HTIS
Hazardous Technical Information Services
BULLETIN
Vol. 21, No.1 January – February 2011

The Good, The Bad & The Future: Sulfur Hexafluoride

Managing a Mission - Critical Greenhouse Gas —

Sulfur Hexafluoride (SF_6) is a gas used by the Navy in many tactical systems, from shipboard targeting radar to torpedo propulsion systems and underwater warfare acoustic countermeasures. Unfortunately, SF_6 is also a potent greenhouse gas (GHG) that is more than 22,800 times more potent than carbon dioxide. Because SF_6 is non-flammable, nontoxic and a strong dielectric (providing excellent electrical insulation), it is a critical material in a host of Navy applications including the MK 50 torpedo, electric switchgear on shoreside power facilities, submarine countermeasures and mine hunting and in radar domes.

Clearly, proactive management and control of SF_6 emissions will be needed to sustain mission capability while complying with emerging GHG reduction policies and regulations. As the debate continues on how to best regulate GHGs, several key Department of Defense (DoD) offices collaborated to assess the risks related to DoD's use of SF_6 and identify risk management actions.

In November 2007, the Clean Air Act Services Steering Committee (CAASSC), which addresses military issues relevant to the Clean Air Act (CAA), and staff from the Office of the Secretary of Defense's (OSD) Emerging Contaminants Program discussed the possibility of conducting an assessment related to the evolving regulatory climate surrounding SF_6. The Emerging Contaminants Program, part of OSD's Chemical and Material Risk Management Directorate (CMRMD), identifies, assesses and takes steps to manage the impacts posed by emerging contaminants (EC) on major DoD func-

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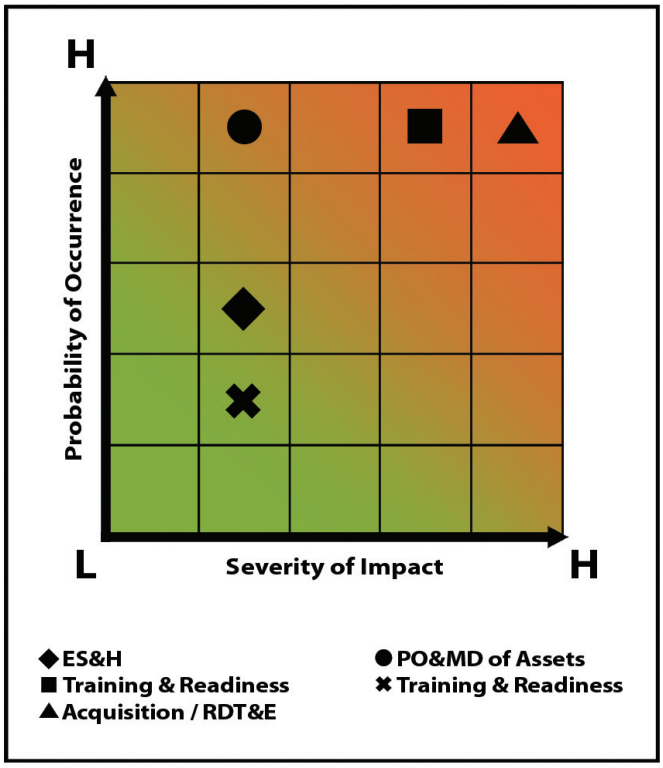
tional areas before regulations take effect. The program uses a "scan-watch-action" process for "looking over the horizon" to identify and assess ECs. This collaborative assessment prompted the development of Risk Management Options (RMO) and a recommendation that SF_6 be elevated to CMRMD's high priority "Action List" for ECs.

The average global SF_6 concentrations increased by about seven percent per year during the 1980s and 1990s, mostly as the result of its use in the magnesium production industry, and by electrical utilities and electronics manufacturers. Given the low amounts of SF_6 released compared to carbon dioxide, its overall contribution to global warming is estimated to be less than 0.2 percent.

The DoD's assessment found that 22 states had GHG emission targets. Most significantly, the California Air Resources Board has proposed a phase-out of all uses of SF_6 in 2013. In this instance, the CMRMD, Air Force and the DoD Regional Environmental Coordinator teamed up to secure an extension until 2020 for critical uses of SF_6 as a tracer gas to trace leaks in tanks and pipelines.

SF_6 is also monitored under the United Nations Framework for Climate Convention (UNFCC) and the Intergovernmental Panel on Climate Change. After the United States Supreme Court in April 2007 determined that GHGs are air pollutants under the CAA, the U.S. Environmental Protection Agency issued a proposed "endangerment" finding for GHGs under Section 202(a) of the CAA. These developments, in combination with a recent U.S. House of Representatives energy bill identifying SF_6 as a GHG, led to CMRMD's conclusion that restrictions, reductions in availability, higher costs and producer phase-outs are the likely results of potential GHG regulations. The graph below



Summary of impact assessment of SF_6 on DoD functional areas.

summarizes the first phase of the SF_6 assessment and displays which DoD functional areas are most likely to be affected by expected changes in the management of SF_6 risks.

The potential risks and impacts to DoD functions were identified through the input of subject matter experts. On the graph shown above, high risks to DoD are in the upper right, while lower risks are located in the lower left. Possible SF6 regulations (i.e., a proposed GHG regulatory scheme) would pose high risks to both Acquisition, Research, Development, Testing and Evaluation (Acquisition/RDT&E) and Readiness and Training. Regulation of SF_6 would pose little to moderate risk in other DoD functional areas, such as Production, Operations & Maintenance and Disposal (PO&MD), and Environment, Safety and Health (ES&H). The results of the assessment were so striking that SF_6 was elevated to the CMRMD's "Action List" and development of RMOs was accelerated. As a result of the assessment, some risk management actions were initiated immediately. For example, the Strategic Environmental Research and Development Program issued a Statement of Need for research on substitutes in November 2008.

The assessment and draft RMOs were completed by CMRMD in June of 2009. The RMOs include:

- Expanding research and development for substitutes for SF_6 in DoD applications,
- Developing a mandatory DoD policy for leak detection, capture and reuse,
- Leveraging research and development being performed by the Electric Power Research Institute regarding substitutes for use in electrical infrastructure, and
- Evaluating the feasibility and cost of stockpiling SF_6 for critical uses.

The fact that DoD would need a baseline for SF6, and means to reduce its use, was underscored on 5 October 2009 when President Obama issued Executive Order (EO) 13514, Federal Leadership in Environmental, Energy and Economic Performance. Aimed at making broad improvements in the sustainability of the federal government, the EO requires all federal agencies inventory their GHGs and set targets to reduce their emissions by 2020.

The SF_6 RMOs were endorsed for implementation by the executive level EC Governance Council at its annual meeting on 13 October 2009.

Conclusion

The military services have many critical uses for SF6, and awareness is growing that the gas is a potent global warmer for which cost increases and restrictions are on the horizon. The collaboration between the CAASSC and CMRMD resulted in an expedited and thorough assessment of the risks and the development of RMOs to manage the risks. However, as there are currently no suitable SF_6 substitutes for most military operations, finding, testing, and qualifying substitutes may be a long-term effort. All of these factors point to the need for a well-organized plan for minimizing releases until substitutes are developed, tested and deployed.

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News From DoT

Hazardous Material —
Miscellaneous Packaging Amendments

By Muhammad Hanif, Chemist, HTIS

On February 2, 2010, the Department of Transportation's (DoT), Pipeline and Hazardous Materials Safety Administration (PHMSA) amended the Hazardous Materials Regulations (HMR) packaging requirements to enhance compliance flexibility, improve clarity, and reduce regulatory burdens.

Specifically, the amended packaging requirements in the HMR provide:

- **Several revised packaging related definitions, and clarifications —**

  The amended rule removes the definition of "Strong outside container" and clarifies that the phrases "strong outside container" and "strong outside packaging" are synonymous in meaning with "strong outer packaging." Based on overwhelming opposition by those who submitted comments, the proposed definitions for ``bulk packaging'' and ``non-bulk packaging'' were not adopted in this final rule. But these definitions will be considered more fully in future rulemaking. However, per PHMSA, packaging manufacturers and shippers should be aware that packagings (i.e. receptacles) for a: 1) liquid with a volumetric capacity of greater than 450 liters (119 gallons); or 2) solid, with both a maximum net capacity greater than 450 L (119 gallons) and a maximum net mass greater than 400 kg (882 pounds); or 3) a gas with a water capacity greater than 454 kg (1,000 pounds) are bulk packagings under the HMR regardless of the weight or volume of the hazardous material contained therein. Although the proposed definition of "Bulk packaging" was not adopted, the phrase "with no intermediate form of containment" was removed from the current definition of a "Bulk packaging." Modifying the definition in this way clarifies that "Large Packagings," that contain inner packagings, are considered bulk packagings for purposes of the HMR.

- **More flexibility when preparing and transmitting closure instructions, including conditions under which closure instructions may be transmitted electronically —**

  A packaging manufacturer may transmit the packaging information, including closure instructions, using electronic means instead of, or in addition to making a written notification. Such electronic means of notification may include eMailed transmissions or transmission on a CD or other similar device and the transmission must be in a form that can be printed in hard copy by the person receiving the notification. Referring the person (user) receiving the notification to a website for the required information is not acceptable. The final rule requires shippers to retain packaging closure instructions provided by the packaging manufacturer for at least 365 days after offering the package for transportation.

- **Measures for stenciling UN numbers on packagings —**

  The final rule adds an exception to permit marking of the UN symbol on specification packagings with a stencil. Consistent with this revision, in this final rule, Sec. 178.703 (a)(1)(i) was also revised to authorize stenciling of the UN symbol for Intermediate Bulk Containers (IBCs).

- **Clarified methods for determining whether a changed packaging configuration is a new design or a variation —**

  Current HMR Sec. 178.601(g)(1) provides exception "Variation 1" that allows a person to substitute an inner receptacle without additional testing to demonstrate compliance with the applicable performance standard, if it can be determined that the substitute inner packaging, including its closure, maintains an equivalent level of performance as the originally tested package. The current requirements do not specifically require documentation of the methodology used to determine that a packaging maintains an equivalent level of performance. The final rule clarifies shippers' responsibilities to comply with the HMR's packaging standards, and to document the method used when determining whether a change in packaging configuration requires retesting as a new design, or may be considered a variation of a previously tested design.

- **Clarification of minimum thickness of Remanufactured, Reused, and Reconditioned Packagings —**

  The rule clarifies that when a packaging no longer meets the minimum thickness criteria, it is no longer suitable for reconditioning or remanufacturing. This provision applies to packagings intended for reuse as well. Under this rule, a reference to "reused packaging" is also added to the reader's aid Sec 171.8 of the HMR.

- **Requirements for the construction, maintenance, and use of Large Packagings —**

  Large packagings are currently authorized for the transportation of hazardous materials if approved by the Associate Administrator for Hazardous Materials Safety. The final rule removes the approval requirement and adds two new subparts (P and Q) to Part 178 for the design, construction, and testing of Large Packagings. The design, construction and testing requirements are based on the UN Recommendations on the Transport of Dangerous Goods, Thirteenth Revised Edition (2003); Part 6, Chapter 6.6 Requirements for the *Construction and Testing of Large Packagings*. The regulatory layout and language is modeled on the current requirements for IBCs. Additionally, a new section 173.36, "Hazardous Material in Large Packaging" is added in the HMR to specify operational requirements for the use of Large Packagings.

For additional information and to discuss specifics of the February 2010 and September 2010 rulemakings, please contact:

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References:

1. Federal Register Volume 75, Number 21, Tuesday, February 2, 2010, pages 5375 -5403 (75 FR 5375)]

2. Federal Register Volume 72, Number 189, Thursday, September 30, 2010, Pages 60333- - 60340 (75 FR 60333)

Driver Distraction and Personal Electronic Devices

By Beverly Howell, Industrial Hygienist, HTIS

The Department of Transportation has identified three main types of distraction that occur while operating a motor vehicle: **Visual**-taking your eyes off of the road; **Manual**-taking your hands off the wheel; and **Cognitive**-taking your mind off of driving.

Among cell phone related tasks, such as talking, dialing, reaching for the phone, and texting while driving; texting while driving is the most dangerous. Here are some statistics:

- Teen drivers are four times more likely than adults to get into car crashes or near crash events directly related to talking on a cell phone or texting.
- A car driver dialing a cell phone is 2.8 times more likely to get into a crash than a non-distracted driver.
- A driver reaching for a cell phone or any other electronic device is 1.4 times more likely to experience a car crash.
- A car driver talking on their phone is 1.3 times more likely to get into an accident.
- A truck driver texting while driving is 23.2 times more likely to get into an accident than a trucker paying full attention to the road.
- A truck driver dialing a cell is 5.9 times more likely to crash.
- A trucker reaching for a phone or other device is 6.7 times more likely to experience a truck accident.
- For every 6 seconds of drive time, a driver sending or receiving a text message spends 4.6 of those seconds with their eyes off the road. This makes texting the most distracting of all cell phone related tasks.

The above data are from a study conducted by the Virginia Tech Transportation Institute (VTTI) commissioned by the Federal Motor Carrier Safety Administration (FMCSA). The study titled "Driver Distraction in Commercial Vehicle Operations" points out the danger posed by drivers distracted during cell phone use and/or texting while driving.

In order to reduce and prevent certain truck and bus related crashes, fatalities, and injuries associated with distracted driving, FMCSA has issued a final rule on limiting the use of Wireless Communication Devices to strengthen the safety of drivers on the Nation's highway.

Essentially the rule prohibits texting by commercial motor vehicle (CMV) drivers while operating in interstate commerce and imposes sanctions, including civil penalties and disqualification from operating CMVs in interstate commerce, for drivers who fail to comply with this rule. Additionally, motor carriers are prohibited from requiring or allowing their drivers to engage in texting while driving.

FMCSA also amended its commercial driver's license (CDL) regulations to add to the list of disqualifying offenses a conviction under State or local traffic laws or ordinances that prohibit texting by CDL drivers while operating a CMV, including school bus drivers.

Continuing across the spectrum of drivers DOT's, Pipeline and Hazardous Material Safety Administration (PHMSA) issued a safety advisory notice to remind offerors and carriers of hazardous materials of the risks associated with the use of personal electronic devices (PEDS) by individuals operating motor vehicles that contain hazardous materials.

PHMSA published a notice of proposed rulemaking to prohibit texting on electronic devices by drivers during the operation of a motor vehicle containing a quantity of hazardous materials requiring placarding under part 172 of the 49 CFR or any quantity of a select agent or toxin listed in 42 CFR part 73.

The conclusion is that texting or using an electronic device while driving creates a dangerous situation, and puts the driver, the cargo, and other drivers at risk for accidents.

References:

1. Virginia Tech Transportation Institute (VTTI), Blacksburg, VA" DRIVER DISTRACTION IN COMMERCIAL VEHICLE OPERATIONS", September 2009 (study funded by DOT's FMCSA);

2. Federal Register: " Safety Advisory Notice : Personal Electronic Device Related Distractions "August 3, 2010, Volume 75, Number 168 , page 45697; and,

3. Federal Register: Hazardous Materials: Limiting the use of Electronic Devices by Highway. September 27, 2010, Volume 75, Number 186, pages 59197-59204.

Environmental News

134 Chemicals Added to EPA's EDS Program

By Abdul Khalid, Chemical Engineer, HTIS

On November 17, 2010, the Environmental Protection Agency (EPA) listed 134 chemicals/substances it has identified as potentially disruptive to the endocrine system. This is the EPA's second list of chemicals/substances that are subject to testing under its Endocrine Disruptive Screening Program (EDSP).

Endocrine disruptors are chemicals/substances that interact with and possibly disrupt the hormones which a human or animal endocrine system produces or secrets to regulate growth, metabolism, or reproduction. Lisa Jackson, EPA's Administrator, has indicated that the EDSP is an Agency priority intended to identify actual endocrine disruptors and help to ensure their safe use.

The EPA established the EDSP in response to Section 408 (p) of the Federal Food, Drug, and Cosmetic Act (FFDCA). In an effort to include all pesticides as required by the FFDCA, the second list not only includes these chemicals /substances, but also has added priority drinking water chemicals into the program for screening as authorized by Section 1457 of the Safe Drinking Water Act (SDWA).

According to EPA's regulations, the manufacturers, importers, processors, and users of these chemical are responsible for their testing. Per EPA's test protocol, the testing will identify those chemicals that are actual rather than suspected disruptors. Among the chemicals listed are those used in products such as solvents, gasoline, plastics, personal care products, pesticides, and pharmaceuticals, including benzene, perchlorate, urethane, ethylene glycol, and erythromycin.

For more information, call on EPA's Technical Information Contact:

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More information on the Endocrine Disruptor Screening Program, including the notices on the second list of chemicals and the draft supplemental policies, is available at: http://www.epa.gov/endo/.

Occupational Safety and Health News

OSHA's HAZCOM Standard and the UN's GHS

By Abdul H. Khalid, Chemical Engineer, HTIS

The U. S. Occupational Safety and Health Administration (OSHA) is working on bringing its HAZCOM (Hazard Communication) standard closer to the United Nations (U.N.) Globally Harmonized System (GHS) of classifying and labeling chemicals. OSHA's current chemical HAZCOM standard is codified in 29 CFR 1910.1200.

Although a revised HAZCOM was an OSHA regulatory agenda priority during the fall of 2010, it is still unknown when OSHA will publish its final rule on a revised standard that incorporates the UN's GHS principles. OSHA placed its intention to align its HAZCOM standard with the U.N.'s GHS on its Regulatory Agenda in 2005.

In the Federal Register of September 30, 2009, OSHA published a proposal to revise its standard, and indicated that revising it would definitely enhance the quality and consistency of

information on chemicals and hazardous substances available for workers, employers, other chemical users. According to OSHA, chemical companies, trade associations, small business owners, as well as unions broadly support the idea of revising its HAZCOM Standard.

The GHS classification and labeling of chemicals which the U.N. adopted in 2003 has been recognized internationally and has agreed upon classifications for:

- Physical hazards;
- Potential health hazards, or potential ecological hazards posed by chemicals; and,
- Standard pictographs and signal words to be used to label chemicals.

Experience has shown that the cost and schedule of implementation has proven to be challenging. With respect these two matters, OSHA proposed a three-year deadline for compliance. As expected, there are questions with respect to the time period with which to comply, as well as the cost of training, printing of new labels, and updating organizations' existing hazard communication programs.

OSHA's formal proposal to not require the use of American Conference of Governmental Industrial Hygienists (ACGIH) exposure limits (i.e. Threshold Limit Values (TLVs)) in the Material Safety Data Sheets (MSDSs), or Safety Data Sheets (SDSs), is the current "hot" topic that appears to have slowed GHS efforts. However, OSHA may maintain the requirement to list its mandatory permissible exposure limits, known as PELs, on the SDSs.

Although there would be a closer alignment of OSHA's HAZCOM standard with the GHS, OSHA will still maintain the same basic framework and requirements – that is, chemical manufacturers and importers will need to identify chemicals and their known hazards, and every employer with chemicals in the workplace will have a hazard communication program. Specific changes in the proposed rule include:

- Revising material safety data sheets to use a standard 16-section format.
- Requiring worker training on the new labeling system and safety data sheets within two years of finalizing the rule.
- Providing specific criteria for classifying the health and physical hazards of chemicals and of chemical mixtures.
- Requiring chemical makers or importers to label products with a 'harmonized word', standard pictograms, and a hazard statement for each hazard class and category.

As noted earlier, it is still unknown when OSHA will publish its final rule on a revised standard that incorporates the U.N.'s GHS principles.

References:

1. OSHA's website on the United Nation's Globally Harmonized System for Classification and Labeling of Chemicals is at: http://www.osha.gov/dsg/hazcom/global.html

2. Proposed regulations, Federal Register September 30, 2009 at: http://edocket.access.gpo.gov/2009/E9-22483.htm

3. Facts on Aligning the Hazard Communication Standard to the GHS at: http://www.osha.gov/as/opa/facts-hcs-ghs.html

Welding Electrodes Containing Thorium

By Ariel Rosa, Environmental Protection Specialist, HTIS

The Regulation

10 CFR 40.13(c)(1)(iii), Any person is exempt from the regulation in this part and from the requirements for a license set forth in section 62 of the Act to the extent that such person receives, possesses, uses, or transfers: (1) Any quantities of thorium contained in, (iii) welding rods.

Background

Thoriated tungsten welding rods were introduced approximately fifty years ago as an alternative to the use of pure tungsten rods. The word "thoriated" means that each of the electrodes contains a small amount (1 or 2% by weight) of thorium dioxide (ThO_2) or thoria. Historically, higher concentrations, (up to 4%) have been used. 2% thoriated tungsten electrodes contain a minimum of 97.30% tungsten and 1.70 to 2.20% thorium. They are the most commonly used electrodes today and are preferred for their longevity and ease of use. Thorium increases the electron emission qualities of the electrode, which improves arc starts and allows for a higher current carrying capacity. This type of tungsten operates far below its melting temperature, which results in a considerably lower rate of consumption and eliminates arc wandering for greater stability. It also features a lower level of weld contamination than other electrodes.

Thoriated welding rods are used as "nonconsumable" electrodes when arc welding with Tungsten Inert Gas (TIG) or when plasma welding. Reactive metals such as aluminum are welded using a thoriated tungsten welding electrode that is attached to a source of argon gas, such that the local atmosphere around the weld is inert. This action serves to protect the electrode, arc and weld pool from atmospheric contamination. The metal is heated by the arc formed between the electrode and the grounded component to be welded. The rod is actually consumed during this process, but it does not act as filler that binds two pieces of metal together. During this process, some of the electrode is vaporized in the arc, and is potentially liberated to the surrounding air. This situation may result in a hazardous airborne thorium level. As the electrode is consumed during welding, the electrode tip must be repeatedly dressed by grinding the tip to a fine point, so that the optimal welding conditions are maintained. These grinding activities can produce both airborne and surface thorium contamination.
The TIG welding process is one of the more expensive welding processes; and therefore, used primary in industries that

require high quality / low contamination welds (e.g., aircraft, petrochemical, nuclear power plants construction and food processing industries).

Thoriated tungsten welding electrodes are produced in nine standard diameters between 0.25 and 6.35 mm and six standard lengths between 7.6 and 61 cm. A typical rod would be about 2.4 mm in diameter and 15.2 cm long containing 0.23 g of thorium. Most electrodes in current use appear to contain about 2% by weight of ThO_2.

The Radioactivity Problem

The thorium used in tungsten is a radioactive element with a long half life that emits mainly alpha (α) particles, and occasionally some beta (β) and gamma (γ) radiation. Thorium is contained in the matrix of the tungsten rod so there is little radiation emitted externally. Alpha particles cannot penetrate skin or even paper; however, they are harmful if released inside the digestive tract, or inside the lungs. The radiation exposure occurs primarily during the inhalation of dust caused by the grinding of tips for welding, and to a lesser extent when breathing any fumes released during the welding process.

Data generated in the 1950s suggested that these electrodes posed no significant health hazard, and seemed to justify their exemption from licensing requirements for source material. Since that time, other studies have been performed and present conflicting results as to the level of risk.

Health Concerns

The principal concern from low to moderate level exposure to ionizing radiation is an increased risk of cancer. Studies have shown that inhaling thorium dust causes an increased risk of developing lung cancer, and cancer of the pancreas. Bone cancer risk is also increased because thorium may be stored in bones.

Airborne Thorium Concentration Studies

Study by Ludwing et al. (1999)

The airborne activity generated through welding and grinding of electrodes was measured using personal air samplers and stationary air samplers that collected the respirable dust fraction.

The airborne levels of Th_{232} during welding operations as measured by Ludwig et al. ranged from $< 7 \times 10^{-9}$ to 5×10^{-6} uCi/m^3 with a geometric mean of 3×10^{-8} uCi/m^3. The concentrations measured during AC welding operations were approximately 30 times those measured during DC welding. In a room with a volume of 100 m^3 and without local exhaust ventilation, 35 electrodes (4% by weight thorium) were ground in 15 minutes. The activity concentration for Th_{232} during grinding was 5×10^{-6} uCi/m^3. The airborne concentration decreased soon after the grinding ended.

The only case from the Ludwig et al. study that involved local exhaust ventilation indicated a reduction factor of 100.

Study by Vinzents et al. (1994)

Vinzents et al. conducted their study during the grinding of rods containing 4% thorium. The conditions selected for the study were a "worst case" scenario (one person grinding for 139 minutes with no exhaust hood used). Typically electrodes are ground once each day for approximately one minute. The measurements resulted in a respirable concentration of 2×10^{-5} uCi/m^3 (with respirable fraction of 0.3).

Study by Crim and Bradley (1995)

Crim and Bradley evaluated six minutes grinding of 2% thorium oxide welding electrodes. The range of the air samples were from 3.6×10^{-8} to 8.2×10^{-6} uCi/m^3 with a geometric mean of 6.3×10^{-7} uCi/m^3.

Study by Jankovic et al. (1999)

The study conducted by Jankovic provided results of 15 different welding operations (welding and grinding) with 2% thorium. Some samples were taken using dilution ventilation with samplers outside and inside the welding helmet, while others using local exhaust ventilation with samplers outside and inside the welding helmet.

Dose

Detailed dose estimates are described in NUREG-1717 (see reference). The conclusion was that the highest individual and collective doses resulted from routine welding and grinding operations. The estimated doses during the process of transportation, distribution, disposal in landfills and incinerators were relatively small.

Doses from grinding.

The grinding of the rod to form a pointed end can take anywhere from 20 to 60 seconds depending on the skill of the grinder. For welders that grind their own rods, this can take a minute or even longer. Individuals who specialize in this activity can complete the task much quicker. At a large facility, e.g., with 50 welders, about 150 rods would have been sharpened per day (3 per welder). For the purpose of the calculations, NUREG-1717 assumed that the activity median aerodynamic diameter (AMAD) or particle size was 1 um.

An individual welder sharpening his own rods was estimated to receive an annual Effective Dose Equivalent (EDE) of 20 mrem per year. This could be reduced by a factor of ten or so if a local exhaust system is used.

A dedicated grinder sharpening rods for 200 hours per year, without the benefit of a local exhaust system, was estimated to receive approximately 800 mrem.

Doses from Welding Operations

As NUREG-1717 acknowledges, any estimation of the inhalation dose due to welding operations is highly speculative. Assumptions have to be made about the amount of thorium becoming airborne, the amount of time spent welding, the effect of the welder's mask, the ventilation rate, the size distribution of the particulates, etc. Assuming that 1000 hours per year

were spent in actual welding operations, NUREG-1717 estimated that the dose would be 20 mrem per year for DC operations and 500 mrem per year for AC operations. These estimates assume that no local exhaust system was used. Should local exhaust be utilized, the estimated doses would be a factor of ten lower. The external dose to welders was determined to be an insignificant fraction of the dose due to inhalation.

Dose from Carrying Welding Rods in Pocket

The estimated effective dose equivalent to an individual carrying three thoriated welding rods (0.9 g thorium) in a shirt pocket for 2000 hours (based on a 40hr / week's schedule) was 8 mrem.

Alternatives to Thoriated Tungsten

Lanthanum, cerium, yttrium and zirconium oxides can all be used with tungsten. The general consensus of users is that ceriated or lanthanated tungstens are acceptable alternatives to thoriated tungstens, particularly with a DC current, while zirconiated tungsten is preferred for AC current welding. There are very minor differences in the arc voltages required for equal currents between the various alternatives. Consideration should be given to justifying the use of thoriated tungsten electrodes in preference to other suitable alternatives. If a thoriated tungsten electrode is used, it is important to inform the worker that the electrode contains radioactive material. Furthermore, it is necessary to reduce the risk of exposure using a local exhaust ventilation system and respiratory protection. Good industrial hygiene and sanitary practices will also prevent further exposure and contamination.

Reference: Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials (NUREG-1717) June 2001

NIOSH's Prevention Thru Design Plan

By Beverly Howell, Industrial Hygienist and
Ariel Rosa, Environmental Protection Specialist, HTIS

In 2008, 5,071 U.S. workers died from occupational injuries, 3.7 million suffered serious injuries, and 187,400 became ill due to work-related exposures [BLS 2008]. The estimated direct and indirect costs of occupational injury, disease, and death range from $128M to $155M [Schutte]. While the underlying causes vary, a recent study implicates design in 37% of job related fatalities [Discroll et. al. 2008].

To protect lives and livelihoods, there was a need for a comprehensive approach that considered stakeholders across all industrial sectors of the economy while addressing work health and safety issues. Among the issues of consideration are: the elimination of hazards as well as the minimization of risks to workers throughout the life cycle associated with: work premises, tools, equipment, machinery, substances, and work processes including their construction, manufacture, use, maintenance, and ultimate disposal or reuse.

In November 2010, the National Institute for Occupational Safety and Health (NIOSH) Centers for Disease Control and Prevention (CDCP) released "The Prevention Through Design Plan (PtD) for the National Initiative" whose mission is to prevent or reduce occupationally related injuries, illnesses, fatalities, and exposures by including prevention considerations in all designs that affect individuals in the occupational environment.

In the forward to the Plan, John Howard, M.D, Director of NIOSH's CDCP states that "designing out hazards is the most effective means of preventing occupational injuries, illnesses and fatalities". Although this concept was well known, there had not been a concerted effort to achieve broad implementation of it. In 2007, NIOSH initiated a national initiative via a PtD Council consisting of a diverse group of stakeholders from industry, labor, academia, and government agencies. PtD subject matter experts drafted the goals, activities, and timeframes set forth in the PtD National Initiative. The Council based its work on input received from stakeholders who participated in two PtD's-NIOSH cosponsored workshops: one held in July 2007, *Prevention through Design,* and a second one held in December 2009, titled *Making Green Jobs Safe*. One hundred and seventy green economy stakeholders attended the latter workshop to frame the issues for ensuring that green jobs, technologies, and products are safe for workers.

This plan is for the Nation, and focuses on specific goals, and activities in the areas of research, education, practice, policy as well as small business. NIOSH will continue to seek partners to implement this Plan. By having specific goals and activities, the national effort can be focused to more effectively protect workers from occupational injury and disease. Collectively, achieving these goals will influence the change in culture that is necessary to include PtD principles in all designs affecting workers.

The plan is organized around five overarching areas:

- Research to establish the value of already adopted PtD interventions, address existing design related challenges, and suggest areas for future research.
- Education to help designers, engineers, employers, and others to understand and apply PtD methods.
- Practice of PtD through accessing, sharing, and applying successful strategies.
- Policy initiatives to encourage business leaders, labor, academics, government entities, and standard setting organizations to endorse a culture that includes PtD principles in all designs affecting worker safety and health.
- A small business focus to tailor and diffuse successful PtD programs and practices to the needs of small employers.

John Howard M.D. has noted that "in many respects, PtD is a transformative concept for the 21st century. It views investment in worker safety and health as an integral part of business efficiency and quality, rather than as a cost. It is also a practical concept that has already been used successfully in

several model applications. We look forward to working further with our partners to advance the goals outlined in the plan".

PtD describes intermediate goals for each focus area, which represent steps through which progress toward each goal can be achieved and measured. It also includes four case studies in which PtD was a principle behind successful safety and health partnerships. Additional information on PtD can be found at www.cdc.gov/niosh/topics/PtD/.

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Control and Prevention of Harmful Occupational Skin Exposures

By Abdul H. Khalid, Chemical Engineer, HTIS

The skin is the largest organ of the body and accounts for more than 10 percent of its mass, and protecting it from external exposures. At the same time, it preserves water, absorbs shocks, has physical sensation, preserves calories, synthesizes vitamin D, controls temperatures, helps lubrication, and behaves as an insulting agent.

Occupational skin disease is the second most common type of disease. It occurs in many forms such as contact (irritant as well as allergic) dermatitis, skin injuries or infections, as well as skin cancers. Thus, it is important that one protects one's skin from exposures to industrial chemicals, physical agents such as extreme temperatures (hot or cold), and radiation (solar, ultra violet), and biological agents such as parasites, microorganisms, plants, and other animal materials. One should recall that many chemicals are readily absorbed through the skin, and can cause other health effects and/or contribute to the dose of the chemical absorbed by inhalation.

The National Institute for Occupational Safety and Health (NIOSH) estimates that more than 13 million workers in the US are potentially exposed to chemicals that can be absorbed through skin. Workplace skin diseases account for 15-20 percent of all reported occupational diseases in the US. According to the Bureau of Labor Statistics (BLS), the rate of skin disease in the US exceeds recordable respiratory illnesses both in the number of cases and the rate of skin disease.

With respect to contact dermatitis, in general, there are two forms:

1. Irritant contact dermatitis; and,
2. Allergic contact dermatitis or skin sensitization.

Contact with irritating chemicals or agents such as alcohols, cutting oils, coolants, degreasers, disinfectants, petroleum products, detergents and solvents can cause contact dermatitis, while allergic occupational or skin sensitization occurs when using substances such as cobalt, chromium and chromates, certain cosmetic agents, epoxies, nickel, certain plants, preservatives, resins, and acrylics.

At times, it is difficult to recognize the signs and symptoms of skin diseases. Sensitization may develop after some period of time – perhaps, weeks or months after the initial exposure, and before the disease becomes visible. At that time, medical personnel will need to conduct specific tests to confirm from which of the two forms of contact dermatitis one may be suffering. In addition, there will be a need for an exposure evaluation, as well as continual monitoring, via direct or indirect methods.

The American Conference of Governmental Industrial Hygienists (ACGIH) has published a limited number of guidance values for chemicals measured in the body, known as biological exposure indices (BEIs). There are some studies available in the literature that report on chemical exposure levels for workers who are at greater risks of developing occupational contact dermatitis.

The Occupational Safety and Health Administration (OSHA) addresses dermal exposures in its standards for the General Industry (29 CFR 1910), Shipyard (29 CFR 1915), Marine Terminal (29 CFR 1917), and Construction (29 CFR 1926) employment, as well as the identification, classification, and regulation of carcinogens in 29 CFR 1990.

Employers are required to inform workers about the nature of the substances with which they are dealing, and how to work with them safely. Per OSHA's regulations, employers are required to assess the risks associated with chemicals in the workplaces, and eliminate/minimize/control exposure by using engineering controls (first choice), administrative controls, or personal protective equipment (PPE) as a last resort; when engineering or administrative controls are not feasible. Employers must involve workers, safety representatives and unions in health and safety matters. In addition, employers should review their assessment from time to time as new changes are made in processes and operations.

Below are some suggestions on how to control and prevent skin diseases:

- Substitution of a less toxic chemical is almost always

a good option, unless the alternative chemical is much more volatile.

- Redesigning a work process to avoid splashes or immersion. Where this is not feasible, personal protection in the form of chemical protective gloves, an apron, or clothing should be selected. Good housekeeping can avoid the accumulation of stable, low volatility, dermal toxic contaminants on horizontal surfaces. The use of enclosures, as well as isolation, may be feasible for both liquid and solid large aerosols.
- Use of appropriate gloves for skin protection. Since "glove breakthrough" can occur in considerably less time than expected based upon many factors, one should view the published breakthrough information from glove manufacturers and lab test data with caution.

Personal Protective Equipment (PPE)

Hand contact is a significant route of exposure. Therefore, proper glove selection is a major means of controlling dermal exposure. Factors that affect glove selection include:

- type of chemical(s) to be handled (or used)
- frequency and duration of chemical contact (often to rarely)
- nature of contact (total immersion, splash, mist, contaminated surfaces)
- concentration of the chemical
- temperature of the chemical
- abrasion, puncture, tear resistance requirements of the job or task
- length to be protected (hands only, forearms, arm)
- dexterity requirements of the job or task
- grip requirements (dry grip, wet grip, oily)
- glove features (e.g. cuff edge, lining, color (to show contamination))
- thermal protection
- size and comfort requirements
- price

In summary, employer and employee should work in concert in eliminating or minimizing exposure of one's skin to harmful exposures.

For further information on health and safety matters, contact:

OSHA Directorate of Technical Support and Emergency Management

PH / Commercial: 202.693.2300; or,

Visit OSHA websites at: http://osha.gov.

References:

1. Dermal Exposure at: http://www.osha.gov/SLTC/dermalexposure/index.html

2. Skin Exposures and Effects at: http://www.cdc.gov/niosh/topics/skin/recommendations.html

Other News

An Introduction to the Hazardous Characteristic Code

By Philip Saunders, Chemical Engineer, HTIS

The Hazardous Characteristic Code (HCC) is a two character alpha-numeric code used to communicate the hazard or hazards associated with a material. It is intended to assist in properly segregating and storing hazardous materials in a warehouse[1] (wholesale) setting, but it can also be used to properly store hazardous materials in other more localized settings such as aboard Navy ships[2] (retail). A proper understanding and use of the HCC will help to ensure that incompatible chemicals are not stored in the same areas of a warehouse or other storage facility.

The HCC is used to separate hazardous materials into one of 10 primary hazard segregation areas. In many cases, the appropriate segregation area can usually be determined by the first letter of the HCC, and include radioactive materials (A), corrosives (B, C), oxidizers (D), explosives (E), flammable materials (F), compressed gases (G), organic peroxides (P), reactive materials (R), toxic/poisonous materials (T) and low hazard materials. However, it should be noted that some low risk materials with the HCC beginning with the letters B, C, E and T may also be stored in the low hazard segregation area.

The HCC may be obtained from several sources, but they are only assigned to individual records in the DoD Hazardous Materials Information Resource System (HMIRS). HMIRS may "feed" information, including the HCC from some records, down (never the reverse) to other systems, such as the Federal Logistics Information System (FLIS); but HMIRS should be the primary resource for obtaining the HCC for any product. It should be noted that the HCC for a product will only propagate downstream to FLIS if the HCC assigned to an HMIRS record contains a part number and Commercial and Government Entity (CAGE) in a combination that exactly matches one of those found in the Master Cross Reference List (MCRL) in Segment C of the FLIS record for that National Item Identification Number (NIIN). If the CAGE and part number are not found in a combination that matches information in the FLIS, then the HCC will not appear in the FLIS information for that NIIN.

Even when an HCC is found in the FLIS record for a specific NIIN, the assigned HCC may not reflect all products with that National Stock Number (NSN). This is because products from

different manufacturers (or even from the same manufacturer if they have reformulated their product) may have a different HCC even if products have the same NSN. This is especially true for assets that are based on performance requirements rather than a requirement for a specific formulation. This is one reason why an HCC is assigned to (and must be obtained from) the individual HMIRS record that applies to a specific product, rather than having one HCC that is applicable to all products with the same stock number. Another reason that one HCC is not assigned to an entire NSN is that kits or end items may have more than one hazardous component, and each of those components may have their own HCC even if they have the same NSN.

As noted above, the first character of the HCC is a letter that in most cases can be used to identify the specific hazard associated with that material (C applies to acids, F applies to flammable materials, G applies to compressed gases, etc.) and generally determines the segregation area in which a material is stored. The second character is a number which more specifically identifies the type or degree of hazard associated with a material and determines more specifically where to store that material within one of those 10 primary segregation areas. In some cases, a lower number signifies a greater hazard than a higher number (F1 is more hazardous than F4, T1 is more of a hazard than T4), but this is not always the case, especially when it comes to those codes with the letter V (aerosols, high flash materials, environmental hazards, etc) or Z (manufactured articles such as batteries) as the first character.

Detailed definitions of each HCC are in Appendix B of DLAI 4145.11 (Storage & Handling of Hazardous Materials), and other published or online resources. In many cases, the criteria used to assign an HCC for a material that is regulated by OSHA, EPA, DOT (or other transportation regulatory modes such as covered by IATA or IMO) incorporate the definitions for that material as promulgated by those regulatory bodies. In those cases, the criteria for that HCC tend to be very explicitly defined, and are usually based on either the degree of risk associated with that material or on the presence of a characteristic hazard.

Flammable liquid is an example of materials where the HCC depends on the level of risk associated with the product since it is assigned based on the flash point, and the boiling point (which determines severity of the liquid's flammability). Compressed gas is an example of materials where the HCC is determined by the hazard characteristic since the codes for compressed gases are based on their hazard class (or classes) which indicates if the gas is flammable, nonflammable, a corrosive, an oxidizer, or a combination of those characteristics. In addition, some HCCs are assigned based on an inherent design or characteristic rather than a specific hazard. These HCC include those for dry cell batteries as well as petroleum products.

While there are many HCC definitions that have objective criteria for assigning that code, there are several HCC definitions that are much more subjective. For example, the definition of the HCC T6 (Health Hazard) states that "the classification of a material into this category is a process which relies heavily on the professional judgment of the evaluator". The HCC for B3 (Alkali, Low Risk) and C3 (Acid, Low Risk) contain language that is very similar to this as well. In any situation where the 'professional judgment of the evaluator' is required, two competent professionals could come to differing conclusions, and be able to reasonably justify their decision based on their own criteria and risk or hazard thresholds. This can lead to similar products with the same stock number not all having the same HCC without it necessarily being an erroneous entry of information. Fortunately, the codes which rely on professional judgment tend to fall into the low hazard segregation category; and having two similar low-hazard products where each has a different HCC is much less of an issue than it would be for more hazardous materials going into the other segregation areas.

Since there are more than 60 hazardous characteristic codes that may be assigned to an HMIRS product record, it is impractical to go into detail on all of them in a single article, but there are several key concepts that should be remembered. First, the HCC is what determines where a hazardous material is to be stored within a warehouse or other chemical storage facility. The HCC may have other uses, but segregation for storage is its primary function. Second, the HCC for a product should only be obtained from the DoD HMIRS record that applies to the specific material in question. Third, the HCC is defined based on either the level of risk associated with a hazard, the mere presence of a particular hazard, or on inherent characteristics other than the presence of a specific hazard. Finally, similar products with the same NSN can have a different HCC without there being an error.

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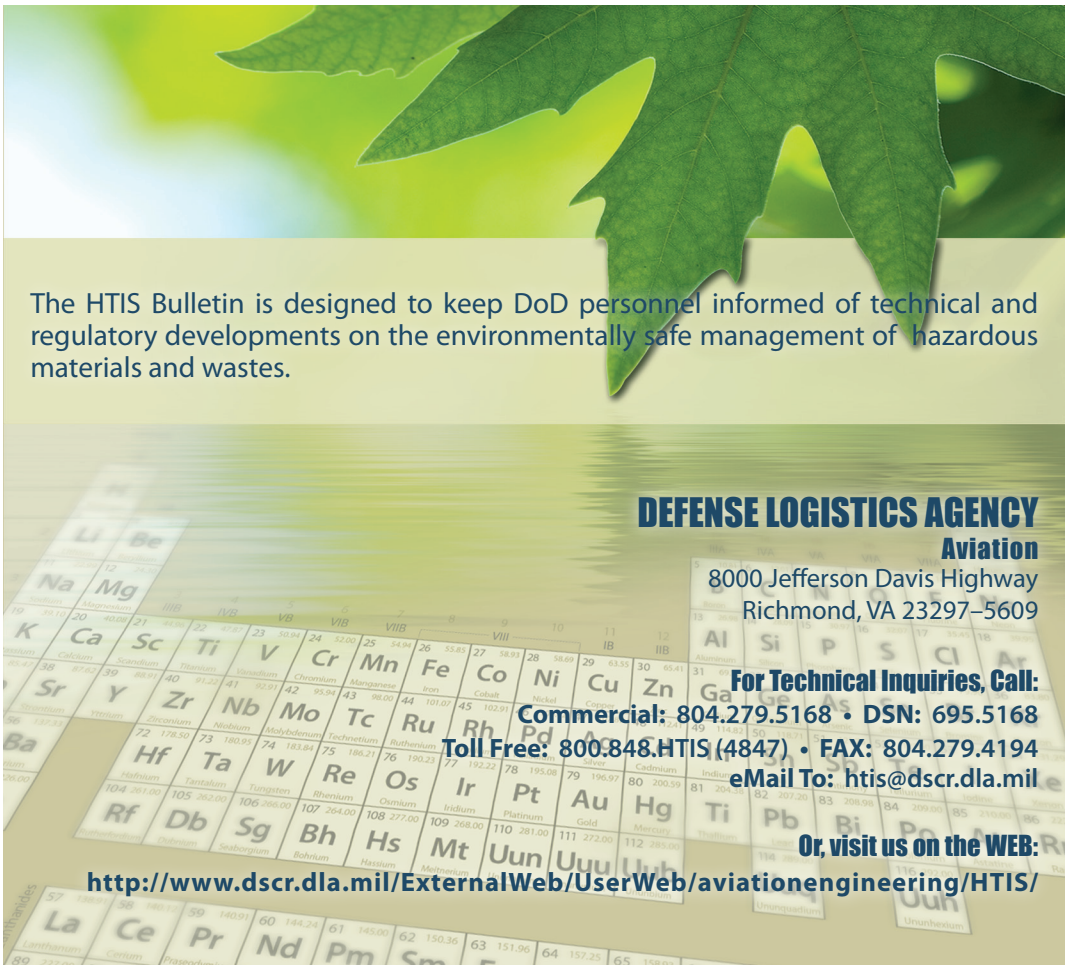
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