U.S. Department of Energy
**Office of Environment, Safety and Health**
June 30, 2005

# OPERATING EXPERIENCE SUMMARY

## OE SUMMARY 2005-10

# Awareness of Heat Stress Dangers Can Prevent Tragedy

1

On May 2, 2005, at the Kansas City Plant Kirtland Operations facility, a painter working in a spray-paint booth became overheated and lightheaded, then activated his emergency pager and collapsed to the floor, unconscious. An emergency response team member removed the painter's PPE, noticed that he was red in the face and soaked with sweat, and opened the paint booth doors to let cool air in. The painter regained consciousness about a minute later and spoke to the responder. He was transported to a local hospital, examined, and released. (ORPS Report ALO-KC-AS-FMTNM-2005-0003; final report filed June 9, 2005)

The painter had been working alone in a closed booth at an estimated temperature of 94° F while wearing Tyvek® PPE and an air line respirator. Investigators found that although the paint manufacturer specified applying the paint at a temperature above 85° F, the potential hazard of heat stress had not been addressed in the job hazard analysis.

Corrective actions being taken in response to this event include the following.

- Revise the job hazard analysis to address the potential for heat stress during painting and other tasks where workers could become overheated.
- Revise training modules on working in extreme temperatures indoors or outdoors.
- Revise the preliminary hazard analysis checklist to include considering the potential for heat stress and inquiring whether manufacturers' specifications could introduce additional hazards.
- Revise the preliminary hazard analysis and job hazard analysis programs to clarify the types of process changes that entail additional hazard analysis.

All site personnel are required to be trained on these revisions.

This event demonstrates the hazards workers face when they become overheated. Warm weather increases the potential for heat stress, especially for those who work outside in direct sun or who must wear protective clothing in contaminated areas. The average number of deaths from heat stroke is 200 each year. In fact, the National Weather Service Forecast Office reports that heat kills more people in the United States than the next two types of weather-related events (floods and tornadoes) combined.

While climate alone is often used to gauge the potential for heat stress, other factors, such as required protective gear, can play a major role. A worker may see that the outside temperature is 83 degrees and think that he or she need not worry. However, with the addition of flame-retardant coveralls and a hard hat (Figure 1-1), air flow can no longer cool the worker's skin, and evaporation cannot occur.

**Figure 1-1. Worker wearing respirator and anti-contamination clothing**

In addition, the coveralls create their own microclimate where heat can rapidly build. If the relative humidity rises to 60 percent or more, the capacity for heat removal is further diminished. As a result, the worker has reached a critical level of risk for heat stress while the outside temperature remains a comfortable 83 degrees. The "Heat Index Chart" (courtesy of the National Weather Service) below illustrates the relationship between ambient temperature and relative humidity (RH) and their combined effect on people.

When the body's internal temperatures rises, its vital functions begin to shut down. A person's bodily response to the rising temperature depends on their age, overall health, and whether prescription/non-prescription drugs are in their system. Other factors, such as hydration, how well-rested a person is, and recent food intake can also affect bodily responses. The heat ailments text box describes some identifiable heat stress symptoms.

**Heat Index Chart**

| | Environmental Temperature (°F) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *RH%* | ***85*** | ***90*** | ***91*** | ***92*** | ***93*** | ***94*** | ***95*** | ***96*** | ***97*** | ***98*** | ***99*** | ***100*** | ***101*** | ***102*** | ***103*** | ***104*** | ***105*** |
| *90* | 102 | 119 | 123 | 128 | 132 | 137 | 141 | 146 | 152 | 157 | 163 | 168 | 174 | 180 | 186 | 193 | 199 |
| *85* | 100 | 115 | 119 | 123 | 127 | 132 | 136 | 141 | 145 | 150 | 155 | 161 | 166 | 172 | 178 | 184 | 190 |
| *80* | 97 | 112 | 115 | 119 | 123 | 127 | 131 | 135 | 140 | 144 | 149 | 154 | 159 | 164 | 169 | 175 | 180 |
| *75* | 96 | 109 | 112 | 115 | 119 | 122 | 126 | 130 | 134 | 138 | 143 | 147 | 152 | 156 | 161 | 166 | 171 |
| *70* | 94 | 106 | 109 | 112 | 115 | 118 | 122 | 125 | 129 | 133 | 137 | 141 | 145 | 149 | 154 | 158 | 163 |
| *65* | 92 | 103 | 106 | 108 | 111 | 114 | 117 | 121 | 124 | 127 | 131 | 135 | 139 | 143 | 147 | 151 | 155 |
| *60* | 90 | 100 | 103 | 105 | 108 | 111 | 114 | 116 | 120 | 123 | 126 | 129 | 133 | 136 | 140 | 144 | 148 |
| *55* | 89 | 98 | 100 | 103 | 105 | 107 | 110 | 113 | 115 | 118 | 121 | 124 | 127 | 131 | 134 | 137 | 141 |
| *50* | 87 | 96 | 98 | 100 | 102 | 104 | 107 | 109 | 112 | 114 | 117 | 119 | 122 | 125 | 128 | 131 | 135 |
| *45* | 87 | 94 | 96 | 98 | 100 | 102 | 104 | 106 | 108 | 110 | 113 | 115 | 118 | 120 | 123 | 126 | 129 |
| *40* | 86 | 92 | 94 | 96 | 97 | 99 | 101 | 103 | 105 | 107 | 109 | 111 | 113 | 116 | 118 | 121 | 123 |
| *35* | 85 | 91 | 92 | 94 | 95 | 97 | 98 | 100 | 102 | 104 | 106 | 107 | 109 | 112 | 114 | 116 | 118 |
| *30* | 84 | 89 | 90 | 92 | 93 | 95 | 96 | 98 | 99 | 101 | 102 | 104 | 106 | 108 | 110 | 112 | 114 |

*Note: Exposure to full sunshine can increase heat index values by up to 15°F.*

| Apparent Temperature (°F) | Heat-stress risk with physical activity or prolonged exposure |
|---|---|
| 80° – 90° | Fatigue possible. |
| 90° – 105° | Sunstroke, heat cramps, and heat exhaustion possible. |
| 105° – 130° | Sunstroke, heat cramps or heat exhaustion likely; heatstroke possible. |
| 130° and up | Heat stroke highly likely with continued exposure. |

## Heat Ailments

**Heat stroke:** sweating stops, the victim becomes confused or delirious and may lose consciousness. Body temperatures reach 106° or higher, the skin is hot and dry, may be mottled, red, or bluish. Without prompt treatment, fatality can result. Immediately move the person to a cool area, soak his clothes with water, fanning him vigorously, and summon medical attention.

**Heat exhaustion:** results from dehydration, electrolyte imbalance, or both. The victim is still sweating but is giddy, nauseous, has a headache; skin is clammy and moist. Let victim rest in a cool place and drink an electrolyte solution to quickly restore potassium, calcium, and magnesium salts.

**Heat cramps:** muscle spasms result when workers drink enough water but do not replace their bodies' salt loss. Tired muscles may be the first to cramp either at work or after.

**Heat syncope:** a mild form of heat illness in which the skin blood vessels, in an effort to maximize heat loss, dilate to such an extent that blood flow to the brain is reduced, resulting in symptoms of faintness, dizziness, headache, increased pulse rate, restlessness, nausea, vomiting, and possibly a brief loss of consciousness.

**Heat rash:** also known as prickly heat; occurs in hot, humid environments where sweat does not easily evaporate. Taking rest periods in a cool place can prevent or alleviate it.

*— Occupational Health & Safety Online*

Workers experiencing heat stress may have trouble concentrating and may become disoriented to the extent that they can no longer tend to their own well-being. A worker may lose as much as 6 quarts of water a day through sweating, leaving the body dangerously dehydrated and low on electrolytes. Sports drinks that replace carbohydrates and electrolytes (e.g., Gatorade®) are marketed just for that purpose.

Currently, there is no Federal OSHA standard for heat stress, but OSHA has held liable those employers who have required their employees to work in excessively high temperatures. Liability is based on the requirements of the General Duty Clause of the Occupational Safety and Health Act of 1970, Section 5(a)(1). The section states that each employer "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees…."

OSHA has Voluntary Safety and Health Program Guidelines that include a heat stress program. Section III, Chapter 4 of the *OSHA Technical Manual* provides general guidelines for identifying and controlling potential heat stress situations. The threshold limit value (TLV) guidelines are based on those in the ACGIH publication *Heat Stress and Strain: TLVs for Physical Agents*.

How can employers protect their workers? There are numerous options. For example, commercially available personal heat stress monitors provide audible and visual alarms when a person's core temperature exceeds a preset maximum. The monitor takes measurements from multiple sensors and calculates the Wet Bulb Globe Temperature (WBGT) Index Value, which is the combined effect of air temperature, wind speed, humidity, and radiant heat. There are also heat stress calculator programs available on the Internet (e.g., the PPE Heat Stress Calculator by GEOMET) that help determine risk levels based on individual characteristics, PPE worn, work levels and durations, and ambient environments.

Employers may choose from a wide variety of engineered controls such as fans or personal cooling systems (vests, headwear, wrist bands, etc.). Alternatively, work schedules can be changed so that work is performed at night or with more frequent breaks. Tips to help workers and employers prevent heat-related events are detailed in the text box "Work Defensively to Protect Yourself from Heat Stress."

Knowing that heat and anti-contamination (anti-c) clothing can be a dangerous mix, facility managers and occupational safety and health representatives need to be proactive in recommending control measures and planning work and should consider having industrial hygienist staff implement the following procedures.

- Evaluate all tasks for heat stress risk.
- Perform measurements (WBGT, for example) to compute stress, using *time* + *temperature* + *conditions* in their computations.
- Offer toolbox briefings to alert personnel to heat dangers and to demonstrate the monitoring equipment they use.

## Work Defensively to Protect Yourself from Heat Stress

- Drink one cup of cool water every 20 minutes; avoid coffee, alcohol, and soft drinks.
- Schedule work in the coolest part of the day or on the night shift with short, frequent rest periods.
- Understand your "stay time;" that is, the time limit for safe work, before you begin to work. Closely monitor your time and do not overstay.
- Recognize that medical conditions make a person more susceptible to heat: heart conditions, medication, pregnancy, age, obesity, and previous heat injuries, for example.
- Ask coworkers how they're feeling and be alert to a coworker who is flushed, confused, has a rapid heartbeat, or has stopped sweating. If these symptoms are present, get emergency medical attention immediately. Remember, ignoring the precursors could result in a death.
- If possible, remove the worker to a cooler environment. If you cannot move the worker, loosen clothing to allow air flow.
- Receive training on protecting yourself and protecting others in hot environments.
- Wear personal cooling systems when available.

**In most cases, heat is a greater danger than radiation.**

*— Occupational Health & Safety Online*

*It is important to understand how serious heat stress can be and what actions to take if it occurs. The immediate health effects from heat stress or heat stroke pose a far greater risk to workers wearing anti-c's, chemical suits, or heavy firefighters' equipment than those of other job-related hazards. Workers should be vigilant and aware of the signs of heat stress, both theirs and their co-workers. If a coworker wearing anti-c's exhibits symptoms of heat stress while in a contaminated area, you must act quickly to get the person out to the step-off pad as soon as possible. If that is not possible, you should loosen the PPE (taped wrists, hood, etc.) to allow air to circulate and cool the victim. Having the victim lie on a concrete floor can help in cooling, for example, as can applying a cooling vest or ice pack.*

**KEYWORDS:** *Heat stress, anti-c's, PPE*

**ISM CORE FUNCTIONS:** *Analyze the Hazards, Develop and Implement Hazard Controls*

## Make Sure Students Know How to Work Safely

2

Each year, a handful of events involving students is reported to ORPS. We have found that in most cases, the students were adequately trained on general employee and electrical safety procedures. However, if an unexpected hazard arose, the students were often poorly supervised and uncertain about how to deal with the hazard. Student workers require mentoring and supervision, especially when performing potentially hazardous tasks. In addition, a mentor can instill in a student the importance of a strong safety culture — a lesson that will prove beneficial throughout the student's working life.

Described below are four events that have been reported over the past year where students went beyond their assigned scope of work or encountered a hazardous condition, nearly causing serious injury to themselves.

On May 10, 2005, at Los Alamos National Laboratory (LANL), a student using a thermocouple to take temperature readings in a furnace received a mild electrical shock when he leaned his arm against the surrounding fume hood and the thermocouple contacted the furnace heating coils, creating a short circuit. A ground-fault circuit interrupter tripped and de-energized the furnace. The student reported a tingling sensation in his fingers and was examined at the onsite medical facility and released without restriction. (ORPS Report ALO-LA-LANL-TSF-2005-0001)

Facility management stopped all student work so the event could be evaluated. Investigators discovered that the person in charge and the team leader had added a new task to the activity without first reviewing its hazard potential. Also, the student was unsupervised because his assigned mentor was out of the office that day. Corrective actions include rewriting the integrated work document and requesting the group electrical safety officer to inspect all electrical equipment that requires his approval.

On January 10, 2005, at LANL, a student was connecting batteries he had just replaced in an uninterruptible power supply (UPS) (shown in Figure 2-1) when the uninsulated crescent wrench he was using became stuck between two bolts leading to positive and negative terminals, causing a short circuit. The student was not injured, but the positive terminal post melted (Figure 2-2) and welded the wrench to the unit. The student, who was wearing rubber-soled shoes, kicked the wrench free. (ORPS Report ALO-LA-LANL-RADIOCHEM-2005-0002)

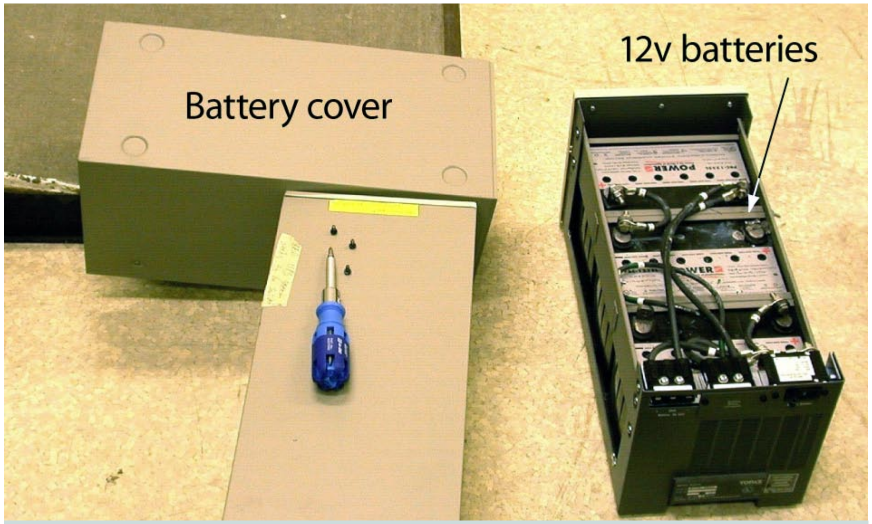


**Figure 2-1. Topaz Powermaker Micro UPS**

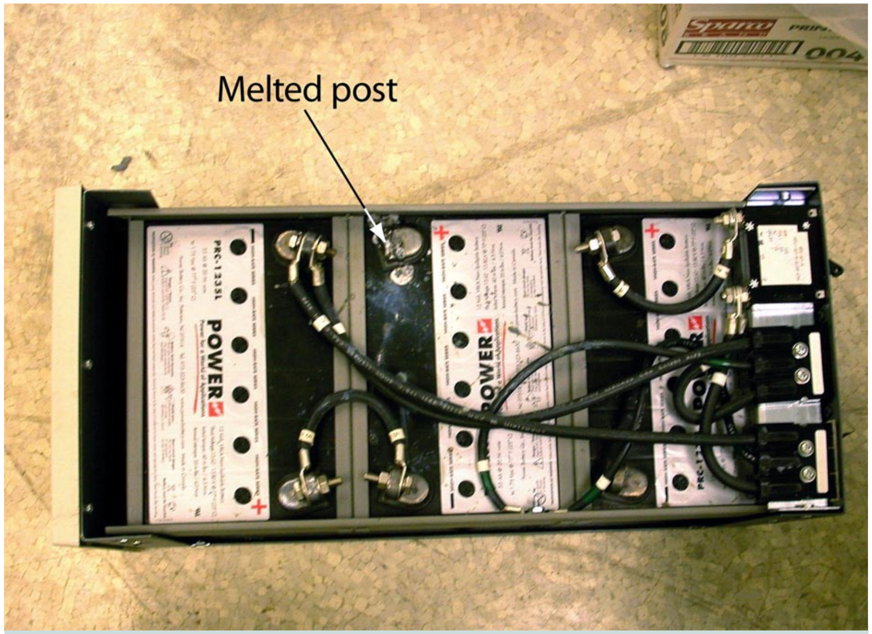


**Figure 2-2. Controller unit with batteries**

After the event, electrical safety officers performed calculations and concluded that this task should have been performed by two qualified electrical workers wearing PPE (eye protection, insulated gloves, and insulated tools) under a special electrical work permit.

Investigators identified numerous causal factors, beginning with the mentor and team leader mischaracterizing the work. Both the team leader and the mentor assumed that changing batteries was a nonhazardous task. The student made the same assumption as he had performed similar tasks before. However, the replacement batteries came with longer screws than the old batteries. There was a small, difficult-to-read diagram with installation instructions (Figure 2-3) inside the cover of the UPS, but the student put the cover aside and did not see the instructions.

The installation instructions directed users to place the screws with the threaded shafts facing away from each other, but the student installed the batteries with the threaded shafts facing each other, leaving very small gaps between them. When the wrench became wedged between the bolts, it caused a short circuit between the terminals.

The student is to be commended for taking quick action and kicking the wrench free from the terminal. His response prevented a potential explosion or fire.

The UPS was replaced with a newer model that has plug-in ends rather than exposed terminals. Also, the Laboratory updated its guidance on battery safety to more clearly define the potential hazards of changing batteries.

On September 30, 2004, at Oak Ridge National Laboratory, a student intern working under the supervision of a division group leader to assemble an experiment cut his left hand when he used his own pocket knife to cut a heavy plastic strap holding a cable.

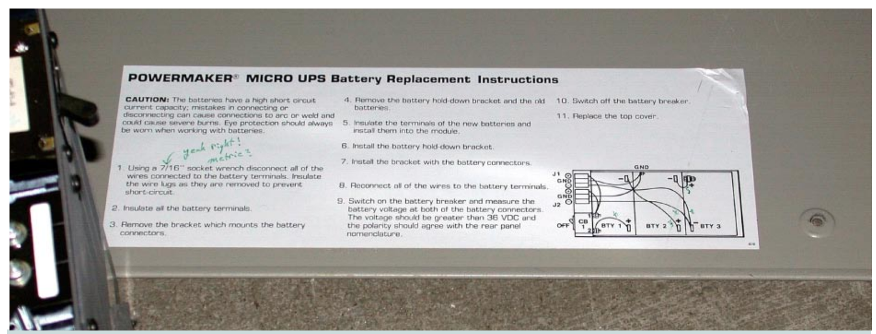


**Figure 2-3. Battery installation instructions**

Although the group leader went to get a pair of cutters, the student decided to use the pocket knife instead. (ORPS Report ORO--ORNL-X10CENTRAL-2004-0018)

The student's use of the wrong tool was discussed at the ensuing critique and at the monthly safety meeting for students. The monthly safety meetings were instituted following a 2003 incident (not reported in ORPS) in which an unsupervised graduate student injured his hand in a rotating drill press when a ½-inch-diameter steel rod (Figure 2-4) grabbed the gloves he was wearing. A label was posted on the front of the drill warning users not to wear gloves.


**Figure 2-4. Drill press**

*These events illustrate the importance of carefully planning and supervising work done by students. Even if they are familiar with the task being performed, they may not be fully prepared to deal with unexpected problems. The laser eye injuries at Los Alamos in July 2004 and at the National Renewable Energy Laboratory in January 2005, discussed in Special Operations Report: Laser Safety, are more extreme examples of students who were injured at work.*

**KEYWORDS:** *Student, oversight, conduct of operations, electric shock*

**ISM CORE FUNCTIONS:** *Identify the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

**Good Practice:** Conduct regular safety meetings with student workers to discuss potential hazards they could encounter in the course of work and to reinforce the importance of a strong safety culture.

## Preventing Slip, Trip, and Fall Injuries in the Workplace

3

Slips, trips, and falls account for more than 1 million injuries in the United States each year. Clearly, if you walk, you're at risk. Slips, trips, and falls can occur in the office, in the parking lot, on the stairs, and on the job.

Workers can suffer debilitating injuries from falls on slippery or degraded walking surfaces and from tripping hazards associated with poor housekeeping. The majority of falls occur at the same level, rather than from a height, and most fall-related fatalities occur at construction sites.

The DOE Office of Corporate Performance Assessment searched the ORPS database for slip, trip, and fall events that occurred between January 1, 2004 and March 31, 2005, at DOE facilities. Fifty-three events that resulted in worker injuries were reported to ORPS in that timeframe. As expected, the two largest categories involved fractures to the extremities, such as the ankle/foot (initiating location) or the hand/wrist (breaking the fall). Figure 3-1 shows the distribution of these injuries.

The majority of these events occurred because of wet and slippery conditions (e.g., ice, snow, and mud), with 21 percent occurring while walking to and from the office or work location.

There are four general categories under which fall-down accidents are grouped.

1. Slip-and-fall accidents — failures in the interface between shoes and walking surfaces
2. Step-and-fall accidents — missteps, unexpected holes, depressions

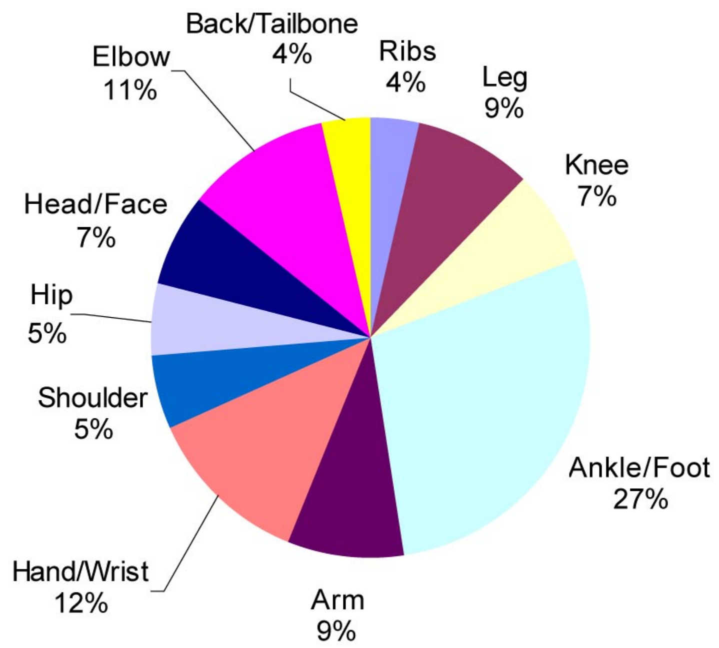


**Figure 3-1. Distribution of worker injuries**

3. Stump-and-fall accidents — impediments in the walking surface
4. Trip-and-fall accidents — foreign objects in the walking path

Our analysis and categorization of the 53 events reported to ORPS showed that 41 percent were slip-and-fall accidents. Most of these resulted from weather conditions, failing to adequately remove ice and snow, and continuing to work during slippery conditions because of workload and schedule. Other causal factors included performing work on wet surfaces, walking on wet floors during cleaning, and failing to factor issues with walking or work surfaces into the job plan.

Step-and-fall accidents comprised 25 percent of the events. Causal factors for this category included inattention while walking and carrying objects, stepping into depressions in walking surfaces, poor lighting conditions, not wearing appropriate footwear, and missteps.

Trip-and-fall accidents and stump-and-fall accidents each contributed to 17 percent of the 53 events. Causal factors included poor housekeeping practices, uneven walking surfaces, missing warning signs/paint for damaged walkways, and physical obstructions.

Indoor floor areas that are not carpeted, such as workshops, offices, and hallways, can be slippery because of highly polished walking surfaces or because of spilled water, oil, or grease. Spills need to be cleaned up as soon as possible. The National Safety Council reports that many slip accidents on floor surfaces result from improper cleaning methods and recommends cleaning floors only with water. Additional measures must be taken if soap or commercial strippers are used to ensure that no residue remains when the floor dries.

Federal regulations from the Americans with Disabilities Act recommend a coefficient of friction (a measure of the slipperiness of a surface) of 0.6 or higher for floor surfaces. For example, the coefficient of friction for a rubber-soled shoe on asphalt is 0.6, but on ice it decreases to 0.06 (i.e., 10 times as slippery).

Tripping hazards can be caused by poor housekeeping. Maintaining a safe workplace can be a real problem, especially during construction or demolition activities. Because of the nature of the work and other job-related hazards, workers can easily lose sight of tripping hazards. Figure 3-2 is an example of poor housekeeping.

**Figure 3-2. Can you find the tripping hazard?**

*These events illustrate that slips, trips, and falls can happen anywhere and at any time. It is an especially serious problem for older workers because of the types of debilitating injuries that can occur. Because walking is a motor skill that occurs without conscious direction, workers need to be aware of their surroundings and remain observant in order to avoid potential hazards as they walk and step. Facility managers need to ensure that a safe workplace is provided, both in offices and at job sites. Subpart D,* Walking-Working Surfaces, *in the General Requirements of 29 CFR 1910, provides guidance on housekeeping.*

## Good Work Practices for Preventing Falls in the Workplace

- Remove snow and ice as quickly as possible.
- Factor weather conditions that can affect walking surfaces into job planning and scheduling.
- Use non-skid waxes and surfaces coated with grit.
- Mark (signs/paint) or barricade uneven or damaged walking surfaces until permanent repairs can be made.
- Ensure that adequate lighting is provided for stairwells, walkways, and parking lots.
- Keep aisles, stairs, and walkways free of clutter and tripping hazards.
- Keep exits free of obstructions.
- Clean up spills immediately.

**KEYWORDS:** *Slip, trip, fall, injury, walking, snow, ice, floor, walkway, stairs*

**ISM CORE FUNCTIONS:** *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*

# Use the Correct Respirator Cartridge to Prevent Inadvertent Exposures

4

Two events recently reported to ORPS involved workers using respirator cartridges that did not protect against the contaminant encountered in the work area. Respirator cartridges and canisters are designed to protect against individual contaminants or a combination of potentially hazardous contaminants. All cartridges are specifically labeled and color-coded (see Figure 4-1) to indicate the type and nature of protection they provide. Using the wrong cartridge can result in long-term health problems or a fatality.

Figure 4-1. Various respirator cartridges

On February 23, 2005, at the Oak Ridge East Tennessee Technology Park, a subcontractor work crew removing asbestos-containing floor tiles was potentially exposed to legacy mercury when crew members used the wrong respirator cartridge for mercury protection. The workers had already completed the tile-removal task when a subcontractor safety officer read the cartridge label and realized the error.

Following the incident, work was stopped, and the area was posted to prohibit entry. (ORO--BJC-K25GENLAN-2005-0006; final report issued April 15, 2005)

The crew of five had been instructed to wear additional respiratory protection for mercury because historical information indicated there had been a mercury spill in the room. Before the work task began, the subcontractor safety officer called his contractor's lead safety officer to ask which cartridge should be used when mercury was a potential hazard. He then assigned cartridges to the workers based on the information he received during the phone call.

The crew worked on the tile-removal task for about 3 hours. When they left the work area, the safety officer checked their cartridges and realized there was no indication on the label that the cartridge provided protection against mercury. He called Mine Safety Appliances (the supplier) and confirmed that in fact the wrong type of cartridge had been used. Apparently the error occurred because of a miscommunication between the safety officers that led to the workers using a GME-P100 cartridge rather than the correct cartridge, the Mersorb P100. The GME-P100 protects against particulates, such as asbestos, but provides no protection against vapors. All five workers were sent for a bioassay, and the results were negative for mercury contamination.

Investigators determined that a Mine Safety Appliances chart showing the different cartridge types and the contaminants they provided protection against was hanging on the wall in an office at the job site. However, no one checked the chart to verify the information exchanged in the phone call between the safety officers.

Corrective actions for this event emphasized the need to use written (rather than spoken) communication when identifying hazards and controls. In addition, a review of respiratory hazards and equipment selection (including cartridge selection) will be incorporated into pre-job briefings.

On May 11, 2005, Los Alamos National Laboratory (LANL) reported that they had received information that a worker who had used the wrong filter cartridge during an acid-pouring work activity in 2003 has decreased lung function and has experienced respiratory difficulties for the past 18 months. (ALO--LANL-FIRNGHELAB-2005-0005).

On October 2, 2003, two LANL workers were exposed to 36 percent hydrochloric acid vapors when they used high-efficiency particulate air (HEPA) filter cartridges in their respirators instead of the required acid gas cartridges. When they began pouring acid, the workers noticed a strong smell of acid and a burning sensation, so they left the room and checked the seals on their respirators. They re-entered the room, again smelled acid vapors, and exited. They later learned that they had worn the wrong cartridges. One of the workers began experiencing respiratory difficulties after a few months. Physicians determined that he had experienced an occupational injury as a result of the event. Investigation into this event is ongoing.

The table on the following page shows the designated colors for various contaminants. Color-coding provides a rapid method for identifying respirator cartridges, but users should always read the cartridge label to ensure that the correct cartridge is being used. If the safety officer for the tile-removal task had read the label before the workers entered the room, rather than after, a potential mercury exposure could have been prevented.

It is also essential to consult the Material Safety Data Sheet for the substance that needs to be filtered before choosing a filter. Additional information about respirators, including respirator and cartridge selection and maintenance, is available on the NIOSH website.

*These events illustrate the importance of checking the Material Safety Data Sheet for a contaminant before choosing respiratory protection. It is also essential to read the label on a respiratory cartridge in addition to checking the color to ensure that the correct cartridge is used. Users should always self-check their personal protective equipment before using it. Both workers and supervisors must also realize that relying on spoken communication can result in a miscommunication that may lead to using improper controls for the hazard encountered.*

**KEYWORDS:** *Respirator cartridge, color-code, respiratory protection, contaminants, mercury, exposure*

**ISM CORE FUNCTIONS:** *Analyze the Hazards, Develop and Implement Hazard Controls*

ANSI Standard, ANSI Z88.7-2001, *Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters*, establishes a system for identifying NIOSH-approved respirator air-purifying elements by means of color-coding.

This standard replaces ANSI K131.1-1973, and some of the designated colors have been changed in the new standard. The table on the following page shows the current designations.

## ANSI Z88.7-2001 COLOR CODES

| CONTAMINANT | COLOR |
|---|---|
| Acid gases | White |
| Organic vapors | Black |
| Ammonia gas | Green |
| Ammonia/methyl amine gas | Green |
| Carbon monoxide gas | Blue |
| Acid gases and organic vapors | Yellow |
| Acid gases, ammonia and organic vapors | Brown |
| Organic vapors, chlorine, chlorine dioxide, hydrogen chloride, hydrogen fluoride, sulfur dioxide, formaldehyde, hydrogen sulfide, ammonia, and methyl amine | Tan (Pale Brown) |
| Acid gases, ammonia, organic vapors carbon monoxide | Red |
| Other vapors and gases or combinations not mentioned above | Olive |
| High-efficiency (PAPRs only) | Purple |
| Any particulates (P100) | Purple |
| Any particulates (P95, P99, R95, R99, R100) | Orange |
| Any particulates free of oil (N95, N99, or N100) | Teal |

## Commonly Used Acronyms and Initialisms

| Agencies/Organizations | |
|---|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ANSI | American National Standards Institute |
| CPSC | Consumer Product Safety Commission |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| EPA | Environmental Protection Agency |
| INPO | Institute for Nuclear Power Operations |
| NIOSH | National Institute for Occupational Safety and Health |
| NNSA | National Nuclear Security Administration |
| NRC | Nuclear Regulatory Commission |
| OSHA | Occupational Safety and Health Administration |
| SELLS | Society for Effective Lessons Learned |

| Units of Measure | |
|---|---|
| AC | alternating current |
| DC | direct current |
| psi (a)(d)(g) | pounds per square inch (absolute) (differential) (gauge) |
| RAD | Radiation Absorbed Dose |
| REM | Roentgen Equivalent Man |
| v/kv | volt/kilovolt |

| Job Titles/Positions | |
|---|---|
| RCT | Radiological Control Technician |

| Authorization Basis/Documents | |
|---|---|
| JHA | Job Hazards Analysis |
| NOV | Notice of Violation |
| SAR | Safety Analysis Report |
| TSR | Technical Safety Requirement |
| USQ | Unreviewed Safety Question |

| Regulations/Acts | |
|---|---|
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| RCRA | Resource Conservation and Recovery Act |
| D&D | Decontamination and Decommissioning |
| DD&D | Decontamination, Decommissioning, and Dismantlement |

| Miscellaneous | |
|---|---|
| ALARA | As low as reasonably achievable |
| HVAC | Heating, Ventilation, and Air Conditioning |
| ISM | Integrated Safety Management |
| MSDS | Material Safety Data Sheet |
| ORPS | Occurrence Reporting and Processing System |
| PPE | Personal Protective Equipment |
| QA/QC | Quality Assurance/Quality Control |

## EH Publishes "Just-In-Time" Reports

The Office of Environment, Safety and Health publishes a series of Just-In-Time reports on its Lessons Learned and Best Practices web site. These reports are targeted to work planners and workers and discuss safety topics relevant to the work they do. Each report presents examples of problems and mistakes encountered in actual reported cases and offers points to consider to avoid similar mistakes in the future.

EH plans to issue more Just-in-Times soon on other safety issues. All of the Just-in-Times can be accessed at http://www.eh.doe.gov/paa/jit.html.

The Office of Environment, Safety and Health, Office of Corporate Performance Assessment publishes the Operating Experience Summary to promote safety throughout the Department of Energy complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, EH relies on preliminary information such as daily operations reports, notification reports, and conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Frank Russo, (301) 903-8008, or Internet address Frank.Russo@eh.doe.gov, so we may issue a correction. If you have difficulty accessing the Summary on the Web (URL http://www.eh.doe.gov/paa), please contact the ES&H Information Center, (800) 473-4375, for assistance. We would like to hear from you regarding how we can make our products better and more useful. Please forward any comments to Frank.Russo@eh.doe.gov.

The process for receiving e-mail notification when a new edition of the OE Summary is published is simple and fast. New subscribers can sign up at the following URL: http://www.eh.doe.gov/paa/oesummary/subscribe.html. If you have any questions or problems signing up for the e-mail notification, please contact Richard Lasky at (301) 903-2916, or e-mail address Richard.Lasky@eh.doe.gov.