms must have "[d]irect outside ventilation by means of windows, air conditioning, or mechanical ventilation,"[279] and the facility must "[m]aintain the temperature and humidity within a normal comfort range by heating, air conditioning or other means."[280] Moreover, under emergency management regulations, long-term care facilities must annually update policies and procedures to ensure the availability of "[a]lternate sources of energy to maintain . . . [t]emperatures to protect resident health and safety and for the safe and sanitary storage of provisions."[281] The emergency preparedness regulations are applicable to all long-term facilities and are not limited by the certification date of the facility.

ii. Statutes on Aging

In 1965, Congress passed the Older Americans Act ("OAA")[282] to provide citizens over 60 years of age with essential services, such as meals-on-wheels, in-home care, transportation, and elder abuse prevention resources.[283] The OAA is administered by the Department of Health and Human Services through the Administration for Community Living ("ACL"), which distributes funding and resources to "56 state agencies, over 200 tribal organizations, two native Hawaiian organizations, more than 600 area agencies on aging and 20,000 local service providers."[284]

Two components of Title VII of the OAA provide legal recourse for older Americans suffering heat-related harms. First, Section

278. *Id.* § 483.10(i).

279. *Id.* § 483.470(e)(1)(ii).

280. *Id.* § 483.470(e)(2)(i).

281. *Id.* § 483.73(b)(1)(ii)(A).

282. Older Americans Act of 1965, Pub. L. No. 89-73 (codified as amended at 42 U.S.C. §§ 3001—3058 (2016).

283. ADMIN. ON AGING, ELDER RIGHTS: SAFEGUARDS FOR THE MOST VULNERABLE AMONG US (2017), https://www.acl.gov/sites/default/files/news%202017-03/Elder_Rights_Safeguards_for_the_Most_Vulnerable_Among_Us_1.pdf [https://perma.cc/JQN6-866U].

284. *Older Americans Act*, NAT'L COMMITTEE TO PRESERVE SOC. SECURITY & MEDICARE (Oct. 3, 2018), http://www.ncpssm.org/PublicPolicy/OlderAmericans/Documents/ArticleID/1171/Older-Americans-Act [https://perma.cc/CLH8-EFWT].

731 creates the State Legal Assistance Development Program to provide low-cost legal services to older individuals.[285] The Program is an essential tool in combatting elder abuse, which, by definition,[286] encompasses exposure to dangerous levels of heat. Second, Section 712 establishes the Long-Term Care Ombudsman Program, which requires a state-appointed ombudsman to "identify, investigate, and resolve complaints" made by, or on behalf of, nursing facility residents for actions or inactions that "may adversely affect the health, safety, welfare, or rights of the residents."[287]

While the OAA does not directly contemplate the vulnerability of older individuals to extreme weather, at least one state has passed a statute to address that concern. Under Illinois law, the Department on Aging is required to disseminate "information alerting seniors on safety issues regarding emergency weather conditions, including extreme heat and cold, flooding, tornadoes, electrical storms, and other severe storm weather."[288] Such information must include safety instructions for emergency weather events, and the emergency telephone numbers of organizations equipped to provide safety information and aid.[289]

2. Children

Few statutes explicitly address the public health implications of extreme weather on children, even though children account for a significant number of heat-related fatalities per year. For instance, in 2018, 51 minors died of heat stroke while trapped inside of motor vehicles.[290] Since 1998, nearly 750 children have died from vehicular heat stroke,[291] which is the leading cause of non-crash

285. 42 U.S.C. § 3058j (2018).

286. Under the OAA, "abuse" is defined as "the knowing infliction of physical or psychological harm or the knowing deprivation of goods or services that are necessary to meet essential needs or to avoid physical or psychological harm." *Id.* § 3002(1).

287. *Id.* § 3058g(a)(3)(A)(i)–(ii).

288. 20 ILL. COMP. STAT. ANN. 105/4.01(22) (2016).

289. *Id.*

290. *Children, Pets and Vehicles*, NAT'L WEATHER SERV., https://www.weather.gov/safety/heat-children-pets [https://perma.cc/9LS5-5YY7] (last visited Mar. 31, 2019).

291. JAN NULL, DEP'T OF METEOROLOGY & CLIMATE SCI., SAN JOSE STATE UNIV., TRENDS AND PATTERNS IN PEDIATRIC VEHICULAR HEATSTROKE DEATHS, 1998–2017 fig.4 (2018). An observational study of vehicular heat in temperatures ranging from 72°F to 96°F found that the average increase in temperature over 1-hour was "3.2°F per 5-minute interval, with 80% of the temperature rise occurring during the first 30 minutes." Catherine McLaren et al.,

vehicle-related deaths in children 14 and younger.[292] Indeed, a child's body can heat up 3 to 5 times faster than an adult's, and at 104°F, a child's central nervous system may begin to malfunction, resulting in convulsions and the possibility of coma.[293] A child becomes susceptible to death when his or her body temperature reaches 107°F.[294]

Indiana is the only state that provides direct statutory protection for children in regard to extreme heat. Under Title 16 of the Indiana Code, the Indiana State Department of Health is charged with "adopt[ing] guidelines concerning the safety of children during bad weather conditions,"[295] which includes extreme heat.[296] The Indiana Code also delineates certain contexts which may require more tailored weather-related standards for children, including at schools, child care centers, organized sporting events, and public parks.[297]

In complying with this statutory directive, Indiana implements the Child Care Weather Watch safety system produced by the Iowa Department of Public Health with the support of the federal Maternal & Child Health Bureau of the Health Resources and Service Administration, a division of the U.S. Department of Health and Human Services.[298] Though developed by the Iowa Department of Public Health, the Child Care Weather Watch system is a widely disseminated guide among state health agencies and is endorsed by the American Academy of Pediatrics ("AAP"). The Child Care Weather Watch employs the NWS's heat index and a three-part color-coded system of temperature guidelines for three

Heat Stress from Enclosed Vehicles: Moderate Ambient Temperatures Cause Significant Temperature Rise in Enclosed Vehicles, 116 PEDIATRICS 109, 109 (2005). Further, the study found that there was an average increase of 40°F for the ambient temperature range of 72°F to 96°F, and that cracking the car windows had little effect on the rate of temperature increase. *Id.*

292. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., DOT-HS-812-120, NON TRAFFIC SURVEILLANCE: NON-CRASH FATALITIES AND INJURIES 1 (2015).

293. JAN NULL, DEP'T OF METEOROLOGY & CLIMATE SCI., SAN JOSE STATE UNIV., PEDIATRIC VEHICULAR HEATSTROKE FACT SHEET (2016); McLaren et al., *supra* note 291, at 111.

294. McLaren et al., *supra* note 291, at 111.

295. IND. CODE § 16-19-3-6.5(a) (2005).

296. *Id.* § 6.5(b)(G).

297. *Id.* § 6.5(c)(1)–(5).

298. IOWA DEP'T PUB. HEALTH, CHILD CARE WEATHER WATCH (2009), http://www.c-uphd.org/documents/wellness/weatherwatch.pdf [https://perma.cc/Q2Y3-SXKC]; *Extreme Temperatures: Heat and Cold*, AM. ACAD. OF PEDIATRICS, https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/Children-and-Disasters/Pages/Extreme-Temperatures-Heat-and-Cold.aspx [https://perma.cc/BLE9-CND9] (last visited Apr. 14, 2019).

categories of minors: infants and toddlers, young children, and older children.[299] Each category provides recommendations for clothing, hydration, and the use of sunscreen for a range of heat indices.[300] Nevertheless, the standards are decidedly vague; for example, under the "yellow" heat index category, "[c]hild care providers need to structure the length of time for outdoor play for the young child."[301] However, the category does not provide sample lengths of play or indoor rest periods, an omission that is characteristic of the entire Child Care Weather Watch schematic.[302]

While Indiana is the only state with a child welfare statute specific to heat, child endangerment statutes are often used to criminally prosecute adults and caretakers for exposing children to extreme temperatures.[303] Moreover, many states have published general guidelines to protect children from heat, often employing the standards of the AAP. AAP guidance parallels that of the Child Care Weather Watch system, as it uses the heat index to provide suggested exposure times for children playing outdoors in the heat, and offers generally applicable recommendations, such as dressing lightly, staying hydrated, and securing access to air conditioning.[304]

Air conditioning is generally not required in schools—likely because schools are closed during the summer—but excessive heat has a quantifiable effect on educational performance. A Harvard University study published in 2017 examined the effects of heat on students in New York City public schools, the largest school district in the U.S., through empirical analysis of standardized test scores.[305] The study found that for the average student taking a

299. IOWA DEP'T PUB. HEALTH, *supra* note 298.

300. *Id.*

301. *Id.*

302. *Id.*

303. In *People v. Maynor*, the Court of Appeals of Michigan affirmed the district court's reinstatement of felony-murder charges against defendant mother for leaving her ten-month-old daughter and three-year-old son in a hot car for three and one-half hours. The Court employed the general child abuse statute of the Michigan Penal Code to establish the underlying felony. People v. Maynor, 470 Mich. 289, 296 (2004).

304. For a compendium of AAP guidance, see *Protecting Children from Extreme Heat: Information for Parents*, AM. ACAD. OF PEDIATRICS (June 27, 2017), https://www.healthychildren.org/English/safety-prevention/at-home/Pages/Protecting-Children-from-Extreme-Heat-Information-for-Parents.aspx [https://perma.cc/3T6H-THCF]; *see also Extreme Temperatures: Heat and Cold*, AM. ACAD. OF PEDIATRICS, *supra* note 298.

305. JISUNG PARK, TEMPERATURE, TEST SCORES, AND HUMAN CAPITAL PRODUCTION (2017), http://scholar.harvard.edu/files/jisungpark/files/temperature_test_scores_and_human_capital_production_-_j_park_-_2-26-17.pdf [https://perma.cc/57YY-K47M].

standardized test, hot weather ". . . leads to -0.22% lower performance per °F above room temperature (72°F). . . . Put another way, a 90°F day reduces exam performance by 15 percent of a standard deviation relative to a more optimal 72°F day."[306] In 2017, approximately 11,500 New York City public school classrooms lacked air conditioning, but that same year, Mayor Bill DeBlasio announced a $28.75 million initiative to bring air conditioning to every public school classroom by 2022.[307] New York City also requires buses for disabled children to have air conditioning, but there is not a comparable regulation for general purpose buses.[308]

At the federal level, the U.S. Department of Education has promulgated no regulations governing air-conditioning in schools. However, the Individuals with Disabilities Education Act ("IDEA")[309] requires schools to make reasonable accommodations for students with special needs, which could include students with heat sensitivities.[310] Several states have regulations on acceptable classroom temperatures,[311] and beginning in 1995, Mississippi conditioned school accreditation on the provision of air-conditioned classroom space.[312] In 2016, Hawaii passed its Sustainable School Initiative which calls upon the Hawaii Department of Education to "expedite the cooling of all public school classrooms to a temperature acceptable for student learning" [313] but does not delineate specific temperatures.

306. *Id.* at 3.

307. Press Release, City of New York, Mayor de Blasio, Chancellor Fariña and City Council Announce Every Classroom Will Have Air Conditioning by 2022 (Apr. 25, 2017), https://www1.nyc.gov/office-of-the-mayor/news/261-17/mayor-de-blasio-chancellor-fari-a-city-council-every-classroom-will-have-air [https://perma.cc/PHD3-4CEQ].

308. N.Y.C. ADMIN. CODE § 19-605 (2017) ("Any bus or other motor vehicle transporting a child with a disability to and from a school in the city pursuant to any agreement or contract shall be air-conditioned when the ambient outside temperature exceeds seventy degrees Fahrenheit.").

309. 20 U.S.C. §§ 1400–1450 (2018).

310. *See id.* § 1401(3)(A)(i) (defining a child with a disability to include general "health impairments").

311. *See, e.g.*, 410 IND. ADMIN. CODE 33-4-4 (2018) (requiring schools with air conditioners to maintain a temperature that does not exceed 78°F and 65% relative humidity in occupied classrooms); WASH. ADMIN. CODE § 246-366-080 (2018) (mandating that all rooms occupied by students be free of excessive heat).

312. MISS. CODE ANN. § 37-17-6(2) (2018). However, Mississippi does not have a statutory range of acceptable temperatures.

313. HAW. REV. STAT. § 302A-1510(d) (2018).

3. Inmate Population

The Bureau of Justice Statistics reports that, as of year-end 2016, approximately 1.5 million prisoners were under the authority of state and federal correctional authorities,[314] and an additional 740,700 inmates were held in county and city jails.[315] When factoring in the "[n]early half a million correctional employees work in these facilities . . . [i]ndoor environmental conditions in prisons and jails . . . have a direct impact on the health of well over 2.5 million people."[316]

Even though extreme heat has claimed the lives of numerous inmates in recent years, the correctional sector has been slow to adapt to the imminent dangers of climate change, and "[e]xisting policies and regulations are generally inadequate to ensure that temperatures remain within a healthy range."[317] In challenging exposure to dangerous heat levels, however, inmates and advocates have both statutory and constitutional legal tools at their disposal, most notably the Eighth Amendment of the U.S. Constitution forbidding cruel and unusual punishment.[318] In 1991, the U.S. Supreme Court recognized that "a low cell temperature at night combined with a failure to issue blankets" could constitute a violation of the Eighth Amendment,[319] but the Court has made no such findings regarding extreme heat. For detainees awaiting trial, dangerous exposure to extreme heat can implicate the Due Process Clauses of the Fifth and Fourteenth Amendments for federal and state facilities, respectively.[320]

In February 2018, inmates at the Wallace Pack Unit correctional facility in Navasota, Texas reached a temporary settlement with the Texas Department of Criminal Justice ("TDCJ"), whereby the TDCJ agreed to install air conditioning in the housing areas of the facility, where the temperature regularly reaches 100°F during the

314. E. ANN CARSON, BUREAU OF JUSTICE STATISTICS, U.S. DEP'T OF JUSTICE, NCJ 251149, PRISONERS IN 2016 1 (2018).

315. ZHEN ZENG, BUREAU OF JUSTICE STATISTICS, U.S. DEP'T OF JUSTICE, NCJ 251210, JAIL INMATES IN 2016 1 (2018).

316. DANIEL W.E. HOLT, SABIN CTR. FOR CLIMATE CHANGE LAW, HEAT IN US PRISONS AND JAILS: CORRECTIONS AND THE CHALLENGE OF CLIMATE CHANGE i (2015).

317. *Id.* at ii.

318. *Id.* at 33 ("Corrections is by far the largest on a very short list of sectors for which the failure to adapt [to climate change] has constitutional implications.").

319. Wilson v. Seiter, 501 U.S. 294, 304 (1991).

320. HOLT, *supra* note 316, at 36.

summer months.[321] Plaintiff inmates brought their class action lawsuit in the U.S. District Court for the Southern District of Texas, arguing that TDCJ violated their 8th Amendment right to be free of cruel and unusual punishment by allowing the temperatures to rise above 88°F.[322] In July 2017, District Judge Keith Ellison granted injunctive relief for plaintiffs, stating that "[e]ach summer, . . . Plaintiffs face a substantial risk of serious harm from the sweltering Texas heat, and Defendants have been deliberately indifferent in responding to this risk."[323] Importantly, the Court took judicial notice of climate scientists' high degree of confidence that climate change will engender more frequent, severe, and prolonged heat waves.[324]

Federal statutes also provide avenues for litigation regarding dangerous heat exposure levels. For instance, under the Civil Rights of Institutionalized Persons Act of 1980, the U.S. Department of Justice ("DOJ") may also bring constitutional challenges against correctional facilities for dangerous exposure to extreme heat if it "finds a pattern and practice of civil rights violations and has reasonable cause to believe that state or local authorities are subjecting inmates to conditions that violate their constitutional rights."[325] Further, employees of correctional facilities may bring claims under the General Duty clause of the OSH Act or OSHA-approved state plans, and disabled inmates may seek relief under the Americans with Disabilities Act.[326] Finally, state and local jurisdictions have implemented a variety of policies and regulations on temperature levels in correctional facilities.[327] For example, under the Texas Administrative Code, temperatures in both new and existing facilities "shall be reasonably maintained

321. *Settlement Reached in Lawsuit over Sweltering Texas Prison*, DALL. NEWS: COURTS (Feb. 2, 2018), https://www.dallasnews.com/news/courts/2018/02/02/settlement-reached-lawsuit-sweltering-texas-prison [https://perma.cc/WX34-RCSU]; *see also* Cole v. Collier, No. 4:14-CV-1698, 2017 WL 3049540, at *11 (S.D. Tex. July 19, 2017), *appeal dismissed sub nom.* Yates v. Collier, No. 17-20529, 2018 WL 994125 (5th Cir. Feb. 8, 2018).

322. *Cole*, 2017 WL 3049540, at *2.

323. *Id.* at *46.

324. *Id.* at *31 n.27. In taking judicial notice, Judge Ellison cited HOLT, *supra* note 316, at i.

325. HOLT, *supra* note 316, at 53–54 (citing 42 U.S.C. §§ 1997–1997j (2014)).

326. *See supra* Part III.A; *see also* HOLT, *supra* note 316, at 54–59 (discussing potential legal avenues for correctional officers).

327. For a comprehensive list of state policies and regulations governing heat in prisons, see HOLT, *supra* note 316, at 91–134.

between 65 degrees Fahrenheit and 85 degrees Fahrenheit in all occupied areas."[328]

4. Homeless Population

Without reliable access to shelter or hydration, homeless individuals are acutely vulnerable to excessive heat and other extreme weather events.[329] While some states have passed laws and regulations to mitigate these vulnerabilities,[330] municipalities have taken the lead in policy development, increasingly incorporating provisions for the homeless in EHE emergency response plans and resiliency strategies.[331]

For instance, in mid-July 2005, Phoenix, Arizona experienced a 2-week period during which all but 3 days topped 110°F; even in this well-acclimatized city, several heat-related fatalities were reported.[332] In response, Phoenix broadened the scope of its EHE

328. 37 TEX. ADMIN. CODE §§ 259.256, 261.255 (2015).

329. Even a single extreme weather event can have long-term negative implications for the homeless. For instance, of the 3,600 Houston residents who were already homeless prior to Hurricane Harvey, very few will have the opportunity to move into federally-subsidized housing, let alone acquire self-funded housing, as FEMA prioritizes assistance for those who had housing before the storm. *See* Peter Henderson, *Storm Pits Houston's Homeless Against Newly Displaced*, REUTERS, Sept. 2, 2017, 3:34 PM, https://www.reuters.com/article/us-storm-harvey-homeless/storm-pits-houstons-homeless-against-newly-displaced-idUSKCN1BD0SP?utm_source=34553&utm_medium=partner [https://perma.cc/MVQ3-5D4V]. For a brief discussion of the institutional discrimination faced by homeless persons before, during, and after natural disasters and extreme weather events, see NAT'L LAW CTR. ON HOMELESSNESS & POVERTY, VIOLATIONS OF THE HUMAN RIGHTS OF PERSONS EXPERIENCING HOMELESSNESS IN THE UNITED STATES 4 (2017), https://www.nlchp.org/documents/sr-ep-2017 [https://perma.cc/BY2Y-9Z9P].

330. Interestingly, many states have been more active in addressing the extreme cold as opposed to the extreme heat when developing rules to mitigate the effect of extreme weather on the homeless. In January 2016, New York Governor Andrew Cuomo signed Executive Order No. 151, Emergency Declaration Regarding Homelessness During Inclement Winter Weather, which "direct[s] all local social service districts, police agencies . . . and state agencies to take all necessary steps to identify individuals reasonably believed to be homeless and unwilling or unable to find [] shelter . . . in inclement *winter* weather, and move such individuals to the appropriate sheltered facilities." N.Y. Exec. Order No. 151 (Jan. 3, 2016), *codified as amended* in N.Y. COMP. CODES R. & REGS. tit. 18, § 304.1 (2017) (emphasis added). In contrast, in New Jersey, homeless shelters "shall not refuse to provide shelter, or food and shelter, for a minimum of 72 hours, to an individual or family seeking these services, unless the shelter is at its licensed capacity or the basis for refusal is otherwise authorized by law or regulation." N.J. STAT. ANN. § 55:13C-2.2 (2014). Emergency conditions include, but are not limited to, excessive cold or heat. *Id.* § 55:13C-2.

331. *See infra* Section IV.A.

332. U.S. ENVTL. PROT. AGENCY, EPA 430-B-16-001, EXCESSIVE HEAT EVENTS GUIDEBOOK 32 (2006).

program, primarily by "opening homeless shelters during daytime hours, bringing homeless individuals to these and other locations with air conditioning, and providing donated bottled water."[333] Prior to the July 2005 heatwave, Phoenix's EHE program relied almost exclusively on the issuance of dangerous weather alerts by the local NWS forecast office, which were then broadcast by the local media along with heat safety guidelines.[334]

Toronto, Canada's Mayor's Task Force on Homelessness directly spurred the creation of the city's EHE program.[335] Following its 1998 survey, the Task Force called upon Toronto Public Health to "establish temperature thresholds that would be used to initiate health alerts and trigger additional homeless interventions . . . [such as] increasing daytime staff and efforts to get the homeless indoors."[336] Accordingly, Toronto Public Health initiated a Hot Weather Response Committee to work directly with vulnerable populations and annually reassess the efficacy of the EHE program.[337]

D. Extreme Heat in Other Legal Contexts

With spates of extreme heat becoming increasingly regular, legislators and policy-makers have started contemplating the relevance of heat in other legal contexts. While by no means comprehensive, this section provides a snapshot of the legal pervasiveness of heat.

1. Public Utilities

Many states have rules prohibiting utilities from disconnecting residential electricity service due to nonpayment of a utility bill during times of extreme heat. Under Missouri's Hot Weather Rule, utility providers are prohibited from ceasing service on any day when the NWS local forecast predicts that the temperature will reach 95°F or the heat index will top 105°F.[338] In 2011, the Maryland Public Service Commission passed a regulation stating that "[a] public service company may not terminate electric service

333. *Id.*
334. *Id.*
335. *Id.* at 30.
336. *Id.*
337. *Id.* at 31.
338. MO. REV. STAT. § 393.108 (2012).

to a residential customer . . . because of nonpayment on a day for which the forecasted temperature is 95 degrees Fahrenheit or above."[339]

In addition to these rules protect customers from electricity outages during EHEs, many utility companies have also developed programs to incentivize consumer energy conservation during heatwaves. For example, at least four Maryland public utility companies— Baltimore Gas and Electricity Company, Pepco, Delmarva Power, and the Southern Maryland Electric Cooperative—offer demand response programs whereby customers can receive rebates or other financial incentives for shifting or reducing their electricity usage during peak periods.[340] At the federal level, the U.S. Department of Energy, through the Smart Grid Investment Grant Program, allocates resources for the development of time-based rate programs and advanced metering infrastructure for electric power companies.[341]

Water utilities are also susceptible to EHEs, due to their reliance on the energy grid, increased water demand during heat waves, and fluctuations in source water quality associated with elevated air temperatures and the increased temperatures of industrial discharges.[342] EPA has disseminated an action checklist for water and wastewater facilities in preparing for and responding to extreme heat.[343] The checklist features dozens of preparedness action items, including the identification of emergency water supply sources and delivery methods, the installation of emergency

339. MD. CODE ANN., PUB. UTIL. § 7-307-1(b) (West 2013). Under this regulation, the temperature forecast is determined at 6:00AM by a designated weather station for a 72-hour period; the 72-hour period is rolling and reassessed every 24 hours at 6:00 AM. *See* Press Release, State of Md. Pub. Serv. Comm'n, No Utility Turnoffs Allowed During Extreme Heat Wave (July 21, 2011). However, the Commission does authorize a utility to terminate service in a theft of service situation or in response to unsafe conditions regardless of prevailing temperature. *Id.*

340. *Empower Maryland*, MD. PUB. SERV. COMMISSION, https://www.psc.state.md.us/electricity/empower-maryland/ [https://perma.cc/M459-MMN8] (last visited May 15, 2019).

341. *Smart Grid Investment Grant Program*, SMARTGRID.GOV, https://www.smartgrid.gov/recovery_act/overview/smart_grid_investment_grant_program.html [https://perma.cc/7NZK-KMS6] (last visited May 15, 2019).

342. U.S. ENVTL. PROT. AGENCY, EPA 817-F-15-004, WATER SECTOR INCIDENT ACTION CHECKLIST—EXTREME HEAT 1 (2015).

343. Further, it goes without saying that utility company employees working in the field—especially those responding to heat-related outages—face safety risks from extreme heat and have legal recourse for work-related injuries through the General Duty Clause of the OSH Act and its state analogs. *See supra* Part III. A.

electricity sources, and the creation of an emergency response plan in collaboration with local media outlets and emergency management agencies.[344]

2. Animal Cruelty

Statutes and ordinances protecting companion animals from extreme heat are pervasive at both the state and local levels. Though animal welfare statutes predominantly address outdoor tethering and confinement in a motor vehicle, they tend to vary in terms of specificity. For instance, under Massachusetts law, "[a] person shall not confine an animal in a motor vehicle in a manner that could reasonably be expected to threaten the health of the animal due to exposure to extreme heat or cold."[345] In contrast, the Pennsylvania General Assembly recently passed HB 1238 to prohibit, in part, the tethering of an unattended dog "for longer than 30 minutes in temperatures above 90 or below 32 degrees Fahrenheit."[346] While Pennsylvania's statute provides more concrete guidance, it is arguable that Massachusetts's law offers more protection for the animal, as it allows for the consideration of more subjective criteria, such as the animal's level of distress.[347]

344. U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 3–7.

345. MASS. GEN. LAWS ch. 140, § 174F(a) (2016). The statute also immunizes anyone who removes an animal from a hot car from criminal or civil liability, provided that he or she makes a good faith effort to locate the owner, and:

> (i) notifies law enforcement or calls 911 before entering the vehicle; (ii) determines that the motor vehicle is locked or there is no other reasonable means for exit and uses not more force than reasonably necessary to enter the motor vehicle and remove the animal; (iii) has a good faith and reasonable belief, based upon known circumstances, that entry into the vehicle is reasonably necessary to prevent imminent danger or harm to the animal; and (iv) remains with the animal in a safe location in reasonable proximity to the vehicle until law enforcement or another first responder arrives.

Id. § 174F(e)–(f).

346. 18 PA. CONS. STAT. § 5536(1)(iv) (2017).

347. Other representative state statutes on animal cruelty and extreme heat include 8 ILL. COMP. STAT. 510 § 70/3.01(c) (2016) ("No owner of a dog or cat that is a companion animal may expose the dog or cat in a manner that places the dog or cat in a life-threatening situation for a prolonged period of time in extreme heat or cold conditions . . ."); MINN. STAT. § 346.39 (2016) ("Confinement areas must be maintained at a temperature suitable for the animal involved."); CONN. GEN. STAT. § 22-350a(b) (2016) ("No person shall tether a dog outdoors . . . when outdoor environmental conditions, including, but not limited to, extreme heat, cold, wind, rain, snow or hail, pose an adverse risk to the health or safety of such dog based on such dog's breed, age or physical condition, unless tethering is for a duration of not longer than fifteen minutes); ME. REV. STAT. ANN. tit. 7, § 4015(2)(A) (2016) ("When

3. Agriculture & Food Supply

As it currently stands, there are few statutes or regulations on extreme heat in regard to food supply. The Food Safety Modernization Act of 2011 addresses temperature controls for food storage and transportation but does not consider extreme weather events.[348] The U.S. Department of Agriculture ("USDA") has, however, acknowledged the relevance of extreme heat in certain contexts. In 2014, the USDA Economic Research Service released a report finding that heat stress markedly lowers dairy productivity; indeed, USDA estimates that in 2010 alone, heat stress lowered the productivity of an average dairy farm by $39,000, totaling $1.2 billion in losses for the entire U.S. dairy sector.[349] To mitigate the effect of temperature on dairy production, USDA recommends the implementation of energy-efficient cooling mechanisms for dairy facilities, the use of heat tolerant breeds, and continued research on the interaction between feed, nutrition, and heat stress for dairy cows.[350]

Extreme heat is also a considerable stressor on crop productivity.[351] However, certain USDA programs may actually be exacerbating the effects of extreme heat and other climate-related phenomena on crop productivity. The Federal Crop Insurance Program, for example, disincentivizes farmers to adapt to extreme weather events, as it more heavily subsidizes farmers with a higher sensitivity to climate variability.[352] As a result, farmers are more likely to continue to grow high-risk crops, rather than implement climate mitigation measures or fully internalize risks. Thus, it is

sunlight is likely to cause heat exhaustion of an animal tied or caged outside, sufficient shade by natural or artificial means must be provided to protect the animal from direct sunlight.").

348. FDA Food Safety Modernization Act, Pub. L. No. 111-353, 124 Stat. 3885 (2011).

349. NIGEL KEY, STACY SNEERINGER & DAVID MARQUARDT, U.S. DEP'T OF AGRIC., ERR-175, CLIMATE CHANGE, HEAT STRESS, AND U.S. DAIRY PRODUCTION iii (2014).

350. *Id.* at 31.

351. *See, e.g.*, Stefan Siebert & Frank Ewert, *Future Crop Production Threatened by Extreme Heat,* 9 ENVTL. RES. LETTERS (2014); Delphine Deryng et al., *Global Crop Yield Response to Extreme Heat Stress Under Multiple Climate Change Futures,* 9 ENVTL. RES. LETTERS (2014). For a detailed analysis of the economic impact of climate change (and extreme heat) on the American agricultural sector, see TREVOR HOUSER ET AL., ECONOMIC RISKS OF CLIMATE CHANGE (2015).

352. Francis Annan & Wolfram Schlenker, *Federal Crop Insurance and the Disincentive to Adapt to Extreme Heat,* 105 AM. ECON. REV. 262, 264 (2015). For example, "sensitivity to extreme heat is 67 percent larger for insured corn than for uninsured corn, and 43 percent higher for soybeans." *Id.*

arguable that, without largescale reform to federal crop insurance subsidies, climate change and extreme heat will continue to engender productivity losses in American agriculture[353] and impose elevated indemnity costs on the federal government.[354]

IV. ADAPTING TO EXTREME HEAT: SUCCESSES & RECOMMENDATIONS

As demonstrated in Part III, the American legal system is characterized by disparate and ambiguous standards regarding extreme heat, making it ill-equipped to address the mounting dangers of climate change. While the current legal scheme leaves much to be desired, there are promising developments in extreme heat adaptation that provide guidance and ample opportunity for improvement. This Part will present such developments and offer law and policy recommendations to make the U.S. and its legal system more resilient against a warming climate.

A. Warning Systems, Emergency Response Plans & Public Outreach

Community preparedness is an essential factor in preventing mortality and morbidity from extreme heat, specifically through community warning systems, emergency response plans, and public education and outreach. While individual plans require local tailoring to maximize their efficacy, there are many examples of community-implemented initiatives that can provide useful, adaptable instructions to other localities.

Phoenix, Arizona, which recorded 128 days with temperatures above 100 degrees in 2018,[355] is perhaps the gold standard for municipal preparedness regarding EHEs. Despite the city's persistently high temperatures, studies have identified little evidence of elevated mortality rates due to extreme heat.[356] Much of Phoenix's success in preventing heat-related fatalities stems from its ubiquitous air-conditioning and an informed, adapted

353. *Id.* at 266; Ann Jaworski, Note, *Encouraging Climate Adaptation Through Reform of Federal Crop Insurance Subsidies*, 91 N.Y.U. L. REV. 1684, 1687–89 (2016).

354. Jaworski, *supra* note 353, at 1697–98.

355. Hayden Packwood, *How Many Days of 100° or Higher Temps Did Phoenix Have in 2018? The Third Most Ever.*, PHOENIX 12 NEWS (Oct. 11, 2018, 11:57 AM), https://www.12news.com/article/news/local/valley/how-many-days-of-100-or-higher-temps-did-phoenix-have-in-2018-the-third-most-ever/75-603416807 [https://perma.cc/3UZ6-6KF2].

356. U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 32.

population.[357] Phoenix also benefits from the proactive public education and outreach of the Arizona Department of Health Services, which developed an Extreme Heat Incident Annex in 2016 and disseminates safety toolkits to schools, outdoor workers, and the elderly to aid them in identifying and mitigating the signs of heat-related illnesses.[358] With a strong baseline of public awareness, the city is able to efficiently target its resources to minimize heat-related deaths and illnesses, making Phoenix a useful model for public education and outreach. For instance, following an EHE in the summer of 2005 wherein all but 3 days during a two-week period in July reached 110°F and several deaths were attributed to excessive heat, Phoenix adjusted its emergency response plan to zero-in on vulnerable populations such as the homeless.[359]

After an 8-day span in the summer of 1993 that killed upwards of 118 people, Philadelphia, Pennsylvania endeavored to develop its Philadelphia Hot Weather–Health Watch/Warning System ("PWWS"), which has served as a template for more than 20 heat-related warning systems worldwide.[360] In the mid-1990s, Philadelphia used heat wave data from the NWS, which focused primarily on the heat index in issuing its warnings, a method that incorporates only the ambient temperature and humidity without considering the physiological effects of consecutive days of hot and oppressive weather.[361] To counteract the limitations of a heat index-based system, the PWWS now uses six weather elements to forecast the prevailing airmass for the current and coming 2 days.[362] The PWWS categorizes these airmasses into groups based on homogenous characteristics and determines which groups are associated with the highest risks of heat-related mortality and morbidity.[363] Using the PWWS categories as guidance, the city of Philadelphia then issues preemptive warnings via television, radio,

357. *Id.*

358. *See generally* ARIZ. DEP'T OF HEALTH SERVICES, EXTREME HEAT INCIDENT ANNEX (2016).

359. U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 32.

360. Kristie L. Ebi et al., *Heat Watch/Warning Systems Save Lives: Estimated Costs and Benefits for Philadelphia 1995–98*, AM. METEOROLOGICAL SOC'Y, Aug. 2004, at 1067, 1067–68. *See also* U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 27–28.

361. Ebi et al., *supra* note 360, at 1067–68.

362. *Id.*

363. *Id.* at 1068.

and newspapers, along with health and safety information to minimize risks.[364] Multiple city agencies are also implicated in the PWWS. For instance, the Fire Department increases staffing when oppressive weather conditions are predicted, local utilities waive service suspensions, and the Department of Public Health actively contacts nursing homes and other facilities housing vulnerable populations to alert them of the risks.[365] EPA has identified the PWWS "as a benchmark for integrated, urban EHE programs . . . [and it] demonstrates the importance of institutional support and shows how response actions can be matched to program partners based on their areas of expertise."[366] The PWWS can thus serve as a template for densely populated northern cities where the urban heat island effect[367] exacerbates increasingly regular EHEs during the summer months.

EPA has also identified Toronto, Canada as a model for excessive heat emergency response plans.[368] Instead of responding to a specific EHE, Toronto politicians developed its Hot Weather Response Plan ("HWRP") as a proactive, precautionary initiative.[369] The city also created a dedicated Hot Weather Response Committee, which meets each fall to evaluate the success of the HWRP over the previous summer.[370] Through these annual meetings, the Committee has adapted its HWRP in multiple ways, for instance, by establishing street patrol teams to provide free transit tokens to those in need of cooling centers and providing additional drinking fountains in city parks.[371] With its inherent uncertainty, climate change increases the need for flexibility and adaptability in municipal responses to extreme weather events. Toronto's HWRP, with both its proactive approach and dedicated heat response committee, is an excellent example of a flexible program, and similar elements should be incorporated into all local emergency planning efforts.

364. *Id.* at 1072.

365. *Id.*

366. U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 26.

367. *See infra* Part IV.E.

368. U.S. ENVTL. PROT. AGENCY, EXCESSIVE HEAT EVENTS GUIDEBOOK, *supra* note 332, at 30.

369. *Id.*

370. *Id.*

371. *Id.*

B. Resiliency Plans

While emergency response plans prepare for and respond to specific extreme weather events, resiliency plans are focused on long-term infrastructure planning to adapt to the dangers of climate change. Behavioral changes are also key components of resiliency planning and require prerequisite public education and outreach. An informed population equipped with resilient infrastructure is essential to resisting the multifaceted effects of extreme heat.

1. Infrastructure Planning & the Urban Heat Island Effect

California, which passed its Global Warming Solutions Act in 2006 ("AB 32"),[372] is at the forefront of resiliency planning for extreme heat. Under the mandate of AB 32, the state developed a Heat Adaptation Workgroup, a subcommittee of the Public Health Workgroup of the California Climate Action Team, which publishes guidance and recommendations for "state and local planners, local governments, emergency response, and public health and health care professionals and institutions" to integrate "extreme projections into plans, policies, and projects.[373] The guidance focuses on the built environment, and notes that over 95% of California's population lives in urban areas, where temperatures are generally higher than in surrounding less urbanized areas.[374] California's resiliency plan features four overarching recommendations for communities: (1) "incorporate changes as appropriate, to state and local regulations, codes and industry practices for buildings, land use and design elements to identify opportunities to accelerate the adoption of cooling strategies for both indoor and outdoor environments;" (2) create an urban heat island effect index to allow cities to set quantifiable goals for urban heat mitigation; (3) "expand the use of cool, porous, or sustainable materials in pavements;" and (4) "expand urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces."[375] The plan also recommends statutory and regulatory changes to better

372. CAL. HEALTH & SAFETY CODE §§ 38500–38598 (West 2006).

373. CAL. CLIMATE ACTION TEAM, PREPARING CALIFORNIA FOR EXTREME HEAT: GUIDANCE AND RECOMMENDATIONS 1 (2013).

374. *Id.* at 1, 4.

375. *Id.* at 11–12.

incorporate public health considerations into the state's Green Building Standards, the incorporation of thermal air quality considerations into residential and commercial building standards, and the implementation of cooling mechanisms into land use planning, specifically for areas with dense building and transit corridors.[376] California's Green Building Standards contain both mandatory and voluntary standards, but most mandatory standards focus on energy efficiency.[377]

While California's resiliency plan features broad recommendations that can be tailored to local needs, dozens of cities throughout the U.S. have created their own climate resiliency plans that take into consideration the particular needs of the locality.[378] New York City's Cool Neighborhoods initiative offers heat mitigation, adaptation, and monitoring strategies for the city as a whole, with targeted strategies to protect vulnerable communities.[379] In terms of mitigation, Cool Neighborhoods looks to the best practices for lessening the impacts of the urban heat island ("UHI") effect, a phenomenon in which urbanized areas experience higher surface temperatures than surrounding less congested areas, primarily due to the built environment's retention of heat.[380] These methods have two primary components: (1) increasing the reflectivity or "albedo" of surfaces, such as roofs and pavements, and (2) increasing trees and other urban vegetation.[381]

376. *Id.* at 11.

377. *See generally* CAL. CODE REGS. tit. 24, § 11 (2018).

378. Many cities have established information-sharing alliances and public policy commitments to resiliency efforts. For example, the 100 Resilient Cities initiative, created by the Rockefeller Foundation, offers funding and planning recommendations to cities throughout the world to mitigate and adequately plan for the current and impending dangers of extreme heat. *About Us*, 100 RESILIENT CITIES, http://www.100resilientcities.org/about-us/ [https://perma.cc/5WV4-F288] (last visited Mar. 31, 2019). In 2012, the Georgetown Climate Center published a guide for municipalities in implementing UHI mitigation techniques. *See* SARA P. HOVERTER, GEORGETOWN CLIMATE CTR., ADAPTING TO URBAN HEAT: A TOOL KIT FOR LOCAL GOVERNMENTS (2012), https://kresge.org/sites/default/files/climate-adaptation-urban-heat.pdf [https://perma.cc/9PLK-WG8U].

379. CITY OF NEW YORK, COOL NEIGHBORHOODS NYC 3, 5 (2017), https://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report_FINAL.pdf [https://perma.cc/52DS-XRW5].

380. JOYCE KLEIN ROSENTHAL ET AL., SUSTAINABLE SOUTH BRONX, URBAN HEAT ISLAND MITIGATION CAN IMPROVE NEW YORK CITY'S ENVIRONMENT 1 (2008).

381. *Id.* at 8. For an empirical analysis of the efficacy of UHI mitigation techniques, in terms of both reducing heat and saving lives, see JENNIFER VANOS ET AL., ASSESSING THE HEALTH IMPACTS OF URBAN HEAT ISLAND REDUCTION STRATEGIES IN THE CITIES OF BALTIMORE, LOS ANGELES, AND NEW YORK (2014), https://www.coolrooftoolkit.org/wp-

Black and dark-colored roofs absorb nearly all sunlight, thereby increasing a building's temperature; this heat retention can be easily mitigated by simply painting a roof white or adding reflective surfaces.[382] By implementing these cool roof techniques, buildings can stay up to 50°F to 60°F cooler during peak summer heat.[383] Paved surfaces also contribute to the UHI effect, as they can reach temperatures of up to 150°F.[384] Increasing the albedo of paved surfaces, in addition to heightening the permeability of such surfaces to increase the cooling effects of evaporation, are implementable techniques to cool urbanized areas.[385]

Vegetation helps to mitigate temperatures by reducing the amount of solar heat that reaches buildings; cooling the air through evapotranspiration (the method through which leaves evaporate water); and indirectly reducing the surface area of paved surfaces by necessitating soil usage.[386] Trees are particularly useful when planted in strategic locations surrounding buildings. Researchers have determined that planting deciduous trees to the west of buildings, ideally shading the windows and roof, is the most effective way to cool the buildings.[387] Roofs that have planted gardens or other forms of vegetation, often referred to as "green roofs," are even better at reducing building temperatures, and green roofs can be cooler than the ambient area during daylight hours.[388] Trees and other urban vegetation have the added benefits of sequestering carbon, lowering energy usage, enhancing stormwater runoff capacity, and providing aesthetic value.[389] California's AB 32 also contemplates the value of urban forests to

content/uploads/2014/07/Three-City-Heat-Health-Report-FINAL-adj.pdf [https://perma.cc/U4VV-K753].

382. *Using Cool Roofs to Reduce Heat Islands*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/heat-islands/using-cool-roofs-reduce-heat-islands [https://perma.cc/AXA2-PVEL] (last visited Mar. 31, 2019).

383. *Id.* Dark-colored roofs can reach temperatures up to 190°F in the summer heat. ROSENTHAL ET AL., *supra* note 380, at 9.

384. ROSENTHAL ET AL., *supra* note 380, at 12.

385. *Id.*

386. *Id.* at 13.

387. U.S. ENVTL. PROT. AGENCY, *Trees and Vegetation*, *in* REDUCING URBAN HEAT ISLANDS: COMPENDIUM OF STRATEGIES 3 (2008), https://www.epa.gov/sites/production/files/2017-05/documents/reducing_urban_heat_islands_ch_2.pdf [https://perma.cc/KCC3-9QE4].

388. U.S. ENVTL. PROT. AGENCY, *Green Roofs*, *in* REDUCING URBAN HEAT ISLANDS: COMPENDIUM OF STRATEGIES 1 (2008), https://www.epa.gov/sites/production/files/2017-05/documents/reducing_urban_heat_islands_ch_3.pdf [https://perma.cc/D5KU-2XB8].

389. U.S. ENVTL. PROT. AGENCY, *Trees and Vegetation*, *supra* note 387, at 5–8.

sequester carbon to mitigate climate change, along with regulating temperatures, decreasing pollution, and providing habitats for urban wildlife.[390]

Climate-conscious infrastructure planning can reduce legal liability for municipalities and government entities alike. For instance, as New York City prepares to replace the Rikers Island detention facility—a facility that has been plagued by public health hazards, including extreme heat, for years[391]—a plan to mitigate environmental hazards could not only protect vulnerable prison populations, but also insulate the city from potential lawsuits.[392] The same can be said for public housing facilities, schools, and transportation infrastructure. Public, government-funded construction projects should incorporate UHI reduction techniques, and similarly, municipalities should institute building codes and zoning laws applicable to private development.

2. Behavioral Changes

The government has a duty to protect citizens from public health risks, but full resilience to extreme heat cannot be achieved without behavioral changes, both individually and by society at large. Some behavioral changes are small scale and easily implementable, such as changing the timing of activities. Clear regulations on the acceptability and timing of outdoor activities for schoolchildren and workers would be an easily implementable first step. Others, such as changing the predominant industries in a region, may be much harder to implement. For example, as California's verdant Central Valley experiences more frequent and severe EHEs,[393] summer farming may no longer be safe or even possible, striking a devastating blow to the region's economy.

390. Ellis Raskin, *Urban Forests as Weapons Against Climate Change: Lessons from California's Global Warming Solutions Act*, 47 URB. LAW. 387, 388–89 (2015).

391. Raven Rakia, *A Sinking Jail: The Environmental Disaster That Is Rikers Island*, GRIST (Mar. 15, 2016), https://grist.org/justice/a-sinking-jail-the-environmental-disaster-that-is-rikers-island [https://perma.cc/M82N-DYGS].

392. *See supra* Part III.C.3.

393. *See, e.g.*, Kat Kerlin, *Climate Change Threats and Solutions for the Sacramento Valley*, U.C. DAVIS: NEWS (Aug. 27, 2018), https://www.ucdavis.edu/news/climate-change-threats-and-solutions-sacramento-valley/ [https://perma.cc/VGP4-VJEN]; Vic Bedoian, *San Joaquin Valley Facing Serious Impacts Says Climate Change Assessment*, COMMUNITY ALLIANCE (Feb. 1, 2019), https://fresnoalliance.com/san-joaquin-valley-facing-serious-impacts-says-climate-change-assessment [https://perma.cc/B3F2-9XKY].

While recent decades have seen relocation from the northern states to the more temperate Sun Belt states, rising temperatures may make such locations less appealing and perhaps uninhabitable.[394] Instituting large-scale climate migration and relocation may be premature, especially with the uncertainty of how climate change will affect individual population centers, but some studies indicate that climate-induced migration is already occurring.[395] By one estimate, over 1.5 million Americans migrated from their homes in the face of climate-related disasters, temporarily or permanently, in 2017 alone.[396] Some of the most vulnerable metropolitan areas in the country, including Miami, Florida[397] have not included migration in their climate adaptation plans; but, undoubtedly, it would be prudent for state and local governments to incorporate such considerations into local planning initiatives.[398]

C. Air Conditioning

Air conditioning is the most effective way to protect vulnerable individuals from extreme heat and its appurtenant illnesses.[399] Costs, however, can be an impediment for low-income households, thereby creating a health-equity issue.[400] The Low Income Home Energy Assistance Program ("LIHEAP"), administered by the U.S.

394. Justin Worland, *Extreme Heat Waves Will Change How We Live. We're Not Ready*, TIME (June 23, 2017), http://time.com/4830147/extreme-heat-climate-change [https://perma.cc/MNY6-NCRP].

395. Victoria Hermann, *U.S. Cities Need to Plan for an Influx of Internal Climate Migrants*, SCI. AM. (June 6, 2018), https://blogs.scientificamerican.com/observations/u-s-cities-need-to-plan-for-an-influx-of-internal-climate-migrants [https://perma.cc/F7S7-W5Y9].

396. *United States*, INTERNAL DISPLACEMENT MONITORING CTR., http://www.internal-displacement.org/countries/united-states [https://perma.cc/FSP2-R9U9] (last visited Apr. 1, 2019). Because the United States often requires evacuations through early warning systems, short-term displacements contribute significantly to this staggering statistic. SARAH OPITZ STAPLETON ET AL., U.N. DEV. PROGRAM, CLIMATE CHANGE, MIGRATION, AND DISPLACEMENT 15 (2017), https://www.odi.org/sites/odi.org.uk/files/resource-documents/11874.pdf [https://perma.cc/7C43-G3DJ] (noting how early warning systems and evacuations lead to large displacements in the U.S. and China).

397. *See generally* MIAMI-DADE CTY., CLIMATE CHANGE ACTION PLAN (2010), https://www.miamidade.gov/greenprint/pdf/climate_action_plan.pdf [https://perma.cc/EZ9C-PP2C].

398. *See generally* LARA WHITELY BINDER & JASON R. JURJEVICH, WINDS OF CHANGE? EXPLORING CLIMATE CHANGE-DRIVEN MIGRATION AND RELATED IMPACTS IN THE PACIFIC NORTHWEST (2016).

399. CITY OF NEW YORK, COOL NEIGHBORHOODS NYC, *supra* note 379, at 27.

400. *Id.*

Department of Health and Human Services, helps to assuage these costs by subsidizing household costs for heating and cooling, among other energy needs.[401] Through LIHEAP, New York City provided over 700,000 heating and cooling grants, totaling $37.5 million, but only a small percentage of these grants went to subsidize air conditioning.[402] Because only 1% of New York State's LIHEAP allocation is used for cooling assistance, a vast majority of LIHEAP funds is used for heating during the winter months.[403] When LIHEAP funds are earmarked for cooling, "assistance applies solely for the purchase and installation of an air conditioning unit for low-income residents with a documented medical need, but the assistance grant cannot be used to offset prohibitive utility costs."[404] With the growing recognition of extreme heat as a public health concern, reconsideration of LIHEAP funding allocation is warranted.

Despite its efficacy in mitigating heat, air conditioning creates multiple negative externalities. For instance, air conditioning units contribute to the UHI effect, as they often discharge hot air from buildings, only adding to the prevailing surface temperature.[405] Air conditioning also requires a lot of energy. Air conditioning accounts for approximately 17% of residential electricity consumption in the U.S.,[406] but during EHEs or other spates of hot weather, it can increase to 70% in certain areas.[407] Likewise, air conditioning is the main driver of peak energy demand,[408] which puts strain on the electricity grid to generate and distribute power

401. *See generally* 42 U.S.C. §§ 8621–8630 (2018).

402. CITY OF NEW YORK, COOL NEIGHBORHOODS NYC, *supra* note 379, at 27.

403. *Id.*

404. *Id.*

405. Stan Cox, *Your Air Conditioner Is Making the Heat Wave Worse*, WASH. POST: POSTEVERYTHING (July 22, 2016), https://www.washingtonpost.com/posteverything/wp/2016/07/22/your-air-conditioner-is-making-the-heat-wave-worse/?utm_term=.7a6281e124c2 [https://perma.cc/UJ79-3NHB].

406. Maggie Woodward & Chip Berry, *EIA's Residential Energy Survey Now Includes More than 20 New End Uses*, U.S. ENERGY INFO. ADMIN. (June 5, 2018), https://www.eia.gov/todayinenergy/detail.php?id=36412&src=%E2%80%B9%20Consumption%20%20%20%20%20%20Residential%20Energy%20Consumption%20Survey%20(RECS)-b1 [https://perma.cc/DJW7-VGEY].

407. INT'L ENERGY AGENCY, THE FUTURE OF COOLING 11 (2018), http://www.oecd.org/about/publishing/TheFutureofCooling2018Corrigendumpages.pdf [https://perma.cc/8U7S-PGJA].

408. Luis Ortiz et al., *Climate Change Impacts on Peak Building Cooling Energy Demand in a Coastal Megacity*, 13 ENVTL. RES. LETTERS 1 (2018).

at high capacity. During peak times, renewable energy sources and baseload generators, such as nuclear, are insufficient to meet energy demands, thereby causing peak generators to ramp up quickly to make up the difference.[409] Peak capacity generators are not only expensive to run and maintain, but they also tend to use carbon-intensive energy sources, such as diesel and natural gas, which release GHGs that further contribute to climate change.[410]

This feedback loop—climate change necessitating air conditioning which in turn necessitates fossil fuel consumption—can be weakened, if not broken, by demand response programs and energy efficiency. In demand response programs, large consumers of electricity enter into interruptible power agreements with electric utilities, whereby the consumers agree to decrease their energy use during peak times in exchange for a lower rate.[411] Residential consumers may also participate in demand response programs, which are often achieved by the electric utility sending out signals through the smart grid to remotely control the energy consumption of the consumer's appliances.[412]

Even though the U.S. has the most efficient air conditioning units available compared to anywhere in the world, they are not legally mandated and constitute approximately 3% of the total market.[413] In fact, the average air conditioning unit sold in the U.S. is less efficient than the average in Europe, South Korea, or Japan.[414] The heightened need for air conditioning from a warming climate coupled with the inefficiency of a vast majority of units may result in power failures and blackouts with potentially life-threatening consequences. A progressive federally-mandated air conditioning efficiency standard, coupled with widespread demand response programs, is essential,[415] and from this baseline, states can implement stricter standards, thereby putting greater pressure on the market to adapt.

409. INT'L ENERGY AGENCY, *supra* note 407, at 27.

410. *Id.* at 28 fig.1.13.

411. *Id.* at 50.

412. *Id.* at 50–52.

413. Michael B. Gerrard & Edward McTiernan, *Legal Tools for Cities to Cope with Extreme Heat*, N.Y.L.J. (Nov. 7, 2018), https://www.law.com/newyorklawjournal/2018/11/07/legal-tools-for-cities-to-cope-with-extreme-heat [https://perma.cc/NW78-9LLB].

414. *Id.*

415. *Id.*

D. Workplace Safety: Best Practices

As demonstrated in Part III.A, workplace safety currently has the most detailed regulatory and policy regime related to excessive heat; nevertheless, there is ample room for improvement. Workers' rights advocacy groups are spearheading the movement toward enhanced worker safety, particularly for outdoor workers. In July 2018, Public Citizen, in conjunction with more than 130 organizations, filed a petition for rulemaking to OSHA to develop the first federal standard to protect indoor and outdoor workers from occupational exposure to excessive heat.[416] The petition calls for mandatory breaks, heat acclimatization plans, PPE, hydration stations, and shaded rest breaks.[417] While the need for such standards is manifest, OSHA has been reluctant to initiate rulemaking for heat stress standards. In September 2011, Public Citizen and an alliance of public interest organizations petitioned OSHA for the development of an emergency temporary standard ("ETS") for occupational heat stress, followed by rulemaking for a permanent heat stress threshold.[418] Under Section 6(c) of the OSH Act, OSHA may issue an ETS when "employees are exposed to a grave danger . . . [and the] issuance of an ETS is necessary to protect employees from that danger."[419] Despite acknowledging the dangers of heat stress, OSHA denied the petition, arguing that the "annual rate of heat-related deaths among crop workers . . . does not exceed those of other hazards OSHA has deemed to be 'significant' (e.g., benzene) and therefore, would likely not meet the legal requirement of 'grave.'"[420] OSHA further contended that the General Duty Clause of the OSH Act[421] provides statutory protection for outdoor workers, as it requires employers

416. Letter from Sidney Wolfe, Founder & Adviser, Public Citizen's Health Res. Group, et al., to Loren Sweatt, Acting Assistant Sec'y of Lab. For Occupational Safety & Health (July 17, 2018), https://www.citizen.org/sites/default/files/180717_petition_to_osha_on_heat_stress-signed_final_0.pdf [https://perma.cc/34TD-37MT].

417. *Id.* at 2.

418. Letter from David Michaels, Assistant Sec'y for Occupational Safety & Health, to Sidney Wolfe, Dir., Public Citizen's Health Research Group (June 7, 2012), https://www.citizen.org/sites/default/files/denial-of-heat-stress-petition.pdf [https://perma.cc/P3L6-G2GP].

419. *Id.* at 1; *see also* 29 U.S.C. § 655(c) (2018) (detailing the parameters of ETS issuance).

420. Michaels, *supra* note 418, at 1–2.

421. *See supra* Part III.A.1.

to make workplaces free of recognized hazards.[422] Facing this precedent, it is unclear if Public Citizen's petition will spur rulemaking; however, being that NIOSH published its Heat Stress Criteria Document in 2016, OSHA is certainly more aware of the risks of excessive workplace heat as compared to 2011.[423]

Pure reliance on the General Duty Clause of the OSH Act to enforce workplace heat standards, specifically for outdoor workers, is untenable, not only due to the prevalence of EHEs, but also "because the industries at highest risk of heat stress injuries and deaths are agriculture and construction, both of which rely heavily on vulnerable workers."[424] Such workers are less likely to report unsafe work conditions for fear of retaliation or deportation.[425] Moreover, California, which became the first state to pass a heat standard for outdoor workers in 2005, conducted at least 50 times the number of inspections resulting in heat exposure violations than OSHA did nationwide between 2013 and 2017.[426] This enforcement disparity demonstrates the importance of a heat-specific standard as opposed to pure reliance on a General Duty Clause, as employers have a greater incentive to maintain safe heat levels if they know that inspectors are honed in on acceptable standards.[427]

Generally speaking, there are four approaches to adapting to extreme heat in the workplace: modifying the type of work; modifying the working environment; modifying the actual worker through acclimatization; and modifying worker clothing and PPE.[428] Modifying the type of work and the working environment would be difficult for outdoor workers, but the availability of shade, cooling and hydration stations, and supervised heat stress screenings and exposure monitoring throughout the workday

422. Michaels, *supra* note 418, at 2.

423. *See supra* Part III.A.1.

424. MICHAEL TANGLIS ET AL., PUBLIC CITIZEN, EXTREME HEAT AND UNPROTECTED WORKERS 27 (2018), https://www.citizen.org/sites/default/files/extreme_heat_and_unprotected_workers.pdf [https://perma.cc/XW92-NFGA].

425. *Id.* at 27–28; *see also* Ingfei Chen, *How Heat Kills Farmworkers*, MOTHER JONES (Sept. 20, 2017, 5:30 AM), https://www.motherjones.com/food/2017/09/farmworkers-hot-days-deadly-mendota-california/ [https://perma.cc/ZSJ6-8KR5].
("Heat sickness is a symptom of an agricultural system where laborers can't speak up against unsafe field conditions, in part because many are undocumented.").

426. TANGLIS ET AL., *supra* note 424, at 5.

427. *Id.*

428. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 82.

would mitigate some of the dangers.[429] The military's pointed focus on acclimatization is indicative of the method's importance in adapting to excessive heat,[430] and Public Citizen is calling for a heat acclimatization plan whereby new workers would be progressively acclimated to outdoor temperatures over the course of 1 to 2 weeks.[431] In terms of clothing, reflective PPE, using the albedo effect, helps to maintain a lower body temperature, as do cooling vests.[432] Rather simple cooling vests which are submerged in cold water for about a minute before being worn can keep outdoor workers cool for several hours as the water slowly evaporates, and have been effective at protecting outdoor migrant workers in the Middle East where temperatures can reach over 110°F.[433] Interestingly, a 2011 study showed that cooling-gel collars worn around the neck lessened participants' perception of heat stress when exercising in a hot environment but had no effect on their body temperatures, thus actually increasing the risk of heat-related illnesses.[434] Since some occupations, such as firefighting and military work, already have industry-specific standards, OSHA should set baseline safety standards for PPE, which can then be tailored, either by agencies or industry groups, based on the type of work.

CONCLUSION

While this Note seeks to establish a legal standard of tolerable heat, it ultimately must conclude that an objective, quantifiable standard is not feasible due to the broad range of environments and acclimatization levels implicated in extreme heat analysis. There are obvious physiological thresholds—for instance, a wet-bulb temperature of 35°C is the upper limit to a survivable temperature[435]—but "tolerability" varies by context and population. Indeed, a mandated tolerable heat level of 106°F (the internal body

429. *See generally id.* at 71–85.

430. *See supra* Part III.A.3.a.

431. Wolfe, *supra* note 416, at 35.

432. NIOSH CRITERIA DOCUMENT, *supra* note 57, at 42; Wolfe, *supra* note 416, at 34.

433. Heba Kanso, *Cooling Vests Aim to Help Migrant Workers Weather the Gulf's Heat*, THOMSON REUTERS FOUND.: NEWS (Sept. 25, 2017), http://news.trust.org/item/20170925160500-hp3dz/ [https://perma.cc/HGU7-6XPZ].

434. Christopher James Tyler & Caroline Sunderland, *Cooling the Neck Region During Exercise in the Heat*, 46 J. ATHLETIC TRAINING 61, 61–67 (2011).

435. *See supra* Part I.A.

temperature that triggers heat stroke)[436] would be a useless standard, as myriad health effects occur at much lower temperatures. Likewise, acclimatized individuals can work at temperatures that may be unbearable or even deadly for others.

To stymie the effects of extreme heat, this Note recommends that the federal government, in coordination with the states, serve as a catalyst by setting regulatory baselines and goals, providing funding for infrastructure projects, offering technical resources for the development of heat adaptation plans, and continually updating and disseminating scientifically-sound climate data. Because local and regional governments often lack the technical and scientific resources to develop adaptation policies, the federal government is uniquely poised to develop programmatic strategies—such as climate resilient infrastructure initiatives—that would be impossible for each state or municipality to independently create. Then, working from a federal framework, state and local governments, which have a greater sense of local conditions and needs, can tailor their individual standards, particularly by creating emergency response plans to protect their most vulnerable populations and implementing UHI mitigation techniques, which have a proven track-record of lowering the prevailing temperature. The federal government, through its sprawling regulatory programs based on cooperative federalism, has the ability to incorporate climate adaptation into a breadth of legal schemes and policies, from agriculture to trade to housing. Just as EPA sets minimum air quality standards under the Clean Air Act and then delegates implementation to the states, the Department of Health and Human Services is more than capable of disseminating baseline, mandatory, and enforceable temperature standards for places such as elder care facilities, which can then be modified at the local level. A proactive approach from the federal government in developing standards would undoubtedly prevent future heat-related casualties, as it would force state and local governments—which may not account for EHE adaptation techniques in their budgets, or even have them on their radar—to take active steps to prepare for extreme heat.

Although heat-related standards are warranted across the board, workplace standards, specifically for outdoor workers in agriculture

436. *See supra* Part II.A.

and construction, are decidedly urgent, as such workers can be exposed to dangerous heat levels on a daily basis and often lack the political clout or collective action to advocate for reform. The USDA estimates that about half of the country's farmworkers are undocumented, and data from the Pew Research Center indicates that approximately 15% of construction workers are in the country illegally.[437] With the current precarious state of immigration, it is unlikely that workplace whistleblowers will alert relevant authorities of safety risks regarding extreme heat and spur reform. Public Citizen's OSHA rulemaking petition is therefore an important step in protecting outdoor workers—migrants or otherwise—throughout the country.

The "invisible" threat of extreme heat is becoming an increasingly visible signifier of a rapidly changing climate. Extreme heat fuels wildfires, cripples infrastructure, and kills hundreds of people each year in the U.S. alone. As the national media and political candidates begin to turn an eye to the dangers of extreme heat, the exigency of action to thwart climate change—or, put more aptly, "global warming"—will gain traction with the general populace. Even though industry-specific organizations, advocacy groups, and state and local governments are taking strides to tackle this growing concern, it is also incumbent upon the federal government to adopt baseline, action-forcing standards recognizing the intolerability of extreme heat.

437. Mary Jo Dudley, *These U.S. Industries Can't Work Without Illegal Immigrants*, CBS NEWS (Jan. 10, 2019, 3:55 PM), https://www.cbsnews.com/news/illegal-immigrants-us-jobs-economy-farm-workers-taxes/ [https://perma.cc/GVA6-E6EQ].