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Inside

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The Conservation Continuum: *Examining the Past/ Envisioning the Future*

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Milwaukee, WI

Deadline for poster absracts: **October 15, 2009**. To submit, send an abstract of no more than 500 words to Ruth Seyler, Membership and Meetings Director, abstracts@conservation-us.org

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Risk Assessment

By Dennis C. Ertel, Jr., CIH, CSP, REM

The conservation community is challenged by a myriad of products, equipment, and environments when they conduct their work. The AIC Health and Safety Committee often receives inquiries about whether something is safe or how to safely perform certain activities. In *Artist Beware*, Michael McCann states, "Every day we find that more and more of the chemicals we eat, drink, breathe, work with, or are exposed to in some other way are hazardous. The twentieth century is the era of chemistry. It is estimated that we are exposed to over 20,000 known toxic chemicals, and of the 500 new chemicals that are introduced into the marketplace every year, most have never been tested for their long-term effects on the human body."

While it is understood that not all chemicals or products are harmful, one needs to be able to determine if a specific use can be done safely; this is the practice of risk assessment. Risk assessment will often be coupled with risk management, which is the coordinated effort to control or reduce identified risks. Conservators do not normally perform formal risk assessment, but will certainly consider elements of risk assessment or work with other professionals who perform risk assessments fairly regularly.

Risk Assessment

Risk assessment is a tool for evaluating risk. According to the United States Environmental Protection Agency (EPA), risk is "the chance of harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor." The EPA "uses risk assessment to characterize the nature and magnitude of health risks to humans (e.g., residents, workers, recreational visitors) and ecological receptors (e.g., birds, fish, wildlife) from chemical contaminants and other stressors that may be present in the environment." Other organizations in the United States and in other countries may have slightly different definitions, but the principals are similar.

Risks have been studied by various government agencies for many years. Generally, toxicological studies—studies of the effects of various toxicants on animals or other organisms—have been a basis for risk analysis with respect to chemical products. Epidemiology studies—studies of disease patterns in groups of people with similar exposures—have also supported the effort to perform risk assessments. When governmental and research agencies evaluate risk, they review information from current research and estimate exposures or doses that will not regularly result in permanent harm to an unacceptable number of individuals. For example, in the United States, occupational exposure levels are designed through the risk assessment process to protect workers from the most pronounced effect of a toxicant for an average eight hour day, during

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a forty hour work week, over 50 weeks a year for a 40-year working lifetime. Limits published by the EPA are typically intended to protect the most vulnerable members of a population—usually children, the infirm or the elderly—for 24 hours per day over a 70-year lifetime.

For many agents or characteristics, the risk levels have been translated into occupational exposure levels (OELs), environmental regulations, guidelines, or other resources that provide guidance for daily exposures. These requirements or guidelines are usually based on established information from a mix of applicable scientific disciplines including epidemiology, toxicology, ecology, and other health sciences.

Most public health guidelines will differentiate between permissible levels over different time periods. For instance, one level may be set as the concentration that an average worker may tolerate without adverse effects over the span of a typical work shift (an 8-hour time weighted average or TWA). There are also Short-Term Exposure Limits for acutely irritating or hazardous substances that set a concentration to which one should not be exposed longer than a certain time frame (typically 15-minute duration). Finally, there can be ceiling or one-time maximum concentrations to which one must not be overexposed for any length of time without severe adverse consequences. None of these standards are construed as absolute lines between safe and unsafe exposures, but should be part of the overall exposure assessment. Some OELs, such as permissible exposure levels (PELs), published by the Occupational Safety and Health Administration (OSHA), have regulatory and legal requirements for compliance. Other OELs, such as the Recommended Exposure Limit (REL), published by National Institute for Occupational Safety and Health (NIOSH), and the Threshold Limit Values (TLVs), published by the American Conference of Governmental Industrial Hygienists (ACGIH), are based on more current scientific studies, but do not carry the regulatory or legal requirements of the PELs.

For non-occupational exposure, there are guidance levels published by EPA regions, such as Region 3's Risk Based Concentrations (RBCs), and other guidance from agencies like the World Health Organization (WHO). Again, the non-occupational risk levels, such as the RBCs, are typically based on lifetime risk levels to the most sensitive members of the population and may not be appropriate for use in all situations.

The evaluation of risk takes into account the specific type of harm caused by the studied toxicants. Effects may be acute or chronic, systematic or localized. Traditionally, government agencies consider cancer and non-cancer effects. The non-cancer effects that might be evaluated are quite diverse and chemicals can be classified based on the type of harm they do, such as asphyxiants, nervous systems toxicants, or respiratory hazards. Carcinogens are often related to specific types of cancers, such as the relationship between benzene and certain forms of leukemia. Chemicals may also be classified as mutagens (an agent that is capable of causing a gene-change) or teratogens (an agent that causes a structural abnormality following fetal exposure during pregnancy).

Perception of Risk

For many years both occupational and environmental regulations in the U.S. have had to consider the risk and benefit of new regulations. A question that risk assessment professionals often face is: what is an acceptable number of individuals that might be harmed by a specific product. With respect to chemical products, most U.S. agencies try to control occupational risks in the range of a few per 1,000. For environmental risks, most U.S. agencies try to control risks in the range of a few per 100,000.

Within risk management, some individuals are dedicated to a discussion of "how safe is safe"? In *The Perception of Risk*, Paul Slovic discusses the fact that the public as a whole is willing to take risks "from voluntary activities (eg. skiing) roughly 1,000 times greater than it would from involuntary activities (eg. eating food with preservatives) that provide the same level of benefit." In addition to "voluntariness," other factors such as perceived control, familiarity, and immediacy played important parts in individual attitudes towards risk. These same factors apply to conservators when they make choices about chemical use.

An important distinction needs to be made between toxicity and hazard. The term toxic means capable of causing injury or death. It does not describe the potential of causing this harm in a particular environment, and the mere fact that something is toxic does not mean that a meaningful dose of the product is present. Theoretically, all agents are potentially toxic and it is the dose and route of exposure that can determine the potential of that agent to cause harm.

Hazard, or risk, is the probability that a certain substance will cause harm in a specific situation. A toxic chemical that is in a sealed container has inherent toxicity, but presents little or no hazard. When the chemical is removed from the container and used in a closed space without appropriate ventilation or protective equipment, a hazard may exist.

Hazard Control and Risk Management Process

A hazard control and risk management process can be

implemented by various operations (labs, fieldwork stations, shops, etc.) and can focus on overall activities, specific processes, or new operations. The British Health and Safety Executive simply defines risk management as "a process that involves assessing the risks that arise in your workplace, putting sensible health and safety measures in place to control them and then making sure they work in practice." The hazard control and risk management process is a continuous improvement cycle with these basic steps:

- Identify the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide on precautions when appropriate
- Record your findings and implement them
- Review your assessment and update if necessary

Hazard Identification

Hazard identification begins with a thorough workplace evaluation with a close look at the operational steps, a review of equipment used and inherent hazards, a review of the materials or products used in the immediate workplace (including Material Safety Data Sheets), adjacent areas, and the ambient environment, and a careful observation of how the workers actually conduct the work. If it is determined that there is something potentially hazardous in a workplace through the hazard identification, appropriate hazard controls should be implemented. The major steps of a job hazard analysis are listed in box 1.

Interpreting Results

If there is an OEL, environmental regulation, or other guideline level, these can be used for comparison to the concentration of the stressor in the particular environment. The factors that lead to the development of the standard should be considered when evaluating the applicability of the standard to a particular situation. For example, a work place OEL would not be used to evaluate exposure to the public.

There are also some situations for which there are no guidelines to rely on for data interpretation. A good example is the situation of mold or fungi. Fungi are generally evaluated with respect to two factors—concentration and the types of organisms present. Indoor concentrations should be at levels near or below outdoor levels. Indoor levels in excess of outdoor levels or the presence of a significant number of different types of organisms in comparison to outdoors, suggest an indoor source of fungi contamination. In the case of fungi or chemicals in which there has been limited or no research, data interpretation requires a more specialized approach. In some cases, a full risk assessment or research effort may be required. The lack of an appropriate limit does not permit concluding that the agents or characteristics do not pose a potential health risk.

For situations where there is no obvious or regulatory-driven guidance on acceptable exposure, conservators should work with various parties involved in the project or at the institution to determine how to establish an acceptable exposure level. These situations may require advice from specialists, such as industrial hygienists, occupational physicians, legal representatives, risk or insurance representatives, public affairs personnel, and other appropriate parties.

There may also be airborne concentrations of certain agents or characteristics that are acceptable or desirable for collections, objects, or museum materials that will not be the same as those from the occupational exposure and environmental health fields. Some of these studies have been published in various journals and publications from the fields of conservation and museum studies. *Pollutants in the Museum Environment*, by Pamela Hatchfield, lists many concentrations of chemical compounds that are believed to be damaging to various museum materials.

Box 1. Major Parts of a Job Hazard Analysis

1. List the major tasks of the operation in question.
2. Determine the possible injury or illness hazards, and judge the degree of risk posed by the hazard in relation to the frequency and duration of worker exposure during the task, versus the severity of the injury or illness posed by the hazard.
3. If the stressor is one that can be measured quantitatively (e.g., chemical, biological, ergonomic), employee exposure or environmental assessments should be performed.

Controls

Effective methods for reducing unacceptable exposures include replacement of hazardous materials with safer substitutes, engineering controls (a more permanent and physical barrier method), administrative methods (safe work practices, worker rotation, training, preventive maintenance), and the use of respirators and other PPE. Many workplace hazards will require a combination of controls, not only to maximize the hazard reduction, but also to offer redundant controls in case of system failures. These controls are described in box 2.

Many conservators and museum professionals assume that engineering or administrative controls are not viable options. However, these should be considered prior to acceptance of PPE as the only alternative to reducing or eliminating

Box 2. Hierarchy of Controls

When implementing controls, this is the preferred order of approach:

- Engineering Controls – Including substitution with less hazardous materials, as well as ventilation, isolation, guarding, and other methods. Engineering controls are recommended as the primary means of control with the idea that reducing or removing hazards from the workplace will be the best method to reduce the potential for overexposure. Engineering controls are considered a more permanent solution to reduce or remove hazardous exposures.
- Administrative Controls – Including actions that can be directed to reduce or remove hazards. Administrative controls don't necessarily remove a hazard from a workplace, but do theoretically reduce the duration or magnitude of exposure. Administrative controls can be implemented as a matter of policy and require the acceptance of those that will be using these methods to control hazards.
- Personal Protective Equipment (PPE) – Chosen to protect from specific hazards and should be considered the last resort for protection or used when engineering and administrative controls are not feasible. PPE may also reduce individual's exposures but they require correct use and maintenance and are not effective when individual behaviors or habits circumvent the protection. The effectiveness of PPE is contingent upon the acceptance of the wearer and the degree that the PPE is effective and fits the wearer.

hazards in the workplace. Many engineering and administrative control solutions are easy to implement and carry out, especially in a museum or conservation laboratory setting.

A job hazard analysis, as well as interpretation of the results and implementation of controls, can be performed by conservators as well as those in more industrial operations. In the U.S., many operations run by conservators technically are considered laboratories, and the requirements for laboratories spelled out in the OSHA Laboratory Standard are fully applicable.

Who ultimately decides if something is too "risky" and whom are you trying to protect?

While the conservator may play an important role in risk assessment, risk management may not ultimately be the sole responsibility of the conservator. In some institutions, legal counsel, public relations, human resources staff, or claims management/insurance staff may play a role in risk management. Protection may be needed for outside researchers or visitors, and these other entities may need a say in the decisions about how to control risks. If hazards are associated with only conservators or museum staff, then OELs and workplace standards may be applicable. In these circumstances, how a job is performed or the appropriate use of PPE may be dictated by an analysis of the job being performed within a particular space. For these cases, risk assessment may dictate the solutions posed, such as increased building-wide ventilation or restricted handling of certain products. If the hazards are associated with the public, environmental risk standards may be more applicable. Where the parties may be mixed or not easy to define (such as visiting researchers or objects that will be shown to children) the application of existing risk levels may not be appropriate.

Finally, the evaluation of risk, the management of the risk, and the development of risk reduction strategies are only ultimately effective when the risk is communicated to staff in order to elicit their participation in preventive policies. Failing to effectively communicate information about risks or lack of risks, associated with particular projects or products, can cause serious alarm and concern, which in some cases may be completely unwarranted. The same is true of the potential risks of a material or activity with which conservators may be involved during the course of their work. Risk assessment and risk management are important components of a comprehensive health and safety program. Understanding the potential risks and solutions to hazards in the workplace is achievable and essential for protecting workers, visitors, the public, and museum collections.

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2009 Annual Meeting Summary Addendum

Philip Klausmeyer of the Worcester Art Museum (WAM) and Mark Mudge of Cultural Heritage Imaging (CHI) presented a newly developed surface imaging technology known as Reflectance Transformation Imaging (RTI) as part of the general session at the 2009 AIC Annual Meeting in Los Angeles. Funded by the Andrew W. Mellon Foundation, they designed and fabricated a domed lighting array for use with small objects to produce interactive digital image files containing three-dimensional information in addition to color. This technique produces images that represent the surface textures of works of art with remarkable clarity and are of great benefit and interest to conservators, curators, scholars and the general public.

Our apologies that mention of this important project was not included in the July issue of *AIC News* (vol. 34. no 4.).