Working Paper

Standardized Regulatory Impact Assessment (SRIA) of the Proposed California Regulation for Heat Illness Prevention in Indoor Places of Employment

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About this Report

This report is a standardized regulatory impact assessment (SRIA) for the California Department of Industrial Relations' (DIR) proposed regulation for heat illness prevention in indoor places of employment. Government Code section 11346.3 specifies that any California state agency proposing to adopt, amend, or repeal a major regulation is required to prepare a SRIA to be submitted to the Department of Finance for review and comment. A SRIA provides a macroeconomic analysis intended to evaluate the economic impact of any administrative regulation on California businesses and individuals. Specifically, SRIAs assess the impact of a proposed regulatory action by quantifying and monetizing the costs and benefits associated with the action as well as by analyzing how implementation of the regulation would impact the broader economic environment.

Senate Bill 617 (Stats. 2011, Ch. 496) requires SRIAs to address specific potential economic impacts, such as the creation or elimination of jobs within the state of California, the creation of new businesses or the elimination of existing businesses within the state, and other impacts of the regulation. While SRIAs have differed in style and scope to accommodate the unique aspects of each proposed regulation, they must contain the background information and analyses needed to meet the requirements of Senate Bill 617 and Chapter 3.5 of the California Government Code. SRIAs must describe the purpose of the regulation (including identifying the problem or problems the agency is trying to solve), specify the evidence (e.g., scientific research, testimony) upon which the regulation is based, and identify the laws or statues that give the agency the authority to issue the regulation. SRIAs must also describe the proposed regulation and specify exactly how it modifies the existing regulatory code.

In any SRIA, economic impacts should be measured relative to a *no regulatory action* baseline. SRIAs should also consider and evaluate at least two regulatory alternatives to the proposed regulatory action. Agencies must provide justification for rejecting those alternatives in favor of the proposed regulatory action. Wherever possible, SRIAs should quantify and monetize costs and benefits over time. Qualitative descriptions should be included whenever quantification is impossible or impractical. Additionally, SRIAs should consider costs and benefits separately for businesses and individuals, with particular attention to impacts on small businesses. SRIAs should also analyze how the regulation will affect the costs or revenues paid to local and state governments. Furthermore, SRIAs should provide information on the model used to conduct the macroeconomic assessment, including what inputs the model uses, what assumptions it makes, and any limitations of the model.

Acknowledgments

This report has benefited from the insights, support, and feedback of many individuals and organizations. The RAND Corporation was contracted to perform this work by the Department of Industrial Relations (DIR) under contract #4901. Eric Berg, Susan Eckhardt, Grace Delizo, and Keummi Park of the California Division of Occupational Safety and Health (Cal/OSHA) and Amalia Neidhardt, formerly of Cal/OSHA, provided guidance and review throughout the research process. We thank Amy Heinzerling of the California Department of Public Health and Jisung Park of the University of California, Los Angeles for sharing their research and insights on occupational heat-related illness. This analysis also benefited from the comments and perspectives of affected industry and labor groups interviewed by RAND. To ensure confidentiality, the identities of these organizations have not been shared in this report or with DIR. Within the RAND Corporation, we thank Weilong Kong for assistance with developing IMPLAN activities for the assessment of macroeconomic impacts, as well as Katherine Carman and Aaron Strong for their thoughtful reviews of an initial draft of this report.

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Executive Summary

Heat stress poses a serious threat to employees working in extreme heat conditions. Occupational exposure to heat can result in reduced productivity, illness, injury, permanent disability, vital organ damage, and death (NIOSH, 2016). Workers' compensation records show that each year, approximately 1,000 California workers submit claims for heat-related illnesses from occupational heat exposure. In extreme cases heat-related illnesses can be fatal. In 2005, California became the first state to pass a heat illness prevention standard (California Code of Regulations, Title 8, Section 3395). However, this standard does not apply to indoor places of employment. Heat illness is by no means limited to outdoor work, as the temperature in many warehouses, factories, kitchens, and boiler rooms often exceeds 80 degrees Fahrenheit (°F). Indoor workers account for approximately 185 of the 1,000 workers' compensation claims for heat-related illnesses each year.[1]

In September 2016, the California state legislature passed, and the governor signed, Senate Bill 1167, which required the California Division of Occupational Safety and Health (Cal/OSHA) to propose a standard that minimizes heat-related illness and injury among workers in indoor places of employment. In response, the California Department of Industrial Relations (DIR) is proposing a new section to the General Industry Safety Orders in Title 8 that would set regulatory requirements for indoor places of employment that equal or exceed specified temperature thresholds.

There are two regulatory thresholds in the proposed regulation. First, if the temperature in the indoor environment is greater than or equal to 82°F when employees are present, a certain set of compliance actions is required, including providing employees access to drinking water and cool-down areas and developing a heat illness prevention plan (HIPP). Second, if the indoor temperature or heat index equals or exceeds 87°F when employees are present, or if the temperature or heat index equals or exceeds 82°F and employees wear clothing that restricts heat removal or work in a high radiant heat work area, an additional set of compliance actions is required. The additional compliance actions include using engineering or administrative control measures or providing personal heat-protective equipment to employees when any of the regulatory thresholds have been reached.

[1] Based on analysis of the Division of Workers' Compensation's Workers' Compensation Information System from 2010 to 2018.

Regulatory Baseline

We estimate there are approximately 196,000 establishments and approximately 1.4 million employees in California potentially impacted by the proposed regulation.[2] This represents approximately 12 percent of all establishments and approximately 8 percent of all employees in California. The number of establishments that will incur incremental costs to undertake specific actions to comply with the proposed regulation relative to the *no regulatory action* baseline is uncertain; therefore, we present a range of estimates using low-end and high-end assumptions for the number of impacted businesses.

Direct Costs and Benefits

The total direct compliance costs of the proposed regulation vary across industries and over time as many of the requirements require both upfront and recurring investments in various heat illness prevention measures. Overall, our primary estimate of the total direct compliance costs of the proposed indoor heat illness prevention requirements is $215 million in 2023 (with a range from $159 to $270 million) and $88 million in each subsequent year (with a range of $64 to $112 million) on an undiscounted annualized basis. These costs are largely driven by two factors: (1) the use of engineering controls, such as evaporative coolers, local exhaust ventilation, air conditioning, or cooling fans, and (2) labor costs related to training employees on identifying risk factors and common signs and symptoms of heat illness, appropriate first aid and/or emergency response, and the importance of frequent consumption of small quantities of water in hot work environments as well as providing access to cool-down areas when any of the regulatory thresholds have been reached.

The proposed regulation is anticipated to provide benefits to both individuals and businesses. Individuals are anticipated to benefit from reduced risk of occupational heat-related illness and death. Businesses are anticipated to benefit from increased labor output by using control measures, such as engineering or administrative controls to mitigate employee exposure to hot indoor temperatures since worker productivity tends to decline in hot indoor environments because employees work fewer hours (Graff Zivin and Neidell, 2014) and because the hours worked become less productive (Park 2016; Tanabe et al., 2006; Seppänen et al., 2006). Based on information provided by industry representatives, a vast majority of establishments in certain industries (such as indoor establishments with a long-history of working with "hot" processes) have existing measures in place to prevent heat-related illness. The pre-existing adoption of control measures in many industries, which is accounted for in this analysis, suggests that many

[2] This estimate is based on 179 North American Industry Classification System (NAICS) codes (at the 4-digit level) identified by Cal/OSHA staff as (1) industries likely to have indoor work environments where employees are exposed to temperatures at or above 82°F due to an indoor radiant heat source, greenhouse, or non-climate controlled facility (e.g., warehouse), or (2) industries likely to have some but not all establishments affected due to climate, geographic, or locational factors.

companies may already view the benefits to their business as exceeding the cost of undertaking those measures. The effectiveness of the proposed regulation in reducing heat-related illnesses and deaths is uncertain; therefore, we present a range of estimates using low-end and high-end assumptions for the number of future incidents that may be prevented. Our primary estimate of the total direct benefits is $404 million (with a range from $257 to $678 million) on an undiscounted annualized basis.

To account for differences in the timing of future costs and benefits, we apply a discount rate of three percent to the estimates reported above. We estimate that the annualized costs of the proposed regulation will be $102 million (with a range from $75 to $129 million) and the annualized benefits will be $402 million (with a range from $256 to $635 million) using a discount rate of 3 percent.[3] Therefore, the anticipated benefits of the proposed regulation are expected to exceed the anticipated costs. We estimate that the net benefits (i.e., benefits less costs) of the proposed regulation will be $300 million (with a range from $181 to $507 million) using a discount rate of 3 percent. Table ES-1 reports the costs and benefits of the proposed regulation by year, showing low-end and high-end estimates in addition to the primary estimate reported in this SRIA using a discount rate of 3 percent. Table ES-2 summarizes the annualized net benefits of the proposed regulation as a range using a discount rate of 3 percent and also presents the impact of using a discount rate of 7 percent.

Table ES-1. Costs and Benefits of the Proposed Regulation by Year with Low-end and High-end Estimates, using a 3 Percent Discount Rate

	Costs			Benefits		
Year	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)
2023	$159.1	$214.7	$270.4	$234.7	$362.2	$571.5
2024	$53.7	$72.3	$90.9	$229.9	$360.4	$560.1
2025	$52.1	$70.2	$88.3	$228.4	$358.5	$559.8
2026	$54.4	$73.4	$92.5	$226.9	$356.5	$559.2
2027	$49.1	$66.2	$83.2	$225.3	$354.5	$558.5
2028	$62.5	$86.1	$109.8	$223.7	$352.3	$557.5
2029	$60.8	$83.8	$106.8	$222.0	$350.1	$556.3
2030	$55.7	$76.7	$97.7	$220.3	$347.9	$554.8
2031	$54.1	$74.4	$94.8	$218.6	$345.5	$553.2
2032	$55.6	$76.7	$97.7	$216.9	$343.1	$551.4
Net Present Value	**$657.1**	**$894.6**	**$1,132.1**	**$2,246.8**	**$3,531.3**	**$5,582.3**
Annualized Value	**$74.8**	**$101.8**	**$128.8**	**$255.7**	**$401.9**	**$635.4**

Note: Totals may not sum precisely due to rounding.

[3] We get similar estimates (although slightly smaller net benefits) using a discount rate of seven percent.

Table ES-2. Annualized Net Benefits of the Proposed Regulation with Low-end and High-end Estimates, using Discount Rates of 3 and 7 Percent

	3 Percent Discount Rate			7 Percent Discount Rate		
	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)
Annualized Costs	$74.8	$101.8	$128.8	$76.1	$103.5	$130.9
Annualized Benefits	$255.7	$401.9	$635.4	$254.0	$399.0	$583.9
Annualized Net Benefits	$180.9	$300.1	$506.5	$177.9	$295.5	$453.0

Finally, in this report we address equity considerations in evaluating the distribution of costs and benefits and discuss how those impacts may relate to and potentially help to address pre-existing inequalities in California.

Macroeconomic Impacts

We also evaluate the statewide macroeconomic impacts of the proposed regulation on the California economy. The proposed regulation would result in changes in expenditures and labor costs by businesses in order to comply with the new requirements for indoor heat illness prevention. It would also result in productivity gains in businesses that use engineering controls to reduce occupational heat exposure in indoor workplaces. These changes would affect employment, investment, and output for businesses that provide goods and services to the industries directly impacted by the proposed regulation. These impacts would also result in induced effects, such as changes in personal income that affect consumer spending.

Overall, we estimate that the proposed regulation will increase the size of the California economy by approximately $479 million in the first year and approximately $528 million in the second year of the regulation. We anticipate that ongoing impacts of the proposed regulation in future years will be comparable to the second year impacts. The gains are largely attributable to improvements in employee productivity, which more than offset the labor costs of the proposed regulation. We also describe anticipated impacts on outcomes such as job creation, creation or elimination of businesses, competitive advantages or disadvantages for California businesses, increases or decreases of investment in the state, and incentives for innovation. In general, these impacts are anticipated to be very small relative to the overall size of the California economy.

Consideration of Regulatory Alternatives

In addition to the proposed regulation, we analyze two regulatory alternatives considered by DIR. The first (less stringent) regulatory alternative would eliminate from the proposed regulation subsection (e), which mandates additional assessment and control measures when the

temperature or heat index equals or exceeds the specified regulatory thresholds. The second (more stringent) regulatory alternative would require employers to use a wet bulb globe temperature (WBGT) device to measure heat stress in indoor workplaces. We evaluate the costs and benefits for each alternative relative to the *no regulatory action* baseline, compare these against the proposed regulation, and provide DIR's justification for rejecting those alternatives in favor of the proposed regulatory action. Based on considerations of the overall efficiency of the requirements, DIR selected the proposed regulation in favor of the regulatory alternatives. The net benefits of the proposed regulation are greater than either of the regulatory alternatives. Table ES-3 summarizes the annualized net benefits of the regulatory alternatives in comparison to the proposed regulation.

Table ES-3. Annualized Net Benefits of Regulatory Alternatives Compared to the Proposed Regulation, using Discount Rates of 3 and 7 Percent

	3 Percent Discount Rate			7 Percent Discount Rate		
	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)
Annualized Costs	$81.6	$101.8	$113.7	$82.3	$103.5	$115.5
Annualized Benefits	$115.0	$401.9	$401.9	$113.4	$399.0	$399.0
Annualized Net Benefits	$33.4	$300.1	$288.2	$31.1	$295.5	$283.5

Limitations

There are many factors that make the precise estimation of the costs and benefits of the proposed regulation difficult, and in some cases, the potential impacts are uncertain. Throughout this SRIA, we include various robustness checks, including sensitivity analyses, to illustrate how key sources of uncertainty might affect the costs and benefits of the proposed regulation. We also highlight other factors that we are unable to measure, but which may impact the costs and benefits of the proposed regulation.

Conclusion

Although most instances of heat-related illness are relatively minor, severe cases can result in serious injuries and even fatalities. It is important to acknowledge that many California employers already take steps to protect their workers from extreme heat, and those actions are often similar to the compliance actions required by the proposed regulation. However, adoption of indoor heat mitigation activities is not universal. Thus, the proposed regulation will impose new requirements on many employers, and the costs associated with these new requirements – including investments in new control measures and time spent on new risk mitigation activities –

will vary across industries. Under the assumptions presented in this SRIA, the anticipated benefits of the proposed regulation, primarily improvements in worker health and productivity, exceed the anticipated costs.

Abbreviations

°F	Degrees Fahrenheit
ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ATSDR	Agency for Toxic Substances and Disease Registry
BLS	U.S. Bureau of Labor Statistics
Cal/OSHA	California Division of Occupational Safety and Health
CBO	Congressional Budget Office
CDC	Centers for Disease Control and Prevention
CDTFA	California Department of Tax and Fee Administration
CFOI	Census of Fatal Occupational Injuries
CGE	Computable general equilibrium
COPD	chronic obstructive pulmonary disease
CPUC	California Public Utilities Commission
DIR	California Department of Industrial Relations
DOT	U.S. Department of Transportation
DWC	California Division of Workers' Compensation
EDD	California Employment Development Department
FEMA	Federal Emergency Management Agency
FTE	Full-time equivalent
HIPP	Heat illness prevention plan
I-O	Input-output
IIPP	Injury and Illness Prevention Program
JOLTS	Job Openings and Labor Turnover Survey
LPP	Local purchase percentages
MSHA	Mine Safety and Health Administration

NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NEPHTN	National Environmental Public Health Tracking Network
NIOSH	National Institute for Occupational Safety and Health
NLDAS	North American Land Data Assimilation System
NRI	National Risk Index
NVSS	National Vital Statistics System
NWS	National Weather Service
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
PPE	Personal protective equipment
QCEW	Quarterly Census of Employment and Wages
REMI	Regional Economic Models, Inc.
RPC	Regional purchasing coefficients
SOC	Standard Occupational Classification
SOII	Survey of Occupational Injuries and Illnesses
SRIA	Standardized regulatory impact assessment
THREDDS	Thematic Realtime Environmental Distributed Data Services
TLV	Threshold limit value
USGS	United States Geological Survey
VSL	Value of a statistical life
WBGT	Wet bulb globe temperature
WCIS	California Workers' Compensation Information System
WTP	Willingness to pay

1. Introduction

Heat stress poses a serious threat to employees working in extreme heat conditions. Occupational exposure to heat can result in reduced productivity, illness (including rhabdomyolysis (death of muscle tissue), heat stroke, or heat exhaustion), injury, permanent disability, vital organ damage, and death (NIOSH, 2016). Workers' compensation records show that each year, approximately 1,000 California workers experience heat-related illnesses from occupational heat exposure. In extreme cases these illnesses can be fatal. In 2005, California became the first state to pass a heat illness prevention standard (California Code of Regulations, Title 8, Section 3395).[4] However, this standard does not apply to indoor places of employment. Heat illness is by no means limited to outdoor work, as the temperature in many warehouses, factories, kitchens, and boiler rooms often exceeds 80 degrees Fahrenheit (°F). Indoor workers account for approximately 185 of the 1,000 workers' compensation claims for heat-related illnesses in California each year.[5]

The California Department of Industrial Relations (DIR) is proposing a new heat illness prevention regulation for indoor places of employment that reach or exceed specified temperature or heat index thresholds.[6] The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to heat stress in the workplace be controlled through "the proper application of engineering and work practice controls, worker training and acclimatization, measurements and assessment of heat stress, medical monitoring, and proper use of heat-protective clothing and personal protective equipment (PPE)" (NIOSH, 2016). NIOSH states that such measures "should prevent or greatly reduce the risk of adverse health effects to exposed workers" (NIOSH, 2016).

Purpose, Scope, and Audience of this Document

This report is a standardized regulatory impact assessment (SRIA) for DIR's proposed regulation for heat illness prevention in indoor places of employment. Government Code section

[4] California Code of Regulations, Title 8, Section 3395 requires employers with employees who work outdoors to provide water, access to shade (when the temperature outdoors exceeds 80°F), emergency response procedures, observation during acclimatization, training, and to establish, implement, and maintain an effective Heat Illness Prevention Plan. In addition, for employers in agriculture, construction, landscaping, oil and gas extraction, and specified transportation and delivery services, high-heat procedures must be implemented when the temperature equals or exceeds 95°F.

[5] Based on analysis of the Division of Workers' Compensation's Workers' Compensation Information System from 2010 to 2018.

[6] Further information on the proposed regulation is available at: https://www.dir.ca.gov/dosh/doshreg/heat-illness-prevention-indoors.

11346.3 specifies that any California state agency proposing to adopt, amend, or repeal a major regulation is required to prepare a SRIA to be submitted to the Department of Finance for review and comment. A SRIA provides a macroeconomic analysis intended to evaluate the economic impact of any administrative regulation on California businesses and individuals. Specifically, SRIAs assess the impact of a proposed regulatory action by quantifying and monetizing the costs and benefits associated with the action as well as by analyzing how implementation of the regulation would impact the broader economic environment.

In this SRIA the methodology for monetizing costs and benefits is based on the relevant academic literature and approaches used by other regulatory agencies for similar regulatory actions. These estimates are for informational purposes only because a cost-benefit analysis cannot be used as a basis for adopting an occupational safety and health standard. In *American Textile Manufacturers Institute, Inc. v. Donovan* (1981),[7] the U.S. Supreme Court held that

> Congress itself defined the basic relationship between costs and benefits by placing the "benefit" of worker health above all other considerations save those making attainment of this "benefit" unachievable. Any standard based on a balancing of costs and benefits by the Secretary that strikes a different balance than that struck by Congress would be inconsistent with the command set forth in [Section (6)(b)(5) of the Occupational Safety and Health Act of 1970].

California Labor Code Section 144.6 is nearly identical to Section (6)(b)(5) of the Occupational Safety and Health Act. In addition, Labor Code Section 142.3 requires California occupational safety and health regulations to be at least as effective as the federal regulations, so the cost-benefit balance established by Congress must be observed in establishing state regulations. While drafting the proposed standard to fulfill its statutory directive, Cal/OSHA also acknowledges applicable sections of the California Government Code pertinent to rulemaking.

This SRIA is designed and written to provide the macroeconomic analysis required by California law, and the intended audiences of this SRIA are the government entities involved in California's regulatory process, California business enterprises and individuals who may be affected by the proposed regulation, and other concerned stakeholders. However, the potential costs and benefits associated with regulations that are intended to prevent occupational heat-related illness may be of interest to other state or federal agencies that are considering similar regulations. While the costs and benefits estimated in this SRIA are specific to the California context, the issues under consideration and methods being applied in this SRIA may be of broader relevance.

[7] 452 U.S. 490 (1981).

Regulatory History

There is currently no federal regulation to prevent heat-related illness and protect workers in hot environments (Heinzerling et al., 2020). The Occupational Safety and Health Administration (OSHA) oversees and enforces standards to protect workers from hazards in the workplace. In addition, certain other states, including California, have the authority to mandate and enforce their own occupational safety and health standards.[8] Although there is no federal standard, NIOSH has developed criteria for a recommended standard for occupational heat exposure (NIOSH, 2016).

In California, heat illness prevention in outdoor places of employment is mandated by Title 8, Subchapter 7, Group 2, Article 10, Section 3395 of the California Code of Regulations, which outlines various protections for employees. However, these heat illness prevention requirements do not apply to indoor places of employment.[9] To address this shortcoming, in September 2016, the state legislature passed, and the governor signed, Senate Bill 1167, which amended the Labor Code. Section 6720 of the Labor Code, which took effect on January 1, 2017, requires the California Division of Occupational Safety and Health (Cal/OSHA) to propose to the Standards Board for the Board's review and adoption a standard that minimizes heat-related illness and injury among workers in indoor places of employment. In response, DIR is proposing a new section to the General Industry Safety Orders in Title 8 that would set regulatory requirements for indoor places of employment that equal or exceed specified temperature thresholds.

Statement of the Need for the Proposed Regulation

Workers who are exposed to extreme heat or work in hot environments may be at risk of heat-related illnesses ranging from mild heat stress-induced symptoms to life-threatening heat stroke (NIOSH, 2016; Heinzerling et al., 2020).[10] Heat stress can occur due to overexposure or physical overexertion relative to an individual's age and physical well-being in the existing thermal environment (Gubernot, Anderson, and Hunting, 2014). Exposure to extreme temperatures can also cause or exacerbate many other medical conditions (Heinzerling et al., 2020). Workers in non-climate controlled environments or in physically demanding occupations, typically with little ability to respond and adapt to extreme heat conditions on an individual basis, may be particularly vulnerable to heat-related illnesses (Roelofs and Wegman, 2014). Some workers may have difficulty acclimatizing to hot environments (NIOSH, 2016). Furthermore, there is evidence that at high heat levels worker productivity decreases (Axelsson,

[8] As of 2020, only California, Minnesota, and Washington have passed occupational heat-related illness regulations.

[9] Section 3400 of the same Article establishes general requirements around the provision of medical services and first aid in the event of any illness or injury, but preventative measures are covered in other sections.

[10] Definitions of extreme temperatures may vary. The Centers for Disease Control and Prevention defines extreme heat as "summertime temperatures that are much hotter and/or humid than average" (CDC, 2017a).

1974; Seppänen et al., 2006; Park, 2016) and overall cognitive performance declines (NIOSH, 2016; Park et al., 2020).[11] According to NIOSH (2016):

> Heat stress can result in illness, including heat stroke, heat exhaustion, heat syncope, heat cramps, heat rashes, or death. Heat can also increase workers' risk of injuries, as it may result in sweaty palms, fogged-up safety glasses, dizziness, and may reduce brain function responsible for reasoning ability, creating additional hazards.

The annual number of reported occupational heat stress-related incidents in California has increased in both indoor and outdoor workplaces in recent years[12]—the decade from 2010 to 2019 was the hottest on record since modern global surface temperature recording began in 1880 (NASA, 2020). In 2005, Section 3395 of the California Code of Regulations established a heat illness prevention standard for outdoor places of employment. The regulation of indoor workplaces is intended to prevent or significantly reduce illnesses, injuries, permanent disabilities, and deaths related to heat stress from occupational indoor heat exposure.

Proposed Regulatory Action

The proposed regulation sets forth requirements for heat illness prevention in indoor places of employment that reach or exceed a temperature of 82°F when employees are present. The proposed regulation requires additional compliance actions when the temperature or heat index is greater than or equal to 87°F when employees are present, or the temperature or heat index is greater than or equal to 82°F and employees wear clothing that restricts heat removal or work in a high radiant heat work area.[13] Some provisions represent substantive changes to the General Industry Safety Orders, while others simply restate existing requirements unlikely to affect the activities of most indoor establishments. DIR estimates the start date of the proposed regulation will be January 1, 2023 and the rule will be fully implemented by December 31, 2023. This section briefly describes the provisions of the proposed rule, and the additional compliance actions required under certain conditions. The full text of the draft standard is available at:

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[11] Axelsson, Olav, Influence of Heat Exposure on Productivity, Journal of Work, Environment, and Health. 1974; 11: 94–9.

[12] Based on analysis of the Division of Workers' Compensation's Workers' Compensation Information System.

[13] According to the proposed regulation, "clothing that restricts heat removal" means full-body clothing covering the arms, legs, and torso that is any of the following: (1) waterproof; or (2) designed to protect the wearer from a chemical, biological, radiological, or fire hazard; or (3) designed to protect the wearer or the work process from contamination. This excludes clothing with flame or arc-flash resistant properties demonstrated by the employer to be all of the following: (1) constructed only of knit or woven fibers; and (2) worn in lieu of the employee's street clothing; and (3) worn without a full-body thermal or moisture barrier. "'High radiant heat work area' means a work area where the globe temperature is at least 5 degrees Fahrenheit greater than the 'temperature.'" Further, "'Temperature' means the dry bulb temperature in degrees Fahrenheit obtainable by using a thermometer freely exposed to the air without considering humidity or radiant heat, to measure the temperature in the immediate area where employees are located."

https://www.dir.ca.gov/dosh/doshreg/Heat-Illness-Prevention-Indoors/Draft-revisions-Apr-22-2019.pdf.

The proposed regulation states that the following compliance actions are required in all indoor places of employment that reach or exceed a temperature of 82°F when employees are present.

1. **Provision of Water:** Employees shall have access to drinking water free of charge. Where water is not plumbed or continuously supplied, water should be provided in sufficient quantities to provide one quart per employee per hour for each shift. Frequent hydration should be encouraged in training as discussed below.

2. **Access to Cool-Down Areas:** Employers are required to provide one or more cool-down areas at all times. The area must be large enough to accommodate all employees on rest periods comfortably and be as close as practicable to areas where employees work. The temperature in an indoor cool-down area must be maintained at less than 82°F, unless the employer demonstrates it is infeasible. Employees shall be encouraged to take cool-down rests as necessary and monitored as needed for symptoms of heat illness.

3. **Emergency Response Procedures**: Employers shall implement emergency response procedures in the event of heat illness. Employees must be able to easily contact a supervisor or emergency medical service at all times in case of heat illness event. In the instance of heat illness, the employer must be able to render first aid measures onsite or provide access to emergency medical services as required by Title 8 Section 3400.

4. **Close Observation During Acclimatization**: Where no effective engineering controls are in use to control the effect of outdoor heat on indoor temperature, all employees shall be closely observed by a supervisor or designee during a heat wave. For the purposes of this section only, heat wave means any day in which the predicted high outdoor temperature for the day will be least 80°F and at least ten degrees higher than the average daily outdoor temperature in the preceding five days. Additionally, any employee who is newly assigned to work under specified conditions must be observed for the first 14 days of that work. These conditions are:

    - Work in an area where the temperature or heat index is at or above 87°; or
    - Work involving the use of clothing that restricts heat removal where the temperature is at or above 82°F; or
    - Work in a high radiant heat work area where the temperature is at or above 82°F.

5. **Training**: Employers shall provide employee training about heat illness to all employees. Training should include information about the different types of heat illnesses and the employer's procedures for complying with the requirements of this regulation.

Supervisors shall receive extra training in order to train employees, monitor employees and weather, and implement emergency response procedures.

6. **Heat Illness Prevention Plan**: The employer shall establish, implement, and maintain an effective heat illness prevention plan (HIPP). The plan shall be written in English and any other language understood by the majority of employees. The plan must be made available at the worksite to employees. The plan must contain the requirements set forth in this regulation.

Additional compliance actions are required under the following conditions: (a) the temperature (or heat index) is greater than or equal to 87°F when employees are present or (b) the temperature is greater than or equal to 82°F and employees wear clothing that restricts heat removal or work in a high radiant heat work area. These compliance actions include:

7. **Assessment:** The employer shall be responsible for measuring and maintaining records of temperature or heat index, whichever is greater, when it is reasonable to suspect that the above conditions apply. Measurements shall be taken again when they are expected to be 10 degrees or more above previous measurements. Records shall be kept for 12 months or until the next measurements are taken (whichever is later). Employers have the option of simply assuming the temperature or heat index exceeds the minimum thresholds in lieu of taking measurements and maintaining records if they implement adequate control measures.

8. **Control Measures**: The employer is required to use control measures in order to reduce the risk of heat illness. These controls include engineering or administrative controls, or the use of personal heat-protective equipment.

Major Regulation Determination

Senate Bill 617 (Stats. 2011, Ch. 496) requires state agencies to conduct a standardized regulatory impact assessment (SRIA) for major regulations. A major regulation is any proposed rulemaking action adopting, amending, or repealing a regulation that will have an economic impact (cost or benefit) on California business enterprises and individuals in an amount exceeding $50 million in any single year (or in the first 12 months after the regulation is fully implemented), computed without regard to any offsetting benefit (or cost savings) or cost that might directly or indirectly result from that action.

The proposed rulemaking has been determined to be a major regulation because the economic impact of the regulation in California is estimated to exceed $50 million in each year (both in terms of costs and benefits, separately) after the rule is finalized. The impacts are the result of direct costs associated with compliance with the indoor heat illness prevention

requirements and monetized benefits in terms of avoided illnesses, injuries, permanent disabilities, deaths, and productivity losses to individuals and businesses within the state.

Public Outreach and Input

Cal/OSHA staff conducted extensive public outreach on the indoor heat illness prevention regulation and received many public comments from stakeholders. From February 2017 through February 2018, Cal/OSHA held three advisory committee meetings that were open to the public to develop a proposed regulation for minimizing heat-related illness among workers in indoor places of employment. Representatives from industry, labor, and advocacy groups as well as government agencies and health and safety experts participated and provided input. In addition, Cal/OSHA presented eight discussion drafts and solicited comments from stakeholders on the drafts. All discussion drafts and minutes from the advisory committee meetings are posted on Cal/OSHA's website. Cal/OSHA conducted numerous additional meetings with stakeholders, both in person and by phone. These meetings provided additional opportunities for stakeholder comments, as well as for the solicitation of alternatives to the proposed regulation. Cal/OSHA staff incorporated feedback it received from stakeholders as the draft regulation was being developed.

2. Baseline Information

In this SRIA, the economic impacts of the proposed regulation are estimated relative to the status quo, or a *no regulatory action* baseline. This baseline represents the world "as is" under the current legal and regulatory framework for California businesses. That is, we assume businesses are already incurring costs related to protecting employee safety and health as required by existing regulations. This includes actual and anticipated trends that are not directly related to the proposed regulation. This section provides an overview of business enterprises and individuals that may be affected by the proposed indoor heat illness prevention regulation.

The proposed regulation identifies a number of conditions that would engender requirements for heat illness prevention, such as the temperature or heat index exceeding a regulatory threshold in an indoor working environment. Unfortunately, sufficient data are not available to identify all potentially regulated business enterprises and individuals. In the absence of detailed information on individual employees' occupational exposure to heat stress, we identify affected establishments and employees using a combination of industry and occupation data along with the expert judgment of Cal/OSHA staff. We define an establishment as a single business location. Businesses may own or operate more than one establishment.

We developed a three-tier classification system to categorize industries based on the likelihood that employees are exposed to temperatures (or a heat index) at or above the regulatory thresholds. In Type 1 industries there is generally an indoor heat source – such as a furnace, kiln, or stove – or a greenhouse and a portion of the workforce is likely exposed to hot indoor work environments. In Type 2 industries there is a mix of establishments, some of which may expose workers to hot indoor work environments depending on the establishment's location, whether or not the work takes place indoors, and whether or not the workplace is climate controlled. In Type 3 industries, most employees generally work outdoors or in climate controlled indoor work environments. Type 3 industries are unlikely to be affected by the proposed regulation.

We define Type 1 industries as those that are likely to have environments where some employees are potentially exposed to temperatures at or above the 82°F threshold. We assume the majority of establishments in Type 1 industries have an indoor heat source in the workplace, such as in restaurants and most types of manufacturing. However, in other Type 1 industries, such as greenhouses, nurseries, and warehousing and storage, the temperature inside the establishment is significantly affected by the temperature and amount of sunlight outside the establishment. Within each Type 1 industry, not all employees will be affected, as there are different job types and exposure risks in each industry. Manufacturing, for example, typically has management personnel, administrative staff, and other staff that are likely to work inside climate-controlled offices and not be affected. In the absence of specific industry data about the

number of employees who are likely exposed to temperatures at or above the regulatory thresholds, we assume that 40 percent of employees in each Type 1 industry are potentially affected, with one exception: for warehousing and storage, we assume that 80 percent of employees are potentially affected.[14]

We define Type 2 industries as those that are likely to have some but not all establishments covered by the standard, depending either on the establishment's location (i.e., climate), existing engineering controls (e.g., air conditioning or local exhaust ventilation), and whether or not work takes place indoors. Certain industries, such as wholesalers, delivery services, and building construction contractors, have heterogeneous exposure risks. For example, some vehicles have air-conditioning, while others do not, and employees could be at risk of being exposed to temperatures at or above the regulatory threshold. Without specific industry data about the number of establishments that are located in warm climates, have indoor workers, and do not have existing engineering controls, we assume that 50 percent of establishments in Type 2 industries are likely to have indoor environments where employees are exposed to temperatures at or above the threshold.[15] We assume the same percentage of employees (40 percent) is affected in Type 2 industries as in Type 1 industries.[16] This includes employees who are potentially exposed to temperatures at or above the threshold while operating vehicles.

We define Type 3 industries as those that are likely to have very few establishments and employees affected by the proposed regulation, thus they are not included in this analysis. Most employees in Type 3 industries work either outdoors or in air-conditioned environments.

We estimate the universe of business establishments and individuals potentially subject to the proposed regulation using data from the California Employment Development Department and the judgment of Cal/OSHA staff on work activities in heat-exposed indoor workplaces. We validated the selection of affected industries using worker survey data from the U.S. Department of Labor-sponsored O*NET Online.[17] We identified occupations that reported working indoors in non-controlled environmental conditions at least once per week. We then cross-referenced these occupations to 6-digit North American Industry Classification System (NAICS) codes and identified how those industries had been categorized in our classification system. Of the 288 industries that had some fraction of their workforce report working indoors in non-controlled

[14] These estimated percentages are based the judgement of Cal/OSHA staff and information provided by industry in public comments in response to the draft regulation.

[15] Based on the judgement of Cal/OSHA staff.

[16] This implies that 40 percent of employees in Type 1 industries (80 percent of employees in warehousing and storage) are affected and 20 percent of employees in Type 2 industries are affected.

[17] Accessed at https://www.onetonline.org on June 1, 2021.

environmental conditions at least once per week,[18] approximately 20 percent fell in our Type 1 category, 16 percent fell in our Type 2 category, and 64 percent fell in our Type 3 category. Although the number of 6-digit NAICS codes falling in the Type 3 category was large, two factors reduce our concern of omitting affected industries. First, working indoors in non-climate controlled environmental conditions does not necessarily mean the worker is exposed to extreme heat. Second, the O*NET industries that fell into the Type 3 category were generally not associated with indoor heat. Some were associated with outdoor heat, such as a wide variety of agricultural and construction NAICS codes. Others were associated with occupations that typically work in indoor or enclosed environments that are climate controlled, such as retail stores, the transportation industry, elder and childcare facilities, health and education activities, and a variety of office-based employment. None of the industries we had categorized as Type 1 or Type 2 were excluded in the O*NET survey. Overall, we concluded that the originally selected industries remained the appropriate selection.

Table 1 shows the breakdown of affected establishments and employees by 2-digit NAICS code. We estimate there are approximately 196,000 Type 1 and 2 industry establishments and approximately 1.4 million employees in California potentially impacted by the proposed regulation.[19] This represents approximately 12 percent of all establishments and approximately 8 percent of all employees in California.

Based on public comments submitted on the draft regulation and additional industry input, we estimate that a significant percentage of the regulated universe has extensive prior experience with heat illness prevention. Specifically, we identified two groups currently implementing a range of mitigation efforts: 1) business enterprises with outdoor workers that have already undertaken measures to comply with Section 3395 and 2) indoor establishments with a long-history of working with "hot" processes (e.g., manufacturing and restaurants) that rely on exiting federal guidance and regulations [e.g., Occupational Safety and Health Administration (OSHA), Food and Drug Administration, NIOSH], industry standards (e.g., ASTM International), and other best practices. For these two groups, we assume 80 percent of establishments have existing measures in place that adhere to the requirements of the proposed regulation, while the

[18] Respondents to the O*NET survey were asked "*How often does this job require working indoors in non-controlled environmental conditions (e.g., warehouse without heat)?*" Respondents measured their frequency of working in an indoors, not environmentally controlled environment on a scale from 1 to 5. Survey anchors were provided indicating 1 is Never, 2 is Once a year or more but not every month, 3 is Once a month or more but not every week, 4 is Once a week or more but not every day, and 5 is Every day. We identified Standard Occupational Classification (SOC) codes where the average response was 4 or higher. We were unable to find a California-specific crosswalk between SOC occupations and NAICS codes, and thus used a national-level crosswalk.

[19] This estimate is based on 179 NAICS codes (at the 4-digit level) identified by Cal/OSHA staff as (1) industries likely to have indoor work environments where employees are exposed to temperatures at or above 82°F due to an indoor radiant heat source, greenhouse, or non-climate controlled facility (e.g., warehouse), or (2) industries likely to have some but not all establishments affected due to climate, geographic, or locational factors. These industries are indicated in Table 1.

remaining 20 percent of establishments will have to take additional steps to comply.[20] Our analysis found that the majority of employers in California have already made investments in air-conditioning or ventilation systems, or rely on natural ventilation or other control measures, on a voluntary basis to reduce heat-related illness and productivity losses. The pre-existing adoption of control measures in many industries, which is accounted for in this analysis, suggests that many employers may view the benefits to their business as exceeding the cost of undertaking those measures. Employers that already have adequate existing measures that comply with the proposed regulation are assumed to incur no incremental costs relative to the *no regulation action* baseline. These industries are indicated in Table 1. For other industries, we assume that 80 percent of establishments will have to take additional steps to comply with the proposed regulation.[21]

[20] Industry representatives we spoke with indicated that a vast majority of establishments in some industries have existing control measures in place – given context and feedback from industry, we assume a "vast majority" means between 70 and 90 percent of establishments. We use 80 percent as a primary estimate for this report, but also present a sensitivity analysis using low-end and high-end estimates. Note that we assume all establishments will have to train some or all workers on the new requirements. However, only a subset will likely incur additional costs, such as investments in engineering controls.

[21] Based on the judgement of Cal/OSHA staff and industry input. Given uncertainty regarding estimates of the number of affected establishments, we present a sensitivity analysis around these estimates.

Table 1. Potentially Regulated Establishments and Employees by Industry

NAICS	Description	Affected Industries	Total Affected Establishments	Total Affected Employees
Type 1 Industries				
11	Agriculture, Forestry, Fishing and Hunting	NAICS 1114	1,060 (a)	10,778
31-33	Manufacturing	NAICS 311-314, 3151, 3159, 316, 321-327, 331-333, 3352, 3353, 3359, 3363, 3364, 3365, 3366, 3369, 337, 339	37,090 (a)	391,388
48-49	Transportation and Warehousing	NAICS 4931	2,236	133,550
72	Accommodation and Food Services	NAICS 7223, 7225	78,277 (a)	574,455
81	Other Services (except Public Administration)	NAICS 8123	3,744	13,932
Subtotal: Type 1 Industries			**122,407**	**1,124,103**
Type 2 Industries				
11	Agriculture, Forestry, Fishing and Hunting	NAICS 1121, 1122, 1123, 1124, 1125, 1129	1,284 (a)	5,643
21	Mining, Quarrying, and Oil and Gas Extraction	NAICS 2111, 2121, 2122, 2123	190 (a)	2,002
22	Utilities	NAICS 221	587 (a)	10,052
23	Construction	NAICS 2361, 2362, 2371, 2383	22,876 (a)	80,025
31-33	Manufacturing	NAICS 3152, 3361, 3362	1,357 (a)	11,115
42	Wholesale Trade	NAICS 423, 4241, 4243, 4245, 4246, 4247, 4249	22,995	96,687
44-45	Retail Trade	NAICS 4442, 4541	3,278	12,839
48-49	Transportation and Warehousing	NAICS 484, 4851, 4852, 492	7,892 (a)	54,625
56	Administrative and Support and Waste Management and Remediation Services	NAICS 5622, 5629	693 (a)	6,199
81	Other Services (except Public Administration)	NAICS 811	12,520	31,730
Subtotal: Type 2 Industries			**73,669**	**310,917**
TOTAL			**196,076**	**1,435,020**

Source: California Employment Development Department (EDD) Labor Market Information Division, Quarterly Census of Employment and Wages (QCEW), 2019 annual data, as of December 15, 2020.
Note: (a) indicates industries in which a majority of establishments are likely to have existing heat illness prevention measures (e.g., engineering controls) in place, based on discussions with industry. Totals may not sum precisely due to rounding.

Impacts of COVID-19

This analysis primarily relies on data collected prior to the start of the coronavirus disease 2019 (COVID-19) pandemic. The long term consequences of COVID-19 on the California labor market and the impact on establishments affected by the proposed regulation are uncertain. One

source of uncertainty is whether the higher number of voluntary and involuntary separations seen in 2020 will persist. Based on BLS data from the Job Openings and Labor Turnover Survey (JOLTS) program, separations reached an all-time high and the annual new hires rate was 52.2 percent for the western United States in 2020.[22] Nationwide, one in six workers lost their jobs in the first months of the pandemic (Armour et al., 2020).[23] Sustained high levels of turnover could put more new workers at risk of heat-related illness and would require employers to train more new employees on safety procedures, personal risk factors for heat illness, and identifying signs and symptoms of heat illness and to closely observe those workers during acclimatization to new work assignments. However, for this analysis we anticipate labor turnover rate will return to historic levels over the next few years.

Changes in work conditions stemming from reducing in-person interactions to limit the spread of COVID-19 may also reduce the number of employees working in hot indoor work environments during some shifts, but it is unclear to what extent this will impact establishments affected by the proposed regulation. We note that telecommuting is not feasible in many industries included in the Type 1 and Type 2 categories described in this report. For example, in May 2020 employees in production occupations and construction/extraction occupations had only three percent of workers telecommuting exclusively (Armour et al., 2020). While nationwide rates of telecommuting increased significantly in 2020, they did to a much lesser extent in the industries affected by the proposed regulation. Establishments that could not transition to remote work may have turned to alternative measures to meet social distancing requirements, such as staggering shifts. Employees that work during cooler periods of the day, such as the early morning or late evening, may be at lower risk for heat illness. The extent to which these measures were adopted and how long they will persist after workplace restrictions are lifted is uncertain.

Interaction with Other Laws, Regulations, or Policies

In 2012, the California Public Utilities Commission (CPUC) ruled that California Public Utilities Code Sections 451 and 399.2(a) give electric utilities authority to shut off electric power in order to protect public safety (CPUC, n.d.). This allows energy companies to shut off power to prevent wildfires where strong winds, heat events, and related conditions are present. CPUC adopted the current set of Public Safety Power Shutoff guidelines on June 5, 2020 (CPUC, 2020). During some events, the CPUC's Resolution authorizing continued de-energization events

[22] U.S. Bureau of Labor Statistics, Table 14. Annual Hires Rates by Industry and Region, Not Seasonally Adjusted, last updated March 11, 2021.

[23] According to an analysis using the RAND American Life Panel, 44 percent of non-employed workers surveyed in May 2020 were laid off, furloughed, or on unpaid leave (Armour et al., 2020). Additional reasons for not working included inability to work due to coronavirus restrictions, being at high risk for coronavirus complications, childcare, and being on paid leave.

across the state may lead to electrical power for some employers being shut off, which may make it difficult for those employers to comply with the proposed indoor heat illness prevention regulation.

DIR has taken steps to minimize potential interactions between the regulations. For example, an employer can demonstrate that during a CPUC de-energization, use of engineering controls is not feasible (including in indoor cool-down areas). In addition, Cal/OSHA listened to stakeholder's concerns that having the regulation apply when the temperature reaches 80°F would go counter to companies' efforts to apply their energy conservation programs, thus the proposal was modified to apply when the temperature reaches 82°F.

Similarly, the proposed regulation provides several options with regards to engineering controls to reduce occupational heat exposure. Engineering controls are not limited to air conditioning/mechanical ventilation, but may include isolation of hot processes, isolation of employees from sources of heat, cooling fans, cooling mist fans, evaporative coolers (also called swamp coolers), natural ventilation where the outdoor temperature or heat index is lower than the indoor temperature or heat index, local exhaust ventilation, shielding from a radiant heat source, or insulation of hot surfaces.

3. Direct Costs

The direct costs of the proposed indoor heat illness prevention regulation that would be borne by employers include investments in mitigation efforts, including engineering and administrative controls, workforce training, development of a written HIPP, and other compliance activities by business enterprises operating in California. The quantified direct costs of the proposed regulation are estimated across several provisions of the rule relative to the status quo or *no regulatory action* baseline described in Chapter 2. Specifically, the total direct costs to industry are calculated on an incremental basis relative to "business as usual" costs, including activities California business enterprises are already undertaking to prevent heat illness.

There are many different ways for employers to comply with the proposed regulation. Due to a lack of available data on specific measures for individual establishments, the cost estimates reported here are based on assumptions that represent methods that we believe a majority of employers would choose to achieve compliance. Furthermore, given a range of options, we believe employers are likely to use the lowest-cost option where feasible. The assumptions underlying the direct cost estimates are detailed in the following sections.

General Cost Assumptions

As a general approach we model the costs (and benefits) of the proposed regulation on a year-by-year basis, assuming that all upfront costs (and benefits) will be incurred in the first twelve months of the regulation and recurring costs (and benefits) will be incurred in subsequent years. In cases where equipment or materials need to be repaired or replaced, for simplicity, we assume all employers will incur those costs at the same time (e.g., if the life expectancy of an evaporative cooler is five years, we assume all employers will repair/replace the unit five years after the initial purchase or installation). In reality, employers will have different purchasing patterns based on their specific need and use of engineering controls and other equipment. Hence, throughout the text of the report we often report costs (and benefits) on an annualized—or average annual—basis. In various tables throughout the report, we also report costs (and benefits) year by year to illustrate the anticipated timing of economic impacts.

This SRIA relies on several assumptions that affect the estimated costs of compliance with the proposed regulation. Some of these assumptions affect several components of the analysis. These include assumptions regarding the following: (1) hourly labor costs, (2) heat hazard frequency, and (3) the discount rate. These assumptions are outlined in detail below.

Hourly Labor Costs

The potential direct cost impacts include the time required of production employees and supervisors to undertake preventative measures to reduce the risk of heat illness, including

developing, conducting, and participating in safety trainings, assessing risk factors, and taking additional rest breaks. The labor cost assumptions are based on the mean hourly wage rates reported by the U.S. Bureau of Labor Statistics (BLS) for a full time employee working 40 hours a week multiplied by a wage rate factor of 1.50.[24] The hourly wage rate adjustment factor is based on the BLS Employer Costs for Employee Compensation, a product of the National Compensation Survey, for civilian workers in "production, transportation, and material moving" industries and accounts for fringe benefits (e.g., paid leave, insurance, retirement and savings, etc.).[25] The fully-loaded labor cost is approximately $30/hour for production workers and $50/hour for first-line supervisors of production and operating workers.

Heat Hazard Frequency

The direct costs of the proposed regulation are affected by the frequency and duration of occupational heat exposure. Employers will need to adopt control measures and employees will need take additional breaks when the temperature or heat index exceeds the specified regulatory thresholds. There are no industrywide average heat index data for indoor places of employment. Therefore, to estimate the number of days that employers will need to undertake compliance actions we rely on future projections of the number of extreme heat days provided by the Centers for Disease Control and Prevention's (CDC) National Environmental Public Health Tracking Network (NEPHTN). The data were obtained from the United States Geological Survey's (USGS) Thematic Realtime Environmental Distributed Data Services (THREDDS).[26] We use the projected number of days exceeding 90°F (in the low emission scenario) in 2025 as a proxy for extreme heat days in the first ten years after the implementation of the proposed regulation—we note the higher temperature threshold in the proposed regulation is 87°F in indoor places of employment.[27] Figure 1 shows the projected number of extreme heat days by county.

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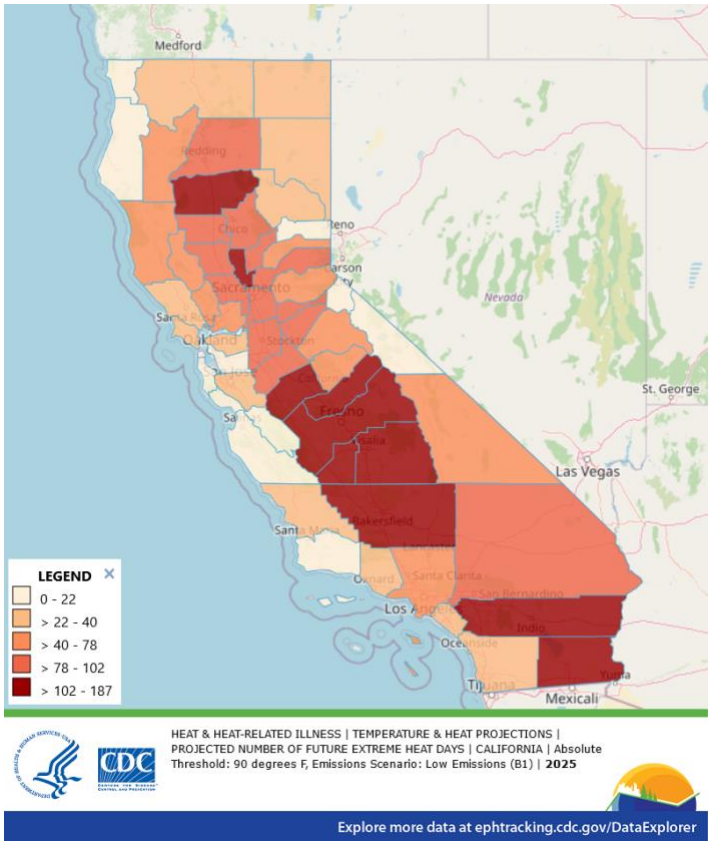
[24] BLS May 2019 State Occupational Employment and Wage Estimates for California. https://www.bls.gov/oes/2019/may/oes_ca.htm

[25] BLS December 2020. Table 2. Employer Costs for Employee Compensation for Civilian Workers by Occupational and Industry Group.

[26] County-level estimates are obtained by processing modeled temperature data, which are available by 1/8th degree grid, from 1/8 degree-CONUS Daily Downscaled Climate Projections by Katharine Hayhoe. Documentation accessed on April 30, 2021 at https://cida.usgs.gov/thredds/catalog.html?dataset=cida.usgs.gov/thredds/dcp/conus_t.

[27] Temperature can vary considerably within counties, particularly for large or coastal counties. We examine temperature at the county level in order to match county-level employment data. Some industries may tend to be located in hotter inland areas due to lower land prices, while others may tend to be located in cooler coastal areas for convenient access to ports or dense urban areas.

Figure 1. Projected Number of Future Extreme Heat Days in California, Absolute Temperature 90°F Threshold, Low Emissions Scenario, by County (2025)



Source: Centers for Disease Control and Prevention, National Environmental Public Health Tracking Network, accessed April 30, 2021 at https://ephtracking.cdc.gov/DataExplorer.

Based on these data, we estimate the number of days each year that temperatures are likely to exceed the regulatory thresholds.[28] We estimate there are 52 days each year, on average, statewide where the maximum outdoor temperature will exceed 90°F. Since future projections were not available for other temperature thresholds, we rely on historical heat index data to estimate the number of days that are likely to exceed the lower threshold in the proposed regulation. From the CDC's NEPHTN we used county-level modeled temperature and humidity data obtained from National Aeronautics and Space Administration's (NASA) North American Land Data Assimilation System (NLDAS). Using these data, we estimate that there are an additional nine days each year, on average, statewide where the outdoor heat index equals or exceeds 82°F but does not exceed 90°F.

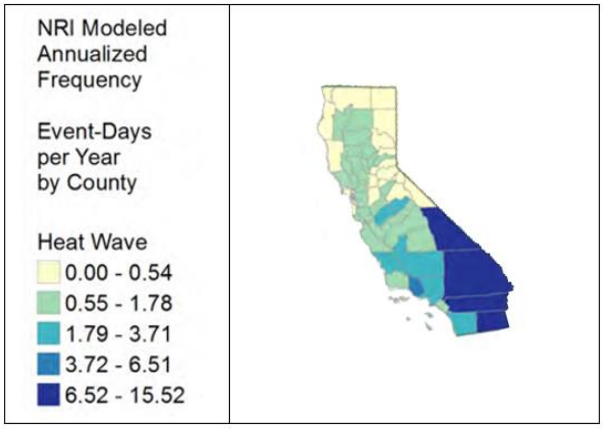
Most establishments in Type 1 industries are likely to have additional factors contributing to indoor heat levels, such as a radiant heat source or a greenhouse. Therefore, we assume

[28] We calculate a weighted average estimate based on the number of affected establishments in each county. We obtained similar results using the average number of workers in each county.

employers will take additional compliance actions on a statewide average of approximately 61 days per year in Type 1 industries and 52 days per year in Type 2 industries. While these estimates are somewhat imprecise as they do not measure heat stress, we believe they are a reasonable proxy for days of occupational exposure to extreme heat conditions. Specifically, they are consistent with input provided from affected industries that the majority of actions they already undertake to prevent heat-related illness occur between May and September. Heinzerling et al., (2020) also show that incidents of heat-related illness in California tend to peak between June and August.

The proposed regulation requires preventative measures for acclimatization during new assignments and heat waves. A lack of proper training, experience in a particular job, or acclimatization can contribute to an increased risk of heat-related illness (Maeda et al., 2006; Gubernot et al., 2014). Heinzerling et al. (2020) found that nine percent of California workers' compensation claims for heat-related illness occurred within the first two weeks of hire. Population-level studies have also found higher mortality rates due to heat exposure during early summer heat waves when workers were less acclimated (Anderson and Bell, 2011). We estimate the number of heat waves using the Federal Emergency Management Agency's (FEMA) National Risk Index (NRI). The NRI is a dataset that helps identify communities most at risk for natural hazards (FEMA, 2020a). For example, the NRI measures the risk of heat waves in annualized "event days" by county or census block. Historical heat wave information is compiled from National Weather Service (NWS) weather alerts. The archived NWS alerts are aggregated, updated, and published in shapefile format by Iowa State University's Iowa Environmental Mesonet (FEMA, 2020b). The historical period for the NRI heat index is November 12, 2005 to December 31, 2017—approximately 12.1 years. The NRI calculates an annualized frequency of heat wave events in California that ranges from 14.4 days in Imperial County and 9.0 days in San Bernardino County to less than 0.01 days in Mono County. Using an industry-based population-weighted average, we estimate that California workplaces experience an average of approximately 3 heat wave event days per year. Figure 2 shows the annualized frequency of heat wave event days by county in California.

Figure 2. Annualized Frequency of Heat Wave Event Days by County



Source: FEMA, National Risk Index Technical Documentation, December 2020, p. 12-10.

Discount Rates

This SRIA reports the direct cost impacts of the proposed regulation over a 10-year period, from 2023 to 2032. Since benefits and costs are not always incurred during the same period, the difference in timing is considered in this analysis. The primary rationale for discounting future benefits and costs is that (a) costs incurred today are more expensive than future costs because businesses must forgo an expected rate of return on investment of that capital and (b) individuals generally prefer present benefits to future ones (OMB, 2003). The Office of Management and Budget recommends that federal agencies use discount rates of 3 percent and 7 percent for regulatory analysis. For simplicity, we report the details of the cost analysis on an undiscounted basis (i.e., using a zero percent discount rate). However, we evaluate the net impact of the proposed regulation using different discount rates to reflect potentially significant differences in the timing of benefits and costs.

Overview of Compliance Actions

The proposed regulation is expected to result in several categories of incremental compliance costs relative to the baseline. There are two general regulatory thresholds in the proposed regulation. If the temperature in the indoor environment is greater than or equal to 82°F when employees are present, a certain set of compliance actions is required (all of which are similar to requirements to prevent outdoor heat illness), including:

- Providing employees with adequate water
- Providing employees with cool-down areas
- Emergency response procedures
- Increased observation of employees during heat waves and new work assignments
- Employee heat illness training

- Developing a HIPP

Additional compliance actions are required if the indoor temperature or heat index equals or exceeds 87°F when employees are present, or the temperature or heat index equals or exceeds 82°F and employees wear clothing that restricts heat removal or work in a high radiant heat work area. When any of these thresholds are reached, additional compliance actions are required, including:

- Undertaking measurement and assessment activities or assuming temperature thresholds are exceeded; and
- Instituting feasible engineering and/or administrative control measures, or providing personal heat-protective equipment

Compliance Actions for Temperatures at or above 82°F

As described above, this analysis estimates the cost of compliance for business enterprises where employees in indoor workspaces are exposed to temperatures at or above the regulatory thresholds.

Water Provision

This requirement mandates the provision of potable drinking water free of charge for all employees. If water is not plumbed or continuously supplied, the regulation calls for water to be provided in sufficient quantities (one quart per employee per hour for each shift). Existing regulations, including Sections 1524, 3363, and 3457, require that an adequate supply of potable water shall be provided in all places of employment. In addition, the water must be located as close as practicable to the areas where employees work, and in indoor cool-down areas. In cases where the employer has to provide additional water to meet the requirements of this regulation, such as in an indoor cool-down area, tap water can be used to meet this requirement. Employers may provide outdoor cool-down areas, which are not subject to the new requirement for water provision.

As described in Chapter 2, we assume that approximately 80 percent of establishments in industries with broad heat illness prevention measures already in place and 20 percent of establishments in industries less likely to have mitigation measures already meet this requirement (see detail in Table 1). Therefore, we estimate that approximately 34 percent of establishments affected by the proposed regulation will have to take additional steps to comply. Of these, we assume 50 percent are likely to provide outdoor cool-down areas due to indoor space constraints or other factors and will not be subject to the requirement for water provision. Thus, overall, we estimate that 17 percent of establishments—approximately 33,000 establishments—will be impacted by the water provision requirement.

Based on industry input, we assume the vast majority of these businesses already have an adequate supply of potable water but may need to take steps to ensure additional water stations

are set up in indoor cool-down areas located near certain work areas. For these establishments, we estimate that the most cost-effective option is to purchase 5-gallon water coolers (or a similar product) and provide paper cups (or reusable water bottles).[29]

Based on a review of manufacturer list prices, we estimate the average cost of a water cooler is approximately $45. Based on discussions with industry, we assume this would need to be replaced about every three years. Employers would also have to purchase paper cups or provide reusable water bottles. We assume each worker would use an average of 4 paper cups per shift for 260 workdays per year, or approximately 1,040 cups per year. Based on a list of vendor prices, the average cost of a paper cup is approximately $0.03. Therefore, the average estimated cost of paper cups (or a single reusable water bottle) is about $30 per employee per year. The typical establishment would have to provide water for approximately seven additional workers near their workspace (up to 15 gallons of water per day). Thus, for the affected establishments the estimated costs of water provision are approximately $280 in 2023 and $220 in each subsequent year, which includes the annualized cost of replacing water coolers.

Cool-Down Areas

This provision requires employers to provide cool-down areas for employees. If the cool-down area is indoors, the temperature must be maintained below 82°F, where feasible. An outdoor area may also serve as a cool-down area if it meets specified requirements. Based on information provided by trade organizations potentially impacted by the proposed regulation, we estimate that approximately 66 percent of establishments already have designated break rooms or outdoor shaded areas that meet this requirement while the remaining 34 percent of establishments will have to designate a cool-down area. Based on the judgement of Cal/OSHA staff, we assume that 50 percent of the remaining affected establishments will provide indoor cool-down areas. We assume that 67 percent of establishments in California—excluding offices, health providers, schools, and restaurants—have air-conditioning (Itron, Inc., 2014) and thus 67 percent of 50 percent of establishments that provide indoor cool-down areas or 33.5 percent of all remaining affected establishments will incur no additional costs beyond designating a break area (a *de minimis* cost). We estimate the remaining 16.5 percent of establishments that will provide indoor cool-down areas—approximately 10,900 establishments—will need to purchase an air-conditioning unit or evaporative cooler. Based on a review of manufacturer list prices, we estimate the average cost of a cooling unit is approximately $300. Based on industry comments, we assume this unit would need to be replaced about every five years.

We assume that 50 percent of the remaining affected establishments will provide an outdoor cool-down area. Of these establishments, we assume that half will meet the specified requirements by designating a shaded outdoor area in compliance with Section 3395. The

[29] Some employers noted that they would purchase plastic water bottles and ice buckets or use a water delivery service during the summer months. We assume these measures would be slightly more expensive.

remaining 50 percent of establishments that designate outdoor cool-down areas—approximately 16,500 establishments—will need to purchase a shade structure. Based on a review of manufacturer list prices, we estimate the average cost of a shade tent is approximately $120. We also assume this structure would need to be replaced about every five years.

In addition, in excessive heat conditions the affected establishments that are not already mandating them would have to provide preventative cool-down rest breaks. As a proxy for excessive heat conditions, we estimate the number of extreme heat days using information from the CDC's NEPHTN. On average, we estimate there will be about nine days per year statewide where the outdoor heat index equals or exceeds 82°F but does not exceed 90°F based on the geographic distribution of establishments in California affected by the proposed regulation.[30] On these days, we assume that each affected employee and supervisor will take one preventative 10-minute cool-down rest break per eight-hour shift (about 1.5 hours per employee per year). We assume each establishment has at least one supervisor or a minimum of one supervisor for every ten employees. Based on BLS data, we assume the average hourly labor cost is $30/hour for employees and $50/hour for supervisors.

For the affected establishments, we estimate the average cost of compliance with this provision varies by industry ranging from approximately $300 to $1,000 per establishment in most industries to $3,300 per establishment in warehousing and storage (which typically has many employees) in 2023. The recurring costs in subsequent years range from approximately $200 to $900 in most industries to $3,100 in warehousing and storage.

Emergency Response Procedures

This provision requires employers to implement emergency response procedures during incidents of employee heat illness, which are nearly identical to the emergency response procedures in the outdoor heat standard.[31] This includes allowing employees to easily contact a supervisor or emergency medical services and for the employer to provide first aid and/or emergency medical services in accordance with the employer's procedures. Since employers are already required under Section 3400 to provide first aid or other prompt medical treatment, we assume business enterprises will incur no additional costs to comply with this requirement. We assume that managers will be able to contact emergency services using existing technologies, such as a landline or mobile phone.

[30] We note that, to avoid double-counting, later in this chapter we separately estimate the impact of additional compliance actions required under subsection (e)(2) when the indoor temperature exceeds the higher of the regulatory thresholds.

[31] Preventing heat illness may create additional benefits for employers by reducing the number of heat-related incidents that require emergency response procedures that may disrupt productivity; however, these benefits are not estimated in this report. Health and productivity impacts are described in further detail later in this report.

Observation During Acclimatization

This provision requires employees to be observed by a supervisor or designee during a heat wave or under a new work assignment when exposed to a specified temperature threshold. The primary compliance activity involves employee observation by a supervisor. We assume this responsibility falls within the standard job description of a supervisor, or alternatively could be performed by another employee, using the buddy system. Therefore, we assume no additional costs will be incurred to comply with this requirement.

Training

This provision requires employers to provide heat illness training to all employees. The training must include information about (a) the environmental and personal risk factors for heat illness; (b) the different types of heat illnesses, the common signs and symptoms of heat illness, and appropriate first aid and/or emergency response; (c) the importance of frequent consumption of small quantities of water in hot work environments; and (d) the employer's procedures for complying with the requirements of the standard for indoor places of employment. Employers that have employees covered by Section 3395 will have already developed training materials that cover some of the same topics as the training requirements are similar. Furthermore, employees that work both indoors and outdoors should have already received training if their outdoor work is covered by Section 3395.

The first compliance action involves developing training materials and the second involves having staff complete a mandatory training. The direct cost of this compliance action is the opportunity cost resulting from supervisors developing, conducting, and completing the training and other employees taking the training course in lieu of their regular shift work. Therefore, we assume that there are two cost impacts: (1) a one-time cost for preparing training materials and administering the initial training and (2) a recurring cost for training new hires during their first year of employment. We assume most businesses will develop and deliver training courses in-house, which is likely the most cost-effective option for many employers. Some smaller firms may choose to outsource this activity to a third-party company that specializes in occupational safety and health training.

For industries that are unlikely to have outdoor work areas covered by Section 3395, we assume developing training materials will require about 1.5 hours of a supervisor's time. We assume that the training will take approximately 30 minutes to administer and separate trainings will be provided to employees and supervisors, requiring an additional 1 hour of a supervisor's time to conduct them. The additional supervisor training will cover implementing provisions of the regulation, monitoring employees for signs or symptoms of heat illness, and implementing emergency response procedures.

Since the indoor heat training requirements are similar to the requirements under Section 3395, we anticipate many employers with outdoor workers will already have training materials

they can use to provide trainings to indoor workers. We assume that industries in which a majority of establishments have outdoor workspaces already prepare training materials and train supervisors. We further assume that the incremental burden for training indoor employees will be half of that for other industries as some employees that work both indoors and outdoors will have already received training.

Both employees and supervisors will be required to take a heat illness training course. We assume each establishment has at least one supervisor or a minimum of one supervisor for every ten employees. Based on BLS data, we assume the average hourly labor cost is $30/hour for employees and $50/hour for supervisors. Furthermore, we assume that all new hires—employees and supervisors—resulting from growth or employee turnover will need to be trained on an ongoing basis. Based on BLS JOLTS data, the annual new hires rate was 45.2 percent for the western United States in 2019.[32] Therefore, we estimate the total cost of training for each establishment varies by industry, ranging from approximately $50 in certain service sectors to $1,100 in warehousing and storage (which typically has many employees) in 2023 and ranging from approximately $20 to $400 in subsequent years.

Heat Illness Prevention Plan

This provision requires employers to establish a written HIPP that contains the requirements and responsibilities of the employer. The direct cost of this compliance action is the opportunity cost of a manager or supervisor's time to create the HIPP. Model HIPPs are freely available from Cal/OSHA which can assist employers in establishing an HIPP for their facility. Alternatively, some workers' compensation insurance companies and certain trade organizations offer legal services to their members that include assistance in preparing a HIPP. We assume that it will take approximately two hours per establishment to develop a HIPP. Some employers with indoor workplaces are already required to have a HIPP in place under Section 3395 because they also have outdoor workers. In these cases, the HIPP would only have to be amended to include the indoor requirements.

Based on discussions with industry and public comments on the draft regulation, we assume that a percentage of establishments in each industry are likely to have outdoor workers and thus are expected to have a HIPP already in place as required under Section 3395. We assume this percentage is approximately 100 percent for greenhouses and nurseries, mining, and transportation; 75 percent for restaurants, animal production facilities, construction, utilities, and waste management facilities; 25 percent for manufacturing facilities; and zero for other industries. Therefore, we estimate that 51 percent of the regulated facilities—approximately

[32] The new hires rate was 52.2 percent in 2020—however, this was associated with a surge in separations due to COVID-19. Therefore, we rely on the 2019 data, which was more similar to prior years and is more likely to reflect new hiring patterns in future years. U.S. Bureau of Labor Statistics, Table 14. Annual Hires Rates by Industry and Region, Not Seasonally Adjusted, last updated March 11, 2021.

100,000 establishments—will need to prepare a new HIPP, while the remaining employers should amend their HIPP to include requirements for indoor worker (a *de minimis* cost). We assume it would take about two hours to create a HIPP. Based on BLS data, we assume the average hourly labor cost for a supervisor is $50/hour. Thus, we estimate that the average cost of preparing a HIPP is $100 per establishment in the first year after the promulgation of the proposed regulation.

Additional Compliance Actions

As described above additional compliance actions are required if the indoor temperature or heat index equals or exceeds 87°F when employees are present, or the temperature or heat index equals or exceeds 82°F and employees wear clothing that restricts heat removal or work in a high radiant heat work area.

Measurement and Assessment

This requirement mandates that employers measure and record the temperature or heat index when any of the regulatory thresholds at met. Many employers already conduct risk assessments to evaluate heat risk. As described in Chapter 2, we estimate that approximately 80 percent of establishments in industries with broad heat illness prevention measures already in place and 20 percent of establishments in industries less likely to have mitigation measures will already meet this requirement. Therefore, we estimate that 34 percent of regulated facilities—or approximately 66,000 establishments—will have to take additional steps to comply with this requirement. Since there is a requirement to determine the heat index, employers will have to obtain a device capable of measuring humidity. We assume the least expensive option for many employers will be to purchase a simple indoor digital thermometer and humidity gauge. Some industries may elect to use a smart digital thermometer that is linked to a computer, which presents a larger cost. We assume each affected establishment will purchase at least one device and a supervisor will manually measure temperature and relative humidity and record the information as needed. Based on a review of manufacturer list prices, we estimate the average cost of a simple device is $30. We assume each device would need to be replaced about every three years. We note that employers are also permitted to omit measurement and recording of temperatures and heat index if they assume the minimum thresholds are met and implement adequate control measures. Therefore, we assume compliance with this requirement will require 30 minutes of supervisor's time to record the heat index and evaluate environmental risk factors about every three years. Based on BLS data, we assume the average hourly labor cost for a supervisor is $50/hour. Thus, we estimate the average cost of assessment measures is $55 per establishment in 2023 and approximately $18 in each subsequent year on an annualized basis.

Control Measures

This requirement mandates that employers use engineering or administrative control measures or provide personal heat-protective equipment to employees when any of the regulatory thresholds have been reached. The selection of control measures shall be based on the environmental risk factors for heat illness present in the work area. The proposed regulation provides an exception if an employer demonstrates that such controls are infeasible. For example, in certain hot processes unidirectional airflow in an industrial facility may render air-conditioning (which relies on air circulation) an infeasible solution. In other work environments, natural ventilation may provide a practical means to reduce indoor temperatures. Engineering control measures include a variety of physical measures that reduce temperature, including mechanization to cool the air, using evaporative coolers, local exhaust ventilation, air conditioning or cooling fans, or shielding to isolate hot processes.[33] Administrative controls include modified work practices, such as working at cooler times of the day or scheduling additional breaks to reduce exposure to heat. Examples of personal heat-protective equipment include water-cooled garments, air-cooled garments, cooling vests, wetted over-garments, heat-reflective clothing, and supplied-air personal cooling systems.

Type 1 and Type 2 industries may rely on different control measures due to differences in their typical workspaces and operations. In Type 1 industries, the majority of establishments have an indoor heat source in the workplace. In other Type 1 industries, such as greenhouses and nurseries (NAICS 1114) and warehousing and storage (NAICS 4931), the indoor temperature is affected by the temperature and the amount of sunlight outside the workplace. For these industries, we assume employees may be exposed to temperatures at or above the regulatory thresholds on approximately 61 days per year, typically during the summer months. We estimate that approximately 80 percent of establishments in industries with broad control measures already in place and 20 percent of establishments in industries less likely to have extensive control measures in place will already meet this requirement.

For the remaining Type 1 establishments, we assume that 60 percent of establishments will adopt engineering controls, 5 percent will use administrative controls, and 35 percent will provide personal heat-protective equipment.[34] The types of engineering controls required may vary considerably by industry. In Table 2, we provide a range of cost estimates for several representative categories of engineering controls. Based on the distribution of industries and the various types of engineering controls they will adopt we estimate the average cost for an

[33] If engineering controls are effective and reduce indoor temperatures to below 82°F, then an establishment would be exempt from the new requirements of the proposed regulation. While this is a likely outcome for many businesses, we do not assume this to be the case for the purposes of this analysis. The result is that some compliance costs may be overestimated.

[34] In practice, some establishments may need both engineering and administrative controls in order to comply with subsection (e) requirements.

employer will be approximately $440 per employee. Based on industry sources, we assume that most engineering controls have an average life expectancy of five to ten years in industrial settings. Therefore, to estimate costs we assume all affected establishments will purchase the necessary equipment in the first year, but then replacement costs will be evenly distributed between six and ten years after the promulgation of the proposed regulation.

Table 2. Cost Estimates for Various Engineering Controls

Description	Low-end Estimate	High-end Estimate	Number of Affected Employees	Average Cost per Employee
Ventilation hood	$2,000	$6,500	10	$425
Drum blower fan	$800	$2,000	5	$280
Exhaust fan/circulation fan	$800	$1,400	5	$220
Evaporative cooler	$2,000	$4,800	10	$340
5-ton (60,000-90,000 Btu) portable air conditioner	$8,000	$12,000	20	$500

Source: Based on analysis of various manufacturer list prices.

In the relatively rare cases that employers use administrative controls, which tend to be substantially more costly than engineering controls, we assume each employee will take two additional 10-minute cool-down rest breaks per day on 61 workdays each year.[35] The total direct costs will be approximately $1,000 per supervisor (at $50/hour) and $600 per employee (at $30/hour) per year. For work environments where personal heat-protective equipment will provide an effective mitigation measure, we assume an average cost of $50 per affected employee—the typical cost of a cooling vest, which would need to be replaced each year. Table 3 summarizes the various cost assumptions for Type 1 industries.

[35] For additional information on this assumption, refer to the earlier discussion of heat hazard frequency.

Table 3. Estimated Use of Control Measures for Affected Type 1 Industries

Control Measure	Percentage of Affected Establishments that will Implement these Measures	Average Annual Cost
Engineering Controls	60%	$440 per employee replaced every 5-10 years (e.g., evaporative coolers, local exhaust ventilation, air conditioning or cooling fans, or heat shields to isolate hot processes)
Administrative Controls	5%	$1,020 per supervisor (0.33 hr./day × $50/hour × 61 days/year) $610 per employee (0.33 hr./day × $30/hour × 61 days/year)
Heat-protective Clothing or Personal Protective Equipment	35%	$50 per employee replaced every year (e.g., cooling vest)

For the remaining Type 2 industries, we assume that 25 percent of establishments will adopt engineering controls, 15 percent will use administrative controls, and 60 percent will provide personal heat-protective equipment. For engineering controls, we use the same cost assumptions as for Type 1 industries. Where employers implement administrative controls, we assume each employee will take two additional 10-minute cool-down rest breaks per day on 52 workdays each year.[36] We estimate the total direct costs will be approximately $870 per supervisor and $520 per employee per year. For work environments where personal heat-protective equipment will provide an effective mitigation measure, we assume an average cost of $50 per affected employee—the typical cost of a cooling vest, which would need to be replaced every other year due to less frequent use than in Type 1 industries. Table 4 summarizes the various cost assumptions for Type 2 industries.

[36] For additional information on this assumption, refer to the earlier discussion of heat hazard frequency.

Table 4. Estimated Use of Control Measures for Affected Type 2 Industries

Control Measure	Percentage of Affected Establishments that will Implement these Measures	Average Annual Cost
Engineering Controls	25%	$430 per employee replaced every 3 years (e.g., evaporative coolers, local exhaust ventilation, air conditioning or cooling fans)
Administrative Controls	15%	$870 per supervisor (0.33 hr./day × $50/hour × 52 days/year) $520 per employee (0.33 hr./day × $30/hour × 52 days/year)
Heat-protective Clothing or Personal Protective Equipment	60%	$50 per employee replaced every other year (e.g., cooling vest)

The direct cost impacts of this requirement vary considerably across industries. The estimated average cost per establishment ranges from $300 for certain service sectors to $16,000 for warehousing and storage in 2023 and ranges from $200 to $3,000 in subsequent years. We note these costs scale directly in proportion to the number of affected employees.

Summary of Direct Costs

The total direct compliance costs of the proposed regulation vary across industries and over time as many of the requirements require an upfront investment in various heat illness prevention measures. We report aggregate costs for the first ten years after the promulgation of the proposed rule by 2-digit NAICS code and separate costs into first year costs for 2023 and average annualized recurring costs for the subsequent years, 2024 to 2032. The total direct compliance costs of the proposed indoor heat illness prevention requirements are estimated to be approximately $215 million in the 2023 and $88 million in each subsequent year on an (undiscounted) annualized basis. Table 5 reports the direct compliance costs of the proposed regulation.

Table 5. Summary of Direct Compliance Costs to Industry

	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
Requirement		
Water Provision	$9.3	$7.9
Cool Down Areas	$31.8	$26.9
Emergency Response Procedures	$0.0	$0.0
Observation	$0.0	$0.0
Training	$29.3	$9.4
Heat Illness Prevention Plan	$10.0	$0.0
Additional Compliance Actions		
Assessment	$3.6	$1.2
Control Measures	$130.5	$42.4
TOTAL	**$214.5**	**$87.8**

Note: Totals may not sum precisely due to rounding.

Table 6 reports the total direct compliance costs by 2-digit NAICS code on an undiscounted basis. The largest costs will be incurred by restaurants, other eating places, and special food services (NAICS 7223 and 7225), which account for approximately 40 percent of all regulated establishments, transportation and warehousing, which has the highest per establishment costs, and manufacturing, which has the largest number of subsectors affected by the proposed regulation. These sectors account for approximately 70 percent of the total costs of the rule.

Table 6. Summary of Direct Compliance Costs to Industry by NAICS Code

NAICS	Description	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
11	Agriculture, Forestry, Fishing and Hunting	$1.4	$0.7
21	Mining, Quarrying, and Oil and Gas Extraction	$0.1	$0.1
22	Utilities	$0.7	$0.4
23	Construction	$7.1	$3.8
31-33	Manufacturing	$46.0	$15.1
42	Wholesale Trade	$32.5	$16.6
44-45	Retail Trade	$4.4	$2.2
48-49	Transportation and Warehousing	$48.3	$19.3
56	Administrative and Support and Waste Management and Remediation Services	$0.6	$0.2
72	Accommodation and Food Services	$54.4	$21.3
81	Other Services (except Public Administration)	$19.0	$8.1
TOTAL		**$214.5**	**$87.8**

Note: Totals may not sum precisely due to rounding.

Direct Costs to Small Businesses

The California legislature defines small businesses as businesses that have fewer than 100 employees, are not dominant in their field, and are independently owned and operated (A.B. 1033, Ch. 346, 2016). Sufficient data are only available to differentiate establishment size based on the number of employees, so we only apply this criterion to define small businesses for the purposes of this SRIA. This likely overstates the cost burden to small businesses as many facilities may be owned and operated by larger business enterprises that may be dominant in their field. For example, many warehouses and storage facilities, including fulfillment and distribution centers, are owned by large corporations.

Due to the average employment size in most industries affected by the proposed regulation, small businesses are likely to face a disproportionately higher share of the total direct compliance costs relative to large businesses. For example, accommodation and food services and industries in the agriculture sector have a very high concentration of small and family-owned businesses. We note that the technologies needed for compliance in such operations are generally not unusually sophisticated or expensive. Moreover, they are also fully scalable, with costs directly commensurate with the size of the business. Many of the direct compliance costs are likely to be incurred in the first year after the promulgation of the proposed regulation and may pose a burden on some small businesses—particularly those facing challenging financial conditions due to COVID-19 impacts on their operations. However, in most cases, these costs are on the scale of

$500 to $1,000 per establishment per year in many industries, and standard borrowing channels are likely to be available to established firms regardless of size.

Using data from the U.S. Census Bureau's County Business Patterns and the U.S. Department of Agriculture's Census of Agriculture, we estimate that approximately 97.5 percent of establishments in affected industries have less than 100 employees or are considered small family farms. Since the vast majority of affected establishments meet the employment-size definition for small businesses, we report the typical costs likely to be incurred by employers under the proposed regulation. Table 7 reports the average costs of the proposed regulation on a per establishment basis. All costs are rounded to two significant digits. The largest costs are likely to be incurred by warehousing and storage facilities—these facilities have the highest number of affected workers with an average of approximately 60 employees per establishment and therefore are likely to incur significant costs related to implementing control measures and training requirements. Other industries likely to incur higher than average costs include drycleaners, certain manufacturers that use hot indoor processes, greenhouses and nurseries, and wholesale trade facilities, which also tend to have a higher average number of employees relative to other affected industries.

Table 7. Estimated Average Compliance Costs for Individual Establishments by NAICS Code

NAICS	Description	First Year Costs, 2023	Annualized Recurring Costs, 2024-2032
NAICS 1114	Greenhouse, Nursery, and Floriculture Production	$910	$370
NAICS 112	Animal Production	$360	$200
NAICS 211, 212	Mining, Quarrying, and Oil and Gas Extraction	$720	$450
NAICS 221	Utilities	$1,200	$720
NAICS 236, 2371, 2383	Construction	$310	$170
NAICS 311-314, 3151, 3159, 316, 321-327, 331-333, 3352-3359, 3363-3369, 337, 339	Food Processing, Textile, Apparel Accessories, Leather Product, Wood Product, Metal Product, Transportation Equipment, Furniture, and Miscellaneous Manufacturing	$1,200	$390
NAICS 3152, 3361, 3362	Cut and Sew Apparel, Motor Vehicle, Motor Vehicle Body, and Trailer Manufacturing	$850	$370
NAICS 423, 4241, 4243, 4245, 4246, 4247, 4249	Wholesale Trade	$1,400	$720
NAICS 4442, 4541	Retail Trade	$1,300	$680
NAICS 4931	Warehousing and Storage	$20,000	$7,500
NAICS 484, 4851, 4852, 492	Trucking, Passenger Transportation, Couriers	$490	$300
NAICS 5622, 5629	Administrative and Support and Waste Management and Remediation Services	$830	$330
NAICS 7223, 7225	Accommodation and Food Services	$700	$270
NAICS 8123	Dry Cleaners	$1,600	$540
NAICS 811	Repair and Maintenance	$1,000	$490

Table 8 reports the total direct compliance costs to small businesses by 2-digit NAICS code. The total direct compliance costs to small businesses are estimated to be approximately $208 million in 2023 and $85 million in each subsequent year on an (undiscounted) annualized basis. Overall, these costs represent approximately 97 percent of the total costs to industry.

Table 8. Summary of Direct Compliance Costs for Small Businesses by NAICS Code

NAICS	Description	Small Business Establishments	Percentage of Total Affected Establishments	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
11	Agriculture, Forestry, Fishing and Hunting	2,062	88.0%	$1.3	$0.6
21	Mining, Quarrying, and Oil and Gas Extraction	183	96.7%	$0.1	$0.1
22	Utilities	535	91.2%	$0.6	$0.4
23	Construction	22,621	98.9%	$7.0	$3.7
31-33	Manufacturing	36,180	94.1%	$43.3	$14.3
42	Wholesale Trade	22,567	98.1%	$31.9	$16.3
44-45	Retail Trade	3,235	98.7%	$4.4	$2.2
48-49	Transportation and Warehousing	9,668	95.5%	$46.1	$18.4
56	Administrative and Support and Waste Management and Remediation Services	675	97.4%	$0.6	$0.2
72	Accommodation and Food Services	77,272	98.7%	$53.7	$21.0
81	Other Services (except Public Administration)	16,173	99.4%	$18.9	$8.1
TOTAL		**191,172**	**97.5%**	**$207.8**	**$85.2**

Note: Totals may not sum precisely due to rounding.

Direct Costs to Individuals

We do not anticipate any direct costs to individuals as a result of the proposed requirements for indoor places of employment. It is possible that consumers may see changes in prices of certain consumer goods and services if costs are passed on to customers in the state. However, significant impacts on prices of consumer goods are unlikely because the typical cost impacts to individual business enterprises are generally small. Individual employees may potentially realize health benefits as described later in the discussion of benefits of the proposed regulation.

Sensitivity Analysis

The estimated costs reported in this SRIA are subject to uncertainty regarding the number of establishments potentially affected by the proposed regulation due, in part, to incomplete information regarding the indoor temperatures in those facilities under regular operations, the extent and overall effectiveness of existing measures to regulate indoor temperatures and protect workers from heat stress, and annual variation in outdoor temperatures and other climate factors. Since we estimate the most significant factor influencing the total estimated costs of proposed regulation is the number of establishments that need to take additional compliance actions, we

present two sensitivity analyses that provide a low-end and high-end estimate of the number of affected facilities. In the discussion of the baseline in Chapter 2, we estimate that 20 percent of establishments in industries where a majority of employers have existing heat illness prevention measures in place and 80 percent of establishments in industries less likely to have mitigation measures will have to undertake additional compliance actions. For the low-end scenario, we decrease these percentages by 10 percent—to 10 percent and 70 percent, respectively. For the high-end scenario, we increase these percentages by 10 percent—to 30 percent and 90 percent, respectively.

Table 9 reports the direct compliance costs to industry over 10 years by requirement and Table 10 reports the total direct compliance costs to industry by 2-digit NAICS code in the low-end and high-end scenario. In the low-end scenario, we estimate that approximately 46,000 of 196,000 establishments are likely to incur costs for the full set of requirements. The remaining establishments will predominantly only incur costs related to training. In the high-end scenario, we estimate that approximately 86,000 establishments are likely to incur costs related to the full set of requirements. Overall, we estimate that the total direct costs of the proposed regulation may range between $159 and $270 million in 2023 and between $64 and $111 million in each subsequent year on an (undiscounted) annualized basis.

Table 9. Summary of Direct Compliance Costs to Industry in Low-end and High-end Scenario

	Low-end Scenario		High-end Scenario	
	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
Requirement				
Water Provision	$6.5	$5.5	$12.1	$10.3
Cool Down Areas	$22.2	$18.7	$41.4	$35.1
Emergency Response Procedures	$0.0	$0.0	$0.0	$0.0
Observation	$0.0	$0.0	$0.0	$0.0
Training	$29.3	$9.4	$29.3	$9.4
Heat Illness Prevention Plan	$10.0	$0.0	$10.0	$0.0
Additional Compliance Actions				
Assessment	$2.6	$0.9	$4.7	$1.6
Control Measures	$88.3	$29.8	$172.6	$55.0
TOTAL	**$158.9**	**$64.2**	**$270.1**	**$111.4**

Note: Totals may not sum precisely due to rounding.

Table 10. Summary of Direct Compliance Costs to Industry by NAICS Code in Low-end and High-end Scenario

NAICS	Description	Low-end Scenario		High-end Scenario	
		First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
11	Agriculture, Forestry, Fishing and Hunting	$0.8	$0.4	$2.0	$0.9
21	Mining, Quarrying, and Oil and Gas Extraction	$0.1	$0.0	$0.2	$0.1
22	Utilities	$0.4	$0.2	$1.0	$0.6
23	Construction	$4.3	$2.1	$9.9	$5.5
31-33	Manufacturing	$30.1	$9.0	$62.0	$21.3
42	Wholesale Trade	$29.3	$14.6	$35.7	$18.6
44-45	Retail Trade	$4.0	$2.0	$4.8	$2.5
48-49	Transportation and Warehousing	$41.4	$16.2	$55.1	$22.3
56	Administrative and Support and Waste Management and Remediation Services	$0.3	$0.1	$0.8	$0.3
72	Accommodation and Food Services	$31.0	$12.3	$77.8	$30.2
81	Other Services (except Public Administration)	$17.2	$7.2	$20.8	$9.1
TOTAL		**$158.9**	**$64.2**	**$270.1**	**$111.4**

Note: Totals may not sum precisely due to rounding.

4. Benefits

Regulations that limit workplace exposure to harmful environmental conditions may yield benefits in the form of avoided costs associated with morbidity (i.e., induced illness) and, in extreme cases, premature death. Heat-related stress can cause health effects ranging from minor (e.g., heat rash or heat cramps) to intermediate (e.g., heat exhaustion) to major (e.g., rhabdomyolysis, heat stroke, permanent disability, and death) (CDC, 2011; NIOSH, 2016). The amount of time it is considered safe for employees to work in hot environments depends on the conditions that affect body temperature including ambient temperature level, humidity level, length of exposure, intensity of task, and personal physical characteristics (Gubernot et al., 2014; NIOSH, 2016; WOSHTEP, 2012). By limiting both the maximum amount of time exposed and the maximum heat that employees are exposed to, the proposed regulation is designed to reduce the incidence of heat-related illnesses and deaths. This SRIA estimates the economic benefits of limiting these damages by reducing occupational exposure to extreme heat in indoor workplaces. Additionally, there is evidence that worker productivity declines in hot environments indoors both because employees work less hours (Graff Zivin and Neidell, 2014) and because the hours worked become less productive (Park 2016; Tanabe et al., 2006; Seppänen et al., 2006). We therefore also estimate productivity impacts from limiting exposure to extreme heat through responses to the proposed regulation that would limit employee exposure.

We first collect data on historic fatal and non-fatal illness/injury due to occupational indoor heat exposure and extrapolate based on recent trends to establish a *no regulatory action* baseline. We use data from the Division of Workers' Compensation's (DWC) Workers' Compensation Information System (WCIS) to identify the average annual number of reported heat related incidents in indoor places of employment. We then estimate the number of cases that would have been avoided under the proposed regulation and monetize those impacts. We also estimate non-health benefits, such as increases in productivity that result from reducing employee exposure to extreme heat. Then, we evaluate sources of uncertainty, including underreporting of indoor heat illnesses, and present a sensitivity analysis to provide a range of potential benefits. Finally, we discuss other potential benefits that we are unable to quantify.

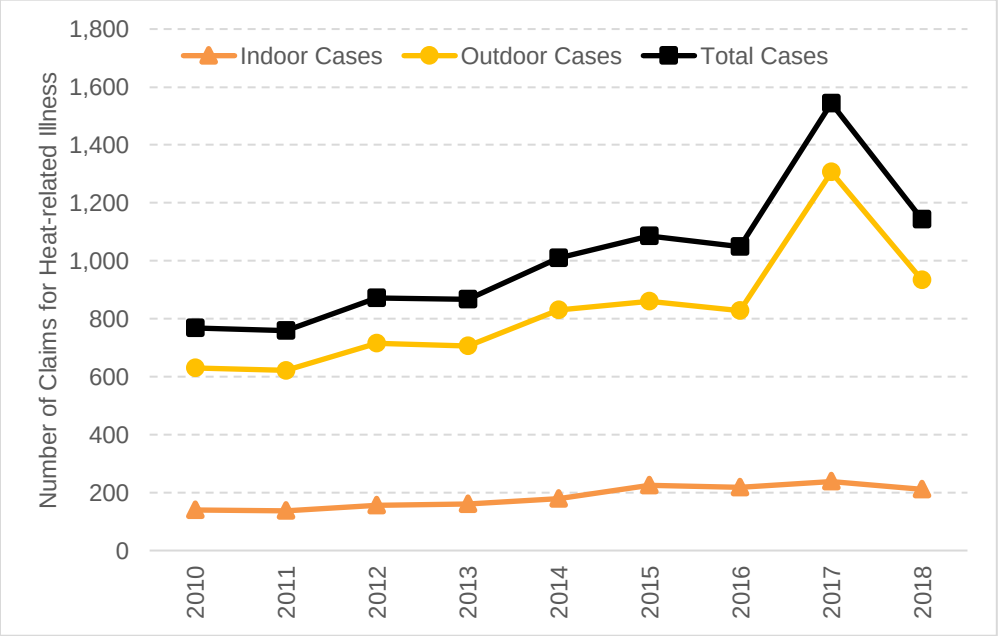
Benefits to Individuals

Estimating the Number of Fatal and Non-fatal Occupational Illnesses and Injuries due to Indoor Heat Exposure

The potential benefits of the proposed regulation include health impacts, such as reducing the number of fatal and non-fatal occupational illnesses and injuries. DIR queried the DWC's WCIS

to identify cases associated with occupational heat exposure in California between 2010 and 2018.[37] There were a total of 9,098 worker compensation claims filed in California that were related to heat stress over the nine-year period for an average of 1,011 claims per year. Of these claims for heat related illnesses, 1,664 were related to indoor heat exposure—an average of 185 claims per year. Figure 3 shows the annual number of worker compensation claims for heat illness in California.

Figure 3. Annual Number of Worker Compensation Claims for Heat Illness in California



Source: DWC WCIS.

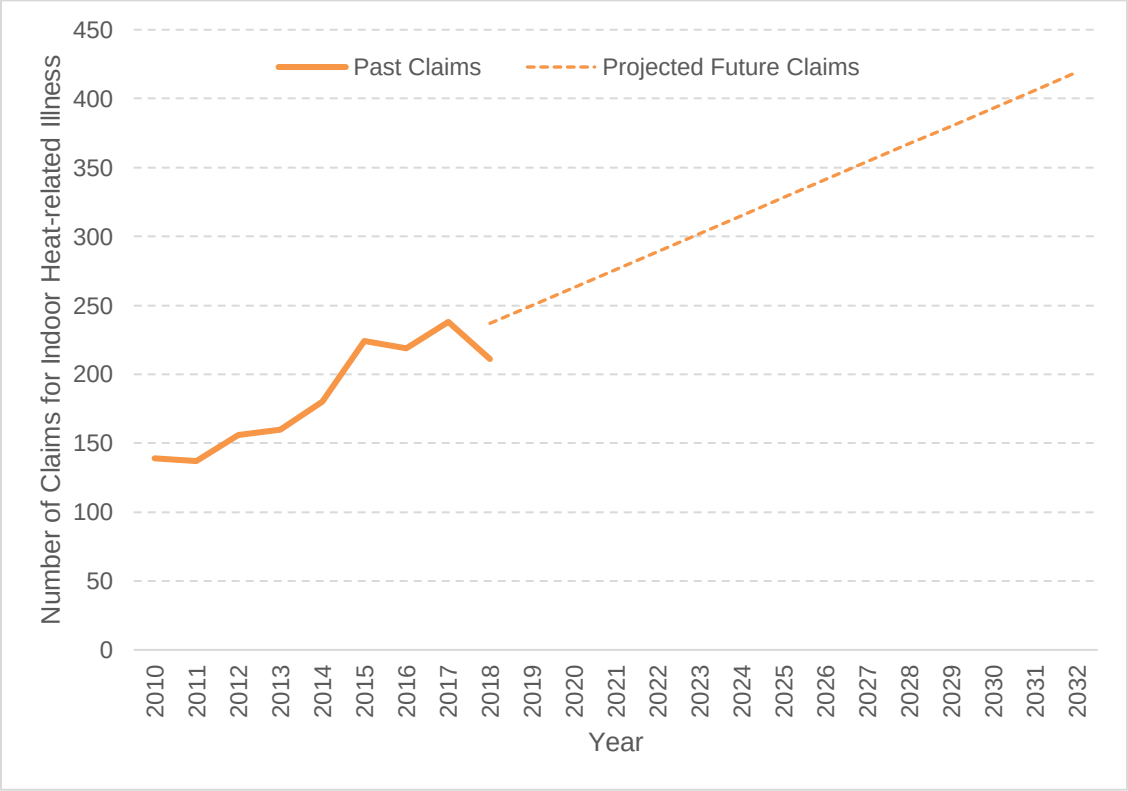
During the hottest decade on record (NASA, 2020), the annual number of both indoor and outdoor heat related cases rose from 2010 to 2018. Indoor cases increased from an average of 138 over the first two years (2010-2011) to an average of 225 over the last two years (2017-2018). As global temperatures and the frequency of extreme weather events increase, heat-related morbidity and mortality are likely to rise further (Heinzerling et al., 2020). To account for the increasing number of claims for indoor heat-related illness over time, we extrapolate along the historical trend to estimate the number of claims that would occur absent the proposed regulation through 2032.[38] These potential future claims are used to estimate potential benefits of the proposed regulation from avoidable illnesses and injuries. Figure 4 shows the projected

[37] Data were accessed from the WCIS on September 7, 2019.

[38] We obtain similar estimates based on historical trends for all (indoor and outdoor) heat-related illnesses. Heinzerling et al. (2020) found 7,011 heat-related illnesses from 2012-2017 compared with 5,676 from 2006-2011, suggesting an average annual growth rate of just below 4 percent.

number of worker compensation claims related to indoor heat illness based on historical trends through 2032. In contrast, if we assumed future claims remained constant at 2017-2018 levels (about 225 claims per year), the projected number of workers' compensation claims would be approximately 30 percent lower by 2025 and 40 percent lower by 2030.[39]

Figure 4. Past and Projected Worker Compensation Claims for Indoor Heat Illness in California



Source: DWC WCIS.

In addition to the claims for non-fatal heat illness, there were 20 reported deaths in California related to occupational heat stress between 2010 and 2017.[40] Of these reported deaths, seven were related to heat stress from indoor heat exposure. This represents an average of 0.875 deaths per year due to occupational indoor heat exposure. We assume that number of fatal incidents will increase at a similar rate to non-fatal incidents through 2032. The BLS Census of Fatal Occupational Injuries (CFOI) showed that fatal occupational injuries related to exposure to

[39] While both projections are plausible, trends in occupational heat-related illness in California (both the number of claims as well as the rate of claims per 100,000 workers) increased from 2000 to 2017. BLS CFOI data also suggest that 2018 and 2019 had the highest nationwide numbers of fatal injuries related to exposure to environmental heat since 2011. Furthermore, California climate projections show increasing temperatures over the next decade. Therefore, we use the linear projection instead of assuming a constant rate of future claims at recent levels. The actual number of future heat-related illnesses may fall somewhere in between.

[40] Data on deaths were not available for 2018.

environmental heat in the United States increased from an average of 37 per year from 2010 to 2015 (with an unusually large number of deaths in 2011) to an average of 46 per year between 2018 and 2019, suggesting this upward trend is a reasonable assumption.[41]

In addition to reported injuries, researchers have shown that the major sources of U.S. occupational health data significantly underestimate the incidence of work-related injuries and illnesses. Lacking a comprehensive national surveillance system for occupational injuries and illnesses, data sources including the BLS's annual Survey of Occupational Injuries and Illnesses (SOII), workers' compensation records, and physician reporting systems have been described as incomplete, unreliable, and inconsistent (Azaroff, Levenstein, and Wegman, 2002). For example, the SOII omits more than one in five workers in the United States, including state and local government employees (Leigh, Marcin, and Miller, 2004). In addition, there is considerable underreporting—accidental or willful omissions—on OSHA 300 forms, which are the basis of the SOII (Leigh, 2011). A staff report by the Committee on Education and Labor of the U.S. House of Representatives (2008) noted several reasons that occupational injuries and illnesses are underreported, including:

- Occupational illnesses are particularly difficult to identify as work-related
- Immigrants are less likely to report workplaces injuries and illnesses
- Workers are reluctant to apply for workers' compensation
- Some workers and employers do not understand the reporting system
- Employers have an incentive to underreport
- Various methods are used by employers to discourage accurate reporting

Studies have shown the incidence of work-related injuries, illnesses, and fatalities may be underreported by as much as several hundred percent (Azaroff, Levenstein, and Wegman, 2002), although we are not aware of any studies that specifically isolate the rate of underreporting for heat-related illnesses. Therefore, to account for underreporting, we scale up our estimates of the annual number of fatal and nonfatal injuries by 25 percent relative to past reported injuries. This relatively conservative estimate is based on an average of BLS and OSHA estimates that employers under-recorded occupational injuries and illnesses by about 10 percent (Azaroff, Levenstein, and Wegman, 2002) and estimates by Leigh (2011) that omissions on OSHA 300 forms likely reflected underreporting of occupational injuries and illnesses by about 40 percent.[42] Therefore, we estimate that the average annual number of nonfatal injuries will increase from about 378 to 524 and the average annual number of fatal injuries will increase from about 1.8 to 2.5 between 2023 and 2032.

[41] U.S. Bureau of Labor Statistics, 2019 Census of Fatal Occupational Injuries, accessed at https://www.bls.gov/iif/oshcfoi1.htm on March 22, 2021.

[42] We were unable to find any studies of underreporting of heat-related illness in particular. Given uncertainty regarding the estimates of the magnitude of underreporting, we present a sensitivity analysis later in this chapter.

Estimating the Number of Reported Cases that Would Have Been Avoided under the Proposed Regulation

Several studies suggest that the proposed regulation is likely to reduce the number of reported illnesses and injuries associated with indoor heat. As described in Chapter 1, NIOSH estimates that the proper use of engineering and administrative controls, heat-protective clothing and PPE, worker training and acclimatization, and measurement and assessment of heat stress "…should prevent or greatly reduce the risk of adverse health effects to exposed workers" (NIOSH, 2016). In addition, a recent publication using California data from the WCIS found that occupational injuries attributable to hot temperatures declined by approximately 30 percent after Section 3395 was enacted in 2005 (Park, Pankratz, and Behrer, 2021). The authors suggest that the combination of increased awareness of the risks of occupational exposure to extreme heat and mandated safety investments contributed to this decline in injury risk.[43]

The proposed indoor heat regulation includes provisions similar to the outdoor heat standard, as well as provisions requiring the use of engineering controls when the temperature or heat index exceeds the regulatory thresholds. For this reason, we assume that the proposed indoor heat regulation may reduce occupational heat-related illnesses by more than the outdoor heat standard. The overall effectiveness of these measures is uncertain, in part due to unobserved risk factors including the underlying health conditions of workers and metabolic heat generated through labor-intensive tasks, such as heavy lifting, in hot indoor work environments. Given uncertainty regarding the overall effectiveness of the proposed regulation in reducing heat-related illnesses, we present a sensitivity analysis using a low-end estimate of 30 percent and a high-end estimate of 60 percent – roughly double the impact of the outdoor heat regulation estimated in Park, Pankratz, and Behrer (2021). For the primary analysis, we assume that the proposed regulation will prevent 45 percent of fatal and non-fatal heat-related incidents.

Monetizing Avoided Health Damages

The proposed regulation would afford health benefits to individuals by limiting occupational exposure to extreme heat in indoor places of employment. These benefits include avoided cases of morbidity and mortality.

First, to monetize avoided fatalities we rely on guidance from the U.S. Department of Transportation's (DOT), which recommends valuing mortality risk reductions based on estimates of the value of a statistical life (VSL). VSL is defined as individuals' willingness to pay (WTP) for improvements in safety that result in a small risk reduction in likelihood of a fatal illness/injury that, in aggregate, would reduce the expected number of fatalities by one (DOT, 2016). DOT recommends using a VSL of $11.6 million for risk reductions using a base year of 2020 (DOT, 2021). Updating the VSL from the original base year to a new base year involves

[43] The authors also found that higher temperatures in indoor workplaces were associated with a higher injury rate.

adjusting for inflation and real income growth over the intervening years, using the following formula:

$$VSL_T = VSL_t \times \frac{P_T}{P_t} \times (1 + I)^{\varepsilon \times (T-t)}$$

where t is the original base year, T is the new base year, P_t is the price index in year t, I is the real income growth rate, and ε is a constant income elasticity. Therefore, to monetize benefits in future years we adjust for changes in real income over time. The Congressional Budget Office (CBO) estimates that real earnings per worker will grow by an average of 0.8 percent annually from 2021 to 2051 (CBO, 2021). The economic literature suggests that changes in the VSL should also take into account income elasticity, or the extent to which WTP is expected to change in response to a change in income; however, there is no consensus on the rate of response—estimated income elasticity values range from 0.5 to 1.6 (Viscusi and Aldy, 2003; Kniesner, Viscusi, and Ziliak, 2010; Costa and Kahn, 2004). Given this uncertainty, DOT recommends using an income elasticity of 1.0. Therefore, we use a VSL that increases at the rate of real income growth, ranging from $11.9 million in 2023 to $12.8 million in 2032.

Second, to monetize avoided cases of non-fatal illness/injury from occupational indoor heat exposure we reviewed the economic literature on the dollar value of preventing an injury. Viscusi and Aldy (2003) conducted a review of 39 studies estimating the value of a statistical injury and reviewed the available WTP literature to identify a suitable range of estimates. This meta-analysis found that most studies resulted in estimates in the range of $20,000 to $70,000 per injury (measured in 2000 dollars) or approximately $30,000 to $100,000 in 2020 dollars, although several studies had in higher estimates.[44] Therefore, for the majority of cases of heat-related illness representing a wide range of injuries, we use a median WTP value of approximately $65,000 measured in 2020 dollars.

Since occupational exposure to extreme heat can have more severe consequences, we use a separate high-end estimate for those injuries. Magat et al. (1996) estimated a WTP for reducing the risk of contracting peripheral neuropathy (nerve disease), which is more comparable to the disabling consequences and long-term health effects of kidney disease or neurological conditions related to heat illness. The median amount that individuals were willing to pay was equivalent to 40 percent of what individuals were willing to pay to avoid death in a car crash. Therefore, for more severe injury categories, we use a high-end WTP estimate of 40 percent of a VSL (approximately $4.6 million in 2020 dollars). Similar estimates have been used by the Mine Safety Health Administration (MSHA) and OSHA to assign values to avoided illnesses related to

[44] In comparison, based on information from the WCIS the average amount paid out per workers' compensation claim due to illness or injury caused by occupational indoor heat exposure between 2010 and 2018 was $2,758, including payouts over multiple years.

occupational exposures, such as chronic obstructive pulmonary disease (COPD), end-stage renal disease, and lung cancer (MSHA, 2014; OSHA, 2016).

Heat-related illness predominantly fall in minor to moderate categories. We assume that 85 percent of heat-related illnesses are minor or moderate illnesses best represented by the WTP estimate of $65,000, while 15 percent of heat-related illnesses are severe cases that are best represented by the WTP estimate of $4.6 million.[45] Based on this distribution of injury severity and WTP values, we use a weighted-average value of a statistical injury of approximately $740,000 measured in 2020 dollars.[46] As described above, we assume 45 percent of heat-related illnesses will be avoided relative to the *no regulatory action* baseline. Table 11 reports the total health benefits of the proposed regulation from 2023 to 2032. We estimate that over the first ten years the proposed regulation would result in approximately 2,029 fewer non-fatal injuries and 10 fewer fatalities.

Table 11. Summary of Benefits to Individuals (2023 to 2032)

Year	Number of Avoided Non-fatal Injuries	Number of Avoided Fatalities	Value per Avoided Injury/Illness ($ millions)	Value per Avoided Fatality ($ millions)	Total Health Benefits ($ millions)
2023	170	0.8	$0.770	$11.9	$140.5
2024	177	0.9	$0.776	$12.0	$147.8
2025	185	0.9	$0.782	$12.1	$155.1
2026	192	0.9	$0.788	$12.2	$162.5
2027	199	1.0	$0.795	$12.3	$170.1
2028	207	1.0	$0.801	$12.4	$177.7
2029	214	1.0	$0.808	$12.5	$185.5
2030	221	1.1	$0.814	$12.6	$193.4
2031	228	1.1	$0.821	$12.7	$201.4
2032	236	1.1	$0.827	$12.8	$209.5

Benefits to Businesses

There are other potential benefits from limiting indoor heat exposure, in addition to those from avoided worker illness. There is evidence that at high heat levels worker productivity decreases (Seppänen et al., 2006; Park, 2016) and overall cognitive performance declines (Park et al., 2020). These results suggest that reducing indoor heat exposure may increase worker

[45] Flouris et al. (2018) found that 15 percent of workers who typically or frequently worked under heat stress (for a minimum of 6 hours per day, 5 days per week, 2 months of the year) experienced severe health consequences, including kidney disease or acute kidney injury.

[46] We calculate this as $740,000 = 85% × $65,000 + 15% × $4,600,000.

productivity. Seppänen et al. (2006) estimate that every degree the indoor temperature rises above 75°F decreases office productivity. At temperatures around 87°F, the authors estimate that productivity is 9 percent lower than it would have been at 75°F. Evidence from developing countries suggest similar patterns for manufacturing work (e.g., Adhvaryu et al., 2020; Somanathan et al., 2015; Kjellstrom et al., 2009). Results from Park (2016) also suggest that the effect crosses industry sectors. Using non-agricultural payroll data from across the United States, Park estimates that each day above 90°F reduces payroll per capita and that the effect is larger for industries with extreme exposure to heat. While this estimate represents a combined effect of both indoor and outdoor heat exposure, it excludes the agricultural sector which is one of the main drivers of outdoor heat impacts. Park estimates that the effect for industries characterized by NIOSH as "highly exposed" to environmental stressors is significantly larger than the overall estimate and highly statistically significant, while the effect in less exposed industries is estimated to be less than one-third of the overall effect and statistically insignificant.[47] This subset of highly exposed industries is the primary source of the overall impact.

While the proposed regulation covers a wide range of industries with different levels of occupational indoor heat exposure, the main focus of the potential productivity benefits is in industries that are not climate controlled and where the production process often generates considerable heat. Therefore, we draw on the Park (2016) estimates of payroll effects from occupational heat exposure for highly exposed industries to estimate productivity benefits. This may potentially overstate impacts for a small number of establishments in less exposed industries. An additional consideration is that not all compliance actions are expected to generate the same level of productivity benefits. Compliance actions, such as administrative controls that provide employees with additional breaks, or the use of heat-protective clothing or PPE, may not result in large productivity benefits.[48] However, engineering controls such as new evaporative coolers or air conditioning units would be expected to improve productivity if they reduce the number of days employees are exposed to extreme heat. We note that the number of establishments anticipated to invest in new engineering controls, which we discuss in the cost of control measures, is less than the total number of establishments impacted by the regulation because some employers – particularly those in geographic areas less prone to extreme heat conditions – will use other control measures.

To estimate avoided productivity losses, we first estimate the average per capita payroll for Type 1 and Type 2 industries. According to data from the California EDD's QCEW, average per

[47] NIOSH (2016) defines "highly exposed" industries as industries where the work is primarily performed outdoors—agriculture, forestry, fishing, and hunting; construction; mining; and transportation and utilities—as well as manufacturing, where facilities are typically not climate controlled and the production process often generates considerable heat.

[48] It is possible that administrative controls and the use of personal heat-protective equipment could yield productivity benefits as they would provide physical relief to employees from excessive heat stress. However, we are unable to correlate the use of administrative controls with the data on highly exposed industries used by Park (2016).

capita payroll in 2019 was $44,961 for Type 1 industries and $71,047 for Type 2 industries. We allow this estimate to increase over time—CBO (2021) estimates that real earnings per worker will grow by an average of 0.8 percent annually. Park (2016) estimates for the United States as a whole that each additional day above 90°F results in about a 0.0333 percent decline in annual payroll per capita in industries highly exposed to environmental stressors.[49] Based on the analysis of cost impacts related to control measures described in Chapter 3, we estimate that there are 313,310 affected employees in Type 1 industries and 146,937 affected employees in Type 2 industries. Of these, approximately 60 percent of employees in Type 1 industries and 25 percent in Type 2 industries will benefit from the adoption of engineering controls to manage environmental heat stress. We also estimate that the indoor temperature will meet or exceed the regulatory threshold on 61 days per year for Type 1 industries and 52 days per year for Type 2 industries in the *no regulatory action* baseline. We calculate avoided productivity losses using the following formula:

$$
\begin{aligned}
&Avoided\ Productivity\ Losses_t \\
&= Payroll\ per\ capita_t \times percentage\ of\ establishments\ using\ engineering\ controls \\
&\times (exp(-.000333 \times number\ of\ extreme\ heat\ days\ per\ year) - 1) \\
&\times number\ of\ affected\ employees
\end{aligned}
$$

We estimate the avoided productivity losses for Type 1 industries will range from approximately $176 to $189 million per year, which represents approximately a 0.15 percent increase in productivity across the Type 1 industries affected by the proposed regulation. We estimate the avoided productivity losses for Type 2 industries will range from approximately $46 to $50 million per year, which represents approximately a 0.04 percent increase in productivity across the Type 2 industries affected by the proposed regulation.[50] Table 12 reports the estimated avoided productivity losses associated with the proposed rule.[51]

[49] We note that Park (2016) estimates a non-linear relationship between number of heat days and the estimated decline in annual payroll per capita, so this impact diminishes slightly as the number of days increases.

[50] As noted in Table 1, many Type 1 and Type 2 industries have already adopted such features, which suggests many companies may view the benefits to their business as exceeding the cost of compliance.

[51] Our estimated productivity benefits would be approximately 20 percent lower if we used the Park (2016) estimate for all industries, rather than the estimate for industries highly exposed to environmental stressors.

Table 12. Summary of Benefits to Businesses (2023 to 2032)

Year	Avg. payroll per capita		Avoided Productivity Losses ($ millions)		Total Productivity Benefits ($ millions)
	Type 1 Industries	Type 2 Industries	Type 1 Industries	Type 2 Industries	
2023	$46,417	$73,348	$175.5	$46.3	$221.7
2024	$46,788	$73,935	$176.9	$46.6	$223.5
2025	$47,162	$74,526	$178.3	$47.0	$225.3
2026	$47,540	$75,122	$179.7	$47.4	$227.1
2027	$47,920	$75,723	$181.1	$47.8	$228.9
2028	$48,303	$76,329	$182.6	$48.1	$230.7
2029	$48,690	$76,940	$184.0	$48.5	$232.6
2030	$49,079	$77,555	$185.5	$48.9	$234.4
2031	$49,472	$78,176	$187.0	$49.3	$236.3
2032	$49,868	$78,801	$188.5	$49.7	$238.2

Other Benefits

Our estimate of potential health impacts omits injuries that are too small to qualify for worker's compensation. There are insufficient data to quantify avoided health damages for minor illnesses and other health impacts that are too small to qualify for worker's compensation but would be avoided under the proposed regulation. However, we address uncertainty related to the number of injuries that qualify, but are not reported, using a sensitivity analysis described later in this chapter. In addition, avoiding future claims for heat-related illnesses may also reduce workers' compensation insurance premiums paid by employers. We do not have sufficient data to estimate this impact, although given the relatively small number of annual workers' compensation claims for heat-related illness we do not anticipate this to be a large effect. Similarly, while preventing heat illness may create additional benefits for employers by reducing the number of heat-related incidents that require specific emergency response procedures that may disrupt productivity, we do not have sufficient data to estimate this impact.

Total Benefits

The quantifiable benefits of the proposed rule include avoided illnesses and fatalities as well as increases in productivity that arise from reducing employee exposure to extreme heat. Table 13 summarizes the total benefits of the proposed rule by year.

Table 13. Summary of Total Benefits (2023 to 2032)

Year	Avoided Health Impacts ($ millions)	Avoided Productivity Losses ($ millions)	Total Benefits ($ millions)
2023	$140.5	$221.7	$362.2
2024	$147.8	$223.5	$371.2
2025	$155.1	$225.3	$380.4
2026	$162.5	$227.1	$389.6
2027	$170.1	$228.9	$399.0
2028	$177.7	$230.7	$408.5
2029	$185.5	$232.6	$418.1
2030	$193.4	$234.4	$427.8
2031	$201.4	$236.3	$437.7
2032	$209.5	$238.2	$447.7

Sensitivity Analyses

We present two sensitivity analyses related to assumptions regarding potential health impacts and the number of affected establishments in the regulated universe.

Uncertainty Related to Health Impacts

In the analysis above we assume that most health impacts attributable to occupational indoor exposure to extreme heat are captured in workers' compensation claims, but we scale up this estimate by 25 percent to account for underreporting (i.e., affected workers that did not file for compensation or injuries that were incorrectly attributed to causes other than exposure to indoor heat). However, recognizing that there may be more significant underreporting of occupational injuries and illnesses, the potential health benefits of the proposed regulation could be greater. We also assume that the indoor heat mitigation measures required under the proposed regulation will reduce cases of heat-related illness by 45 percent. In reality, the magnitude of the impact of the proposed requirements on the incidence of heat-related illness may be higher or lower.

We present a sensitivity analysis using low-end and high-end scenarios based on different values for key assumptions regarding underreporting of workers' compensation claims and the potential reduction in future heat-related illnesses. In the low-end scenario, we assume that heat-related illnesses are underreported by 10 percent and 30 percent of heat-related incidents are likely to be avoided under the proposed regulation. In the high-end scenario, we assume that the number of heat-related injuries are twice the reported rate and the proposed requirements will

reduce cases of heat-related illness by 60 percent.[52] Table 14 provides a summary of avoided heat-illness related injuries and fatalities under the low-end and high-end scenarios.

Table 14. Summary of Health Benefits in Low-end and High-end Scenario (2023 to 2032)

Year	Low-end Scenario			High-end Scenario		
	Number of Avoided Non-fatal Incidents	Number of Avoided Fatalities	Total Health Benefits ($ millions)	Number of Avoided Non-fatal Incidents	Number of Avoided Fatalities	Total Health Benefits ($ millions)
2023	104	0.5	$85.7	378	1.7	$311.8
2024	104	0.5	$86.7	378	1.8	$315.2
2025	108	0.5	$91.0	394	1.9	$330.9
2026	113	0.5	$95.4	409	2.0	$346.7
2027	117	0.6	$99.8	425	2.0	$362.8
2028	121	0.6	$104.3	441	2.1	$379.2
2029	125	0.6	$108.8	456	2.2	$395.8
2030	130	0.6	$113.5	472	2.3	$412.6
2031	134	0.6	$118.2	487	2.3	$429.7
2032	138	0.7	$122.9	503	2.4	$447.0

Uncertainty Related to the Number of Affected Establishments

As described in Chapter 3, there is considerable uncertainty regarding the number of establishments potentially affected by the proposed regulation. Therefore, we consider low-end and high-end scenarios using the same set of assumptions presented in the sensitivity analysis for the estimated costs of the proposed regulation. In the low-end scenario, we estimate that approximately 9,500 Type 1 establishments and 7,700 Type 2 establishments are likely to adopt engineering controls. Therefore, we estimate that approximately 121,000 employees in Type 1 industries and 29,000 employees in Type 2 industries will be affected. In the high-end scenario, we estimate that approximately 24,200 Type 1 establishments and 11,300 Type 2 establishments are likely to adopt engineering controls. Therefore, we estimate that approximately 225,000 employees in Type 1 industries and 45,000 employees in Type 2 industries will be affected. Table 15 summarizes the potential benefits of the proposed regulation under the low-end and high-end scenarios.

[52] The range of estimates for underreporting is based on several studies cited in Azaroff, Levenstein, and Wegman (2002).

Table 15. Summary of Total Benefits in Low-end and High-end Scenario (2023 to 2032)

Year	Low-end Scenario			High-end Scenario		
	Avoided Health Impacts ($ millions)	Avoided Productivity Losses ($ millions)	Total Benefits ($ millions)	Avoided Health Impacts ($ millions)	Avoided Productivity Losses ($ millions)	Total Benefits ($ millions)
2023	$85.7	$149.0	$234.7	$311.8	$294.4	$606.3
2024	$86.7	$150.2	$236.8	$315.2	$296.8	$612.0
2025	$91.0	$151.4	$242.4	$330.9	$299.2	$630.0
2026	$95.4	$152.6	$247.9	$346.7	$301.6	$648.3
2027	$99.8	$153.8	$253.6	$362.8	$304.0	$666.8
2028	$104.3	$155.0	$259.3	$379.2	$306.4	$685.6
2029	$108.8	$156.3	$265.1	$395.8	$308.9	$704.6
2030	$113.5	$157.5	$271.0	$412.6	$311.3	$723.9
2031	$118.2	$158.8	$276.9	$429.7	$313.8	$743.5
2032	$122.9	$160.0	$283.0	$447.0	$316.3	$763.3

5. Macroeconomic Impacts

This chapter describes the estimated macroeconomic impacts of the proposed regulation on the California economy. The proposed regulation would result in changes in expenditures and labor costs by businesses in order to comply with the new requirements for indoor heat illness prevention. The proposed regulation would also result in productivity gains in businesses that implement engineering controls to reduce occupational heat exposure in indoor workplaces. These changes would affect employment, investment, and output for businesses that provide goods and services to the industries directly impacted by the proposed regulation. These impacts would also result in induced effects, such as changes in personal income that affect consumer spending. We estimate the incremental macroeconomic impacts relative to the *no regulatory action* baseline in the first two years of the proposed regulation using the assessment of direct costs and benefits described earlier in this report.

Methodology

In order to evaluate the statewide macroeconomic impacts of the proposed regulation in California, we utilize the changes in direct expenditures (including capital and labor) described in Chapter 3 to estimate the total economic and fiscal impacts with multipliers derived with IMPLAN social accounting matrices.[53] IMPLAN is an input-output (I-O) model of the U.S. economy used to assess regional economic impacts (French, 2018). I-O models represent the linkages or interactions between sectors of the economy, capturing the flow of goods and services among industries and to consumers. IMPLAN is based on the methods developed by Wassily Leontief in the late 1930s for which he received the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1973 (Leontief, 1936; Leontief, 1941; Miller & Blair, 2009, p. 1).

IMPLAN and other I-O models have been widely used in industry and academia as well as in other Standardized Regulatory Impact Assessments in California (University of California Agricultural Issues Center, 2018; Eschker et al., 2018; Steffensen and Juarez, 2018; California Department of Fish and Wildlife, 2020; Sumner et al., 2020). IMPLAN provides data on an annual basis for all inputs to production, outputs from production, and the distribution of final consumption across households and various levels of government for 546 sectors representing all private industries in the United States. IMPLAN data describe these flows between sectors of an economy based on Leontief production functions. Leontief production functions assume that

[53] This discussion is based, in part, on a prior cost-benefit analysis prepared by the RAND Corporation for DIR (Gonzales et al., 2016).

outputs require fixed ratios of specific inputs, implying that there is no substitution across inputs. Due to the linkages across the economy, a one-dollar increase in output in one sector can have more than a one-dollar impact on the overall economy, a concept commonly referred to as the multiplier effect. This modeling framework allows for a relatively simple analysis of economic impacts for a wide variety of policy changes.

I-O models analyze how changes in final demand ripple throughout the economy via direct, indirect, and induced effects. Direct economic effects are the changes in expenditures and production that result from the initial purchases and changes made to comply with the proposed regulation. Indirect effects capture the changes in expenditures and production caused in turn by the direct effects, such as the business-to-business transactions that result from the supply chain effects of initial expenditures made to comply with the proposed regulation. Finally, induced effects are the household purchases as a result of changes in wages, after removal of taxes, savings, and commuter income (Demski, 2018).

There are three main limitations to the I-O modeling framework. First, the Leontief production functions do not allow for substitution across inputs to production. If the price of an input rises, input costs simply rise due to the fixed ratios of inputs. Second, there is no mechanism to capture price changes. As described in Gonzales et al. (2016), this presents challenges for IMPLAN analyses of changes in tax policy or shocks that would result in changes to the underlying production functions. Finally, capacity and capital does not play a role in the production functions and assume constant returns to scale (Christ, 1955). That is, production functions remain fixed over the long term and do not reflect improvements in technology. Thus, the further out a forecast is made, the greater potential for error.

An alternative to I-O models is a computable general equilibrium (CGE) model, such as Regional Economic Models, Inc. (REMI). CGE models relax the assumption of a fixed production function and assume a constant elasticity of substitution across inputs. One of the main advantages of using a CGE framework is the ability to assess a wider set of economic impacts, including relative price changes. However, CGE models are more complex, generally requiring significantly more data inputs. CGE models are less transparent relative to I-O models—analyses using CGE models generally provide little information to external stakeholders about the relationship equations, parameters, and elasticities—and are heavily dependent on assumptions. As another point of comparison, IMPLAN provides a greater degree of industry disaggregation, facilitating analysis of more targeted impacts, while REMI relaxes the fixed production assumptions to better capture dynamic economy-wide price changes. The choice of a model will depend largely on the specific policy in question.

Our analysis of direct costs and benefits of the proposed regulation suggests the changes in final demand are relatively modest and unlikely to change the underlying production functions in the model; therefore, we determined that IMPLAN's simplicity and transparency made it a suitable tool for assessing macroeconomic impacts in this SRIA. To the extent that the use of an I-O model introduces biases as compared with a CGE model (e.g., REMI), which can allow for

substitution based on relative prices, that bias would result in estimating slightly larger economic impacts. Given the magnitude of the direct impacts, we estimate these effects will be minor and within the margin of error for this economic analysis.

Inputs to the Macroeconomic Analysis

For this analysis, we use IMPLAN's 2018 model year data. This has some consequences for our model assumptions and forecasting. First, the IMPLAN model is a snapshot of the economy at a given time and therefore has limited forecasting ability. It assumes that the relationships between industries are static, which can create challenges for forecasting when economic optimization, prices, and technologies may change over time. Second, IMPLAN accounts for price changes and inflation based on inflator or deflator assumptions from that model year. These inflation estimates can be adjusted in the model, but the underlying composition of the economy will be unchanged from the model year.

We model the economy-wide impacts of expenditures and changes in labor costs for businesses to comply with the proposed regulation as outlined in Chapter 3. Typical expenditures include air-conditioning and ventilation systems, as well as ventilation and exhaust fans; water coolers, paper cups, and water bottles to meet the water provision requirements; shade tents for outdoor cool-down areas; personal heat-protective equipment; and digital heat thermometers. Business expenditures are modelled as positive changes in final demand for the IMPLAN manufacturing sectors outlined in Table 16.

Table 16. IMPLAN Inputs, Changes in Final Demand

IMPLAN Sector	IMPLAN Description	Upfront Costs, 2023 ($ millions)	Recurring Costs, 2024 ($ millions)	Examples of Business Expenditures
273	Air purification and ventilation equipment manufacturing	$40.86	$8.17	Air-conditioning and ventilation systems, evaporative coolers, fans
275	Air conditioning, refrigeration, and warm air heating equipment manufacturing	$61.29	$12.26	
151	All other converted paper product manufacturing	$3.59	$3.59	Paper cups
192	Plastics bottle manufacturing	$3.94	$3.94	Plastic bottles
190	Polystyrene foam product manufacturing	$1.76	$0.35	Water coolers
119	Textile bag and canvas mills	$1.98	$0.40	Shade tents
128	Apparel accessories and other apparel manufacturing	$7.69	$7.69	Personal heat-protective equipment
314	Industrial process variable instruments manufacturing	$1.98	$0.66	Heat thermometers
Total		**$123.10**	**$37.06**	

To model the economic impact of changes in labor costs—in this case, labor costs refer to the time required for supervisors or workers to undertake specific compliance actions—we measure worker output in terms of full-time equivalent (FTE) workers. That is, one FTE employee accounts for 2,080 hours per year. Across 136 IMPLAN sectors, we estimate employers will incur labor costs related to training employees on safety procedures and identifying signs and symptoms of heat illness, writing a HIPP, and providing cool-down rest breaks or implementing other administrative control measures. These labor costs range from less than 1 to more than 225 FTEs per industry in the first year of the regulation and less than 1 to approximately 180 FTEs per industry on a recurring basis. For modeling purpose, the labor impacts described in the cost analysis are converted from FTEs to IMPLAN jobs using IMPLAN's conversion tool (Clouse, 2020a). We use the IMPLAN job equivalent figures to estimate the direct, indirect, and induced economic impacts of changes in labor costs or productivity on overall economic output. However, these labor impacts are not anticipated to materialize as direct job losses (or gains) in the affected industries. Therefore, we do not report job losses (or gains) associated with these impacts. Similarly, we do not include changes in employee compensation associated with IMPLAN's job equivalent figures, as we do not expect salaries to change as a result of relatively small changes in worker productivity.[54] This model adjustment results in smaller direct effects, which more accurately reflects the labor impacts described in the analysis. We use a similar approach to model potential increases in productivity that are described in the analysis of benefits of the proposed regulation. As described in Chapter 4, worker productivity is expected to increase in certain industries, but we do not anticipate there will be associated job gains. Finally, we assign one additional FTE to state government employment (IMPLAN Sector 541) to account for the labor cost of one additional FTE position for a safety inspector. We use IMPLAN's default values for employee compensation in this sector due to the expectation of a direct job gain.

As a final adjustment, for capital expenditures we replace the default industry local purchase percentages (LPP) with regional purchasing coefficients (RPC) to account for imports and exports to/from California.[55] By default, IMPLAN sets all industry LPPs to 100 percent, indicating that all of the impacts should be applied to the study region. For labor costs, we use the default assumption as these impacts only apply to employees in the state.

Macroeconomic Impacts of the Proposed Regulation

The macroeconomic analysis estimates the upfront and recurring impacts for three different types of activities: (1) business expenditures, (2) labor costs, and (3) productivity gains. The

[54] There are, however, additional labor income impacts that we report associated with changes in proprietor income, meaning the income of sole proprietors or partnerships.

[55] RPCs are the "percentage of total demand that is met by local supply" (Clouse, 2020b).

upfront impacts occur only during the first year of the regulation, while the recurring impacts occur in all subsequent years (but not the first year). We limit our analysis to the first and the second year of the proposed regulation due to IMPLAN's limited forecasting ability and concerns that forecasts based on static analyses becomes less reliable further out from the model year data. We anticipate that ongoing impacts of the proposed regulation in future years will be comparable to recurring impacts in the second year, which are estimated on an annualized basis. All macroeconomic impacts are measured in 2020 dollars.

We first consider the upfront macroeconomic impacts, which are those impacts predicted to occur during the first year of the regulation. We estimate that upfront capital expenditures (and one additional safety inspector FTE) will result in direct effects of approximately 67 jobs and $7.9 million in value added and indirect and induced effects of approximately 75 jobs and $9.4 million in value added (measured in 2020 dollars). We note that the macroeconomic impact of capital expenditures is small relative to the cost to businesses; this is because the RPCs suggest that the demand for manufacturing of air-conditioning and ventilation systems, etc., will largely be met out-of-state and result in imports to California. While we do not anticipate direct or indirect job losses as a result of the proposed regulation, labor costs, including the time spent training employees and providing cool-down rest breaks, will result in reduced production hours for some affected businesses. The direct effects of the estimated first-year labor costs are equivalent to approximately 1,234 IMPLAN jobs across all of the affected industries. This represents a loss to the California economy of approximately $78.7 million in direct effects and $119.3 million in indirect and induced effects. However, we estimate that these losses will be more than offset by productivity gains in businesses that implement engineering controls to reduce occupational heat exposure in indoor workplaces. We estimate the direct effects of these productivity gains are equivalent to approximately 4,744 IMPLAN jobs. This represents an overall increase of approximately $256.8 million in direct effects and $402.7 million in indirect and induced effects. Therefore, we estimate the net impact of these labor activities results in direct effects of approximately $178.2 million and indirect and induced effects of $283.5 million in value added to the state economy. Therefore, we estimate the proposed regulation will increase the size of the California economy by approximately $478.9 million in the first year after its implementation.[56] Table 17 reports the total upfront macroeconomic impacts of the proposed regulation.

[56] IMPLAN calculates this as $17.3 million in total expenditures - $197.9 million in total labor costs + $659.5 million in total productivity gains = $478.9 million.

Table 17. Summary of Upfront Macroeconomic Impacts of the Proposed Regulation

Impact Type	Employment	Labor Income, 2023 ($ millions)	Value Added, 2023 ($ millions)
Direct effects	67	$27.9	$186.0
Indirect effects	38	$129.7	$205.4
Induced effects	38	$47.5	$87.5
Total effects	**142**	**$205.1**	**$478.9**

Note: Totals may not sum precisely due to rounding.

We next consider the recurring costs, which we report as the second year impacts. We anticipate these will be similar to the annual impacts of the proposed regulation in future years. We estimate that the recurring costs associated with recurring annualized capital expenditures (and one additional safety inspector FTE) will result in direct effects of approximately 26 jobs and $2.7 million in value added and indirect and induced effects of approximately 26 jobs and $3.2 million in value added. As with the reported first year costs, we do not anticipate direct or indirect job losses as a result of the proposed regulation. We estimate that the direct effects of recurring labor costs to businesses will be about two-thirds of the upfront labor costs, or the equivalent of approximately 879 IMPLAN jobs. We further anticipate that the direct effects of the recurring productivity gains associated with reducing worker exposure to extreme heat conditions, which are identical to the upfront gains, will more than offset the labor costs associated with new compliance actions. This represents a net increase (due to labor impacts) of approximately $202.4 million in direct effects and $319.9 million in indirect and induced effects. Overall, we estimate the proposed regulation will increase the size of the California economy by approximately $528.2 million in the second year of the regulation.[57] Table 18 reports the total macroeconomic impacts of the proposed regulation in the second year after its implementation.

[57] IMPLAN calculates this as $6.0 million in total expenditures - $128.1 million in total labor costs + $650.3 million in total productivity gains = $528.2 million.

Table 18. Summary of Recurring Macroeconomic Impacts of the Proposed Regulation

Impact Type	Employment	Labor Income, 2024 ($ millions)	Value Added, 2024 ($ millions)
Direct effects	26	$27.2	$205.1
Indirect effects	13	$144.0	$228.0
Induced effects	14	$51.6	$95.1
Total effects	**52**	**$222.8**	**$528.2**

Note: Totals may not sum precisely due to rounding.

Results of the Macroeconomic Assessment

This section discusses additional potential economic impacts of the proposed regulation that are not described elsewhere in this report.

Impact on Jobs in California

The statewide employment impacts of the proposed regulation are estimated to be small, but positive due to new expenditures on heating, air-conditioning, and ventilation equipment and services and other changes in final demand. We estimate there will be a temporary increase of approximately 142 jobs in the first year of the proposed regulation and an average of approximately 52 additional jobs supported in subsequent years relative to the *no regulatory action* baseline. These changes represent less than a 0.01 percent increase in employment in California. We do not anticipate direct, indirect, or induced job losses as a result of the labor impacts of the proposed regulation because the labor costs to individual businesses are relatively small and more than offset by productivity gains associated with businesses implementing engineering controls to reduce occupational exposure to extreme heat.

Creation of New Businesses or the Elimination of Existing Businesses within the State

We do not anticipate the elimination of any existing businesses in California as a result of the proposed regulation. The increase in final demand for engineering controls may lead to increases in the number of businesses manufacturing these products and companies specializing in installation of heating, ventilation, and air-conditioning systems. Furthermore, increases in productivity across several sectors may result in a small increase in the number of businesses that supply products and services to these industries. IMPLAN cannot directly estimate the creation or elimination of businesses within the state. However, the overall macroeconomic impacts of the proposed regulation are very small relative to the overall California economy (less than a 0.01 percent change); therefore, we do not anticipate substantial impacts to the creation of new businesses.

Competitive Advantages or Disadvantages for California Businesses

The proposed regulation is unlikely to have a significant impact on the advantages or disadvantages for businesses operating in California. We note, however, that only one other state, Minnesota, has an existing indoor heat standard. The estimated costs of the proposed regulation are relatively small on a per establishment basis; however, the additional requirements add to the costs of doing business in California. We assume that other reasons for doing business in California likely outweigh the costs associated with the proposed regulation. Furthermore, we assume the proposed regulation will be unlikely to significantly impact the ability of California businesses to compete with businesses in other states with similar climate and geographic conditions (and comparable industrial processes that generate heat) that pose a similar risk of heat-related illness to workers.

The Increase or Decrease of Investment in the State

The implementation of the proposed regulation is likely to increase investments in systems and processes to reduce temperatures in indoor workspaces when employees are present, which may provide an opportunity for existing facilities to evaluate other investments in automation and technology. However, for many industries, the investment in heating, air-conditioning, and ventilation systems is likely to be very small on a per establishment basis. The majority of employers in California have already made investments in such cooling or ventilation systems or rely on natural ventilation or other control measures and will incur few additional compliance costs associated with engineering controls. In the long run we expect the proposed regulation may slightly increase average annual investment in the repair, replacement, and operation and maintenance of heating, air-conditioning, and ventilation systems.

The Incentives for Innovation in Products, Materials, or Processes

The indoor heat-illness prevention regulation provides an incentive for employers with hot indoor environments to reduce the temperature or heat index below the regulatory thresholds because those workplaces would no longer be subject to the more stringent (and costly) requirements of the proposed rule. This incentive to avoid more costly regulatory requirements is in addition to pre-existing incentives to mitigate indoor heat to avoid worker injuries and increase worker productivity. Although many companies already have temperature control systems in place due to these pre-existing incentives, the proposed regulation will likely increase the demand for air-conditioning and ventilation systems. There is likely to be a particular need to reduce temperatures in large warehouses, manufacturing and production facilities, greenhouses, and wholesale and retail distribution centers—as well as improve airflow and exhaust systems in smaller hot indoor environments, such as restaurant kitchens and dry cleaners. As a result, there may be an increase in demand for innovative products, materials, or processes to cool these types of work environments.

In addition to mechanical adaptations, affected employers may also innovate through changes in processes and procedures. For example, employers may incentivize supervisors to provide additional cool-down rest breaks in the summer months and during heat waves. Certain industries already move work shifts to cooler times of the day or schedule additional breaks to reduce exposure to heat; the prevalence of these adaptations may increase to avoid working during periods of time when the more stringent (and costly) requirements of the proposed rule would apply.

6. Fiscal Impacts

This chapter summarizes the costs and benefits that will be incurred by state and local governments due to the proposed regulation. The proposed regulation is not anticipated to have a significant fiscal impact on public entities. However, some state and local government establishments may be subject to new safety and health requirements. Cal/OSHA will also incur costs related to enforcement of the proposed regulation. Finally, state and local governments may benefit from changes in revenues due to sales taxes as well as cost savings from potentially avoidable heat-related illnesses among public employees.

Fiscal Impacts to State and Local Governments

The proposed regulation will result in new costs for public entities and changes in revenue from state and local sales tax. First, the proposed regulation will result in new compliance actions imposed on state and local government establishments. Second, Cal/OSHA will incur new enforcement costs to conduct additional workplace inspections due to an anticipated increase in complaints of occupational heat exposure in indoor places of employment.

Based on information from the California EDD's QCEW, there are approximately 1,000 local government establishments in industries subject to the proposed regulation. Of these, approximately one-third are Type 2 establishments that are not likely to be subject to the indoor heat requirements. While it is feasible that a small number of state government establishments may be affected, the vast majority are Type 3 establishments (i.e., workplaces with climate controlled environments) and are unlikely to be subject to the proposed regulation. The remaining local government establishments—approximately 600—are estimated to incur costs totaling approximately $1.3 million in 2023 and $0.6 million in each subsequent year on an (undiscounted) annualized basis. Table 19 reports the total direct compliance costs to state and local entities by 2-digit NAICS code.

Table 19. Summary of Direct Compliance Costs for State and Local Government Entities by NAICS Code

NAICS	Description	State and Local Government Establishments	First Year Costs, 2023 ($ millions)	Annualized Recurring Costs, 2024-2032 ($ millions)
22	Utilities	329	$0.4	$0.2
48-49	Transportation and Warehousing	176	$0.8	$0.3
56	Administrative and Support and Waste Management and Remediation Services	8	<$0.1	<$0.1
72	Accommodation and Food Services	101	$0.1	<$0.1
TOTAL		**614**	**$1.3**	**$0.6**

Source: The number of state and local establishments is based on the California EDD's QCEW, 2019 annual data, as of December 15, 2020. Totals may not sum precisely due to rounding.

DIR intends to enforce the proposed regulation through outreach efforts intended to encourage affected workers to report complaints to Cal/OSHA—similar to past efforts on the outdoor heat standard. Cal/OSHA estimates that the proposed regulation may result in 15 to 25 additional inspections per year. We estimate it will take approximately 27 hours to complete an inspection and submit a final report, or an additional 400 to 700 hours per year in total.[58] These inspections will be primarily investigations of complaints. Employers are already required to protect employees from workplace hazards, including indoor heat, under the Injury and Illness Prevention Program (IIPP) (Section 3203). Therefore, the baseline level of inspections may contribute to identifying potential cases of non-compliance and addressing indoor heat-related work environment conditions at no additional cost to the agency, particularly for establishments that have both indoor and outdoor workers. In addition, Cal/OSHA staff may conduct outreach activities, including awareness programs and setting up, promoting, and monitoring a hotline for worker complaints in English and Spanish.

Cal/OSHA estimates that overall enforcement efforts, including additional inspections, will require up to one additional FTE safety engineer.[59] The current annual salary of an experienced safety engineer at Cal/OSHA is approximately $120,000 (Cal/OSHA, 2019). Accounting for salary and fringe benefits, the fully-loaded labor cost for a safety engineer is approximately $180,000. In addition, we estimate that inspectors will require equipment, materials, and

[58] Based on 2019 data for *outdoor* heat inspections, the overall average time (total activity hours) to investigate a heat case is 26.7 hours. This includes time spent on-site during the inspection, as well as time spent on case review, data entry, etc.

[59] One FTE amounts to 2,080 hours per year, which is greater than the estimated 700 hours per year required to conduct inspections.

transportation (such as a vehicle, personal computer, and tablet or another device with a digital camera). We estimate these costs may be an additional $45,000 per inspector (an overhead factor of approximately 0.38). Therefore, for one additional FTE we estimate the incremental enforcement costs will be approximately $0.2 million per year. This represents approximately one-sixth of Cal/OSHA's annual budget for enforcement of the outdoor heat standard.

Revenue Impacts

As described in Chapter 3, businesses are anticipated to increase their capital expenditures on equipment by $123.1 million in 2023, $17.3 million per year from 2024 to 2027, and $37.1 million in subsequent years to repair or replace older equipment in order to comply with the new requirements for indoor heat illness prevention. This increase in spending may result in higher revenue for state and local governments because equipment purchased or imported in California will incur a sales tax on top of the purchase price. However, we do not know whether or how spending associated with meeting regulatory requirements will affect other business spending. If businesses financed these expenses by reducing other spending categories that would offset potential increases in sales tax revenue.

For this analysis, we use a combined state and local sales tax rate of 8.62 percent (CDTFA, 2021), which is a weighted average based on the location of affected establishments, with 3.94 percent going to state sales tax and 4.68 percent going to local sales tax (CDTFA, n.d.). We estimated that if the additional expenditures associated with meeting the new requirements do not trigger other changes in spending, then California state and local governments would collect up to an additional $10.6 million in revenue in the first year of the regulation, $1.5 million per year for the next four years, and $3.2 million in subsequent years. If businesses finance these expenditures by reducing other spending categories, then the aggregate revenue to state and local governments may be lower.

Cost Savings to Public Entities

The number of public employees that may avoid a potentially serious heat-related illness or death due to the proposed regulation is uncertain. Based on the baseline estimates described in Chapter 2, we estimate that there are approximately 14,600 state and local employees in affected industries, which represents about 1 percent of all affected workers. To the extent that the proposed regulation improves the safety and health of public employees – resulting in fewer heat-related illnesses – the proposed regulation would result in a cost savings for public entities.[60] However, we do not have sufficient information to estimate the number of state and

[60] Based on information from the WCIS, the average amount paid out per workers' compensation claim due to illness or injury caused by occupational indoor heat exposure between 2010 and 2018 was $2,758, including payouts over multiple years. In comparison, Schmeltz, Petkova, and Gamble (2016) found that the median total billed charges for hospitalization due to a heat-related illness in the United States between 2001 and 2010 was $8,965.

local employees treated each year for heat-related illnesses in the baseline. Given the relatively small number of affected state and local employees – and that many work in industries that already have outdoor workers subject to Section 3395 requirements – we do not expect this impact to be large.

Similarly, productivity benefits that accrue to state and local employees may result in cost savings to public entities. However, we estimate that very few public employees will benefit from the added use of engineering controls as a result of the proposed regulation as many state and local employers already use control measures to reduce occupational exposure to extreme heat.

Summary of Fiscal Impacts

Table 20 summarizes the total fiscal and revenue impacts of the proposed regulation to state and local government. We estimate the total fiscal impacts, including costs to state and local entities and Cal/OSHA enforcement costs, would be approximately $1.5 million in 2023 and $0.8 million in each subsequent year. We estimate the total change in revenue due to sales taxes would be an increase of approximately $10.6 million in 2023, $1.5 million from 2024 to 2027, and $3.2 million in each subsequent year if businesses do not finance their expenditures by reducing other spending categories. If businesses finance these costs by reducing other categories of spending, the aggregate increase in tax revenue would be lower.

Table 20. Summary of Fiscal Impacts to State and Local Governments

Year	Compliance Costs for State and Local Entities ($ millions)	Cal/OSHA Enforcement Costs ($ millions)	State Sales Tax Revenue ($ millions)	Local Sales Tax Revenue ($ millions)
2023	$1.3	$0.2	$4.8	$5.8
2024	$0.6	$0.2	$0.7	$0.8
2025	$0.6	$0.2	$0.7	$0.8
2026	$0.6	$0.2	$0.7	$0.8
2027	$0.6	$0.2	$0.7	$0.8
2028	$0.6	$0.2	$1.5	$1.7
2029	$0.6	$0.2	$1.5	$1.7
2030	$0.6	$0.2	$1.5	$1.7
2031	$0.6	$0.2	$1.5	$1.7
2032	$0.6	$0.2	$1.5	$1.7

7. Regulatory Alternatives

In addition to the proposed regulation described in this SRIA, DIR considered two regulatory alternatives that we analyze in this chapter. In the following sections, we describe the less stringent alternative and the more stringent alternative, evaluate the costs and benefits for each relative to the *no regulatory action* baseline and the proposed regulation, and provide DIR's justification for rejecting those alternatives in favor of the proposed regulatory action. We first describe each of the regulatory alternatives and then summarize the costs and benefits of these relative to the proposed regulation.

Alternative 1: Removal of Subsection (e)

The first regulatory alternative would eliminate from the proposed regulation subsection (e), which mandates additional compliance actions related to assessment and control measures when the temperature or heat index equals or exceeds the specified regulatory threshold. Removal of these requirements would make the indoor heat illness prevention requirements generally more consistent with the requirements in Section 3395 (the outdoor heat standard). Specifically, it would remove the requirement to adopt engineering controls or other control measures, where feasible, in indoor workplaces with higher risk of heat illnesses. This recommendation was provided by industry in various public comments submitted on the draft regulation. In this section we summarize the direct impacts of compliance with this regulatory alternative—an indoor heat standard that is similar to the outdoor heat standard without the additional compliance actions required in subsection in (e)—relative to the *no regulatory action* baseline and the proposed regulation.

Costs

The direct costs of the less stringent alternative would be identical for water provision, emergency response procedures, observation during acclimatization, training, and developing a HIPP. This regulatory alternative would remove the requirements that employers measure and record the temperature or heat index and adopt engineering or administrative control measures or provide personal heat-protective equipment to employees when any of the regulatory thresholds have been met. While this would eliminate some of the relatively more costly impacts associated with subsection (e), it is uncertain whether it would result in an overall lower cost for employers because subsection (d) mandates employees be allowed to take preventative cool-down rest breaks to protect themselves from overheating. For instance, if every employee were to take one additional rest break each day the heat index exceeded 82°F, the productivity losses would likely significantly outweigh the upfront costs of adopting engineering controls in indoor workplaces.

Our analysis found that many businesses already use engineering controls on a voluntary basis to reduce heat-related illness and productivity losses. However, there is no requirement that employers do so. Without such a requirement, businesses that do not currently have engineering controls may not choose to adopt them. Without subsection (e), we assume that workers would take extra cool-down rest breaks, in addition to required rest breaks they already take, on about one-third of the days when the heat index is equal to or exceeds 82°F and during heat waves (approximately 20 workdays per employee per year). This accounts for acclimatization during extreme weather events, new assignments, and in the early summer months. This would result in increased costs of administrative control measures associated with the requirement for cool-down areas by a factor of about two compared to the proposed regulation. Therefore, while the upfront costs of the less stringent alternative are significantly lower than the proposed regulation, some costs in subsequent years may exceed costs under the proposed regulation because employers will likely need to implement additional administrative control measures in place of using engineering controls on hot days. Table 21 summarizes the total costs of the less stringent alternative compared to the proposed regulation.

Table 21. Summary of Total Direct Costs of Alternative 1 Compared to the Proposed Regulation

Year	Total Costs of Proposed Regulation ($ millions)	Total Costs of Less Stringent Alternative ($ millions)	Difference ($ millions)
2023	$214.7	$113.8	-$101.0
2024	$74.5	$76.2	$1.7
2025	$74.5	$76.2	$1.7
2026	$80.2	$78.3	-$1.9
2027	$74.5	$76.2	$1.7
2028	$99.8	$81.8	-$18.1
2029	$100.0	$78.3	-$21.7
2030	$94.3	$76.2	-$18.1
2031	$94.3	$76.2	-$18.1
2032	$100.0	$78.3	-$21.7
TOTAL	**$1,006.9**	**$811.6**	**-$195.4**

Note: Totals may not sum precisely due to rounding.

Benefits

The less stringent alternative would not require employers to evaluate heat risk and attempt to reduce the temperature or heat index in indoor places of employers. Instead, it would rely primarily on other practices recommended by OSHA, NIOSH, and other organizations, including providing access to water, cool-down areas, emergency response procedures, observation during acclimatization, training on safety procedures and identifying signs and symptoms of heat illness, and developing a HIPP. We assume these measures would still be helpful in preventing or

reducing occupational heat-related illness in indoor places of employment; however, they would likely be less effective than if they were combined with the additional compliance actions in the proposed regulation. While the relative contribution of each compliance action individually is uncertain, we assume the less stringent alternative would reduce cases of occupational heat-related illness by about 30 percent—using our low-end estimate from the sensitivity analysis of potential benefits—compared to our estimate of 45 percent for the proposed regulation. However, we are unable to quantify potential impacts to worker productivity under the less stringent alternative.[61] Under the proposed regulation, the estimated productivity impacts were of a similar order of magnitude to the estimated health impacts of the new requirements. Therefore, the overall benefits of the less stringent alternative are significantly less than the proposed regulation. Table 22 summarizes the total benefits of the less stringent alternative compared to the proposed regulation.

Table 22. Summary of Total Direct Benefits of Alternative 1 Compared to the Proposed Regulation

Year	Total Monetized Benefits of Proposed Regulation ($ millions)	Total Monetized Benefits of Less Stringent Alternative ($ millions)	Difference ($ millions)
2023	$362.2	$93.7	-$268.6
2024	$371.2	$98.5	-$272.7
2025	$380.4	$103.4	-$277.0
2026	$389.6	$108.4	-$281.3
2027	$399.0	$113.4	-$285.6
2028	$408.5	$118.5	-$290.0
2029	$418.1	$123.7	-$294.4
2030	$427.8	$128.9	-$298.9
2031	$437.7	$134.3	-$303.4
2032	$447.7	$139.7	-$308.0
TOTAL	**$4,042.2**	**$1,162.4**	**-$2,879.9**

Note: Totals may not sum precisely due to rounding.

Reason for Rejecting

DIR rejected the less stringent alternative because it is less likely to effectively prevent or reduce heat-related illness relative to the proposed regulatory action. Specifically, the engineering controls included in subsection (e)(2) represent the most effective method to reduce temperatures in indoor places of employment. Furthermore, the less stringent alternative may not yield the level of productivity benefits estimated under the proposed regulation, while it would

[61] The productivity estimates in Park (2016) are based on actions that are consistent with the adoption of engineering controls. We cannot estimate productivity benefits associated with administrative control measures, such as scheduling additional cool-down rest breaks to provide employees physical relief from excessive heat stress.

still require administrative actions to comply with the other requirements. The less stringent alternative would be less effective than the proposed regulation at reducing the number of cases of heat-related illness and therefore the overall benefits of this alternative would be significantly lower.

Alternative 2: WBGT Device Required to Measure Temperature, Relative Humidity, Air Velocity, and Radiant heat

The second regulatory alternative would require employers under subsection (e)(1) to use a wet bulb globe temperature (WBGT) device to measure the temperature, relative humidity, air velocity, and radiant heat and record these measurements when the temperature is expected to be 10 degrees or more about previous measurements. The WBGT index was developed in 1957 to monitor environmental heat stress in order to reduce heat-related casualties during military training exercises—the WBGT is the most frequently used measure of heat stress and is recommended for use throughout the world (NIOSH, 2016). WBGT takes into account temperature, relative humidity, wind speed, and radiant heat. In comparison, heat index only takes into consideration temperature and relative humidity. The device is slightly more expensive than a basic digital thermometer, and measurements, including the calculation of the WBGT, are relatively easy to make.[62] Various public comments on the draft regulation recommended including a requirement for WBGT measurement of indoor heat stress. Use of a WBGT device may help employers utilize recommendations from NIOSH, OSHA, the American Industrial Hygiene Association (AIHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) for limiting exposure to occupational heat stress.[63] In this section we summarize the direct impacts of compliance with this regulatory alternative—requiring measurement and assessment of exposure to heat stress using a WBGT device—relative to the *no regulatory action* baseline and the proposed regulation.

Costs

The direct costs of the more stringent alternative would be directly comparable to those under the proposed regulation, with the exception that the costs of measuring and recording heat stress levels would be higher. DIR assumes that while using a WBGT may provide employers with the ability to measure indoor heat stress more accurately, it would not help identify additional instances when the indoor temperature equals or exceeds the regulatory thresholds and therefore will not result in additional costs. Furthermore, under the proposed regulation, in lieu of

[62] The indoor WBGT is calculated as *WBGT = 0.7× natural wet bulb temperature + 0.3 × black globe temperature.* The outdoor WBGT is calculated as *WBGT = 0.7 × natural wet bulb temperature + 0.2 × black globe temperature + 0.1 × dry bulb (air) temperature*.

[63] For example, see ACGIH's threshold limit value (TLV®) guidelines for hot environments.

complying with subsection (e)(1), an employer may simply assume a work area is subject to the compliance actions in subsection (e)(2) that are required when the indoor temperature equals or exceeds the regulatory thresholds. Thus, we assume no additional compliance actions would have to be undertaken as a result because employers would already be subject to the requirements in subsection (e)(2). The cost of a WBGT device is higher than a digital thermometer and relative humidity gauge. Based on a review of manufacturer list prices, we estimate the average cost of a WBGT device is about $200. We assume this device would have to be replaced about every three years. Furthermore, using the device would likely require more of a supervisor's time to properly measure and record levels of heat stress. Therefore, we assume each assessment would take 1.5 hours relative to 0.5 hours under the proposed regulation. In addition, we assume supervisors would require training on the proper use of a WBGT device—devices generally come with instructions.[64] We assume it would take an additional 30 minutes of supervisor's time to read the instructions and test the device the first time it is used.

We further assume that about twice as many establishments would need to purchase a device relative to the proposed regulation since WBGT devices are used less frequently by industry.[65] Therefore, we estimate that about 131,000 establishments would need to purchase a new device and conduct assessments relative to about 66,000 establishments under the proposed regulation. For half of the affected establishments, measuring and recording heat stress levels represents a new cost relative to the *no regulatory action* baseline. We estimate that the average cost would be approximately $300 in 2023 and $90 in subsequent years on an annualized basis. For establishments that are already assessing environmental conditions by measuring the indoor heat index, this represents an incremental cost of about $245 in 2023 and $70 in subsequent years on an annualized basis relative to the activities they are already carrying out in the *no regulatory action* baseline. This requirement would increase the average costs of compliance for most small businesses by about 10 to 30 percent relative to the proposed regulation. Table 23 summarizes the total costs of the more stringent alternative compared to the proposed regulation.

[64] OSHA also provides information on the use of WBGT devices. As of April 21, 2021: https://www.osha.gov/heat-exposure/hazards.

[65] We assume that half of the establishments that already conduct measurement and assessment activities would have to switch to using a WBGT device.

Table 23. Summary of Total Direct Costs of Alternative 2 Compared to the Proposed Regulation

Year	Total Costs of Proposed Regulation ($ millions)	Total Costs of More Stringent Alternative ($ millions)	Difference ($ millions)
2023	$214.7	$246.8	$32.1
2024	$74.5	$74.5	$0.0
2025	$74.5	$74.5	$0.0
2026	$80.2	$109.1	$28.8
2027	$74.5	$74.5	$0.0
2028	$99.8	$99.8	$0.0
2029	$100.0	$128.9	$28.8
2030	$94.3	$94.3	$0.0
2031	$94.3	$94.3	$0.0
2032	$100.0	$128.9	$28.8
TOTAL	**$1,006.9**	**$1,125.5**	**$118.5**

Note: Totals may not sum precisely due to rounding.

Benefits

The potential benefits of using a WBGT device include more accurate measurement of heat stress and improved ability to adopt specific recommendations based on the WBGT by government agencies or ACGIH's threshold limit value (TLV®) guidelines, for example. We are unable to quantify these benefits; however, other requirements of the proposed regulation that generally adhere to these guidelines are likely to achieve similar outcomes. Therefore, the benefits of the more stringent alternative are not likely to significantly differ from the proposed regulation. While environmental conditions contributing to heat stress could be more accurately measured by employers, the additional compliance actions employers would have to undertake would be identical to those required under the proposed regulation. Employers could also use a WBGT device on a voluntary basis to monitor the indoor work environment.

Reason for Rejecting

DIR rejected this more stringent alternative because the additional benefits of using a WBGT device are not likely to significantly exceed the benefits of adopting engineering controls in indoor places of employment or reducing heat stress through other preventative measures, such as administrative controls. The WBGT device is more costly than a digital thermometer and relative humidity gauge and using the WBGT would require more time to take a reading as well as training in how to properly use the device. Furthermore, under the proposed regulation, in lieu of complying with subsection (e)(1), an employer may simply assume a work area is subject to the compliance actions in subsection (e)(2) that are required when the temperature or heat index exceeds one of the regulatory thresholds. In this case the employer would still have to comply

with subsection (e)(2). The use of a WBGT device in and of itself is not likely to engender extra compliance actions that will result in additional health or productivity impacts.

Comparison of Regulatory Alternatives to the Proposed Regulation

DIR considered two regulatory alternatives and rejected them in favor of the proposed regulation. Table 24 summarizes the costs and benefits of the less stringent alternative and the more stringent alternative relative to the proposed regulation by year using a discount rate of 3 percent.

Table 24. Costs and Benefits of the Regulatory Alternatives Compared to the Proposed Regulation by Year, using a Discount Rate of 3 Percent

Year	Costs			Benefits		
	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)
2023	$113.8	$214.7	$246.8	$93.7	$362.2	$362.2
2024	$74.0	$72.3	$72.3	$95.6	$360.4	$360.4
2025	$71.8	$70.2	$70.2	$97.5	$358.5	$358.5
2026	$71.7	$73.4	$99.8	$99.2	$356.5	$356.5
2027	$67.7	$66.2	$66.2	$100.7	$354.5	$354.5
2028	$70.5	$86.1	$86.1	$102.2	$352.3	$352.3
2029	$65.6	$83.8	$107.9	$103.6	$350.1	$350.1
2030	$62.0	$76.7	$76.7	$104.8	$347.9	$347.9
2031	$60.2	$74.4	$74.4	$106.0	$345.5	$345.5
2032	$60.0	$76.7	$98.8	$107.1	$343.1	$343.1
Net Present Value	**$717.3**	**$894.6**	**$999.2**	**$1,010.4**	**$3,531.3**	**$3,531.3**
Annualized Value	**$81.6**	**$101.8**	**$113.7**	**$115.0**	**$401.9**	**$401.9**

Note: Totals may not sum precisely due to rounding.

Table 25 summarizes the annualized net benefits (i.e., benefits less costs) of the regulatory alternatives compared to the proposed regulation using discount rate of 3 percent and also presents the impact of using a discount rate of 7 percent. Based on considerations of the overall efficiency of the requirements, DIR selected the proposed regulation in favor of the regulatory alternatives described in this chapter. The net benefits of the proposed regulation are greater than either of the regulatory alternatives.

Table 25. Annualized Net Benefits of Regulatory Alternatives Compared to the Proposed Regulation, using Discount Rates of 3 and 7 Percent

	3 Percent Discount Rate			7 Percent Discount Rate		
	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)	Less Stringent Alternative ($ millions)	Proposed Regulation ($ millions)	More Stringent Alternative ($ millions)
Annualized Costs	$81.6	$101.8	$113.7	$82.3	$103.5	$115.5
Annualized Benefits	$115.0	$401.9	$401.9	$113.4	$399.0	$399.0
Annualized Net Benefits	$33.4	$300.1	$288.2	$31.1	$295.5	$283.5

8. Equity Considerations

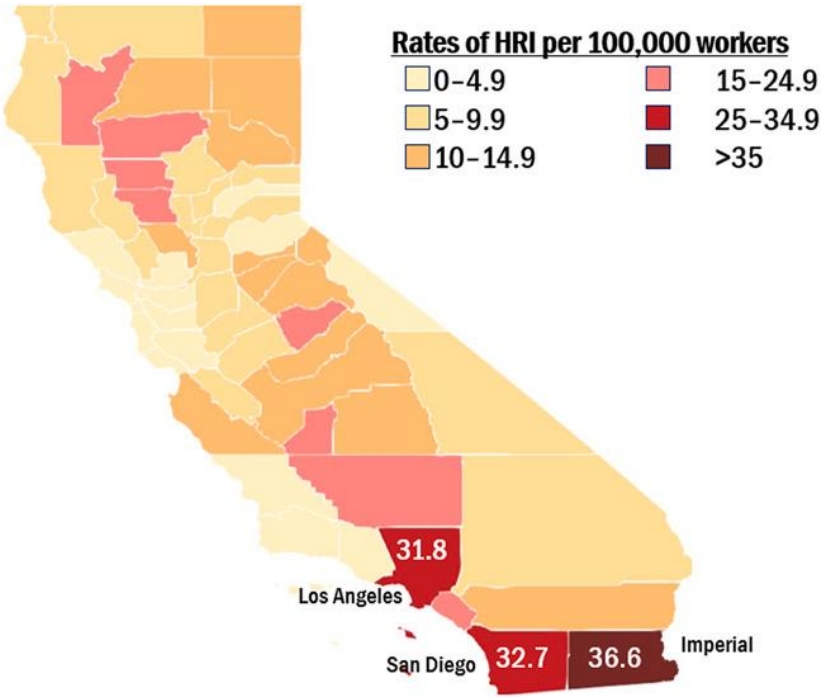
Heat stress poses a serious threat to employees working in non-climate controlled environments or in physically demanding occupations. Occupational exposure to extreme heat conditions can be especially hazardous because individual workers typically have little control over the work environment and activities (Gubernot, Anderson, and Hunting, 2014; Roelofs and Wegman, 2014). Some of those with extremely hazardous jobs—temporary workers, immigrants, and/or those with lower socioeconomic status—are also likely to have little education, low income, no health insurance, chronic health problems, and live in housing that lacks air conditioning, which are individually significant risk factors for heat-related morbidity and mortality (Culp et al. 2011; Vallejos et al. 2011; Lowry et al. 2010).

Workers in hot indoor environments have heterogeneous exposure risks and their individual risk factors for heat-related illness may vary considerably. Some populations are more vulnerable to heat-related illness than others, including (CDC, 2017b; Minnesota Department of Public Health, n.d.):

- Older adults (age 65 and older)
- People with underlying medical conditions, such as: diabetes, high blood pressure, heart disease, mental illness, respiratory conditions, asthma, and obesity
- People taking medications (such as those used to treat high blood pressure and heart problems, reduce allergy symptoms, or reduce psychiatric symptoms) that affect their body's ability to stay hydrated and respond to heat
- People who consume diuretics, such as caffeine and alcohol

Given California's diverse climate and geographic conditions, the population of workers affected by heat-related illness varies substantially across the state. However, workers in any hot indoor environment—particularly with a lack of proper training, experience in a particular job, or acclimatization—may be at risk of heat-related illness. Figure 5 shows the rates of occupational heat-related illness in California by county. Note that the majority of reported cases of heat-related illness represent outdoor workers. Nonetheless, based on the distribution of projected future extreme heat days, we expect the same geographic areas will produce the most extreme heat conditions for indoor workers as well.

Figure 5. Rates of Heat-related Illness by County, California 2000-2017



Source: Heinzerling et al., Risk Factors for Occupational Heat-related Illness Among California Workers, 2000–2017, Figure 2, American Journal of Industrial Medicine, 2020 © 2020 Wiley Periodicals LLC; 63(12):1148. Used with permission.

Overall, both the majority of the costs and benefits of the proposed regulation will be incurred in counties with the largest number of affected establishments and employees. However, the distribution of benefits will be relatively skewed toward areas that are particularly vulnerable to heat stress and those with the highest incidence of heat-related illness. The areas with the highest rates of occupational heat-related illness from 2000 to 2017 were in Imperial, San Diego, and Los Angeles counties.

Table 26 summarizes baseline socioeconomic conditions in California by county. Counties are sorted by the projected number of extreme heat worker-days, which we define as the number of affected indoor workers (from Chapter 2) multiplied by the projected number of extreme heat days (from Chapter 3) for each county. We note that about half of the 11 counties with highest rates of heat-related illness—those identified in Figure 5 as having 15 or more cases per 100,000 workers—fall within the top 20th percentile on the CDC/Agency for Toxic Substances and Disease Registry's (ATSDR) Social Vulnerability Index in California.[66] The median household income in counties most vulnerable to extreme heat conditions is about ten percent lower than in other parts of California, about $72,500 compared to $81,200. The percent of the population

[66] The CDC/ATSDR Social Vulnerability Index uses 15 U.S. census variables to help local officials identify communities that may need support before, during, or after disasters or extreme weather.

living in poverty in these areas is about 13.5 compared with about 12.3 percent in other areas. Furthermore, approximately 44 percent of the population is Hispanic, or Latino, compared to about 35 percent in other areas. According to data from the BLS CFOI, the fatal injury rate for Hispanic workers was nearly 25 percent higher than for non-Hispanic workers and the number of fatal injuries for foreign-born Hispanic workers was 90 percent higher than for native-born Hispanic workers, suggesting that the language barrier may be an obstacle to workplace safety.[67]

Therefore, existing socioeconomic conditions in California suggest the population of workers in areas prone to extreme heat may be particularly vulnerable to the consequences of heat-related illness due to factors such as income status and temporary (e.g., seasonal) worker status—such workers are often reluctant to report any work-related injury or illness due to their dependence on employers for work and wages (Culp et al., 2011). For example, migrant and seasonal farmworkers that are typically foreign-born tend to work long hours, rotate to different employers, and may spend more time acclimatizing to new work assignments and environmental conditions and are likely to have less formal training on identifying signs and symptoms of heat-related illness and preventative safety measures. The proposed regulation may help in addressing longstanding issues of occupational safety and health vulnerability and social and economic inequality by ensuring that employers provide physical relief to employees from excessive heat stress.

[67] U.S. Bureau of Labor Statistics, 2019 Census of Fatal Occupational Injuries, accessed at https://www.bls.gov/iif/oshcfoi1.htm on March 22, 2021.

Table 26. Socioeconomic Conditions in California by County

County	Estimated Number of Affected Employees[1]	Projected Number of Extreme Heat Days[2]	Projected Number of Extreme Heat Worker-Days (millions)	Total Population[3]	Median Household Income[4]	Percent of Population Living in Poverty[4]	Percent of Population, All Non-white Races Including Hispanic[5]	Percent of Population, Hispanic All Races[5]	CDC/ATSDR Social Vulnerability Index[6]
Los Angeles	393,351	49	19.3	10,081,570	$67,986	14.2	29.2	48.6	0.616
Riverside	81,345	120	9.8	2,411,439	$66,793	12.7	20.2	49.4	0.689
San Bernardino	94,119	96	9.0	2,149,031	$63,310	14.9	23.3	53.9	0.828
Orange	152,361	28	4.3	3,168,044	$89,373	10.5	28.4	34.0	0.325
Fresno	32,331	120	3.9	984,521	$52,318	21.3	23.2	53.4	0.924
Sacramento	42,446	90	3.8	1,524,553	$69,475	14.3	36.9	23.4	0.534
San Diego	121,520	28	3.4	3,316,073	$78,777	11.5	24.4	33.9	0.391
Kern	23,204	121	2.8	887,641	$51,586	20.5	17.6	53.9	0.936
San Joaquin	30,052	86	2.6	742,603	$63,567	14.3	33.4	41.8	0.762
Stanislaus	21,670	92	2.0	543,194	$59,616	15.6	16.5	46.9	0.809
Santa Clara	70,837	27	1.9	1,927,470	$125,933	7.3	46.9	25.2	0.193
Tulare	14,172	116	1.6	461,898	$48,763	22.2	11.7	65.1	0.969
Alameda	66,933	18	1.2	1,656,754	$101,744	9.0	50.2	22.4	0.255
Contra Costa	27,647	40	1.1	1,142,251	$101,463	7.8	34.4	25.8	0.248
Placer	12,216	89	1.1	385,512	$89,175	7.1	15.6	14.2	0.072
Solano	13,498	69	0.9	441,829	$82,808	7.9	40.1	26.8	0.370
Merced	7,870	106	0.8	271,382	$56,169	21.2	17.8	60.3	0.962
Yolo	7,417	94	0.7	217,352	$67,804	20.1	25.7	31.7	0.566
Sonoma	16,686	39	0.7	499,772	$81,002	9.9	13.1	27.0	0.255
Ventura	27,877	23	0.6	847,263	$84,170	9.1	15.8	42.9	0.344
Imperial	2,978	185	0.6	180,701	$46,633	21.4	9.8	84.6	0.985
Butte	5,758	93	0.5	225,817	$50,945	18.5	13.9	16.6	0.658
Napa	10,027	42	0.4	139,623	$85,624	8.8	16.1	34.2	0.258

County	Estimated Number of Affected Employees[1]	Projected Number of Extreme Heat Days[2]	Projected Number of Extreme Heat Worker-Days (millions)	Total Population[3]	Median Household Income[4]	Percent of Population Living in Poverty[4]	Percent of Population, All Non-white Races Including Hispanic[5]	Percent of Population, Hispanic All Races[5]	CDC/ATSDR Social Vulnerability Index[6]
Shasta	4,053	101	0.4	179,212	$53,908	15.2	12.2	10.3	0.489
Kings	3,126	118	0.4	150,691	$58,255	18.8	18.9	55.0	0.928
San Luis Obispo	10,913	29	0.3	282,165	$70,626	12.7	11.1	22.7	0.233
Madera	2,471	110	0.3	155,433	$53,632	20.2	13.9	58.2	0.926
El Dorado	3,881	66	0.3	188,563	$81,869	8.1	11.0	13.0	0.171
San Mateo	30,572	8	0.2	767,423	$122,930	6.8	39.9	24.2	0.118
Sutter	2,156	104	0.2	96,109	$57,879	13.5	27.0	31.4	0.788
Marin	8,189	26	0.2	259,943	$122,933	6.6	14.5	16.1	0.033
Monterey	12,462	16	0.2	433,410	$69,665	13.3	17.1	59.1	0.583
Santa Barbara	15,744	8	0.1	444,829	$75,646	12.6	14.4	45.7	0.519
Mendocino	2,363	53	0.1	87,224	$51,386	17.5	13.8	25.5	0.697
Nevada	2,286	50	0.1	99,244	$66,681	10.3	6.6	9.6	0.217
Santa Cruz	8,324	13	0.1	273,962	$84,213	12.2	12.8	33.8	0.428
Tehama	730	105	0.1	63,912	$47,572	17.0	9.6	25.5	0.851
Yuba	657	102	0.1	76,360	$47,504	17.2	21.4	28.7	0.808
Tuolumne	852	71	0.1	54,045	$56,500	12.5	9.6	12.5	0.362
Amador	660	83	0.1	38,429	$58,515	11.8	10.2	14.4	0.390
Glenn	514	101	0.1	27,976	$47,365	15.4	10.7	42.4	0.865
Calaveras	598	82	<0.1	45,514	$62,984	12.1	8.8	12.4	0.314
Lake	684	66	<0.1	64,195	$45,086	18.4	12.7	21.3	0.796
San Francisco	40,287	1	<0.1	874,961	$110,601	10.1	46.9	15.2	0.224
Colusa	395	100	<0.1	21,454	$57,249	11.0	8.7	60.2	0.590
Inyo	398	78	<0.1	17,977	$53,793	12.3	19.9	23.1	0.284
San Benito	1,033	22	<0.1	60,376	$80,063	8.6	12.0	60.4	0.498
Siskiyou	582	34	<0.1	43,468	$47,560	17.1	13.9	12.9	0.602
Mariposa	168	67	<0.1	17,420	$51,402	14.9	10.5	11.7	0.478

County	Estimated Number of Affected Employees[1]	Projected Number of Extreme Heat Days[2]	Projected Number of Extreme Heat Worker-Days (millions)	Total Population[3]	Median Household Income[4]	Percent of Population Living in Poverty[4]	Percent of Population, All Non-white Races Including Hispanic[5]	Percent of Population, Hispanic All Races[5]	CDC/ATSDR Social Vulnerability Index[6]
Humboldt	3,378	3	<0.1	135,940	$49,471	20.3	16.6	11.8	0.643
Plumas	207	25	<0.1	18,660	$55,079	12.5	9.2	9.3	0.256
Trinity	82	57	<0.1	12,700	$40,680	21.6	12.9	7.5	0.657
Mono	529	5	<0.1	14,310	$66,499	9.3	9.7	27.1	0.178
Modoc	84	30	<0.1	8,907	$45,227	19.1	11.5	14.1	0.753
Lassen	18	33	<0.1	30,818	$57,705	15.8	18.9	19.3	0.692
Sierra	18	11	<0.1	3,040	$52,308	13.3	6.8	11.9	0.119
Alpine	21	2	<0.1	1,039	$55,384	17.3	30.2	11.6	0.667
Del Norte	271	0	<0.1	27,495	$48,518	20.4	21.9	20.1	0.879

Source:

1) Employee industry and geographic data from California Employment Development Department, Labor Market Information Division, Quarterly Census of Employment and Wages, 2019.
2) Centers for Disease Control and Prevention's National Environmental Public Health Tracking Network using data from the United States Geological Survey's Thematic Realtime Environmental Distributed Data Services, 2021.
3) United States Census Bureau, American Community Survey, 5-year estimates, 2019.
4) United States Census Bureau, American Community Survey, Socioeconomic Measures, 2018.
5) Centers for Disease Control and Prevention, National Vital Statistics System (NVSS), Bridged-Race Population Estimates, 2018.
6) Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry, Geospatial Research, Analysis, and Services Program, Social Vulnerability Index. Developed using data from the American Community Survey, 2018.

9. Conclusion

Workers who are exposed to extreme heat or work in hot environments may be at risk of heat-related illnesses ranging from mild heat stress-induced symptoms to life-threatening heat stroke (NIOSH, 2016; Heinzerling et al., 2020). Exposure to extreme temperatures can also cause or exacerbate many other medical conditions (Heinzerling et al., 2020). Workers in non-climate controlled environments or in physically demanding occupations, typically with little ability to respond and adapt to extreme heat conditions on an individual basis, may be particularly vulnerable to heat-related illnesses (Roelofs and Wegman, 2014).

The annual number of reported occupational heat stress-related incidents in California has increased in both indoor and outdoor workplaces in recent years—the decade from 2010 to 2019 was the hottest on record since modern global surface temperature recording began in 1880 (NASA, 2020). In 2005, Section 3395 of the California Code of Regulations established a heat illness prevention standard for outdoor places of employment. In September 2016, the California state legislature passed, and the governor signed, Senate Bill 1167, which required Cal/OSHA to propose a standard that minimizes heat-related illness and injury among workers in indoor places of employment. In response, DIR is proposing a new section to the General Industry Safety Orders in Title 8 that would set regulatory requirements for indoor places of employment that equal or exceed specified temperature thresholds. The regulation of indoor workplaces is intended to prevent or significantly reduce illnesses, injuries, permanent disabilities, and deaths related to heat stress from occupational indoor heat exposure.

This SRIA analyses the potential economic impacts of the proposed regulation for heat illness prevention in indoor places of employment.

Summary of Direct Costs and Benefits

Chapter 3 described the anticipated direct costs associated with the compliance actions required by the proposed regulation relative to the *no regulatory action* baseline. The total direct compliance costs of the proposed regulation vary across industries and over time as many of the requirements require both upfront and recurring investments in various heat illness prevention measures. Overall, our primary estimate of the total direct compliance costs of the proposed indoor heat illness prevention requirements is $215 million in 2023 (with a range from $159 to $270 million) and $88 million in each subsequent year (with a range of $64 to $112 million) on an undiscounted annualized basis. These costs are largely driven by two factors: (1) the use of engineering controls, such as evaporative coolers, local exhaust ventilation, air conditioning, or cooling fans, and (2) labor costs related to training employees on identifying risk factors and common signs and symptoms of heat illness, appropriate first aid and/or emergency response,

and the importance of frequent consumption of small quantities of water in hot work environments as well as providing access to cool-down areas when any of the regulatory thresholds have been reached.

Chapter 4 described the anticipated benefits of the proposed regulatory action to both individuals and businesses. Individuals are anticipated to benefit from reduced risk of occupational heat-related illness and death. Businesses are anticipated to benefit from increased labor output by using control measures, such as engineering or administrative controls to mitigate employee exposure to hot indoor temperatures since worker productivity tends to decline in hot indoor environments because employees work fewer hours (Graff Zivin and Neidell, 2014) and because the hours worked become less productive (Park 2016; Tanabe et al., 2006; Seppänen et al., 2006). Based on information provided during interviews with industry representatives, a vast majority of establishments in certain industries (such as indoor establishments with a long-history of working with "hot" processes) have existing measures in place to prevent heat-related illness. The pre-existing adoption of control measures in many industries, which is accounted for in this analysis, suggests that many companies may view the benefits to their business as exceeding the cost of undertaking those measures. The effectiveness of the proposed regulation in reducing heat-related illnesses and deaths is uncertain; therefore, we present a range of estimates using low-end and high-end assumptions for the number of future cases that may be prevented. Our primary estimate of the total direct benefits is $404 million (with a range from $257 to $678 million) on an undiscounted annualized basis.

To account for differences in the timing of future costs and benefits, we apply a discount rate of three percent to the estimates reported above. We estimate that the annualized costs of the proposed regulation will be $102 million (with a range from $75 to $129 million) and the annualized benefits will be $402 million (with a range from $256 to $635 million) using a discount rate of 3 percent.[68] Therefore, the anticipated benefits of the proposed regulation are expected to exceed the anticipated costs. We estimate that the net benefits (i.e., benefits less costs) of the proposed regulation will be $300 million (with a range from $181 to $507 million) using a discount rate of 3 percent. Table 27 reports the costs and benefits of the proposed regulation by year, showing low-end and high-end estimates in addition to the primary estimate reported in this SRIA using a discount rate of 3 percent. Table 28 summarizes the annualized net benefits of the proposed regulation as a range using discount rate of 3 percent and also presents the impact of using a discount rate of 7 percent.

[68] We get similar estimates (although slightly smaller net benefits) using a discount rate of seven percent.

Table 27. Costs and Benefits of the Proposed Regulation by Year with Low-end and High-end Estimates, using a 3 Percent Discount Rate

Year	Costs			Benefits		
	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)
2023	$159.1	$214.7	$270.4	$234.7	$362.2	$571.5
2024	$53.7	$72.3	$90.9	$229.9	$360.4	$560.1
2025	$52.1	$70.2	$88.3	$228.4	$358.5	$559.8
2026	$54.4	$73.4	$92.5	$226.9	$356.5	$559.2
2027	$49.1	$66.2	$83.2	$225.3	$354.5	$558.5
2028	$62.5	$86.1	$109.8	$223.7	$352.3	$557.5
2029	$60.8	$83.8	$106.8	$222.0	$350.1	$556.3
2030	$55.7	$76.7	$97.7	$220.3	$347.9	$554.8
2031	$54.1	$74.4	$94.8	$218.6	$345.5	$553.2
2032	$55.6	$76.7	$97.7	$216.9	$343.1	$551.4
Net Present Value	**$657.1**	**$894.6**	**$1,132.1**	**$2,246.8**	**$3,531.3**	**$5,582.3**
Annualized Value	**$74.8**	**$101.8**	**$128.8**	**$255.7**	**$401.9**	**$635.4**

Note: Totals may not sum precisely due to rounding.

Table 28. Annualized Net Benefits of the Proposed Regulation with Low-end and High-end Estimates, using Discount Rates of 3 and 7 Percent

	3 Percent Discount Rate			7 Percent Discount Rate		
	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)	Low-end Estimate ($ millions)	Primary Estimate ($ millions)	High-end Estimate ($ millions)
Annualized Costs	$74.8	$101.8	$128.8	$76.1	$103.5	$130.9
Annualized Benefits	$255.7	$401.9	$635.4	$254.0	$399.0	$583.9
Annualized Net Benefits	$180.9	$300.1	$506.5	$177.9	$295.5	$453.0

Summary of Macroeconomic Impacts

Chapter 5 described the estimated statewide macroeconomic impacts of the proposed regulation on the California economy. The proposed regulation would result in changes in expenditures and labor costs by businesses in order to comply with the new requirements for indoor heat illness prevention. It would also result in productivity gains in businesses that use engineering controls to reduce occupational heat exposure in indoor workplaces. These changes would affect employment, investment, and output for businesses that provide goods and services to the industries directly impacted by the proposed regulation. These impacts would also result in induced effects, such as changes in personal income that affect consumer spending.

Overall, we estimate that the proposed regulation will increase the size of the California economy by approximately $479 million in the first year and approximately $528 million in the second year of the regulation. We anticipate that ongoing impacts of the proposed regulation in future years will be comparable to the second year impacts. The gains are largely attributable to improvements in employee productivity, which more than offset the labor costs of the proposed regulation. Other potential impacts to outcomes such as job creation, creation or elimination of businesses, competitive advantages or disadvantages for California businesses, increases or decreases of investment in the state, and incentives for innovation are anticipated to be very small relative to the overall size of the California economy.

Consideration of Regulatory Alternatives

Chapter 7 analyzed two regulatory alternatives considered by DIR, evaluating the costs and benefits for each alternative relative to the *no regulatory action* baseline, comparing these against the proposed regulation, and providing DIR's justification for rejecting those alternatives in favor of the proposed regulatory action. Based on considerations of the overall efficiency of the requirements, DIR selected the proposed regulation in favor of the regulatory alternatives. The net benefits of the proposed regulation are greater than either of the regulatory alternatives.

Equity Considerations

Chapter 8 described equity considerations associated with occupational exposure to hot indoor environments. Workers in hot indoor environments have heterogeneous exposure risks and their individual risk factors for heat-related illness may vary considerably. Factors such as age, medical conditions, and living environments can affect workers' vulnerability to heat-related illness. Risk factors are known to be correlated with race and income. For example, within major urban environments, Hsu et al. (2021) find that people of color and people in households living below the poverty line are more likely to live in census tracts where urban conditions contribute to additional heat exposure relative to white or wealthier populations. California's geography also plays an important role. Individuals who work or live in southern or inland California are more likely to be exposed to extreme heat. The proposed regulation may help in addressing longstanding issues of occupational safety and health vulnerability and social and economic inequality by ensuring that employers provide physical relief to employees from excessive heat stress.

Limitations

There are many factors that make the precise estimation of the costs and benefits of the proposed regulation difficult, and in some cases, the potential impacts are uncertain. Throughout this SRIA, we include various robustness checks, including sensitivity analyses, to illustrate how

key sources of uncertainty might affect the costs and benefits of the proposed regulation. We are unable to measure other sources of uncertainty. For example, temperature can vary considerably within counties, particularly for large or coastal counties, but we are unable to systematically identify the geographic location of affected business establishments and employees within counties. Some industries may tend to be located in hotter inland areas due to lower land prices, while others may tend to be located in cooler coastal areas for convenient access to ports or dense urban areas. This sorting may affect the overall, as well as the distributional, costs or benefits of the proposed regulation.

Indeed, the number of establishments in California that will be subject to the proposed regulation is uncertain and may change over time. There is no complete census of indoor workplaces that use hot indoor processes, that are subject to geographic or climate conditions that may result in hot indoor temperatures, or that use air-conditioning. In addition to the approach used in this analysis, we considered an alternative source of information—the U.S. Department of Labor-sponsored O*NET Online—which may be useful for other state or federal policymakers considering the adoption of heat illness prevention regulations. In the California context, we found O*NET was useful to validate the classification of affected industries but did not clearly differentiate between indoor workers and outdoor workers that are already subject to Title 8 Section 3395 of the California Code of Regulations.

Some potential benefits of the proposed regulation were not considered in this SRIA due to the lack of available information about these impacts at the time of the analysis. These include the extent to which exposure to extreme heat in indoor work environments contributes to injuries beyond heat-related illnesses and negatively affects individual other than employees, such as customers or students. It is possible that there are costs which are similarly unaccounted for. It is similarly difficult to precisely estimate the fiscal impacts to state and local government due to uncertainty around whether businesses will compensate for any new spending requirements by reducing other types of expenditures, or exactly what expenditures businesses might adjust. As noted in Chapter 6, we expect those impacts to be relatively small.

As described in Chapter 5, the I-O modeling framework we use to estimate macroeconomic impacts is relatively static, in that it does not allow for substitution across inputs to production or changes in the production function and does not capture the impacts of relative price changes. We determined for the proposed regulation that the benefits provided by the ability to more precisely model targeted macroeconomic impacts among different sectors of the economy was of greater importance than accounting for the impacts of relative price changes. However, this means that the potential for error in our macroeconomic impact estimates increases over time.

Concluding Remarks

Although most instances of heat-related illness are relatively minor, severe cases can result in serious injuries and even fatalities. It is important to acknowledge that many California

employers already take steps to protect their workers from extreme heat, and those actions are often similar to the compliance actions required by the proposed regulation. However, adoption of indoor heat mitigation activities is not universal. Thus, the proposed regulation will impose new requirements on many employers, and the costs associated with these new requirements – including investments in new control measures and time spent on new risk mitigation activities – will vary across industries. Under the assumptions presented in this SRIA, the anticipated benefits of the proposed regulation, primarily improvements in worker health and productivity, exceed the anticipated costs.

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