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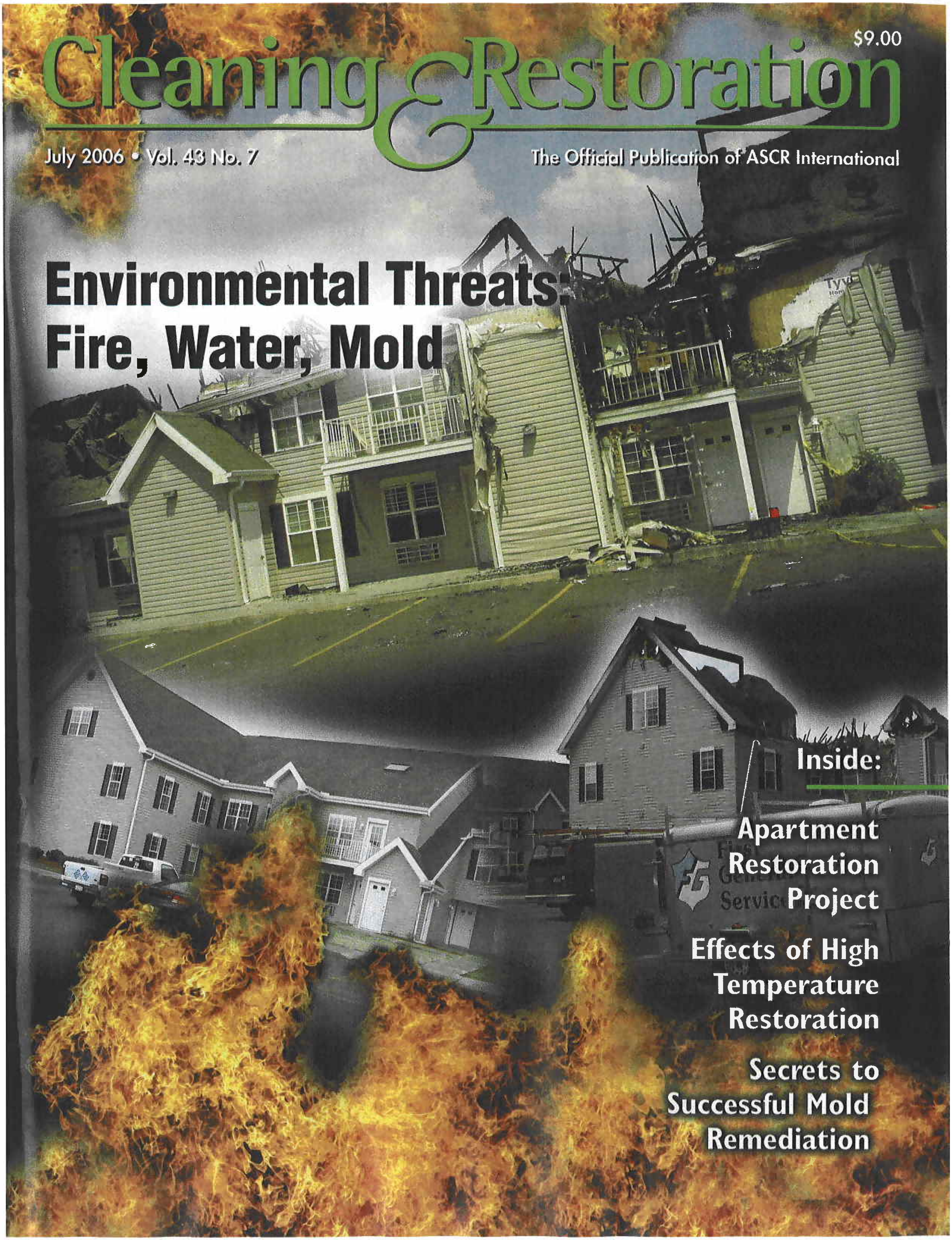

Environmental Threats: Fire, Water, Mold

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HIGH TEMPERATU

EFFECTS ON BUILDING MATERIAL

Cliff Zlotnik, CR, WLS, CMH

RE RESTORATION:
CONTENTS AND SAFETY – PART 3

By Ralph E. Moon, Ph.D. CHMM, CIAQP

Restoration temperatures above 120°F naturally evoke questions about potential contents damage and occupational safety concerns. If you've ever entered an attic space during the summer months when temperatures can reach 140 to 145°F, you can appreciate how hostile the high temperature environment is to both microorganisms and man. These conditions support the strategy to protect vulnerable contents from high temperatures and to carefully monitor human exposure. A summary of maximum temperatures recommended by selected construction material institutes and manufacturers of building materials, electronics and appliances are summarized in Table 1.

With the exception of roofing materials, concrete and ovens, the vast majority of manufacturers of building materials and appliances recommended upper temperature limits of less than 150°F. Consumer relations representatives admit that laboratory testing above 120°F is rarely performed because there is little expectation that consumers would allow these conditions to occur.

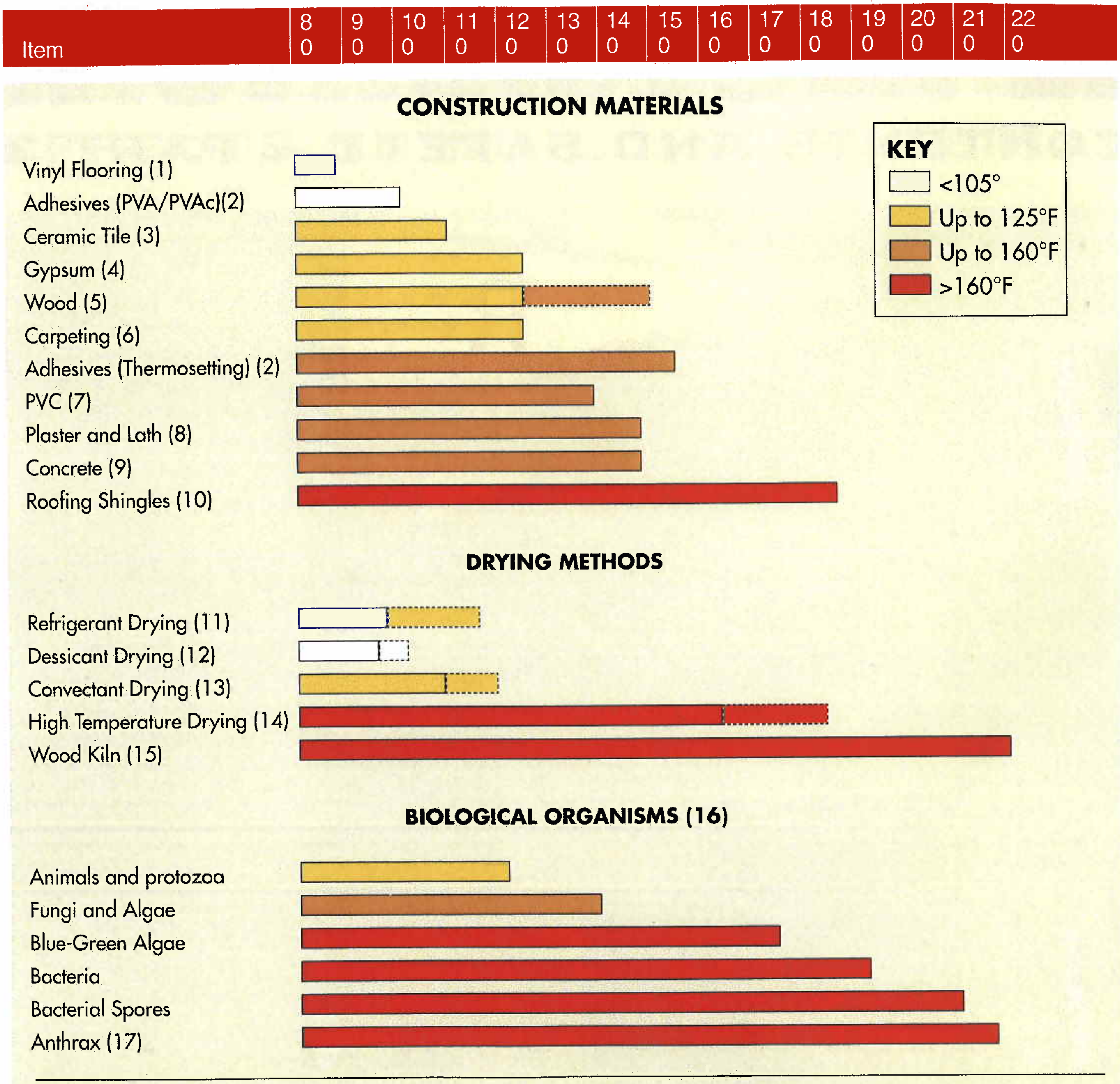
Manufacturers use the term "extended period of time" to describe the duration of time their product should not be exposed to high temperatures. The term clearly offers a great deal of latitude to interpret damage. Without specific information to the contrary, manufacturers are likely to withdraw warranty coverage once the temperature has been documented to exceed the recommended upper limit.

Effects on Building Materials

Large Appliances

The General Electric Consumer Relations Department references upper limit temperatures for different appliances (GE, 2006). Temperatures above 110°F pose a risk to refrigerators and freezers because of potential overheating conditions to the oil and subsequent damage to the compressor. Dishwashers have an upper limit of 150°F because the pump seal will lose integrity above this temperature. Temperatures up to 210°F are acceptable for electric ranges and gas and microwave ovens.

Table 1. Maximum Temperature Regimes



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2 Conner, 2001.
3 Lafortune, 2006.
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5 American Wood Council, 2005.
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Carpeting

A temperature range between 65 and 95°F is recommended for the life of carpet (Mannington, 2006). This modest temperature range prompted further discussion with The Carpet and Rug Institute (CRI) (Turner, 2006). According to CRI, carpeting is briefly exposed to temperatures in excess of 250°F during the manufacturing process; however, the recommended criteria for temperature exposure after sale are much lower. Table 2 shows the current annual CRI Green Label Program criteria for 24-hour testing.

The temperature regime recommended by CRI is driven by the possibility of volatile organic emissions. During the application of high temperatures in a home, carpet emissions will be highest during the early stages of the heating process. CRI explained that carpeting may experience wrinkles and general loosening during high temperatures; however, the carpet should recover to its original configuration once the temperature declines to ambient conditions.

Ceramic Tile

Large expanses of ceramic floor tiling ranging from 30 to 60 feet in length would pose a problem at temperatures ranging between 130 to 160°F (LaFortune, 2006). Floor tiles vary in their thermal expansion coefficients depending on their composition; therefore, a specific statement on their performance at these temperatures cannot be made. Most floor tile installers do not strictly follow industry guidelines for the construction of expansion joints. As a result, any forgiveness in the ceramic tile flooring at elevated temperatures may not be provided by expansion joints. Based on field reports for radiant floor heating systems, maximum temperatures that range between 100°F and 110°F have not shown problems. Temperatures that exceed 160°F are likely to experience tile release from the floor according to the CRI representative.

Concrete

Concrete is generally resistant to damage when heated between 120 and 160°F (Zalesiak, 2001). The literature is sparse on the effects of heat on concrete at high heat restoration temperatures; however, detrimental effects may occur depending on the rate of heating (Tholen, 2006). Very rapid concrete surface heating will result in rapid expansion and cracking. The most relevant guidelines were offered by the American Concrete Institute (ACI) and were described in ACI 349R-01 Appendix A, "Code Requirements for Nuclear Safety Related Concrete Structures."

> A.4.1 - The following temperature limitations are for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are allowed to have increased temperatures not to exceed 200°F.

Table 2. Carpet 24-Hour Emissions Test Criteria

Target Contaminant	Maximum Emission Factor (EF) (μgm2-hr)
Acetaldehyde	20
Benzene	55
Caprolactam	120
2 Ethylhexanoic Acid	46
Formaldehyde	50
1-Methyl-2-pyrrolidinone	300
Naphthalene	20
Nonanal	24
Octanal	24
4-Phenylcyclohexene	50
Styrene	410
Toluene	280
Vinyl acetate	400
TVOC	500

Source: The Carpet and Rug Institute, Green Label Program Criteria, (Turner, 2006).

Gypsum

Gypsum should not be exposed to temperatures above 125°F for extended periods. The Gypsum Association (GA) provides written specifications for the "Application and Finishing of Gypsum Panel Products" (Gypsum Association, 2004). GA technical documents state the following recommendations:

> 1.4 Gypsum panel products shall not be used where they will be exposed to sustained temperatures for more than 125°F (52°C) for extended periods of time.
>
> 1.5 Where gypsum panel products are used in air handling systems, the surface temperature of the gypsum panel products shall be maintained above the air stream dew point temperature but not more than 125°F (52°C).


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PVC Products

Polyvinylchloride (PVC) is used in an extensive array of products including electrical components, wiring insulation and coatings, membranes, water supply piping, exterior windows and window shades, home appliances, tables and chairs. The maximum service temperature is 140°F with heat deflection at 170°F (Harvel, 2006).

Plaster and Lath

Technical representatives of the New York Plaster and Lath Institute expressed confidence that temperatures between 120 and 160°F would have no effect on the integrity of a plaster and lath wall (Hohlfield, 2006). The only circumstances that might pose an exception would be a recently constructed plaster wall that had not yet cured. Plaster curing requires approximately 30 days.

Roofing Shingles

Asphalt shingles are durable at high temperatures because the minimum softening point is approximately 190°F (GAF, 2006). GAF technical staff expressed three concerns. The adhesive sealant used in the GAF shingle is "Dura-Grip." This adhesive has a lower softening point than the shingle and may "ooze" at lower temperatures. Should this occur, it will become evident immediately after the heating event. After exposure to elevated heat, shingles are prone to "slippage," and as a result, it is not recommended to access the roof until the shingles reach ambient temperatures. Finally, elevated temperatures may accelerate the aging process in the shingles. The effects of aging may not be visible.

Vinyl Flooring

Vinyl floor coverings are tested by the Resilient Flooring Coverings Institute (RFCI) using ASTM F1514, heat stability tests (Freeman, 2006). The test elevates the temperature of the flooring to 158°F for seven days. After this period, the flooring exhibits noticeable discoloration. The maximum temperature recommended by the RFCI is 85°F; this temperature is based on radiant heat temperatures achieved during the heating season. The warranty for resilient flooring that exhibited discoloration after heating may not be honored by the manufacturer.

Safety Concerns

The use of temperature regimes above 120°F pose a higher level of care, training and OSHA and EPA scrutiny than any other restoration strategy. Four areas of concern (i.e., direct-fired propane heaters, dust, heat stress and property damage) are described below.

Direct-Fired Propane Heaters

When used properly, propane is an odorless and colorless gas that is safe and convenient (OPA, 2006). Propane leaks, however, pose an immediate hazard because propane settles in low spaces and a low concentration can create a flammable mixture. In a confined space, a propane gas leak poses an explosive hazard.

Propane requires a large volume of air to burn correctly; one cubic foot of propane requires 23.5 cubic feet of air. The proper mixture of air and fuel is essential because too much fuel will result in incomplete combustion and the formation of carbon monoxide.

Carbon monoxide poisoning occurs when carbon monoxide preferentially attaches to the blood molecule (hemoglobin) that carries this gas instead of oxygen. A person with carbon monoxide poisoning is overcome by carbon monoxide (instead of oxygen) and immediately feels lightheaded, dizziness and/or nausea (U.S. DHHS, 2005). Prolonged exposure may result in death. When direct-fired propane burning heaters are used, monitoring of carbon monoxide and proper ventilation with fresh air are required for safe operation and the protection of personnel. Indirect-fired propane heaters greatly lessen the safety risks associated with heating a structure.

Dust

Turbulent fans assist the drying process; however, they also aerosolize microbial matter and dust. As a result, turbulence also creates potential combustible conditions by the emancipated dust. A cloud of dust, within its flammable concentration limits, will not burn unless sufficient energy is provided to ignite it such as open flames (i.e., propane heaters) and hot surfaces (i.e., dryers, heaters) (DSEAR, 2002). Both of these conditions are present with the use of a direct-fired propane heater. Safety information provided by the manufacturer of propane forced air heaters reinforces these concerns (DESA, 2006). This safety hazard can be reduced with indirect fired heaters.

Heat Stress

Drying and heating processes that involve high temperatures, radiant heat sources and high humidity can induce heat stress. The human body maintains a fairly constant temperature even though it is exposed to a range of temperatures (U.S. DHHS, 1986). As the surrounding temperature approaches the skin temperature, cooling becomes more difficult. Increased body temperature and physical discomfort promote irritability, anger and other emotional conditions that may prompt workers to overlook safety procedures and divert attention from hazards.

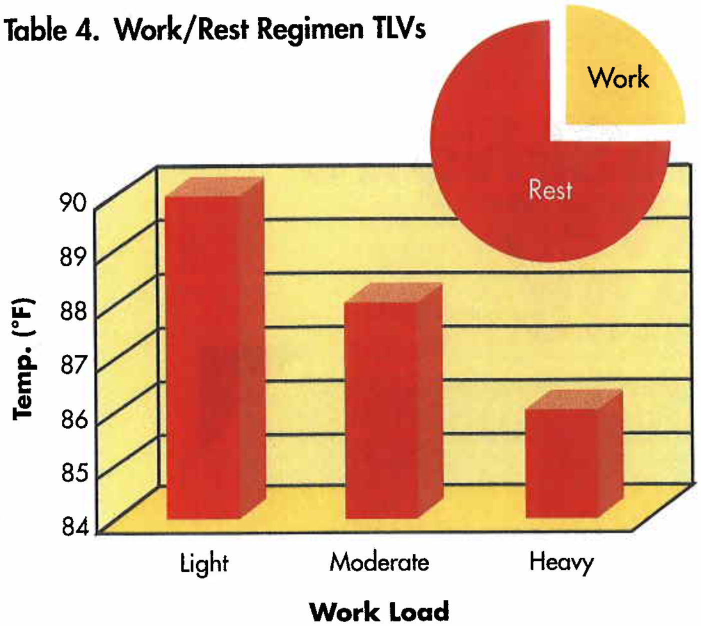
The current permissible heat exposure threshold limit values (TLVs) pose limitations for light work at 90°F for 15 minutes

Table 3. Permissible Heat Exposure Threshold Limit Values

Work/Rest Regime		Workload		
Work	Rest	Light	Moderate	Heavy
100%	0%	86°F	80°F	77°F
75%	25%	87°F	82°F	78°F
50%	50%	89°F	85°F	82°F
25%	75%	90°F	88°F	86°F

Source: U.S. Dept. of Labor, 2006.

Table 4. Work/Rest Regimen TLVs



of work and 45 minutes of rest (ACGIH 1992). The ACGIH TLVs state that,

> Higher heat exposure than those in Table 3 are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to heat than the average worker. Workers should not be permitted to continue work when their deep body temperature exceeds 38°C (100.4°F).

The OSHA Technical Manual states, "Every worker who works in extraordinary conditions that increase the risk of heat stress should be personally monitored. Personal monitoring can be done by checking the heart rate, recovery rate, oral temperature, or extent of body water loss."

High temperature or "pasteurization" restoration techniques pose both creative restoration opportunities and elevated risks. Structures that are contaminated with pathogens or support extensive microbial contaminants may benefit from desiccation and the capture of microbial mass.

The likelihood of property damage using high temperatures is much greater using this restoration procedure. Efforts to remove and protect contents are essential for customer satisfaction and to lessen potential liability.

Heating beyond 120°F requires an exceptional level of safety training, personal protection and a detailed understanding of combustible and explosive environments. Unforeseen safety hazards and accidents will undoubtedly initiate OSHA's scrutiny in the workplace. High temperature procedures will place safety as an extreme concern on the jobsite.

Client expectations are bound to soar if "high temperature restoration" is marketed as a sanitation technique. Historical studies on thermal death in bacteria and spores ranges as high as 212°F, making sanitation an unachievable goal.

No restoration process is permanent. High temperature is clearly a benefit in the short-term; however, structures where the moisture content is poorly regulated will return to their previous condition. Client training and orientation to the importance of maintaining building performance and moisture controls may help lessen claims of misrepresentation. ■

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