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PPE

Hazmat Gear Considerations for Chemical Spills

One item does not fit all, especially when it comes to chemical hazards. Here's what you need to know when reviewing your personal protective equipment and chemical protective clothing options.

Tricia Hodkiewicz

Chemical spills vary from incidental to deadly. No matter the spill type, as a responder, you risk overexposure. When entering a hot zone, you must be protected against the actual or potential hazards. The good news is, personal protective equipment (PPE) and chemical protective clothing (CPC) may work to shield, isolate or otherwise protect you from not only chemical hazards but also physical and biological hazards when other control measures are not enough.

It's important to know, though, this gear has its limits. No single set of PPE and CPC will guard against *all* hazards. These suits may even pose their own threats to wearers, such as heat illness; psychological/physiological stress; muscle fatigue; and impaired mobility, dexterity, tactility, vision, and communication.

Therefore, choosing the right PPE-CPC combination is a critical part of any spill response operation. Your goal, however, is to reach an adequate level of protection and avoid over- and under-protection.

Examples of PPE

PPE minimizes your exposure to chemical, physical and/or biological hazards that cause injuries, illnesses and/or fatalities. Examples of PPE include—but are not limited to—respiratory, head, eye, face, hearing, hand, foot and fall protection.

Examples of CPC

CPC protects your skin and/or body from chemical splashes, dusts, gases and vapors. Thoughts of CPC may conjure images of the fully encapsulating chemical-protective suit, which looks like an astronaut suit. However, there are plenty of other sorts of CPC, including hooded one- and two-piece chemical-protective suits, long-sleeved jackets/coats, chemical-protective gloves/over-gloves, protective sleeves/leggings, aprons, coveralls/pants, hoods and disposable shoe/boot covers.

and PPE at the same time. For instance, a glove that protects the hands from chemical contact (and subsequent skin absorption, chemical burns, etc.) would fall under all three terms.

Levels of protection

PPE and CPC are worn together in a "PPE ensemble," informally called a "hazmat suit." The Occupational Safety and Health Administration (OSHA) and the U.S. Environmental Protection Agency (EPS) have long referred to four ensemble levels — A, B, C and D. *Table 1* describes the protection provided as well as the typical and optional types of PPE and CPC that make up each level.

Table 1: OSHA/EPA ensemble levels

Level A	Level B	Level C	Level D
Highest degree of respiratory, skin and eye protection	Highest degree of respiratory protection but a lower degree of skin protection	Lower degree of respiratory and skin protection	No respiratory protection but the lowest degree of skin protection
Typical components: • Positive-pressure, full-facepiece self-	**Typical components:** • Positive-pressure, full-facepiece	**Typical components:** • Full-face or half-mask, air-	**Typical components:** • Coveralls

contained breathing apparatus (SCBA) or a positive-pressure, supplied-air respirator with an escape SCBA • Fully encapsulating chemical-protective suit • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots **Optional components:** • Cooling unit • Coveralls • Long underwear • Hard hat • Disposable suit, gloves and boots worn over the suit	SCBA or a positive-pressure, supplied-air respirator with an escape SCBA • Hooded chemical-resistant clothing • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots **Optional components:** • Coveralls • Chemical-resistant, disposable boot covers • Hard hat • Face shield	purifying respirator with appropriate cartridge • Hooded chemical-resistant clothing • Inner and outer chemical-resistant gloves **Optional components:** • Coveralls • Chemical-resistant safety boots • Chemical-resistant, disposable boot covers • Hard hat • Escape mask • Face shield	• Chemical-resistant safety shoes or boots • Safety glasses or goggles **Optional components:** • Gloves • Chemical-resistant, disposable boot covers • Hard hat • Escape mask • Face shield

Table 1 sources:

29 CFR 1910.120 Appendix B, General Description and Discussion of the Levels of Protection and Protective Gear.

OSHA Technical Manual (OTM) Section VIII: Chapter 1, Chemical Protective Clothing.

Emergency Responder Health and Safety Manual (Version 2.0, January 2017): Chapter 5, Personal Protective Equipment Program.

EPA's Personal Protective Equipment webpage within the agency's Emergency Response homepage.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (DHHS publication no. 85-115).

Hazard assessment

Before you try to work out which PPE ensemble level is appropriate for the spill at hand, size up the situation. Consider:

- The chemical(s) involved (or suspected) and its state, concentration, hazard(s) and exposure route(s);
- Oxygen deficiency and immediately dangerous to life or health (IDLH) conditions;
- Actual exposure levels and the required/recommended exposure limits;
- The chemical container(s) type, size, location and condition;
- The temperature, weather and changing conditions;
- Site hazards, such as uneven surfaces, confined spaces, electrical hazards and falling objects;
- The physical requirements of each response task and duration to complete them;
- Any engineering, administrative and work practice controls that will be in place;
- The relative risk (severity plus probability) for damage to people, property and/or the environment; and
- Available PPE and CPC (and their limitations), along with other resources.

Selecting levels of protection

Based on the hazard assessment, your next step is ensemble selection. This is complex, but the more you know about the hazards, the easier it becomes. OSHA and EPA suggest a starting point: a list of hazardous conditions under which each of the levels may be appropriate. These are described in *Table 2*.

Table 2: Ensemble-level selection quick start

Level:	Used when:
A	• High concentration of identified airborne substance requires highest level of protection for skin, eyes and respiratory system; or • Atmosphere is less than 19.5% oxygen (level B also acceptable); or • Substance with high degree of hazard to skin is known/suspected to be present; or • Operation is in confined or poorly ventilated area; or • Operation involves high potential for splash, skin immersion or exposure to suspected skin hazards; or • Direct-reading instruments indicate high levels of unidentified, potentially hazardous vapors/gases in air; or • Direct-reading instruments are not available to test air, but highly toxic substances suspected to be present.

B	• High concentration of identified airborne substance requires high level of respiratory protection but allows lesser level of skin protection; or • Atmosphere is less than 19.5% oxygen; or • Unknown hazardous substance, but not suspected to: (1) contain high degree hazard to skin, (2) be capable of being absorbed through skin, nor (3) readily penetrate level B suit.
C	• No hazardous substances present that would negatively affect skin nor be absorbed by skin; and • Airborne hazardous substances, if any, are completely identified; and • Air contaminant concentrations do not exceed Immediately Dangerous to Life or Health (IDLH) levels; and • Contaminants can be removed by available air-purifying respirator; and • Atmosphere is not less than 19.5% oxygen; and • All criteria for use of air-purifying respirators are met.
D	• Air contains no known hazards above the permissible exposure limits after site characterization; and • Work precludes splashes, immersion, unexpected inhalation or contact with hazardous levels of substances.

Table 2 sources:

29 CFR 1910.120 Appendix B, General Description and Discussion of the Levels of Protection and Protective Gear.

OSHA Technical Manual (OTM) Section VIII: Chapter 1, Chemical Protective Clothing.

Emergency Responder Health and Safety Manual (Version 2.0, January 2017): Chapter 5, Personal Protective Equipment Program.

EPA's Personal Protective Equipment webpage within the agency's Emergency Response homepage.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (DHHS publication no. 85-115).

Regardless of *Tables 1 and 2* , it's important to tailor your ensemble to your specific situation. Also, review the respirator selection requirements at 29 CFR 1910.134, Respiratory Protection, and the ensemble selection recommendations in Appendix B to 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

Performance factors

Imagine this scenario: You just entered a hot zone with your level A ensemble. Suddenly, chemical vapors begin to seep into your suit through the zipper. Your facepiece clouds over,

then melts. You're unable to proceed with the response. That kind of suit failure is an example of a "performance" issue.

An ensemble must provide an *adequate* level of protection. Yet, relying solely on the OSHA/EPA level criteria takes you only so far. You also need to consider performance factors related to:

- Permeation or chemicals moving through a material on a molecular level;
- Degradation or material changes, such as fading, swelling, loss of strength and deterioration;
- Penetration or chemicals leaking inwardly through zippers, seams or imperfections in material;
- Breathability or heat transfer of the material;
- Strength and durability of the material and components;
- Resistance to cuts, punctures, tears, abrasion, cracking, etc.;
- Functionality in extreme cold and heat;
- Flame-resistance of the material and components;
- Degree of dexterity, mobility and visibility for the wearer; and

The National Fire Protection Association (NFPA) publishes standards used by PPE/CPC manufacturers and others to test the performance of products. NFPA divides ensembles into several standards and classes, but Annex A to NFPA 1990-2022 offers a table that compares these standards and classes to the OSHA/EPA levels. Look for a label certifying that a product is compliant with NFPA's performance criteria.

Upgrading/downgrading ensembles

Be aware that ensemble selection and re-selection is an *ongoing* process. You may decide to upgrade or downgrade the protection level because:

- Spill conditions change,
- You gain more insight about site hazards and conditions over time,
- A change in response tasks brings an increase or decrease in chemical exposure, or

- A worker simply requests an ensemble change.

Other factors to consider

Note that some factors might be considered prior to or during an ensemble purchase. These are listed in *Table 3*.

Table 3: Ensemble-purchasing factors

• Sizes and proper fit • Compatibility with site chemicals • Compatibility with other PPE • Compatibility with accessories (e.g., flashlight, two-way radio, personal monitor and dosimeter)	• Time needed to put on/take off • Likely duration of use • Decontaminating/laundering difficulty • Reusability • Storage and other instructions • Inspection and maintenance	• Repair and replacement options • Expiration or service life • Disposal options • Manufacturer disclaimers • Warranty and return policy • Cost

Table 3 sources:

NFPA 1891-2022, *Standard on Selection, Care and Maintenance of Hazardous Materials, CBRN, and Emergency Medical Operations Clothing and Equipment*.

J. J. Keller® Compliance Network – Institute Safety & Health: HAZWOPER subject.

29 CFR 1910.120 Appendix B, General Description and Discussion of the Levels of Protection and Protective Gear.

OSHA Technical Manual (OTM) Section VIII: Chapter 1, Chemical Protective Clothing.

Emergency Responder Health and Safety Manual (Version 2.0, January 2017): Chapter 5, Personal Protective Equipment Program.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (DHHS publication no. 85-115).

Final thoughts

A PPE ensemble is your last line of defense against hazards presented during spill response. As such, its selection is critical and complex.

OSHA and EPA give you a simple method for selecting a PPE-CPC combination. However, you must base this determination on a complete hazard assessment of the spill situation.

You must also consider performance and other factors. There's no substitute for paying attention to changing conditions and news to help you select (and re-select) the *right* gear for the task at hand.

EHS Today®

HEALTH

AIHA Launches New Heat Stress App

The app that can more accurately gauge heat stress risks in real time, unlike any tool offered previously the group says.

Heat records were shattered this past summer and the early fall forecast predicts above average temperatures to continue in large areas of the country, countless outdoor workers face significant health risks from heat hazards on the job.

To address the increased risk of heat illnesses posed by rising temperatures, the American Industrial Hygiene Association (AIHA) announced on September 10 the availability of its new free **AIHA Heat Stress Mobile App.**

"As climate change continues, AIHA recognizes the need to better protect workers from heat stress—which is why our team of occupational and environmental health and safety experts worked so diligently to develop an app that can more accurately gauge heat stress risks in real time, unlike any tool offered previously," said Lawrence D. Sloan, CEO of AIHA, in a statement.

Developed by leading OEHS heat safety experts from the AIHA's Thermal Stress Working Group in partnership with East Carolina University, the AIHA Heat Stress Mobile App is now available as a free download on both iOS and Android platforms. Prior to the official launch, AIHA requested input from target audiences during its Open Beta testing phase earlier this summer and modified the app based on feedback.

This easy-to-use tool allows users to input the following customized information that will factor into their overall heat stress risk assessment:

- Location (multiple locations can be selected)
- Intensity of workload (users can select light, moderate, heavy, very heavy)
- Clothing type (six different options)
- Cloud coverage (degree of sun exposure)
- Preferred language (English, Spanish, French, or Portuguese)

By combining this information with local weather data automatically pulled from the local National Weather Service, the app calculates the individual's Wet-Bulb Globe Temperature (WBGT) index—the gold standard for evaluating heat stress that incorporates air temperature, relative humidity, wind, and radiant heat—and associated heat stress risk level. The app also delivers heat alerts based on the user's work schedule and their location's current heat stress risk level, as well as health recommendations (i.e., rest breaks and water consumption) based on their individual risk level. Additional resources available include fast reads on recommended heat stress prevention measures, warning signs of heat-related illness, and first aid recommendations to assist a worker in distress.

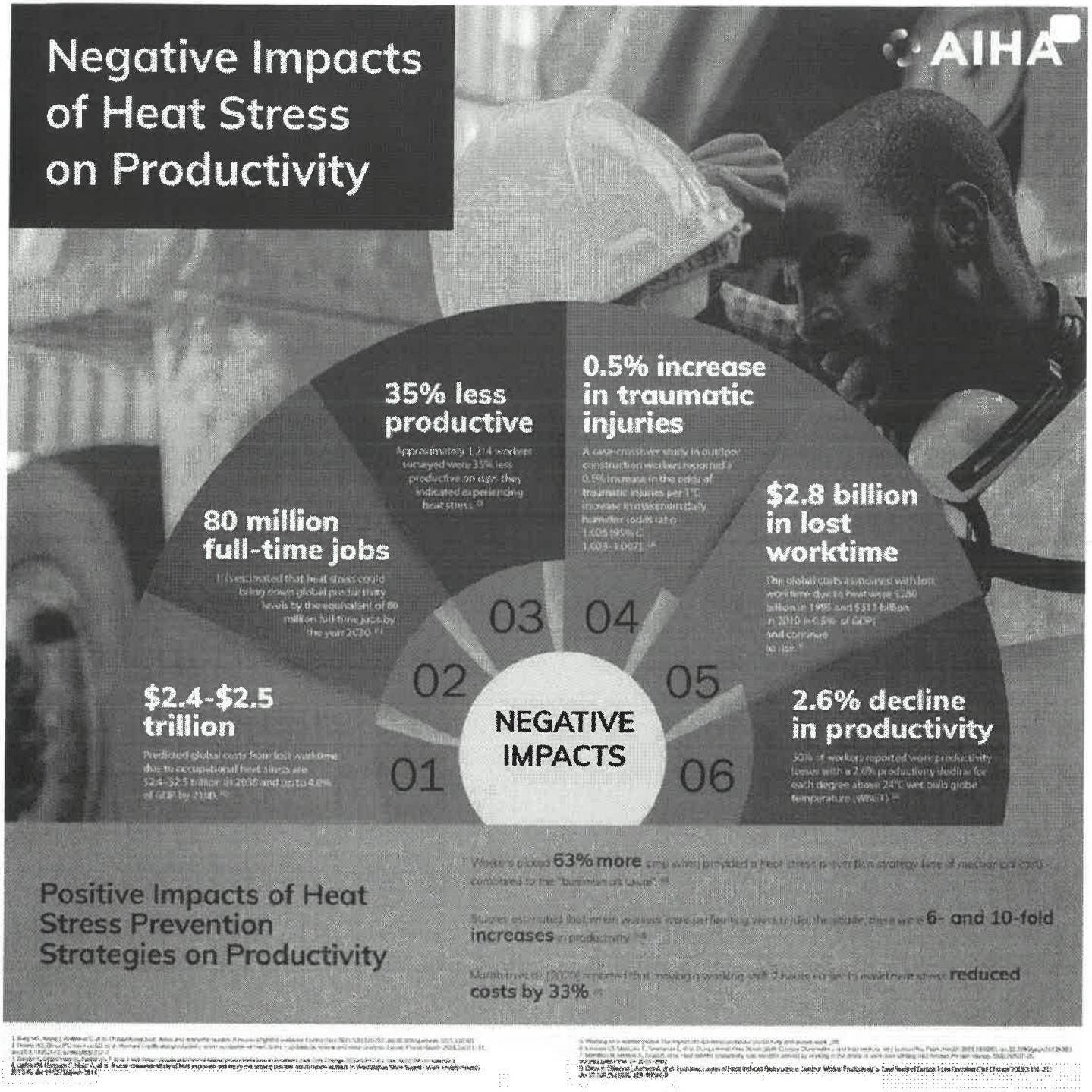
Dr. Morrissey-Basler's research has shown that workers experiencing heat-related symptoms do not perform their job as efficiently as workers not impacted by this type of heat exposure, which can negatively impact an organization's bottom line. In addition, recent research has shown that there are more than 700 heat-related fatalities per year on average in the United States, making environmental heat exposure the leading cause of weather-related deaths.

While both the AIHA Heat Stress Mobile App and the Heat Safety Tool released by OSHA and NIOSH in 2017 have several similar features, a significant difference is that the OSHA/NIOSH app calculates heat risk based on the heat index or "feel like temperature" rather than the more accurate WBGT. The AIHA Heat Stress Mobile App is not a replacement of the OSHA/NIOSH app, but the new app utilizing the WBGT is a more advanced version that both employees and employers can use with additional tools

designed to calculate high and extreme heat stress risks more accurately for workload types.

While the new app monitors the WBGT index in real time, another distinguishing feature is its ability to forecast the WBGT up to five days in the future. Dr. Morrissey-Basler noted that the ability to determine the projected WBGT ahead of time can help employers plan and adjust their work schedules accordingly. The app can assess weather data globally.

Dr. Morrissey-Basler added that exposure to extreme heat can result in occupational illnesses caused by heat stress, including heat stroke, heat exhaustion, cardiac events, kidney injury, or even 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.



As part of AIHA's ongoing commitment to raising awareness of the dangers of occupational heat stress, new free resources devoted to workplace heat stress were recently added to its **Healthier Workplaces** website. A separate **section for employees** outlines personal risk factors that increase one's risk of heat-related injuries or illnesses on the job, tools to assess personal fluid needs, and important warning signs and symptoms of exertional heat stroke. In addition, employers can find strategies to establish evidence-based heat stress protocols designed to safeguard both indoor and outdoor workers.